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CACDA JIFFY III WAR GAME
VOLUME II
METHODOLOGY

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Technical Report 6-80

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Technical Report TR 6-80
September 1980

US Army Combined Arms Studies and Analysis Activity

Fort Leavenworth, Kansas 66027

CACDA JIFFY III WAR GAME
VOLUME II
Methodology

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This report is one of a set of five volumes produced to document the combat assessment methodologies and automated features of the Combined Arms Combat Development Activity (CACDA) JIFFY III war gaming process, developed to support TRADOC SCORES scenario development and force evaluation efforts. This report contains the methodologies used in the automated routines of the JIFFY III game and their unclassified data base. The other four volumes in the set are the Executive Summary (Vol I), the classified data and their sources (Vol III), the User's Manual (Vol IV), and the Programmer's Manual (Vol V).

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FOREWORD

The Jiffy III War Game model was used in the development of the SCORES Europe III scenario, which provides the combat developments community with a common base of assumptions, threat forces, weapons, organizations, terrain, and tactics for the 1986 timeframe. The 1977 version of Jiffy was extensively modified and improved for the Europe III work. This report documents the Jiffy III model as used for Europe III and incorporates a significant portion of CACDA Jiffy War Game Documentation, Technical Manuals TR 2-77, TR 3-77, and TR 4-77, originally published in 1977. This report documents all the changes and improvements completed through April 1980.

There are five volumes of Jiffy III War Game documentation. The first volume is the Executive Summary. Volume II is the Methodology, which describes the overall Jiffy III War Game methodology including detailed descriptions of the combat assessment equations. The computer calculates the attritions based on these equations. The unclassified portions of the data are given in Volume II. Volume III contains classified data as required for the Jiffy III model. Volume IV is the Users Manual, which contains a discussion of the manual aspects and the automated features of the gaming process and exemplifies the relationship between them through some sample runs. Volume V, the Programmers Manual, consists of descriptions and FORTRAN code of all programs and routines associated with the Jiffy III Game.

This report was compiled principally by Dr. Channing L. Pao, Dr. Robert J. Schwabauer, Ms. Sandra Elliot, Mr. James H. Kennington and Mr. William D. Relph. The compilers wish to acknowledge the SCORES gaming staff of the Combined Arms Combat Development Activity who served as consultants during the methodology improvement.

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ABSTRACT

This report is one of a set of five volumes produced to document the combat assessment methodologies and automated features of the Combined Arms Combat Developments Activity (CACDA) Jiffy III war gaming process. The Jiffy process was originally developed to support the TRADOC Scenario Oriented Recurring Evaluation System (SCORES) scenario development and force evaluation efforts. In 1978, the 1977 version of the Jiffy was extensively modified and improved to support Europe III scenario gaming. This report documents the Jiffy model used for that gaming through March 1980. Volume II of this report contains the methodologies used in the automated routines of the Jiffy III Game. An unclassified data base, which was developed for test and demonstration purposes, is presented in Volume II. The classified data used in the Jiffy III Game during secure production runs, and their sources, are published separately as Volume III to keep the methodology volume unclassified. The other three volumes in the set are the Executive Summary (Volume I), the User's Manual (Volume IV), and the Programmers Manual (Volume V).

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CACDA JIFFY III WAR GAME
Methodology

1. INTRODUCTION. This report describes the methodologies and data used in the Jiffy III model, a computer program that automates the combat assessments of the CACDA Jiffy war gaming process. Discussions of the manual aspects of the CACDA Jiffy III war gaming process may be found in the CACDA Jiffy III War Game Users Manual, Volume IV. To avoid classifying the methodology discussions in this report, all classified data used in the Jiffy III model are published separately as Volume III to this CACDA Jiffy III War Game documentation. However, the Jiffy model continues to be modified or improved for new scenarios/studies. This report documents all the changes and improvements completed through April 1980.

2. OVERVIEW.

a. Background.

(1) The Jiffy Game has existed, as a manual war game, since the late 1960's. In its early stages, the game was completely manual and, correspondingly, its assessment methodology was simplistic based on the firepower scores of a few key weapon systems. In late 1973, USATRADOC established the Scenario Oriented Recurring Evaluation System (SCORES), the standard scenario development process that was to be based on the Jiffy Game. With the advent of SCORES, it was recognized that the simplistic, firepower score-driven Jiffy Game, although responsive, was not of adequate resolution to produce the quality product expected from SCORES. Thus, the Jiffy Game underwent major methodology modifications, which allowed the gaming of the complete spectrum of conventional weapon systems and upgraded the assessment methodologies to use weapon characteristics as the basis for assessments. However, as the level of detail increased, the number of manual calculations and the amount of data required to make the calculations also increased. Finally, it became necessary to automate the assessment calculations to maintain the Jiffy Game responsiveness. The automation process was completed in May 1975. This methodology was developed principally by MAJ Karl Lowe, assisted by LTC Tom Buff, MAJ Ken Nash, and MAJ Bob Riddick, and was documented in July 1975 with the publishing of the USACACDA SCORES "Jiffy" War Gaming Methodology.

(2) In the fall of 1975, as a quality assurance measure, the Jiffy Game methodology was subjected to sensitivity analysis. A Jiffy Game improvement program was initiated as a result of the analysis. The improvement program basically accomplished three tasks. First, the assessment methodology was modified and improved. Second, the capability to maintain on computer files a hierarchy of units consistent with the overall gaming methodology was added to the Jiffy Game in 1977. Finally, detailed documentation of the revised methodology and all supporting computer programs was published in 1977 by Timothy J. Bailey, Gerald A. Martin and MAJ Francis W. O'Brien, Jr. of CACDA. This report incorporates substantial portions of the 1977 documentation.

(3) In 1978, TRADOC directed CACDA to develop the SCORES Europe III Scenario in the 1986 timeframe to integrate NATO forces and employ new weapons, doctrine, and organizations to assess combat and combat support units. The Jiffy model was extensively modified for the Europe III gaming; and further improvements in areas such as EW, smoke, dust, thermal sight, and the attack helicopter/air defense assessment subroutines were made. This report documents the Jiffy III Game model used for Europe III gaming.

b. Gamer Functions.

(1) The CACDA Jiffy III war gaming process is a computer-assisted, manual war game developed and operated at the USATRADOC Combined Arms Combat Developments Activity (CACDA), Fort Leavenworth, Kansas, for scenario development and force structure evaluation. The Jiffy III Game is a two-sided, interactive war game, which is designed to be oriented toward the military gamer. This interactive characteristic of the model permits military gamers to interject timely, realistic tactical decisions during the play of the game.

(2) The manual functions of the CACDA Jiffy III war gaming process are the aspects of military operations that are associated with doctrine and tactics. The manual functions include the commander's concept of the situation, the allocation of forces, terrain analysis, movement/map maneuver, engage/disengage criteria, and the distribution of personnel and materiel replacements. Some of the functions of the game are automated to remove from the gamers the burden of manually performing the many tedious, repetitious calculations necessary for these functions. These computerized functions include the rate-of-advance calculations, the combat loss assessment of personnel and materiel, and apportionment of the losses to the combat units.

c. Game Resolution. The CACDA Jiffy III war gaming process is a low resolution game that is capable of playing virtually any size force but is usually gamed at the corps level. During an application of the model, the corps front is divided into sectors in which the rate-of-advance and combat assessment calculations are made. The sectors are typically Blue battalion sized, which corresponds to that portion of the corps front that is the area of operation for a Blue battalion. The unit resolution in the game is generally at the Blue company and Red battalion levels. The rate-of-advance and combat assessments are based on the aggregate of the weapon systems of all Red and Blue combat units in the sector. The length of time during which the combat occurs is known as the "critical incident." Critical incidents (CI) typically last 4 to 6 hours. The results from these low resolution games cannot be compared with those from high resolution models, because the Jiffy model is highly aggregated and includes many judgmental factors. Thus, some questions cannot be answered explicitly, but the results should show the trend of tactics and doctrine being studied. The Jiffy game can also be used for initial selection of fewer alternatives from a large group of alternatives in evaluating forces.

d. Model Capability. The Jiffy III model computer program computes combat assessments and maintains history files for each sector played as well as cumulative totals for all sectors. Specific capabilities represented in the Jiffy III model are as follows:

(1) Weapon systems in the 1986 timeframe.

(2) Indirect fire.

(3) Armor/antiarmor.

(4) Infantry.

(5) Attack helicopter/air defense.

(6) Minefields.

(7) Thermal sights.

(8) Smoke.

(9) Electronic warfare (EW).

(10) Degradation factors (dust, terrain, and weather).

(11) Automatic computation of the mass value of ground units as required by the Tactical Air Land Operations (TALON) model.

(12) Postprocessor (summary of the output).

3. ASSUMPTIONS AND LIMITATIONS OF JIFFY III MODEL. The following assumptions and limitations are generally applicable to the overall model. The specific assumptions concerning each assessment and degradation factor are discussed in later sections of the report.

a. In general, the Jiffy III model methodologies do not consider any synergistic effects among the different combat assessments; e.g., the fact that an armored vehicle is in a minefield does not have any impact on the assessment of the armored vehicles by the indirect fire combat. However, dust from the indirect fire routine feeds into the armor and AH/AD routines and EW from the rate of advance routine feeds into the indirect fire routine. Although the smoke effects can vary in different routines, smoke can not be played in any routine unless it is played in the rate of advance routine.

b. Rate of advance is based on firepower scores adjusted for terrain, visibility, the tactical situation, mines, smoke, and EW.

c. Line of sight is not played explicitly in the direct fire routines but was considered in the development of the expected number of engagements for direct fire weapons.

d. Visibility is played both as a decrement to acquisition discriminators, which reduce the number of targets at which to fire, and as a restriction to the maximum engagement range for direct fire combat.

e. Suppression is based on firepower scores and is played as a decrement to the number of weapon systems available to fire.

f. No specific unit geometry is played in the Jiffy III model except for indirect fire target classes, which are assumed to be of specific size and shapes. All the other combat units in a sector are reduced to characteristic arrays of weapon systems, which engage each other. Any other considerations concerning unit geometry and battlefield geometry are played by the gamers, off-line.

g. Weapon systems in one sector cannot engage the weapon systems in another sector.

h. Assessments are generally nonlinear aggregates of one-on-one duels, except for the infantry and minefield assessments.

i. Dismounted infantry combat casualties are based on firepower scores.

j. Mounted infantry casualties are assessed in proportion to infantry personnel carrier losses. If infantry is mounted, it remains mounted during the entire CI, except for a special case in the indirect fire assessment.

k. Infantry materiel losses are assessed in proportion to infantry personnel casualties.

l. Crews are lost in proportion to crew-served weapon and vehicle losses.

m. Ammunition expenditures reflect only the number of rounds fired at the opposing force. They do not include rounds lost to combat damage.

n. Electronic warfare (EW) is accounted for in the rate of advance (ROA) and artillery assessment routines. In the rate of advance, EW degrades the firepower scores. In the artillery assessment routine, EW degrades the number of battery missions for both sides.

o. Dust effects in Jiffy will degrade ground and aerial direct fire missile systems and CLGP.

p. The Jiffy model calculates the portion of weapon systems lost in combat that are recoverable and nonrecoverable. The recoverable weapon systems are those accessible and repairable within 2 to 5 days (see paragraph 17).

4. FORCE STRUCTURE.

a. General. The Jiffy Game has the capability to game two forces in combat against each other. The forces are composed of basic elements called units. The size of the units varies, but they are generally company or battalion size for the defending force, and the next higher echelon for the attacking force. Units are grouped (task organized) into higher echelon organizations, which are referred to as parent units. During applications of the game, the gamers are able to manipulate the forces at the unit and/or parent unit levels defined for that game.

b. Force Definition. Units are initialized into the forces through a process designed to take advantage of the US Army's concept of Tables of Organization and Equipment (TOE). The process, which is performed before any gaming can begin, involves generating a data base of TOE standard requirements codes (SRCs). The SRCs define the numbers and types of weapon systems found in each specific subunit organization; e.g., an infantry squad or a tank platoon. From the completed SRC data base, each unit is defined by giving it a unique name and specifying all SRCs to be included in it. The units are then task organized into parent units which, as a final step, are loaded into the Red or Blue force. A more detailed discussion of this process may be found in the Programmers Manual, and an example is given in appendix A of the Users Manual.

c. Weapon System Arrays. The Jiffy model does not process units in the combat assessments but, instead, bases its calculations on aggregates of the weapon systems of the opposing forces in a given sector. All units engaged in combat in a sector are reduced to their individual weapon systems, which are accumulated for each force as arrays of individual weapon systems to oppose each other in combat.

5. GAMER INTERACTIONS

a. General. Jiffy is a two-sided, computer-assisted, open war game. Gamers manipulate forces, using maps and performance indicators, to simulate land combat. Gamer inputs are integrated in the computer model to assess the combat. A detailed user's guide for the gamer and gamer inputs is contained in the CACDA Jiffy III War Game Volume IV, Users Manual.

b. Gamer Interactions. The interactive Jiffy game is played through the assessment officer who plays the interaction on the terminal. The assessment officer works closely with the controller and the Red and Blue gamers to insure the correctness of all actions. Many game situations and decision points may be played through the questions appearing on the terminal display screen and outlined as follows (detailed questions will be shown in Volume IV):

- Load forces into a sector.
- Calculate rate of advance.
- Assess combat (options to play smoke, thermal sight, EW, etc.).
- Apportion combat losses to units.
- Display battle statistics.
- Display weapon arrays.
- Add Standard Reference Codes (SRC) to the SRC file.
- Restart at a previously gamed CI.
- End game and/or update history file.
- Reset element array.
- Review previous run.
- Reset terminal output (connect, disconnect).

6. DATA REQUIREMENTS. The data base generated for the Jiffy III model consists of both unclassified and classified data. The unclassified data are contained in the tables in this report and in the data statements in the model. The classified data are contained in Volume III and in a separate classified data file in the computer. The major categories of data are listed below and will be defined and discussed in later sections.

a. Multi-System or General:

(1) Operational Availability Data.

(2) Suppression Factors.

(3) Rate of Advance Data.

(4) Visibility.

(5) Combat Intensity Level Factors.

(6) Percents of Force Deployed Forward.

(7) Materiel Losses Per Man Lost.

(8) Crewmen Killed Per Weapon System.

(9) Equipment Repairability Data.

(10) Firepower Scores.

(11) Red Equipment Replacement Policy.

(12) Dust factor.

b. Indirect Fire:

(1) Tubes per Battery.

(2) Military Worth.

(3) IDF Level Data.

(4) Elements per Area Target.

(5) Non-Targeted Missions.

(6) Probability of Knowledge.

(7) Rates of Fire.

(8) Fractional Damage Tables.

(9) CLGP Kill Probabilities.

(10) Probability that GLLD not Suppressed or the RPV survives.

c. Minefield:

(1) Hours to Manually Emplace Mines.

(2) Hours to Mechanically Emplace Mines.

(3) Minefield Density.

(4) Antitank Minefield Lethality Data.

(5) Antipersonnel Minefield Lethality Data.

(6) FASCAM Antitank Lethality Data.

(7) FASCAM Antipersonnel Lethality Data.

d. Armor/Antiarmor:

(1) Expected Number of Completed Firings.

(2) Acquisition Data.

(3) Thermal Visibility.

(4) Category Weights.

(5) Infantry Personnel Killed Per Antitank Weapon.

(6) Kill Probabilities.

e. Infantry:

(1) Casualty Rates.

(2) Ambush Casualty Rates.

f. Attack Helicopter/Air Defense:

(1) Helicopter Rates of Fire.

(2) Helicopter Ordnance Loads.

(3) AD Weapon Control Factors.

(4) AH Kill Probabilities.

(5) AD Kill Probabilities.

(6) Probabilities of Line of Sight.

(7) Sorties Available.

(8) Dust Factors.

(9) Probabilities of Acquisition or Detection.

(10) Maximum Numbers of Pop-ups.

7. RATE OF ADVANCE.

a. General. An attacker rarely advances uniformly; instead, he advances in many short, uneven bounds. The single value for rate of advance determined in the Jiffy model is the average of these nonuniform bounds over a substantially large period of time. The determination of the rate of advance defines the time-distance relationships for the play of the game. Rate of advance is expressed as either the distance an attacker may expect to advance in a specified time or the amount of time required to advance a specified distance. Rate of advance is affected by both military and enviromental factors, such as terrain, weather, EW, and smoke. (For detailed discussions of smoke and EW see paragraphs 10 and 12.) The gamers have the options of using the computed ROA or a judgemental rate of advance determined off-line by the gamers.

b. Firepower Scores. The rate of advance determined by the Jiffy model is based on firepower scores. Firepower scores are simply numerical values assigned to weapon systems to quantify their potential to inflict damage. The firepower scores used in the Jiffy model were derived from the Concepts Analysis Agency's (CAA) Weapon Effectiveness Indices/Weighted Unit Values II (WEI/WUV-II) (reference 4). They were subsequently updated for the Europe III gaming and coordinated with appropriate TRADOC schools and centers. The Jiffy model firepower scores are classified and may be found in Volume III, table B-1, appendix B. An unclassified set of firepower scores, generated for test and demonstration purposes, is given in table 1 (all tables are shown at the end of this volume). The total firepower score of a force is the sum of the firepower scores of all the weapon systems in the force. The total firepower score may be divided into two groups: combat and fire support. The combat firepower score is the cumulative firepower score of all the weapon systems expected to be found in the maneuver elements of the force. They include small arms, ground mounted antitank weapons, armored vehicles, tanks, and attack helicopters. The fire support firepower score is the cumulative firepower score of the weapon systems associated with fire support roles. These weapon systems typically include air defense artillery and missiles, field artillery and rockets, mortars, and tactical aircraft. The firepower scores for all of the fire support weapon systems except tactical aircraft are contained in the model and totaled automatically. The firepower scores for tactical aircraft are input during each run by the gamers and added to the automatically computed fire support firepower score to yield the overall fire support firepower score.

c. Methodology. The data base for expected rates of advance used in the Jiffy model was developed from historical rate of movement data compiled in the Research Analysis Corporation (RAC) Theater Quick Game Model (TQGM) and Theater Battle Model (TBM-68). The Jiffy model rate of advance data base is contained in tables 2 through 6. These rates are based on an adjusted force firepower ratio and consider the effects of the tactical situation, smoke, EW, attacker mobility, terrain, and visibility. The effects of mines are used to adjust the rate of advance table value accordingly.

(1) Firepower ratio. A firepower ratio is a measure of one force's capability to inflict damage relative to the capability of another force. In forming such a ratio, the tactical situations of the maneuver units of both the attacking and the defending forces are considered, and the firepower scores are adjusted accordingly. For instance, a defending force would expect to be less vulnerable if it were occupying a fortified defensive position than if it were engaging the enemy in the open. Likewise, an attacking force would expect to inflict greater damage

executing a double envelopment than attacking in a frontal assault. Six types of tactical situations, as described in table 7, can be played in the Jiffy model. The firepower score adjustment factors for the weapons in the attacker and defender maneuver units for all tactical situations are contained in tables 8 and 9, respectively. The fire support weapon systems are not as sensitive to the tactical situation as those of the maneuver units. Thus, the adjustment factors for all fire support weapons are unity. The unadjusted total firepower score for each force is multiplied by the appropriate tactical situation adjustment factor, and the attacker-to-defender firepower ratio is then calculated. The firepower ratio calculation is expressed algebraically as:

$$FPR = \frac{\sum\limits_{all\ i} ATSAF_i \quad N_i \quad FPS_i \quad EW_i \quad SMOKE_i}{\sum\limits_{all\ k} DTSAF_k \quad N_k \quad FPS_k \quad EW_k \quad SMOKE_k} \qquad (7\text{-}1)$$

where for all the attacking (i) and defending (k) weapon systems:

FPR = the firepower ratio.

ATSAF = the attacker tactical situation adjustment factor.

DSTAF = the defender tactical situation adjustment factor.

N = the number of the ith attacking and kth defending weapon systems.

FPS = the firepower score of the ith and kth systems.

EW = degradation factor for electronic warfare (EW) to degrade the enemy's firepower score (see paragraph 12).

SMOKE = the percent of the weapon systems not smoked.

(2) Environmental considerations. Many environmental factors may influence rates of movement. Among these are vegetation, soil composition, slope of terrain, natural barriers, weather, and various conditions that restrict visibility. Since these environmental factors cannot be measured easily and must be averaged for the conditions that exist over the entire sector, they have been reduced to only two basic factors for consideration in the Jiffy Game. The two environmental factors of interest are terrain and restriction to visibility. Descriptions of the four generic types of terrain considered in the Jiffy model are presented in table 10. Visibility restrictions are generally considered as decrements to an observer's ability to acquire enemy weapon systems. The visibility categories are given in table 11. The rate-of-advance methodology, however, considers visibility only to the

extent that it is qualitatively assessed as good, fair, or poor. Good visibility corresponds to the visibility categories of 1 and 2 in table 11; fair corresponds to categories 3 and 4; poor visibility corresponds to category 5.

(3) Military considerations. Like the environmental considerations, the military factors that influence rates of advance were first reduced to those that were measurable and then were simplified to the extent possible. The intangible qualities and skills of combat, such as training, morale, fatigue, and a commander's ability to lead and maneuver his forces, are military factors that cannot be measured or quantified realistically. Of the measurable military factors, the factors considered in the Jiffy model have been reduced to combat power (firepower ratio), mobility, manmade barriers, EW and smoke. Firepower ratios were discussed above. Mobility is considered only to the extent that a force is either mounted in armored vehicles or dismounted from them. Manmade barriers are considered as minefields. A minefield reduces a force's rate of advance to 75 percent of what its rate of movement would be otherwise. EW degrades the opponent's firepower score in the rate of advance. Smoke degrades the firepower score totals of both the user and his adversary.

(4) Rate of advance. After the military and environmental considerations have been made, and the firepower ratio between the forces has been calculated as outlined, the rate of advance of the attacking force may be determined from tables 2 through 6. The rate of advance is actually a linear interpolation of the tabulated values, except for the stalemate conditions. When the firepower ratio is below the stalemate threshold shown on each specific table, the rate of advance is set equal to zero. In addition, if minefields or barriers are opposing the attacking force, the interpolated rate of advance is multiplied by .75, except for the attack of fortified or prepared defensive positions whose table values include use of minefields.

d. Effect of Attacker Massing. The Jiffy model provides the attacking force with the capability to mass its weapons within a massing zone for FEBA penetration. This action increases the firepower ratio in the massing zone in favor of the attacker, resulting in an increased rate of advance within the massing zone. The massing concept is accomplished in the Jiffy III model through the use of the following equation:

$$FPR_m = \frac{FPR - FPR_h \ (1 - f)}{f} \qquad (7\text{-}2)$$

where:

FPR_m = the massed firepower ratio.

FPR = the firepower ratio as defined in equation 7-1.

FPR_h = the firepower ratio outside of the massing zone required to hold the enemy.

f = the fraction of the sector which is in the massing zone.

In the Jiffy model the holding firepower ratio (FPR_h) is given by the gamer between 0 and 2.0. For example, assume the attacker enjoys an overall firepower ratio (FPR) of 3:1 and he wishes to mount a penetration over 25 percent of a sector (f=.25). Also assume he inputs a holding firepower ratio (FPR_h) of 2.0. From equation 7-2, the massed firepower ratio computes to be 6.0.

8. SUPPRESSION.

a. General. Suppression is the term given to the condition that occurs when the crew of a weapon system is unable to perform its duty due to fear from incoming enemy fire. Suppression is an intangible; it cannot be directly measured. Suppression occurs in varying degrees, which are related to the vulnerability of the crew. Thus, reasonable indexes of measurement for suppression appear to be crew vulnerability and volume of incoming fire.

b. Methodology.

(1) Suppression is played in the Jiffy Game as a decrement to the number of weapon systems available to fire. Suppression is based on firepower ratios as a measurement of the volume of fire and is adjusted for the vulnerability of each particular weapon system. The weapon systems of maneuver units are considered able to be suppressed by weapon systems of the maneuver and fire support elements of the opposing force. The firepower ratio used for the suppression factor of maneuver weapon systems is the total force firepower ratio. On the other hand, the weapon systems of the fire support elements are generally considered to be beyond the direct fire range of the maneuver element weapon systems. Therefore, the firepower ratio used to determine the fire support suppression factor is the fire support firepower ratio. As defined above, the fire support firepower ratio is determined by the number of air defense artillery and missiles, mortars, field artillery and rockets, and tactical aircraft.

(2) Table 12 gives the expected percent of attacker and defender tanks suppressed for the six types of tactical situations as a function of firepower ratio. This table was developed mainly from RAC TBM-68, vol II,

p. 57 as noted on the table. The values given by the table may be adjusted for weapon systems other than tanks through the use of the vulnerability adjustment factors from table 13. The value extracted from table 12 multiplied by the appropriate value in table 13 produces the expected percentage of weapon systems that are suppressed.

(3) It should be noted that there is no suppression factor for dismounted infantry. This subject is covered in the discussion of dismounted infantry combat assessments. Another observation that can be made from table 12 is that, for a specific tactical situation, as the firepower ratio increases the percentage of suppression for the defender also increases, and the percentage of the attacker suppressed decreases. This is because as the firepower ratio increases, the attacker is able to put a greater volume of fire on the defender, which results in the percentage of the defender suppressed increasing. As the defender becomes more suppressed, fewer weapons are available to fire at the attacker. Thus, the volume of fire being received by the attacker decreases as the firepower ratio increases, and the percent of the attacker being suppressed also decreases.

9. COMBAT ASSESSMENTS.

a. General. The combat assessments of the Jiffy model determine the attrition of weapon systems and personnel suffered by each force in combat. The Jiffy game calculates the portions of weapon systems lost in combat that are recoverable. The recoverable weapon systems are those accessible and repairable. The assessments are made in attrition sectors, which typically are battalion size partitions of the main battle area. Since the combat assessments in a given sector are based on the number and type of individual weapons being employed in combat and their weapon characteristics, the units in the sector engaged in battle are reduced to opposing weapon system arrays. The Jiffy model computes the number of personnel casualties and weapon system losses as a result of five different types of combat assessments. The assessments are made independently and sequentially. The order in which the combat assessments in the model are made normally is (the gamers can change this to any order):

- indirect fire
- minefields
- armor/antiarmor
- infantry
- attack helicopter/air defense

During the gaming of a 6-hour critical incident, the losses due the entire 6 hours of indirect fire combat are calculated first. These losses are then subtracted from the arrays of opposing weapon systems before the next type of combat is assessed. It is obvious that with this type of combat assessment methodology, the synergistic effects of the simultaneous occurrence of the different types of combat cannot be considered. In addition, it should be noted that the kills by tactical aircraft as well as losses of tactical aircraft, although considered in the overall Jiffy War Gaming process, are determined external to the Jiffy model.

b. Generalized Assessment Equation. Except for minefield losses, combat attrition is determined in a nonlinear fashion. The generalized form of the assessment equation is given by equation 9-1:

$$K_k = \left[1 - \prod_{\text{all } i} \left(1 - \frac{SSKP_{ik}}{T_k}\right)^{R_{ik}}\right] T_k \qquad (9\text{-}1)$$

where, for the i on k engagements:

K_k = number of targets killed by all firers.

T_k = number of targets engaged.

R_{ik} = number of rounds fired.

$SSKP_{ik}$ = single-shot kill probability.

This equation may be considered as a one-on-one duel aggregated for all rounds shot by each type of firer and then aggregated for all types of firers. Three assumptions are inherent in the application of this equation:

(1) Each target has the probability of $1/T_k$ that it will be selected to be shot at for each round fired.

(2) The rounds are uniformly distributed against all appropriate targets.

(3) Each firing is an independent event; a target may be engaged more than once, even after damaged or killed.

c. Operational Availability. Operational availability is a parameter included in all Jiffy model assessment calculations to account for those vehicles and other equipment not capable of entering into combat due to inoperability. Some percentage of the weapon systems in a force are, at any given time, being repaired or undergoing routine maintenance and should not be considered in the assessment process. Tables 14 and 15 give the operational availability data developed for all the weapon systems played in the Jiffy Game. The table entries represent that fraction of the weapon systems that are expected to be operationally available for combat. Throughout the Jiffy model assessments, this operational availability is a factor applied in determining both the number of targets and the number of firers.

d. Methodology. A form of the generalized nonlinear assessment equation is used to evaluate all combat assessments except minefield losses. The following subparagraphs discuss the five combat assessments and the associated assumptions and pertinent data in the sequence in which they appear in the model.

(1) Indirect fire assessments.

(a) General. The Jiffy III model indirect fire assessment methodology determines the materiel and personnel losses resulting from the play of three phases of indirect fire support: preparation/counterpreparation fires; combat support fires, e.g., close support, counterbattery, air defense suppression, and interdiction; and final protective fires. The assessment methodology is one-sided and is repeated for all indirect fire weapon-target combinations. The methodology addresses each force, in turn, and computes the expected number of casualties a force's indirect fire assets can inflict on the opposition as determined by the number of each specific area target contained in the enemy force, the number of battery missions available for firing at each specific area target, and the combination of these parameters in the nonlinear assessment equation. The computed losses are not subtracted from the force until all assessments in a phase of indirect fire combat have been made, so the order of assessing the forces does not affect the outcome.

(b) Assumptions.

1. The three phases of indirect fire combat are gamed independently and sequentially, beginning with preparation/counterpreparation fires and ending with final protective fires.

2. The attacker force can fire up to 60 minutes of preparation fires. The defender force can also fire up to 60 minutes of counterpreparation fires, but only if the attacker force fires preparation fires.

3. The defender force can fire up to 60 minutes of final protective fires; however, final protective fires lasting longer than 15 minutes are unrealistic.

4. The rate of fire for weapons firing preparation/counterpreparation missions is their sustained rate of fire.

5. The rate of fire for weapons firing combat support missions is based on estimated resupply rates and doctrine.

6. The rate of fire for weapons firing final protective fires is approximately 67 percent of their maximum rate of fire. (This assumes that only 2/3 of the units are available to fire.)

7. Blue mortars do not fire preparation/counterpreparation missions.

8. Area targets are homogeneous and generally company size.

9. Both the Blue and Red forces have the capability to fire improved conventional munitions-dual purpose (ICM-DP).

10. Crew casualties are assessed in proportion to the number of crew served weapons and vehicles lost.

11. Mounted infantry casualties are assessed in proportion to personnel carrier losses.

12. Infantry materiel losses are assessed in proportion to infantry personnel casualties.

13. A CLGP mission consists of two rounds fired at an interval of 20 seconds. Two CLGP missions may be fired for each 8 tube - 155mm howitzer battery mission available, but every CLGP mission reduces the battery missions for conventional fire by 1/4 of a mission, and the 6 tube - 155mm howitzer battery mission will be reduced by 1/3 of the mission. CLGP rounds are fired at direct fire systems. If in addition to the GLLD, an aerial designation (RPV) is in use, then CLGP rounds are also fired at some indirect fire systems.

(c) Area targets. The indirect fire weapon systems fire at targets that are composed of homogeneous elements (weapon systems). The targets are typically company size, meaning the number of elements in a given target represents the expected number found in a company size area. Table 15 identifies the 17 different types of indirect fire area targets played in the Jiffy game and defines their corresponding characteristics. The number of the kth type area targets (AT_k) in a force is determined by the following equation:

$$AT_k = Q_k N_k O_k / E_k \qquad (9-2)$$

where for the kth type weapon systems:

AT_k = the number of area targets in the force.

Q_k = the probability that the area target will be acquired and targeted.

N_k = the number of elements in the force.

O_k = the operational availability of the elements.

E_k = the number of elements in an area target.

The target acquisition probabilities (Q_k) were taken from the probability of knowledge (POK) concept developed during the Antiarmor Systems Program Review (ASPR) by representatives of the military intelligence and electronic warfare communities (reference 1). The POK were determined by a team of representatives from the US Army Intelligence Center and School (USAICS) and the US Army Security Agency (USASA) who estimated the proportional contribution of each intelligence gathering asset (expected to be available by 1985) to the total target acquisition capability as a function of generic system type, target type, range, and target location error. These individual values were aggregated and qualitatively assessed by experienced military war gamers. The military judgment employed to POK data was based on the knowledge not only that the typical target was likely to be located in certain range bands but also that the configuration of the units depended on their combat role. For example, field artillery elements would typically be located within 16 km of opposing forces. The maneuver unit weapon systems, on the other hand, would most likely be found within 3 km of opposing forces. Since no other POK data are available at this time, the original POK data determined by the team of representatives as described above were reviewed, updated by USACACDA, and coordinated with USA Intelligence Center and Schools. Table 18, Probability of Knowledge, gives the data used in the current model.

(d) Fire distribution. The number of battery missions fired at each specified type of target depends on the distribution of the indirect fire battery missions available to be fired. The fire distribution is determined by an algorithm that considers a targeting scheme and the LEGAL MIX V concept of military worth of the target. The targeting scheme is shown in table 19. It should be noted that this targeting scheme is used for the preparation/counterpreparation and combat support phases of indirect fire combat and is not used for the final protective phase. During this phase, it is assumed that the defender will be firing all its indirect fire assets just beyond the line of contact. Thus, only the weapon systems expected to be found in the forward maneuver units are considered as appropriate targets. The military worth values for Blue and Red targets are given in table 16. In general, indirect fire battery missions are distributed among all appropriate targets according to the expression:

$$FDF_k = \frac{AT_k \; MW_k \; FAC_k}{\sum_{\text{all } k} (AT_k MW_k \; FAC_k)} \qquad (9\text{-}3)$$

where for the kth type of area target:

FDF_k = the fire distribution factor.

AT_k = the number of area targets.

MW_k = the military worth of the area target.

FAC_k = a fire allocation constant.

The fire allocation constant (FAC_k) is used to filter out inappropriate targets based on the targeting scheme. Thus, the FAC_k is set to one if it is an appropriate target for the indirect fire weapon being fired; otherwise, it is set equal to zero. The fire allocation constant is also used to allow the gamers the option to play any combination of close support, counterbattery, or air defense suppression missions. As an example, if a gamer did not want to fire air defense suppression missions, but wanted to concentrate his indirect fire on close support and counterbattery, the FAC_k for air defense type area targets would be set equal to zero. An exception occurs when the infantry is mounted during an attack and dismounts for a final assault on an objective. Infantry type targets are then considered to be targetable as indirect fire missions for only 1 hour. To account for this, the fire allocation constant for this case is expressed as:

$$FAC_k = 1/HR \tag{9-4}$$

where HR is the length of indirect fire support in hours.

(e) Available battery missions. The number of battery missions a force has to fire is directly influenced by the number of tubes a force has available to fire and their rate of fire during the battle period. The rate of fire for each tube is directly influenced by the three phases of indirect fire combat. The rates of fire for each type of indirect fire weapon system have been generated for all Red and Blue indirect fire weapon systems and are contained in table 20 for all three phases of indirect fire combat played in the Jiffy Model. The weapon capabilities (sustained and maximum rates of fire) for all indirect fire weapons were obtained from the sources indicated in table 20. The rates of fire for indirect fire weapons which fire preparation/counterpreparation missions are taken to be their sustained rate of fire. Since final protective fires cannot be considered preplanned fires, not all indirect fire assets will be available to fire. Experienced military gamers have determined that it is reasonable to assume that only 67 percent of the assets would be available. Thus, the rates of fire of all indirect fire weapons during final protective fires are taken to be 67 percent of their maximum rate of fire. The combat support rates of fire for Blue were obtained from the sources indicated in table 20. The hourly rate indicated for each Blue weapon corresponds to the daily resupply capability for that weapon firing at that rate for 24 hours. Table 21, artillery intensity levels and their corresponding multipliers, applies only to Blue indirect fire. Gamers affect combat support firing rates by entering these intensity levels. Red forces expend artillery in terms of units of volume known as units of fire, and the Red method has been duplicated as closely as possible. The Red combat support rates of fire given in table 20 are not true hourly rates of fire. They are translated to true hourly rates through use of discrete multipliers (different from the Blue multipliers found in table 21) which are normally less than 1.0. These discrete multipliers are used in the intensity level entry in equation 9-5. The so-called Red combat support rates in table 20, discrete multipliers, and the resultant rates of fire are based on the Hectare Method fire planning technique which is described in the Warsaw Pact Logistics Guide (U), May 1978. The method is used by Red artillery fire planners to plan ammunition expenditures for given types and numbers of targets and desired results. Military gamer personnel have developed a simple computer program which produces a discrete number based on fire planning input. This number, multiplied by the so-called Red combat support rate, produces a doctrinally correct rate of fire during a particular critical incident. Hourly fire rate figures are based on 12 hours of combat, 6 hours movement time, and 6 hours other per 24 hour day. In addition to this, certain battery missions such as smoke and illumination are not fired at specific targets. For example, Blue fires approximately 3 percent of its missions as smoke and illumination, and Red artillery fires approximately 6 percent of its missions as H&I fires. The smoke firers, Blue heavy mortars and Red 122mm howitzers, are degraded separately with respect to other battery missions (see table 24). The number of tubes in a battery is defined in table 22 for each type of indirect fire weapon system. The number of battery missions that will be fired by a given type of indirect fire weapon system at a specific type of area target is determined by the equation:

$$BM_{ik} = \left(\frac{N_i}{TBAT_i}\right) O_i \; F_i \left(\frac{ROF_i \; AIL_i}{RPM_i}\right) S_i \; FDF_{ik} H \; EW_i \; SM_i \qquad (9\text{-}5)$$

where for the ith type weapons firing at the kth type area targets:

BM_{ik} = the number of battery missions available to be fired.

N_i = the number of weapons in the force.

$TBAT_i$ = the number of tubes per battery.

O_i = the operational availability of the weapon.

F_i = the fraction of targeted missions (excludes smoke/WP, illumination, and H and I fired).

ROF_i = the rate of fire for the given phase of combat.

AIL_i = the artillery intensity level desired.

RPM_i = the rounds per tube per mission.

S_i = the suppression factor for the weapon.

FDF_{ik} = the fire distribution factor.

H = the number of hours of artillery support.

EW_i = degradation factor for EW.

SM_i = the percent of the ith artillery weapon not employed to fire smoke. In all cases SM_i = 1 unless i is used to employ smoke.

A battery mission of six rounds per tube is not intended to restrict the volume of fire placed on a specific target; it serves only as the basis to make the assessment calculations.

(f) Fractional damage. Indirect fire weapon system effectiveness is based on a measurement known as fractional damage. Fractional damage is that portion of a target complex that is expected to be damaged for each indirect fire battery mission fired at the target. The Jiffy model fractional damage values may be found in Volume III, appendix B. Since Cannon Launched Guided Projectiles (CLGP) rounds are fired at point targets, and not area targets, fractional damage is not a meaningful measure of effectiveness for them. CLGP assessments are discussed in subparagraph (h) below. The unclassified fractional damage values contained in table 23 and shown at the end of this volume are fictitious data and were developed for documentation and demonstration purposes.

(g) Indirect fire assessment algorithm. The form of the generalized assessment formula (equation 9-1) that calculates the expected number of personnel casualties and materiel losses as a result of the indirect fire combat is:

$$IDFK_k = \left\{ 1 - \prod_{\text{all } i} \left[1 - \left(\frac{FD_{ik}}{AT_k} \right) \right]^{BM_{ik}} \right\} AT_k \; E_k \qquad (9\text{-}6)$$

where for the ith type firers shooting at the kth type area targets:

$IDFK_k$ = the number of target elements killed by all indirect fire weapons.

FD_{ik} = the expected fractional damage to the area target for each indirect fire mission it receives.

AT_k = the number of area targets.

BM_{ik} = the number of battery missions fired at the area targets.

E_k = the number of elements in an area target.

Since the quantity $IDFK_k$ is the expected number of k-type kills by all indirect fire weapon systems, the portion of these kills accredited to each type of weapon system must be determined. The portion of the total kills accredited to each type of indirect fire weapon system is approximated by the expression:

$$PIDFK_{ik} = \frac{1-PK_{ik}}{\sum_{\text{all } i} (1-PK_{ik})} IDFK_k \qquad (9\text{-}7)$$

where:

$PIDFK_{ik}$ = the portion of the total kth type targets killed that were killed by the ith type weapon systems.

$1.-PK_{ik}$ = the expected probability of killing a kth type target by all the ith type weapon systems where:

$$PK_{ik} = \left[1 - \left(\frac{FD_{ik}}{AT_k}\right)\right]^{BM_{ik}} \qquad (9\text{-}8)$$

where FD_{ik}, AT_k, and BM_{ik} are as defined above.

(h) CLGP. Cannon Launched Guided Projectiles (CLGP) are played in the game as Blue indirect fire weapon systems that fire at point targets. CLGP missions are fired by 155mm howitzers, towed or self-propelled. A CLGP mission is considered to consist of two 155mm tubes firing one round each, 20 seconds apart. Guidance for the CLGP rounds is assumed to be provided by a ground locater laser designator (GLLD) or aerial designator. The number of CLGP missions available to be fired is equal to twice the number of 155mm 8-tube battery missions available. Since a CLGP mission requires two tubes to fire, the number of available 155mm missions for an 8-tube battery is reduced by 1/4 of a mission for every CLGP mission fired.

1. The CLGP missions are fired at Red armor vehicles, which include tanks, BMPs, BRDMs, BTRs, assault guns, and mounted air defense weapons. When an aerial designator (RPV) is used, CLGP missions are also fired at Red artillery. Smoke does not degrade the allocation of artillery targets to CLGP. Because the CLGP missions are fired at these point targets, their fire distribution algorithm differs from that of the other indirect fire missions. The CLGP fire distribution is expressed as:

$$FDF_k = \frac{N_k . OA_k \ SM_k}{\sum_{\text{all } k} N_k \ OA_k \ SM_k} \qquad (9\text{-}9)$$

where for the kth type target:

FDF_k = the fraction of the CLGP missions to be fired against the kth type weapon systems.

N_k = the number of kth type weapon systems.

OA_k = operational availability.

SM_k = the percent of unsmoked maneuver targets (SM_k = 1 for artillery targets).

From this expression it may be observed that the number of CLGP missions fired at each type of weapon system target is proportional to the number of those weapon systems engaged in combat.

2. The assessment equation for CLGP missions was derived from the same general form as was the indirect fire assessment equation. The CLGP assessment equation is expressed as:

$$CLGPK_k = \left[1 - \left(1 - \frac{PK_k \quad LDS'}{N_k \quad OA_k \quad PSN_k \quad SM_k}\right)^{R_k}\right] N_k \quad OA_k \quad PSN \quad SM_k \qquad (9\text{-}10)$$

where, for each CLGP round fired at the kth type weapons, with N_k and OA_k as defined above:

$CLGPK_k$ = the number of kth type weapons killed.

PK_k = the probability of killing a kth type weapon for each CLGP round fired.

LDS' = the probability the ground locater laser designator (GLLD) is not suppressed or the survivability of the aerial designator.

PSN = percent of force deployed forward (table 17) with the exception that for aerial designated artillery in the target array PSN is set to 1.

SM_k = the percent of unsmoked targets.

R_k = the number of CLGP rounds fired at the kth type weapons and is expressed by:

$$R_k = CLGPA_K \quad PEXP \quad PAQ(ICH, VIS) \qquad (9\text{-}11)$$

where:

$CLGPA_K = 2BM_{CLGP} \cdot FDF_K$ with FDF_K as defined above.

BM_{CLGP} = the number of CLGP missions that are fired by 155mm batteries (less than or equal to those available).

PEXP = a terrain degradation factor (.86 for open or rolling, .90 otherwise).

PAQ = an atmospheric degradation factor. (ICH is the cloud height index, VIS is the visibility index, and PAQ is obtained from table 59. An explanation of the cloud height index, ICH, is also given in table 59).

The CLGP probabilities of kill are classified and may be found in Volume III, appendix B. These probabilities assume that the laser designator is not suppressed (i.e., has continuous line of sight and can designate the target). The probability that the GLLD is not suppressed is also classified and may be found in Volume III, appendix B.

(i) Other assessments due to indirect fire combat. Since the indirect fire combat assesses dismounted infantry and crew-served weapons, additional attrition of crews, mounted infantry personnel, and the materiel losses associated with infantry casualties are made in accordance with the methods presented under infantry assessments and crew losses (paragraph 9d(4) below).

(j) Ammunition expenditures. A tally of each type of round fired during the indirect fire combat is kept for the ammunition expenditure statistics. Since the number of battery missions calculated for each type of weapon system is the number of targeted missions fired, the number of rounds fired for all missions is in accordance with the distribution of fire missions determined for each type of tube as shown in table 24. WP, smoke, and illumination rounds are fired as untargeted rounds in the indicated fixed percentages. The remainder of the indirect fire missions are the targeted or ordered missions expending either smoke, HE, ICM-DP, or CLGP rounds.

(2) Minefield assessments.

(a) General. The minefield assessments determine the attrition of dismounted infantry personnel and armored vehicles as a result of an attacking force passing through a mined sector using "bull" tactics or a hasty breach technique. The methodology considers both conventional and FASCAM minefields against attacker weapon systems; defenders are not assessed. The expected losses are determined linearly based on mine density and the minefield-sector geometry. The data for conventional minefields are extracted from the Army field manuals on maneuver control (FM 105-5 and FM 90-7) and landmine warfare (FM 20-32). The mine effectiveness data consider antitank (M15), antipersonnel blast (M14), and antipersonnel fragmentation (M16) type mines. The source document for Red and Blue forces is provided in appendix B, Volume III.

(b) Assumptions.

1. Weapon systems are considered to be dispersed uniformly across the trafficable terrain of the sector.

2. The Red force is using a hasty breach technique to pass through the minefield. Note: If the Red force is bypassing, clearing, or deliberately breaching the minefield, they should suffer no attrition from the minefield.

3. The minefields are composed of both AP and AT mines.

4. Conventional minefields are a minimum of 150m in depth.

(c) Minefield characteristics. Minefields are generally characterized by their mine density and length of frontage. Conventional minefields are considered to be a minimum of 150 meters in depth. The frontage and density are determined by the type of minefield, means of emplacement, and hours and resources available to emplace the minefield.

1. Conventional minefields are emplaced by personnel, either manually or with mechanical mine planters.

a. The number of manhours required to manually emplace each 100 meters of frontage is a function of the mine density of each type of mine being planted. Table 25 contains the manhour requirements for the manual emplacement of conventional minefields of 100 meter fronts for various densities of antitank mines, which includes a constant density of four and eight mines per meter of front for AP FRAG and AP BLAST mines, respectively. The length of potential minefield frontage that may be emplaced manually is determined by the expression:

$$MF_{man} = \frac{N_p \, HR_a \, WDF}{MHR_{(d)}} \, 100 \qquad (9\text{-}12)$$

where:

MF_{man} = the conventional minefield frontage in meters being manually emplaced.

N_p = the number of personnel emplacing mines.

HR_a = the number of hours available to emplace the mines.

WDF = a work degradation factor.

$MHR_{(d)}$ = the manhours required to bury 100 meters of front given in table 25 as a function of mine density.

The work degradation factor (WDF) is simply a means of degrading the efficiency of military personnel in a hostile environment. The work degradation factor is equal to .9 if the minefield is emplaced before the commencement of hostilities, and it is reduced to .7 if the minefield is being emplaced after hostilities have been initiated.

b. Mechanical mine planter platoons have a capability to emplace much greater frontages than can be emplaced manually. Mechanical mine planters emplace minefields with a mine density of two mines per meter of frontage. As depicted in table 26, Blue mechanical mine planter platoons are considered able to emplace a strip of mines 150 meters in depth and 2,000 meters in width in 6 hours. Red mechanical mine planter platoons are considered able to emplace strips 150 by 1,000 meters in 2 hours. The potential frontage of a minefield emplaced by a given number of mechanical mine planter platoons is expressed by:

$$MF_{mech} = \frac{N_{mp}\ HR_a\ WDF}{HR_r}\ F \qquad (9\text{-}13)$$

where, for WDF as defined above:

MF_{mech} = the minefield frontage in meters being mechanically emplaced.

N_{mp} = the number of mechanical mine planter platoons emplacing the mines.

F = the amount of frontage, in meters, to be emplaced.

HR_r = the number of hours required to emplace F-meters of frontage (see table 26).

2. The densities and frontages of FASCAM minefields are determined by their means of delivery. Table 27 contains the minefield characteristics for FASCAM minefields delivered by artillery and ground emplaced mine scattering system (GEMSS).

(d) Sector-minefield geometry. The portion of the attacking force's armored vehicles that will pass through a minefield is determined by the geometric relationships between the force, the sector frontage, and the minefield. The specific relationships of interest are the fractions of the minefield that can and cannot be bypassed by the attacker as described below:

1. The fraction of the minefield that cannot be bypassed is determined subjectively, external to the methodology. This judgment is based on the axis of advance of the attacker with appropriate terrain considerations. The specification of this relationship reduces the amount of minefield frontage through which an attacker must advance.

2. The amount of trafficable terrain in the sector, like the fraction not bypassed, must be qualitatively assessed with military judgment. It is simply an estimate of the amount of terrain (given in meters of width of the sector) that is trafficable to armored vehicles. If it is assumed that the

armored vehicles and personnel, if dismounted, are uniformly distributed over the trafficable terrain, the probability that each vehicle or dismounted infantryman encounters the minefield is given by:

$$PCOV = \frac{F'_{by}(MF)}{T_t} \tag{9-14}$$

where:

PCOV = the probability an attacking weapon system encounters the minefield.

F'_{by} = the fraction of the minefield not bypassed.

MF = the minefield frontage in meters.

T_t = the amount of trafficable terrain in meters.

(e) Assessment methodology. The minefield assessments are determined in a linear fashion based on an expected percent of casualties for armored vehicles and personnel that pass through the minefield. The expected percent of casualties varies as a function of mine density for each generic type of mine. Tables 28 and 29 contain the expected percent of casualties for armored vehicles and dismounted infantry personnel passing through a conventional minefield, and tables 30 and 31 are the percent of casualties expected from FASCAM minefields. The number of armored vehicles and/or dismounted infantry personnel killed as a result of the attacking force passing through a minefield is determined by:

$$MFK_{ik} = N_k \text{ (PCOV) (FA) } (PERCAS_{ik}/100) \tag{9-15}$$

where for the kth type of weapon system passing through the ith type of minefield with PCOV as defined above:

MFK_{ik} = the number of weapon systems killed.

N_k = the number of weapon systems in the sector.

FA = the fraction of the attacking force that enters the minefield and is subjected to attrition.

$PERCAS_{ik}$ = the expected percent of casualties for the weapon system passing through the minefield.

Even though an attacker is using "bull" or hasty breach tactics, not all vehicles in his force will be subjected to attrition by the minefield. Instead, the attacker employs only a portion of his weapon systems to clear channels in the minefield through which the remainder of his force passes. This is accounted for in the methodology by gamer input of the FA factor in equation 9-15.

(3) Armor/antiarmor assessments.

(a) General. The armor/antiarmor combat assessment portrays the exchange of fire between the armored and antiarmor elements of the opposing maneuver units. Only tanks and antitank weapons are considered in the actual assessments both as firers and as targets. In addition, front line air defense systems, armored command vehicles, and armor support vehicles (AVLB) are considered as targets only. Attrition of infantry personnel and materiel, as well as crewmen does result from the armor/antiarmor assessment but only in conjunction with losses of armored vehicles or antiarmor weapons. Losses due to indirect fire, minefields, etc. influence armored combat assessments, only to the extent that the opposing force (weapon system) arrays have been reduced in strength according to the losses suffered. The generalized assessment equation parameterized for single shot kill probabilities and expected number of rounds fired by participating weapons is used to determine actual losses of tanks, other armored vehicles (including DIVAD, ZSU 23/4, and ZSU 37/2 AD systems, etc.), and dismounted antitank weapons.

(b) Assumptions. The following assumptions apply to the armor/antiarmor combat assessments:

1. The weapon systems of the attacker are uniformly distributed throughout a 500-meter-deep range band located some specifed distance in front of the defender.

2. The number of rounds fired by engaging systems is a function of gun sight, terrain, range, day or night, smoke and dust conditions, suppression, weather, and characteristics of the system.

3. The visibility conditions not only degrade the number of targets to be engaged but also determine the maximum range for engagement.

4. Distribution of fire to the target array is determined by categories of detection frequencies developed from previous DYNTACS-X applications.

5. In targeting for assessments 2/3 of the defender weapon systems are in hull defilade with 1/3 fully exposed; for the attacking force, 1/3 are in defilade while 2/3 are fully exposed.

(c) Assessments. Given the environmental and military conditions associated with the battle being gamed, the assessment of losses incurred during armor/antiarmor combat is a relatively straightforward process. The assessment equation itself, along with the necessary preliminary computations, is given in the following subparagraphs.

1. Number of targets. The number of each type of weapon system available for targeting is determined by the equation:

$$TGT_k = NW_k \cdot OA_k \cdot VIS \cdot PC \cdot ACQ \cdot SMOKE \tag{9-16}$$

where, for the kth type target:

TGT_k = the total number of weapon systems targetable.

PC = the percent of targeted force committed.

NW_k = the number of weapon systems remaining in the force array.

OA_k = the operational availability.

VIS = a visibility degradation factor.

ACQ = an acquisition discriminator value for the firing force.

SMOKE = the fraction of unsmoked targets.

The number of weapons remaining in the force array (NW_k) is updated as the battle progresses; that is, the losses incurred during each range increment of the conflict are subtracted from the weapon array before the subsequent assessment begins. Operational availability (OA_k) is discussed in paragraph 9c, with values for all systems played in the Jiffy model given in tables 14 and 15. Visibility degradation factors (VIS) are as presented in table 11. The acquisition discriminator parameter (ACQ) used in equation 9-16 accounts for the differing capabilities to acquire targets under dissimilar tactical situations. An attacking force in particular would be expected to acquire targets at a higher rate during a meeting engagement than during an attack on a prepared defensive position. Acquisition discriminator values, given in table 32, have been adapted from USACACDA TETAM Effectiveness Evaluation and the USMC LFWG Rule Manual as noted. Smoke and dust are discussed separately in paragraphs 10 and 11.

2. Fire distribution. The distribution of rounds fired at the target array is weighted according to a detection frequency distribution derived from previous applications of DYNTACS-X. The weighting considers only four distinct categories of targets, as shown in table 33. Based on these weighting factors, the distribution of fire against a particular type of target is given by:

$$FDF_k = \frac{NW_k \quad OA_k \quad WT_k \quad SM_k}{\sum\limits_{\text{all } k} NW_k \quad OA_k \quad WT_k \quad SM_k} \tag{9-17}$$

where, for target type k with NW_k and OA_k as defined above:

FDF_k = the fire distribution factor.

WT_k = the categorized target weighting factor.

SM_k = the percent of unsmoked targets.

The fire distribution factor thus computed determines the number of rounds fired by each type firer at each type target as follows:

$$RND_{ik} = NW_i \cdot OA_i \cdot PC_i \cdot ECF_i \cdot SF_i \cdot FDF_k \tag{9-18}$$

where, for the ith type firers against type k targets and for NW_i, OA_i, PC_i and FDF_k as defined above:

RND_{ik} = the total rounds fired.

ECF_i = the expected number of completed firings (per weapon).

SF_i = the suppression factor.

The suppression parameter, (SF_i) is discussed in paragraph 8 of this volume. The expected number of completed firings (ECF_i) represents the number of ounds a weapon can expect to fire successfully during an exposure of an enemy target. The data given in tables 34 through 37 are fictitious data for test and demonstration purposes. Derivation and source of the actual data are given in Volume III.

3. Assessment equation. The total losses for a given type target are computed by the generalized assessment equation formulation as follows:

$$LOSS_k = \left[1 - \prod_{\text{all } i} \left(1 - \frac{SSKP_{ik}}{TGT_k} \right)^{RND_{ik}} \right] TGT_k \tag{9-19}$$

where, for all firers against kth type targets with TGT_k and RND_k as defined above:

$LOSS_k$ = the total losses.

$SSKP_{ik}$ = the single shot kill probability.

The single shot kill probabilities for armor/antiarmor are classified and are contained in Volume III, tables 8-4 and 8-8. For unclassified processing an arbitrary value of .5 has been assigned to the SSKPs for all weapon systems. The SSKP data in the Jiffy III model are indexed by range, type firer, type target, and target posture. Since the assumption has been made that not all targeted weapons are in the same posture, the SSKP value entered into the equation is a weighted average of two table values rather than - 'irectly extracted value. For the defender force, a 2:1 ratio is assumeu between weapons in defilade to those exposed. Thus, the SSKP entered for assessment against a defender's weapon system would be 2/3 of the SSKP against the weapon in defilade plus 1/3 of the SSKP against the weapon fully exposed. For an attacker weapon system, the defilade:exposed ratio is 1:2 so the SSKP used would be 1/3 of the defilade SSKP plus 2/3 of the exposed SSKP. The assessment equation as shown computes the number of a given type of target killed by all firers in the opposing force. To provide a record of the losses attributed to each firer, this total must be apportioned back to each of the different weapons that fired. The algorithm for accomplishing this apportionment is given in equation 9-20:

$$KILL_{ik} = \frac{1 - PK_{ik}}{\sum_{\text{all } i} (1-PK_{ik})} LOSS_k \qquad (9\text{-}20)$$

where, for firer i and target type k:

$KILL_{ik}$ = the number of targets killed by firer.

$LOSS_k$ = the total number of targets killed.

$1\text{-}PK_{ik}$ = the probability the firer killed the target where:

$$PK_{ik} = \left(1 - \frac{SSKP_{ik}}{TGT_k}\right)^{RND_{ik}} \qquad (9\text{-}21)$$

with all variables as defined above.

(d) Infantry/crew losses. Infantry personnel, even when dismounted, are not targets for direct assessment. Dismounted infantrymen are attrited in direct proportion to the infantry-served antitank weapon losses, which are directly assessed. Table 38 shows the number of expected infantry personnel casualties per each of the antitank weapons considered in the Jiffy model. The methodology for assessing mounted infantry personnel, all infantry weapons, and crew personnel is consistent with the other Jiffy III model assessments and is discussed in detail at paragraph 9d(4)(c) of this volume.

(e) Ammunition expenditures. As the assessments are made, an accounting is kept of the number of rounds fired so that ammunition consumption can be output with the assessment results.

(4) Infantry assessments.

(a) General. Infantry casualties are assessed in each type of combat assessment in the Jiffy III model. The infantry combat assessment generates those losses resulting from direct conflict between the opposing dismounted infantry forces. In assessments for the other types of conflict, mounted and/or dismounted infantry personnel may be attrited. This section addresses all the various types of personnel casualties considered in the game. Dismounted infantry combat attrition is first considered, followed by description of the assessment procedures applied to infantry personnel/materiel and crew personnel throughout the game.

(b) Infantry combat. The infantry combat assessment determines casualties to dismounted personnel suffered in a direct conflict between two opposing infantry forces. Attrition due to indirect fire, armed helicopter, minefields, tanks, and other major weapon systems is determined in accordance with assessments of other types of combat and is not addressed in this section of the game. As in all infantry assessments, materiel losses are computed in conjunction with infantry casualties. Both conventional and ambush tactics can be played, and any portion of the total infantry forces in a given sector can be committed to the battle.

1. Assumptions. The following assumptions apply to the infantry combat methodology:

a. During conventional infantry combat, the attacking and defending forces are as defined in the other combat assessments; however, during an ambush, the ambusher is always considered to be the attacker regardless of prior designations or other factors.

b. An infantry battle can last no longer than 6 hours.

c. Ambush tactics are valid only during the first hour; any combat beyond that must be conventional type.

d. Casualty rates are determined by the attacker-to-defender firepower ratios.

e. Infantry-served antitank weapons are attrited by the infantry subroutine only when tanks are supporting the infantry combat.

f. No armored vehicles are assessed as losses by infantry combat.

g. All infantry personnel organic or attached to units in the sector being gamed are subject to the attrition in the infantry combat assessments.

2. Firepower ratio. The firepower ratio between the attacking and defending forces provides an index to the casualty rate needed to assess infantry personnel casualties. The firepower scores of all infantry weapon systems and infantry support vehicles are cumulated to obtain the total firepower score for each force. The firepower scores for tanks are included only if the gaming tactics call for tanks to support the infantry in combat. Each total firepower score is then adjusted for the tactical situation by the appropriate coefficient from table 8 or table 9 and the ratio formed as in equation 7-1, restated here for reader convenience.

$$FPR = \frac{\sum_{\text{all } i} ATSAF_i \; N_i \; FPS_i \; EW_i \; SMOKE_i}{\sum_{\text{all } k} DTSAF_k \; N_k \; FPS_k \; EW_k \; SMOKE_k}$$

The attacking and the defending forces in a conventional infantry conflict are as specified for the rate of advance calculation prior to beginning any assessments. For ambush tactics, however, the ambushing force is always the attacker regardless of this prior designation. Thus, the numerator and denominator would be reversed in the above ratio when the defending force was ambushing the attacking force. Furthermore, to account for the surprise factor expected in an ambush attack, the numerator of the ratio (i.e., the ambushing force's adjusted firepower score) is multiplied by 4.5 (reference 5, p. 43) to weight the firepower ratio in favor of the ambushing force.

3. Casualty rates. The firepower ratio as computed above indexes the casualty rates entered into the assessment equation. The casualty rates used in the Jiffy model represent the fraction of unit strength lost per hour of combat. The casualty rates for conventional combat appear in table 39, which is adapted from the USMC LFWG Rule Manual as noted. Both the computed firepower ratio and the tactical situation must be known to enter this table and find the correct casualty rates for the attacker and the defender. The values shown are used directly for an infantry force of less than battalion strength. However, if a force entering the combat is battalion size or larger, the table value is halved before being entered into the assessment equation. This accounts for the many infantrymen who would be held in reserve or located some distance from the front-line conflict during a larger scale battle and would be less susceptible to attrition by opposing infantry fire. A force committed to combat that contains 72 or more infantry personnel is assumed to be at least battalion size in the Jiffy Game. It should be emphasized that not all the infantry personnel need be committed [illegible]mbat, and the casualty rate reduction is based on the size of the fo[illegible]ally committed. For example, even though a full battalion is located i[illegible]ector, the table value for the casualty rate would not be halved if on[illegible]ne or two companies from that battalion entered the conflict. The casu[illegible]y rates for an ambush situation are contained in table 40, also adapted from the USMC LFWG Rule Manual. Only

the firepower ratio is needed to extract the appropriate casualty rates from this table. These values are used exactly as shown regardless of the size of the forces since in an ambush, the assumption is made that all infantry personnel committed would be directly involved in the conflict.

4. Assessment equation. Assessment of infantry losses is made by the equation:

$$LOSS = (PERS.F)\left[1 - (1 - Rate)^{HR}\right] \qquad (9\text{-}22)$$

where, for each force:

LOSS = the number of infantry personnel casualties.

PERS = the total infantry personnel in the force array.

F = the fraction of infantry personnel committed to combat.

RATE = the personnel casualty rate.

HR = the length of battle.

This equation is applied separately to each of the opposing forces. The fraction, F, of personnel committed to battle, a value between 0 and 1, together with the total infantry personnel, PERS, in the force array determine the number of personnel available for attrition. This factor is applied to both forces and allows for gaming situations in which only a portion of each infantry force in a sector is expected to enter the conflict. The length of a battle, HR, can be no more than 6 hours; the actual number of hours entered is prescribed by the situation being gamed. When ambush tactics are played, only the first hour of combat is assessed at the ambush casualty rate because the element of surprise would not reasonably be expected to last any longer. The conflict then reverts to conventional infantry combat for the remainder of the assessment period. The casualty rate, RATE, is extracted from the tables as described in the preceding paragraph. There is no factor for suppression in equation 9-22; suppression was considered in the development of the casualty rates and thus is inherent in the RATE values.

5. Materiel losses. The infantry combat assessment equation determines only infantry personnel casualties. Materiel losses are generated as a function of the personnel loss in accordance with the methodology described below.

(c) Other infantry and crew losses. Losses of infantry personnel, associated weapons and other materiel, and crew personnel are determined in each of the combat assessments of the Jiffy model. In most instances, the actual losses incurred are not the result of a direct assessment but rather are a function of other weapon system losses. The methodology and data for determining these losses are consistent throughout the Jiffy model and are presented in the following subparagraphs.

1. Assumptions. Some basic assumptions underlying all infantry and crew loss calculations are:

a. Defending infantry personnel are always dismounted from their vehicles.

b. Attacking personnel can be either mounted or dismounted depending on the game situation.

c. Mounted infantry personnel are only killed when an armored personnel carrier is killed.

d. Infantry weapons are lost only as a result of infantry personnel kills.

e. When a crew-served weapon or vehicle is killed, crewmen associated with it are also killed.

2. Infantry personnel. The attrition of infantry personnel is determined by different methods for mounted and for dismounted personnel. In the case of dismounted personnel, the losses are computed directly from the assessment equation; that is, dismounted infantry are simply potential targets for which probabilities of kill have been developed and against which fire is allocated. Mounted infantry, on the other hand, suffer casualties that would be expected in proportion to losses of personnel-carrying vehicles at a rate of six infantrymen per vehicle; that is, the number of personnel carriers killed by a direct assessment multiplied by six produces the expected number of mounted infantry personnel attrited.

3. Materiel losses. When a force loses infantry personnel, it also loses trucks, rifles, light machineguns, and other infantry weapons. None of the Jiffy model routines directly assesses losses for these weapons and materiel, except for trucks which are directly assessed in the artillery routine. Rather, each type of infantry materiel in the weapon system array is assessed in proportion to infantry personnel losses. The loss rates, representing the number of systems lost per infantryman, were taken from the SCORES "Jiffy" War Gaming Methodology (reference 5) as given in table 41. The losses of infantry materiel are computed as the product of the number of personnel killed and the appropriate loss rate. No distinction is made between mounted and dismounted infantry in assessing materiel attrition except for trucks, which are killed in the infantry combat assessment only in conjunction with dismounted personnel.

4. Crew losses. The loss of a crew-served weapon system in any assessment of the Jiffy model results in the loss of a portion of its crew as well. The total crew personnel attrited is the product of the number of

weapon systems killed and the number of crewmen losses associated with that system. Tables 42 and 43 give the number of crewmen losses associated with each type of Blue and Red crew-served weapon system, respectively.

(5) Attack helicopter/air defense assessments.

(a) General. Attack helicopter and air defense assessments are considered simultaneously in the Jiffy III model in order to portray the interactions between these two types of systems realistically. The configuration of the helicopter cells and the environmental factors affecting air defense capabilities are played in accordance with the combat situation being gamed and are the primary parameters in determining the casualties suffered by helicopters and ground forces alike. A formulation of the general assessment equation, equation 9-1, is used to compute losses of major weapon systems (including helicopters) and dismounted infantry personnel. Attrition of mounted infantry personnel, all infantry weapons/materiel, and crew personnel is determined by the methods detailed in paragraph 9d(4)(c) above.

(b) Assumptions. The attack helicopter and air defense assessment methodologies are subject to the following assumptions:

1. Helicopters fire at maneuver and forward air defense systems. They do not fire at artillery systems, helicopters, and other systems that are typically beyond 5km from the line of contact.

2. Helicopter missions are essentially antitank missions. Troop-carrying helicopters and the associated missions are not explicity portrayed in the existing logic or data. However, troop-carrying helicopters may be flown for attrition purposes only.

3. Allocation of helicopter fire against a ground target is based upon the target's importance relative to other targets. The target's firepower score is used as a relative measure of importance.

4. Air defense systems cannot distinguish between different types of helicopters for allocation of air defense fire. Therefore, all helicopter types are equally weighted for fire allocation.

5. Attack helicopters in the indirect fire role with scout helicopters to guide the missile to the target are not subject to attrition; however, they are subject to attrition in the autonomous or direct fire mode.

6. A sortie consists of one takeoff and one landing of an aircraft; a mission is the completion of a sortie by one or more helicopters.

7. The probability that an air defense system has its line of sight unobstructed by terrain to a helicopter is equal to the probability that the helicopter has line of sight to the air defense system.

(c) Helicopter cells. A helicopter cell is simply a group of helicopters specified by the gamer for a mission. The characteristics of the helicopters it contains basically determine the mission profile of the cell. Once the assessments for this cell are completed, the gamer may then define a new cell for another mission. Although the Jiffy III model allows attack cells to contain any heterogeneous mixture of helicopters loaded into a force array, a cell should typically contain homogeneous type attack helicopters with or without scout helicopters. Otherwise the performance capabilities, specifically the number of pop-ups allowed, of some helicopters may be reduced by characteristics of other helicopters in the cell. The maximum number of each type helicopter in a particular cell is limited by the smaller of two numbers: (1) the actual number of remaining helicopters, or (2) the number of sorties remaining for that helicopter type. Also, these numbers ultimately constrain the number of missions that can be flown since helicopters are usually killed and sorties are used up in each mission. Typically, though, only one aircraft sortie per helicopter is flown during the usual 4-hour critical incident. The number of type k helicopters, which is available for a given cell n, is computed by:

$$N_{kn} = AC_k \cdot OA_k - \sum_{i=1}^{n-1} LOSS_{ki} \qquad (9\text{-}23)$$

where, for type k helicopters flying the nth mission:

N_{kn} = the number of helicopters available for the mission.

AC_k = the total number of helicopters in the initial weapon array.

OA_k = the aircraft operational availability.

$\sum_{i=1}^{n-1} LOSS_{ki}$ = the number of helicopters lost to air defense systems during previous missions.

Operational availability values are contained in tables 14 and 15 for all helicopters portrayed in the Jiffy model. The number of type k helicopter sorties available for the nth mission is found by:

$$SORT_{kn} = AC_k \cdot OA_k \cdot SPH_k \cdot H - \sum_{i=1}^{n-1} N_{ki} \qquad (9\text{-}24)$$

where, for the type k helicopters to fly the nth mission with AC_k and OA_k as defined above:

$SORT_{kn}$ = the number of sorties available.

SPH_k = the sorties per hour for type k helicopter.

H = the number of helicopter flying hours.

$\sum_{i=1}^{n-1} N_{ki}$ = the number of sorties flown in previous missions.

The number of sorties per hour for each type of helicopter is determined by its physical characteristics and a standard mission (sortie) time line. The time for each type helicopter sortie is calculated from the helicopter endurance time including a rearm/refuel time minus the fuel reserve time. The data to calculate sortie times were obtained from the Threats Office, CACDA, at Ft Leavenworth, and the Forward Area Refueling and Rearming Point Operations manual (reference 12). The SPH_k values used in Jiffy are shown in table 44. The number of helicopter flying hours is a gamer input. It is limited to (and usually set equal to) the length of the critical incident as entered in the rate-of-advance routine.

While equations 9-23 and 9-24 calculate for each helicopter type the number of helicopters and sorties available for a given cell, the number of helicopters which define a given cell should be determined by the number of maneuver units engaged and other tactical considerations. The unit resolution sizes, which are determined during the force initialization process, are generally at the Blue company and Red battalion levels. For a defending force, only one of its maneuver units is engaged by a cell of helicopters. Because the attacker is generally massed, the attacking maneuver forces engaged by helicopters are assumed to be three times what would be engaged if the force were defending. Thus, the number of weapons that is engaged by attack helicopters is the equivalent of three maneuver units (if attacking) or of one maneuver unit (if defending). It should be noted that the number of weapon systems in a maneuver unit is determined by dividing the total number of maneuver weapons in the sector by the number of maneuver units in the sector. The number of helicopters in a cell should, therefore, be the number of attack helicopters that would typically be expected to attack one defending maneuver unit or three attacking maneuver units.

(d) Helicopter mission profile. An attack helicopter mission in Jiffy consists of a helicopter expending or attempting to expend its ordnance load against opposing ground forces. This is not portrayed as a single attack but as a series of helicopter pop-ups. The number of pop-ups needed for a helicopter to expend its ordnance is a function of the ordnance load, the detection capability of a helicopter (or of the scouts for a helicopter in indirect fire), and the probability of line of sight.

Each helicopter type represented in the game has a fixed ordnance configuration as given in table 45. Furthermore, the maximum number of rounds that can be successfully fired if a target has been detected during a single pop-up (the success rate of fire) is given in table 46 for the selected types of ordnance which affect the number of pop-ups. For a given type helicopter the number of pop-ups required to expend all its ordnance is calculated by the following equation:

$$NPOP_k = \sum_{i=1}^{5} \frac{ORD_{ki}}{SROF_i \cdot PDAC_k \cdot PLOS_k} \qquad (9\text{-}25)$$

where, for type k helicopter expending the ith type round:

$NPOP_k$ = the number of pop-ups required for the helicopter to deplete its ordnance.

ORD_{ki} = the number of rounds in the ordnance load.

$SROF_i$ = the success rate of fire (per pop-up) for the round.

$PDAC_k$ = the probability that the helicopter will detect a target.

$PLOS_k$ = the probability that the helicopter will have line of sight to the target.

The $PDAC_k$ for a helicopter is based on four factors: type of sight used, standoff range, visibility condition, and light condition (day/night). The data for attack helicopter probabilities of detection are contained in the classified data appendixes.

The line-of-sight probabilities are based on the range to the target and on two general terrain types: (1) open/rolling, and (2) hilly/mountainous. $PLOS_k$ also depends on the engagement tactics and type of sight employed by the helicopter. Probability of line of sight is only degraded for helicopters flying a pop-up mode. A helicopter which is employing racetrack tactics always has line of sight; i.e., $PLOS_k = 1.0$. For helicopters employing pop-up tactics, $PLOS_k$ depends on whether or not helicopter type k has a mast-mounted sight. Table 47 contains the line-of-sight probabilities for helicopters flying in the pop-up mode. These probabilities are based upon the percent of coverage (to 5000 meters by 500-meter range band increments) in a 30 degree sector. Targets in this sector are assumed to be uniformly distributed. The line-of-sight (LOS) fans for each pop-up position were generated using a digitized terrain data base of various German terrains and typical positions for helicopter pop-ups, as determined by US aviators. Of the pop-up positions chosen, only the good locations for helicopter LOS were used so that the line-of-sight probabilities represent a conservative estimate of $PLOS_k$. For each of the terrain categories, approximately 30 good line-of-sight positions were used to derive the PLOS data. The values in table 47 are the averages calculated and given by terrain type, range band, and type of helicopter sight (mast-mounted sight or not).

1. Only missiles and rockets enter the $NPOP_k$ calculation. Machinegun and cannon rounds included in the ordnance load are not considered. Also, as table 46 shows, 57mm rockets are not used to calculate $NPOP_k$ for the FUTURE AH; however, they are used for other AH's.

2. The $NPOP_k$ of scout designators for the AH-64 using the indirect fire launch method considers the HELLFIRE missile load of the AH-64 and excludes the 30mm rounds. AH-64s in the indirect fire launch mode do not pop up and, consequently, are not killed. Enemy air defense systems engage only their scout designators. The number of pop-ups for a scout designator type k is:

$$NPOP_k = \frac{ORD}{DIV} \tag{9-26}$$

where:

ORD = the number of HELLFIRE missiles in the ordnance load of one AH-64.

and DIV is defined as:

$$DIV = \frac{\sum_{\text{all } k} CELL_k \cdot PDAC_k \cdot PLOS_k}{\sum_{\text{all } k} CELL_k} \tag{9-27}$$

where, for each scout helicopter type k:

$CELL_k$ = the number of scout helicopters in the cell.

$PDAC_k$ = the probability that the scout helicopter will detect a target.

$PLOS_k$ = the probability that the scout helicopter has line of sight.

Only one scout at a time will designate for an AH-64. Thus, when more than one type of scout is used in a cell to designate, the number of pop-ups required to expend all HELLFIRE missiles is based on a weighted average of the performance capabilities of all the scouts in the cell as equations 9-26 and 9-27 indicate.

3. The average number of rounds of each ordnance type i fired per pop-up by helicopter type k, $POPORD_{ki}$, is:

$$POPORD_{ki} = \frac{ORD_{ki}}{NPOP_k} \tag{9-28}$$

where ORD_{ki} and $NPOP_k$ are as defined above. On each pop-up a helicopter will expend a portion of all the ordnance types it carries aboard as calculated by $POPORD_{ki}$. However, if an AH-64 is using the indirect fire launch method, only HELLFIRE missiles are fired and the number of pop-ups used to calculate $POPORD_{ki}$ is that of the scouts.

4. Each helicopter has associated with it a maximum number of pop-ups, $MAXPOP_k$, which it cannot exceed during a sortie. (The determination of $MAXPOP_k$ is independent of $NPOP_k$, computed by equation 9-25 or 9-26, for a helicopter.) This maximum number of pop-ups is based on the on-station time of the helicopter divided by the time between its pop-ups. In general, the on-station time is calculated as follows:

$$OST_k = MFT_k - FR_k - INGRESS_k - EGRESS_k \tag{9-29}$$

where for helicopter type k:

OST_k = the on-station time.

MFT_k = the maximum helicopter flight time (endurance time).

FR_k = the fuel reserve (usually 30 minutes).

$INGRESS_k$ = the ingress time of the helicopter.

$EGRESS_k$ = the egress time of the helicopter.

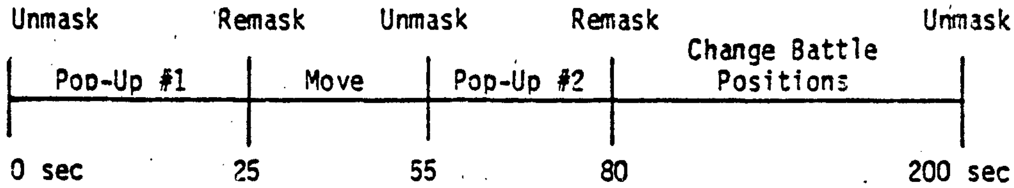
The time between pop-ups is calculated assuming the following:

1. A helicopter unmasks only twice in each battle position.

2. A helicopter moves 100 meters between pop-ups in the same battle position.

3. A helicopter moves 300 to 400 meters between battle positions.

4. Duration of the pop-ups (exposure time) is calculated using an average exposure time for both day and night visibility categories 1, 2, and 3. The range used in the calculation varies depending on the helicopter/ ordnance configuration. Using unclassified numbers, an example of a time-line for a helicopter is illustrated below:



In this instance the average time for one pop-up is 100 seconds or 1.67 minutes. For an on-station time of 40 minutes the maximum number of pop-ups is MAXPOP = 40 min/100 sec = 24 pop-ups. For scout helicopters the time-lines and maximum numbers of pop-ups are calculated using tactics employed in lasing targets for an AH-64. $MAXPOP_k$ for an AH-64 is based on an autonomous firing mode.

5. Since the number of pop-ups by type k helicopter may not exceed $MAXPOP_k$, the number of pop-ups attempted by type k helicopter, $NPOPUP_k$, will be the lesser of $NPOP_k$ and $MAXPOP_k$ (i.e., $NPOPUP_k$ = min ($NPOP_k$, $MAXPOP_k$)). In general, for a cell containing two or more types of helicopters, the number of possible pop-ups for the mission is equal to the min (NPOPUP, $NPOPUP_2$, ... $NPOPUP_n$), where $NPOPUP_k$ is as defined above for each type helicopter in the cell. This assumes that all helicopters must egress after any one helicopter type has either expended all its ammunition or reached its maximum number of pop-ups. Consequently, if heterogeneous cells are flown, some helicopter types may not fly as many pop-ups as if they were flown alone. If scouts are designating for AH-64s in a cell, the number of pop-ups for the mission is based on the $NPOPUP_k$ for the scouts-- not the AH-64-- and the $NPOPUP_k$ of other helicopter types which may be in the cell. Otherwise, scouts are not considered in determining the number of pop-ups a cell will fly, but they will fly the entire sortie with the attack helicopters.

(e) Assessments. The basic form of the assessment equation, 9-1, is used for both attack helicopters and air defense systems. Detailed here are the parameters and data used to apply the general equation to these assessments. The effect of smoke on assessments is discussed separately in paragraph 10.

1. Per pop-up assessments. As outlined above, a mission consists of a series of pop-ups by an attack helicopter cell. Therefore, losses are assessed for each pop-up individually. At the end of a given pop-up, all weapon system arrays are updated before assessments for the next pop-up are begun. If, at any time during the iterations of the assessments, the total number of targetable helicopters remaining in a cell falls below 70 percent of the initial number within that cell, the mission may be aborted at the gamer's option, and no further assessments for that cell are made. If not aborted, a mission will be processed, pop-up by pop-up, to its completion.

2. Air defense assessments. The effectiveness of air defense weapons against helicopters is dependent on several factors determined by the environmental and battlefield characteristics. These parameters affect the assessment equation by modifying the number of engagements against the helicopters and/or by indexing different values of the single engagement kill probability.

a. Air defense systems available. The number of air defense weapons available to engage helicopters for an assessment is determined by:

$$EWPN_i = (NW_i - LOSS_i) \cdot OA_i \cdot PAD_i \cdot WPCTL \cdot S_i \cdot PNSMK_m \qquad (9\text{-}30)$$

where, for type i air defense weapon system:

$EWPN_i$ = the expected number of air defense weapons available.

NW_i = the number of air defense weapons in the force array at the beginning of the attack helicopter/air defense battle.

$LOSS_i$ = the number of air defense systems killed by helicopters in prior pop-ups.

OA_i = the operational availability of the air defense systems.

PAD_i = the fraction of type i air defense systems committed.

WPCTL = the air defense weapon control factor.

S_i = the fraction of type i air defense weapons unsuppressed.

$PNSMK_m$ = the fraction of air defense systems not smoked which is dependent upon the force, the type of air defense sight, and the type of smoke as defined in paragraph 10.

(1) OA_i. Operational availabilities (OA_i) for air defense systems are listed in tables 14 and 15.

(2) PAD_i. Air defense systems are assumed to be equally distributed among the maneuver units and are divided into short, medium, and long range classes for commitment purposes. Table 48 gives the systems in each category. Long range air defense systems do not typically engage attack helicopters. However, an SA-8 will occasionally engage an attack helicopter. Therefore, for long range classes the commitment percentages are 1 percent for Red and 0 percent for Blue. For short and medium range AD systems the commitment percentages depend on the number of the force's maneuver units in the sector and the tactical situation. The average fraction of short and medium range air defense systems belonging to one maneuver unit is computed as:

$$PC_i = \frac{1}{NMU} \qquad (9\text{-}31)$$

where, for type i systems:

PC_i = the fraction of the systems belong to one maneuver unit.

NMU = the number of maneuver units the force has in the sector.

When a cell of helicopters engages an attacking force, it encounters three of the force's maneuver units. Thus, the fraction of short and medium range systems a cell faces corresponds to three of the attacker's maneuver units (i.e., $PAD_i = 3 \cdot PC_i$). When a cell of helicopters attacks the defending side, it engages one of the force's maneuver units. Therefore, the cell generally engages the fraction of short and medium range air defense systems corresponding to one defending maneuver unit ($PAD_i = PC_i$). When the tactical situation is such that the defender is massed in a high density sector, however, units are close enough for medium range air defense systems to provide overlapping coverage against helicopters. In this instance, three-fourths the medium range AD weapons of each of the two flanking units are assumed to provide additional coverage to the unit being attacked, which is equivalent to the number of AD weapons for two and one-half maneuver units. Thus, for the medium range AD weapons of a defending side in a high density sector $PAD_i = 2.5 \cdot PC_i$. Based on the typical unit resolution sizes and a Blue defensive scenario, a high density sector is determined by the gamer when a battalion is defending less than a 4000m front.

(3) WPCTL. The weapon control factor (WPCTL) applies to all air defense systems in the sector and modifies their capabilities for engaging enemy helicopters in consideration of such factors as the presence of friendly aircraft in proximity to the battle area. Table 49 gives the weapon control status factors for the air defense systems along with the criteria for determining the appropriate factor for the gaming situation.

(4) Suppression. The suppression of air defense weapons is determined using the fire support firepower ratio since air defense systems are generally considered to be outside the range of maneuver systems. The vulnerability adjustment factors for air defense systems, contained in table 13, multiplied by the appropriate suppression factor, contained in table 12, give the suppression percents for the air defense systems.

b Number of engagments. The actual number of engagements by an air defense system against a given type of helicopter is computed by:

$$ENG_{ik} = EWPN_i \cdot ACQ_{ik} \cdot PLOS_k \cdot MNV \cdot \frac{CELL_k - LOSS_k}{\sum_{all\ k} (CELL_k - LOSS_k)} \quad (9\text{-}32)$$

where, for the ith weapon system engaging the kth type targetable helicopter with $EWPN_i$ and $LOSS_k$ as defined above:

ENG_{ik} = the number of engagements.

ACQ_{ik} = the probability of acquisition of the helicopter by the air defense system.

$PLOS_k$ = the probability of line of sight to the kth type helicopter.

MNV = the degradation factor due to helicopter maneuvers.

$CELL_k$ = the number of k type helicopters in the cell.

(1) Acquisition. ACQ_{ik}, the probability of detection of a helicopter by an air defense system, is a function of the air defense system and its acquisition sensor, the helicopter type, the range, visibility, and day/night condition. The acquisition data probabilities are contained in the classified data appendix to this report.

(2) $PLOS_k$. The probability of line of sight to the helicopter is assumed to equal the line of sight from the helicopter to the maneuver weapons. These values are shown in table 47 for helicopters using pop-up tactics. Helicopters in a racetrack pattern are fully exposed, and the value for $PLOS_k$ is 1.00.

(3) MNV. The helicopter maneuver factor (MNV) accounts for the decreased capability of an air defense weapon to successfully engage a helicopter carrying out evasive maneuver tactics. A value of .9 has been assigned to this paramenter based on the SCORES "Jiffy" War Gaming Methodology (reference 5).

(4) Distribution of air defense engagements to the different helicopters is directly proportional only to the helicopter configuration of the cell and is accounted for in the equation (9-32) by the ratio, $(CELL_k - LOSS_k) / \sum_{all\ k} (CELL_k - LOSS_k)$. This distribution scheme arises from the assumption that AD systems cannot distinguish among different types of helicopters when engaging a heterogeneous cell.

(5) Some air defense weapons guided by infrared sensors; e.g., Redeye, SA-7, and SA-9, are susceptible to frequent losses of IR lockon opportunities. To account for this, the number of engagements is reduced by 30 percent, a factor which is documented in the SCORES "Jiffy" War Game Methodology (reference 5).

c. Helicopter losses. The general assessment equation, equation 9-1, as formulated to compute helicopter losses is:

$$ACKILL_k = \left(1 - \prod_{\text{all } i} \left(1 - \frac{SEKP_{ik}}{NA_k}\right)^{ENG_{ik}}\right) \cdot NA_k \qquad (9\text{-}33)$$

where, for the ith type AD weapon engaging the kth type helicopter with ENG_{ik} as defined above:

$ACKILL_k$ = the number of helicopters killed.

$SEKP_{ik}$ = the single engagement kill probability.

NA_k = the number of helicopters engaged.

The single engagement kill probabilities ($SEKP_{ik}$) for AD systems firing against helicopters are classified. The effect of IR countermeasures (IRCM) was determined to degrade the Stinger, Redeye, and Chaparral missiles systems. IRCM had no effect on remaining air defense IR acquisition systems. The effect of ECM was not considered on the data development for radar acquisition air defense systems. The SEKP are given from 500 to 5000 meters in 500-meter increments. For generic type air defense guns with acquisition radar, the single engagement kill probabilities differ against helicopters with and without mast-mounted sights. The probabilities for air defense guns against helicopters with mast-mounted sights are contained in the classified data base. They were generated using the SALVO model with data obtained from the Aviation School, Fort Rucker.

The outcome of equation 9-33 represents the total number of a given type helicopter killed by opposing AD weapons. To provide more specific results at the conclusion of the assessments, the number of helicopters killed by each different AD system is determined by an apportionment algorithm expressed algebraically as:

$$KILL_{ik} = \frac{1 - PK_{ik}}{\sum_{\text{all } i} (1 - PK_{ik})} \cdot ACKILL_k \qquad (9\text{-}34)$$

where, for type i AD firers against type k helicopters:

$KILL_{ik}$ = the number of helicopters killed by firer.

$ACKILL_k$ = the total helicopters killed.

$1 - PK_{ik}$ = the probability that the firer killed the helicopter, where:

$$PK_{ik} = \left(1 - \frac{SEKP_{ik}}{NA_k}\right)^{ENG_{ik}} \tag{9-35}$$

with $SEKP_{ik}$, NA_k, and ENG_{ik} as defined above.

3. Armed helicopter assessments. Armed helicopter assessments are made against all front line ground systems in the opposing force array.

a. Targetable weapons. The following equation gives the number of weapon systems of type j available for assessment:

$$TGT_j = (NW_j \cdot OA_j - LOSS_j) \cdot FE \cdot PSN \cdot PNSMK_m \tag{9-36}$$

where, for the jth weapon system:

TGT_j = the number of targetable weapon systems.

NW_j = the number of weapons at the beginning of the attack helicopter/air defense routine.

OA_j = the operational availability of the weapon system.

$LOSS_j$ = the number of weapons lost in previous AH/AD assessments (cumulative).

FE = the fraction of maneuver forces engaged.

PSN = the tactical deployment factor.

$PNSMK_m$ = the fraction of unsmoked targets which is dependent upon the force, the type of helicopter target acquisition sight, and the type of smoke as defined in paragraph 10.

The operational availability (OA_j) for all targeted weapon systems are given in tables 14 and 15. Tactical positioning factors (PSN) are found in table 17 for attacking and defending forces. The fraction engaged (FE) is the average fraction of weapons belonging to one defending maneuver unit, PC_i, as calculated by equation 9-31, or the fraction belonging to three attacking maneuver units ($3 \cdot PC_i$).

b. Fire distribution factors. The proportion of helicopter fire allocated to a particular type of target j is computed by:

$$FDF_j = \frac{FPS_j \cdot (NW_j \cdot OA_j - LOSS_j) \cdot FE}{\sum\limits_{\text{all } j} FPS_j \cdot (NW_j \cdot OA_j - LOSS_j) \cdot FE} \qquad (9\text{-}37)$$

where, for the jth type targeted weapon system with NW_j, OA_j, $LOSS_j$ and FE as defined above:

FDF_j = the fire distribution factor.

FPS_j = the firepower score of the weapon.

The classified firepower scores (FPS_j) are contained in table 8-1 of the classified data appendixes, Volume III. Unclassified firepower scores for unclassified processing are given in table 1. Since certain air defense systems are located within front line maneuver units, they are included in the target array for helicopters. Due to the air defense threat, helicopters may desire a higher priority for firing at targetable air defense weapons than would be realized in a straightforward application of equation 9-37. If so, the amount of helicopter fire directed against air defense systems is increased by multiplying their firepower scores, for use in equation 9-37, by an appropriate factor from 1 to 5, which adjusts their computed fire distribution factors. This factor is a manual gamer input.

c. Rounds expended. For each type of ordnance, the number of rounds/bursts fired during a pop-up is calculated by:

$$ROUNDS_{ijk} = POPORD_{ik} \cdot (CELL_k - LOSS_k) \cdot SH_k \cdot FDF_j \cdot PNSMK_m \qquad (9\text{-}38)$$

where for the ith type ordnance fired by the type k helicopter at type j targets with FDF_j, $CELL_k$, and $LOSS_k$ as defined above:

$ROUNDS_{ijk}$ = the number of rounds fired per assessment.

$POPORD_{ik}$ = the number of rounds per pop-up fired by the helicopter.

SH_k = the fraction of type k helicopters unsuppressed.

$PNSMK_m$ = the fraction of helicopters not smoked which is dependent upon the force, the type of helicopter acquisition sight, and the type of smoke as defined in paragraph 10.

For each type of helicopter the number of rounds of each type fired per pop-up is calculated by use of equation 9-28 and the methodology in subparagraph 9d(5)(d). The helicopter suppression adjustment factor, listed in table 13, multiplied by the appropriate suppression factor in table 12 gives the fraction of the helicopters suppressed. For helicopters, suppression is based on the fire support firepower ratio since they are generally outside the range of maneuver systems.

d. Ground losses. The general assessment equation as applied to helicopter assessments of ground forces is:

$$GFKILL_j = \left\{ 1 - \prod_{all\ k} \prod_{all\ i} \left(1 - \frac{SSKP_{ij}}{TGT_j}\right)^{ROUNDS_{ijk} \cdot ADUST_i \cdot ABORT_i} \right\} \cdot TGT_j \quad (9\text{-}39)$$

where, for ordnance type i fired by type k helicopters against type j targets with TGT_j and $ROUNDS_{ijk}$ as defined above:

$GFKILL_j$ = the number of targets killed.

$SSKP_{ij}$ = the single shot kill probability.

$ABORT_i$ = the probability that the missile will not be aborted during its flight because of loss of line of sight to target, suppression of designator, or mechanical failure.

$ADUST_i$ = the probability that the round is not aborted due to dust conditions.

The single shot kill probabilities ($SSKP_{ik}$) for helicopter weapons are classified and contained in table B-9 of the classified data appendixes, Volume III. The target type, ordnance type, and range are needed to enter the SSKP table. The methodology for calculating the SSKP is identical to that for the armor/antiarmor combat assessments (paragraph 9d(3)). Consequently, the actual SSKP value used in equation 9-39 is a weighted average, depending on the target posture, of two values extracted from the table.

The number of rounds, $ROUNDS_{ijk}$, is modified by the $ABORT_i$ and $ADUST_i$ factors only when the ordnance type i is a missile. For all other helicopter ordnance types, both factors equal 1.00. A value of .8 has been assigned to $ABORT_i$ which is based on the HELLFIRE COEA and military judgment. The probability of abort due to dust ($1-ADUST_i$) is based on sufficient loss of energy transmission at the seeker caused by the dust between the source and the target so as to prohibit missile guidance. The dust factor depends on the dust level, range, visibility conditions, and missile type. These factors are contained in tables 62 and 63 while the dust methodology is documented in paragraph 11.

The helicopter assessment equation, like others previously described, computes the total number of targets killed by all helicopters. To obtain more detailed killer-victim statistics, this total is apportioned among the different types of helicopters involved by the following equation:

$$KILL_{jk} = \frac{1 - PK_{jk}}{\sum_{all\ k} (1 - PK_{jk})} \cdot GFKILL_j \qquad (9\text{-}40)$$

where, for type k helicopters firing at type j targets with $GFKILL_j$ as defined above:

$KILL_{jk}$ = the targets killed by helicopters.

$1-PK_{jk}$ = the probability the helicopters killed the target, where, for type ordnance i:

$$PK_{jk} = \prod_{all\ i} \left(1 - \frac{SSKP_{ij}}{TGT_j}\right)^{ROUNDS_{ijk} \cdot ADUST_i \cdot ABORT_i} \qquad (9\text{-}41)$$

for $SSKP_{ij}$, TGT_j, and $ROUNDS_{ijk}$, $ADUST_i$ and $ABORT_i$ as defined above. It should be observed that this apportionment accounts for those targets killed by all the different types of ordnance the helicopter carried.

(f) Personnel casualties. The only personnel casualties produced by air defense assessments are the crew losses associated with the helicopters that are killed. No infantrymen are killed in conjunction with helicopter losses. Casualties to both mounted and dismounted infantry personnel together with associated weapons/materiel are incurred during helicopter assessments against ground forces. Dismounted infantry personnel are directly targeted for attrition by helicopter fire, while mounted infantry casualties are based on the losses incurred by armored personnel carriers (APCs). The methodology for determining mounted infantry casualties, all infantry weapon/materiel kills, and crew losses has been set forth in paragraph 9d(3)(c) and is directly applicable to the attack helicopter/air defense combat assessment.

(g) Ammunition expenditure. The number of rounds fired by helicopters and air defense weapons is accumulated by individual round type in an ammunition consumption array. This array is provided as part of the game results.

In general the number of rounds of each ordnance type expended per pop-up by an attack helicopter type k at a target type j is determined by equation 9-38. The value of ROUNDS is calculated for the number of missiles/rockets/bursts fired per pop-up. Thus, for 23mm and 30mm HE, this number must be multiplied by the number of rounds per burst. To obtain the round expenditure, the variable ROUNDS, in equation 9-38, is multiplied by 25 rounds/burst for 30mm ordnance and by 100 rounds/burst for 23mm ordnance.

The ammunition expenditure of an air defense system against a given type helicopter per pop-up is given by:

$$ADROUNDS_{jk} = ENG_{jk} \cdot ADB_j \qquad (9\text{-}42)$$

where, for air defense system type j against helicopter type k, ENG_{jk} is as defined in equation 9-32:

$ADROUNDS_{jk}$ = the number of rounds expended per pop-up.

ADB_j = the number of rounds per bursts for type i air defense system ordnance.

For the air defense guns, the number of rounds per burst are contained in table 50. The remaining air defense systems expend only one missile per engagement.

(6) TACAIR assessments. Although the CACDA "Jiffy" war gaming process considers both attacks by and defense against tactical aircraft (TACAIR), no assessments of combat involving TACAIR are made by the Jiffy model. Casualties incurred during TACAIR attack missions are assessed by a separate model known as TALON, developed and run by the US Air Force Tactical Fighter Weapons Center (USAFTFWC). The losses resulting from TACAIR combat, as determined by the TALON model, are added to the losses resulting from the Jiffy model combat assessments so that they are apportioned to units on the force file in accordance with the procedure described in paragraph 15.

10. SMOKE.

a. General. Smoke is not explicitly modeled in Jiffy, but rather for each force the portion of friendly units self-smoked and the fraction of the enemy force smoked are determined off-line. These numbers are an average effect during the entire critical incident and are used in the rate of advance calculations, and in the attack helicopter/air defense, indirect fire, and armor/antiarmor assessment routines. The armor/antiarmor smoke fractions are determined by gamer judgment and an off-line computation for each separate engagement and last for only the duration of that engagement. Smoke also affects the indirect fire assessments by reducing the number of HE/ICM battery missions by the appropriate number of smoke missions.

b. Types of Smoke. Smoke in Jiffy is characterized by two types of smoke. The first type is conventional smoke, which includes indirect fire smoke rounds, HC, white phosphorous (WP) smoke, and self-generated smoke produced by smoke pots or by engine fuel (Diesel) on the exhaust manifold. The effect of conventional smoke, on all weapon systems is that only systems equipped with thermal devices (far infrared imagers) or with radars can penetrate the smoke. Weapon systems with optical and image intensifier (I^2) sights cannot see through it. In the Jiffy game for Europe III, conventional smoke is the only type of smoke employed by either side. However, the model has the capability to employ a second type of smoke, which is a far-IR screening smoke/obscurant. Currently, radars are the only sensor capable of penetrating this type of smoke. The effects of both conventional and far-IR screening smoke/obscurant on the weapon firepower scores in the rate of advance calculations, and on the individual weapon systems as both firers and targets in the armor/antiarmor routine, the indirect fire and CLGP routines, and the attack helicopter/air defense routine will be discussed more explicitly in the following subparagraphs.

c. Methodology.

(1) Rate of advance calculations. Smoke in this routine degrades the maneuver firepower scores of individual weapons. This, in turn, affects the rate of advance and the suppression factors, which are based upon firepower ratios. In general, the fraction of the firepower score of weapon k side i not degraded by smoke is determined by the following equations:

$$PNSMK_{ik} = (1 - P_j)(1 - .5P_i)(1 - Q_i) \qquad (10\text{-}1)$$

where:

$PNSMK_{ik}$ = the fraction of weapon k side i that is not degraded by smoke.

Q_i = the fraction of side i degraded by side i's self-smoke.

P_i = the fraction of side j degraded by smoke from side i.

P_j = the fraction of side i degraded by smoke from side j.

As the equation illustrates, the methodology assumes that if Blue smokes the opposing force to obscure 50 percent of Red's forward elements, this smoke will also obscure Blue's forward elements by one half of this, 25 percent. Also, self-smoke by side i, Q_i, does not degrade the opposing force. The values input to the rate of advance routine for P and Q are based on the average effect over the entire critical incident. In addition, the type of smoke, conventional or far-IR screening smoke/obsurant, employed is specified by the gamers in this routine. The value of $PNSMK_{ik}$ is dependent upon the type of smoke and the type of sight weapon k is equipped with. In general, if weapon k is equipped with a thermal device, all values of P and Q used in equation 10-1 become zero unless the smoke is a far-IR screening smoke/obsurant. If the weapon k is equipped with radar, all values for P and Q become zero regardless of the type of smoke.

(a) Optical sights, I^2s, and eyeballs. Weapon systems relying on optical sights, I^2s, or eyes cannot penetrate either conventional or far-IR screening smoke/obsurant and are degraded according to equations 10-1.

(b) Thermal sights. Weapons equipped with thermal sights are not degraded by conventional smoke. However, they cannot penetrate far-IR screening smoke/obsurant and their firepower scores are degraded for this type of smoke according to equation 10-1.

(c) Radars. Radars are not affected by any type of smoke. Thus, the firepower scores of weapons equipped with radars are not degraded.

(d) Example. If both sides employ smoke with a degradation factor of 40 percent (P_i = .40 (conventional smoke) and P_j = .40 (far-IR screening smoke/obsurant)) with no self-smoke, the effect on different weapon systems varies. For a radar, $PNSMK_{ik}$ = 1.0. For a system on side i with a thermal device, which is degraded only by the far-IR screening smoke/obsurant P_j, $PNSMK_{ik}$ = (1 - .40)(1 - 0)(1 - 0) = .60 while on side j, $PNSMK_{jk}$ = (1 - 0)(1 - .20)(1 - 0) = .80. A system with only optical sights is degraded by both types of smoke; i.e., $PNSMK_{ik}$ = (1 - .40)(1 - .20)(1 - 0) = .48, which is 48 percent of its original firepower score remaining. The adjusted firepower scores are then used in the calculation of the firepower ratios, which affect the rate of advance and the suppression factors.

(2) Armor/antiarmor assessments. The armor/antiarmor routine is fought in a series of engagements at various ranges. The gamers determine the fraction of each force smoked for each engagement. This allows gamers to more realistically portray the point in the battle when smoke would be employed rather than to use the average effectiveness for the entire critical incident. The type and amount of smoke in the engagement affect the numbers of individual weapon systems available both as targets and firers that enter the assessment equation. The fraction of each weapon type k not degraded for smoke is calculated using equation 10-1 considering the type of sight for armor weapon k. Smoke requires that modifications be made in the normal use of the assessment equation since systems with thermal and optical sights can see and engage a different number of targets. The assumption and form of the assessment equation, 9-1, require that the number of type k targets, T_k, remain constant in each use of the equation because the equation is aggregated for all firers. Therefore, for smoke the routine is structured so that two passes are made through the assessement equation for each weapon system. In the first pass, all firers engage only targets in the open (not in any smoke). The second pass allows only systems with thermal sights to fire at targets smoked by conventional smoke. Table 51 displays the fractions of firers and targets for each pass and each type of smoke. The fraction of unsmoked weapons is calculated from equation 10-1 and the sensor type of the weapon, as discussed below.

(a) No smoke. As depicted in table 51, neither optics nor thermals is degraded.

(b) Conventional smoke. On the first pass the fraction of unsmoked firers, PUN(J), with optical systems engage unsmoked targets, PUN(L). Since they cannot penetrate conventional smoke, they do not conduct the second pass. Thermals, however, are not affected by conventional smoke and, as illustrated in table 51, the two passes allow all available firers with thermal sights to fire at all available targets. The percent of those firers in each pass is the same as the percent of the targets being engaged.

(c) Far-IR screening smoke/obscurant. For systems with optical sights, the passes are the same as for conventional smoke since the sights cannot penetrate either. However, as table 51 shows, two passes for weapons with thermal sights allow all targets not obscured by far-IR screening smoke/obscurant, PUN(L+2), to be engaged by all weapons not obscured by far-IR screening smoke/obscurant, PUN(J+2). On the first pass unsmoked targets are engaged. On the second pass those targets in conventional smoke (PUN(L+2) - PUN(L)) are engaged. The thermals that are not in the far-IR screening smoke/obscurant, (PUN(J+2)) fire in proportion to the ratio of unsmoked targets to targets not obscured by far-IR screening smoke/obscurant.

(3) Attack helicopters/air defense assessments. The percentages required for all calculations in this routine are those passed from the rate of advance routine and are based on an average effect over the entire critical incident.

(a) Air defense systems. The air defense systems modeled in Jiffy use one of the three following categories of target detection sensors: eyeballs or optics, radars, or thermal imagers. The effect of smoke on these sensor categories depends on the type of smoke as described in 10b(1) for the rate of advance calculations. The use of the general assessment equation 9-1 for air defense firers requires that three complete passes of the equation for each firer be made so that on any given pass, the number of type k targets, T_k does not vary. Table 52 contains the fraction of air defense firers and attack helicopter targets for each pass and each type of smoke. The fraction of unsmoked air defense systems is determined by the use of equation 10-1 taking into account the type of sensor the AD firer is equipped with. The fraction of helicopters obscured is assumed to be less than other ground elements since they have more maneuverability to avoid the smoke. In general, the fraction of type k helicopters smoked is one-half the fraction of other maneuver elements smoked, i.e., $(1 - PNSMK_{ik})/2$ where $PNSMK_{ik}$ is as defined in equation 10-1 in conjunction with its type of sensor, optics or thermal. The fraction of helicopter type k not obscured is therefore $1 - (1 - PNSMK_{ik})/2$. This calculation for the unsmoked attack helicopters is used for helicopters both as targets and firers. The effect of smoke on air defense weapons with the various sensors is discussed below:

1. No smoke. As table 52 shows there is no smoke effect and all available air defense systems fire at all available helicopters in the first pass.

2. Conventional smoke. For weapons using eyeballs or optical sights for targeting, the unsmoked air defense weapons (PUN(J)) engage unsmoked helicopters (PUN(L)) on the first pass through the assessment equation. Since they cannot penetrate conventional smoke, they do not make additional passes. Radar and thermal imagers, however, penetrate conventional smoke and all available firers equipped with these sensors fire at all available targets as table 52 depicts. On the first pass only unsmoked helicopters (PUN(L)) are engaged while on the second pass the remaining ones are engaged. In both cases the fraction of air defense systems firing equals the fraction of targets engaged.

3. Far-IR screening smoke/obscurant. The employment of this type of smoke affects the three categories of sensors used on air defense systems differently, which necessitates the three pass assessment. As illustrated in table 52 the unsmoked air defense systems using optics or eyeballs only fire at unsmoked helicopters. Because thermals cannot penetrate far-IR screening smoke/obscurant, these type of air defense systems can engage only helicopters when both the firers and the targets are either unsmoked or in conventional smoke. As table 52 shows, the sum of first and third pass has all thermal firers who are not obscured by far-IR screening smoke/obscurant (PUN (J+2)) engaging all targets not obscured by far-IR screening smoke/obscurant (PUN (L+2)). Radar air defense systems are not affected by any type of smoke and experience no smoke degradation to firers or targets. Their assesssments are completed in the first two passes.

(b) Attack helicopters. The effect of various types of smoke on assessments with attack helicopters as firers is similar to that of the armor/antiarmor routine. In both cases firers have optics or thermal imagers for target acquisition sensors and can acquire different numbers of targets, which requires a two pass assessment. The fraction of attack helicopters firing is $1 - (1 - PNSMK_{ik})/2$, as previously discussed, where $PNSMK_{ik}$ is determined from equation 10-1 and the type of AH sensor. Table 53 displays the fractions used in the two passes required for this assessment.

1. No smoke. There is no degradation to firers or targets.

2. Conventional. Unsmoked systems equipped with optics fire only at unsmoked targets. For helicopters with thermal sights all available firers engage all available targets.

3. Far-IR screening smoke/obscurant. Helicopters with optic sensors fire only at targets, both of which are unsmoked. Helicopters equipped with thermal sights cannot penetrate this smoke. Therefore, the fraction of helicopters, PUN(J+2), not obscured by this type of smoke, fire at the fraction targets, PUN(L+2), not obscured by this smoke, as the sum of the two passes illustrates.

(4) Indirect fire assessments. Although smoke has no effect on the number of targets for artillery systems, the requirement for mortars or artillery tubes to deliver smoke rounds reduces the number of indirect fire battery missions. During the indirect fire assessments, the gamers specify the fraction of battery missions used by smoke employers firing smoke rounds.

(5) CLGP assessments. CLGP missions are employed against maneuver targets that are designated by a GLLD and against artillery targets that are designated by aerial designators. The employment of smoke does not degrade the number of artillery targets. Smoke does affect the number of maneuver targets though, since only unsmoked maneuver systems may be targeted, with the fraction of unsmoked systems determined by equation 10-1.

11. DUST. The capability to play dust was recently added to the model as a degradation factor. The dust number is defined as the expected number of rounds impacting per minute per maneuver unit area. The highest dust number determines the dust level. There are three levels of dust: no dust, light dust, and heavy dust, as shown in table 61.

a. Assumptions. Some of the considerations that led to the Jiffy dust methodology are CONFIDENTIAL and are not discussed here (they are discussed in ATZLCA-CAA memorandum, CONFIDENTIAL, dated 24 May 1979). The following unclassified assumptions bear directly on the implementation.

(1) Dust effects in Jiffy will degrade ground and aerial direct fire missile systems and CLGP.

(2) Air defense missiles will not be degraded since they clear the impact areas very quickly during the early portion of the missile flight.

(3) Three levels of dust will be played with no interpolation between levels: no dust, light artillery barrage, and heavy artillery barrage.

(4) Effects of friendly and enemy artillery fire will not be considered cumulative, and only the larger of the two will be used in the calculations.

b. Implementation.

(1) Dust number. The Blue dust number D is determined as follows:

$$D = \frac{H}{60 \cdot M \cdot FMASS} \tag{11-1}$$

where:

H = the number of Red combat support artillery rounds fired per hour at Blue maneuver systems.

M = the number of Blue maneuver units in the sector.

FMASS = the fraction of the sector that Red masses his attack. The Red dust number is similarly determined. (FMASS in the Red dust number equation will be 1 unless Blue is the attacker.)

(2) Dust level. The maximum of the Blue and Red dust numbers determines the dust level as indicated in table 61.

(3) CLGP. Dust causes the number of unaborted CLGP rounds R to be modified. R becomes: R · (1-PDUST), where PDUST is a dust degradation factor and depends on the dust level and visibility. Table 60 shows that with heavy dust and visibility condition 2, all CLGP rounds are aborted. This table and the subsequent dust tables give probabilities that dust will cause round abortion.

(4) Armor/Antiarmor. Dust causes round abortion for the TOW, HOT, DRAGON, MILAN, SPIGOT and SPANDREL missiles. Thus, in these cases, RND, the unaborted rounds, becomes RND (1-PDUST) where PDUST depends on dust level, range, and visibility as shown in table 62.

(5) Attack helicopter. Dust causes the number of unaborted AH missiles (rounds) to be modified. Rounds become ROUND (1-PDUST) where PDUST depends on dust level, range, visibility, and round type. Tables 62 and 63 shows PDUST for wire guided aerial missiles and laser guided aerial missiles, respectively.

12. ELECTRONIC WARFARE (EW).

a. <u>Methodology</u>. EW is accounted for in the rate of advance routine and in the artillery assessments routine. In the rate of advance routine, EW degrades the enemy's firepower score. In the artillery assessment routine EW degrades the number of the enemy's battery missions. In the ROA, if EW is played against force j:

$$FPS = (1\text{-}PCDGR(1))\ AD + (1\text{-}PCDGR(2))\ AH + (1\text{-}PCDGR(3))\ ART + (1\text{-}PCDGR(4))\ MNV + ACFPS \quad (12\text{-}1)$$

where:

PCDGR(1), PCDGR(2), PCDGR(3) and PCDGR(4) are, respectively, the percents that AD, AH, ART, and MNV FPS are degraded. AD, AH, ART, and MNV are the firepower scores, respectively, of all of side j's air defense, attack helicopter, artillery, and ground maneuver systems; ACFPS is the TACAIR firepower score; and FPS is side j's new total firepower score. The number of battery missions available to be fired by side j is degraded by PCDGR(3); that is:

$$BMEW = BM\ (1\text{-}PCDGR(3)) \quad (12\text{-}2)$$

where BM and BMEW are the number of missions available, respectively, before and after communications jamming.

b. Degradation Factors. The degradation factors for EW were previously calculated off line. This calculation has been implemented in the Jiffy III code and is described below. The tables for this application were derived from E-War Adaptation to First Battle, CGSC, Fort Leavenworth. For N = 1,2,3,4:

$$PCDGR(N) = PCFPR(N,M)\ .\ PCEFF(N) \quad (12\text{-}3)$$

where PCDGR(N) is as above and PCFPR(N,M) and PCEFF(N) are, respectively, the percent of reduction of the affected units and the percent units of type N that are affected by radio jamming. M is an integer between 1 and 6 determined by a random variable.

(1) PCFPR(N,M) is determined from table 54.

(2) PCEFF(N) is the percent of the units of type N affected by EW. Each unit (subject to EW) in the sector is assigned one of the EW types when it is created. Table 55 gives the number of EW missions required to jam each unit of type N. An entire unit, not a percentage of it, must be jammed.

c. Number of Missions. The number of missions (max = 50) available is input by the user. These missions are then used to degrade the AD units. If there are not enough missions to degrade all the AD units, then PCEFF(N) = number of jammed AD units degraded divided by the total number of AD units. Any remaining missions are then used to degrade in turn the AH, ART, and MNV units. This priority is inherent in the program but the user can change this order. For example, the user can require that the ART units be degraded first. This will assure maximum mission degradation in the artillery routine.

13. AUTOMATIC COMPUTATION OF THE MASS VALUE OF GROUND UNITS AS REQUIRED BY THE TACTICAL AIR LAND OPERATIONS (TALON) MODEL.

a. General. The purpose of the computation of the mass value of ground units is to keep the ground games synchronized in the Jiffy and the Tactical Air Land Operations (TALON) war games. The mass value describes the relative target value of the ground units, enabling the Air Force to input the air-to-land effects quantification into the SCORES scenario building process.

b. Methodology. At the end of each critical incident (CI), the TALON unit positions and strengths are aligned with the JIFFY maps and unit strengths. To align the unit strengths, a software package accesses the JIFFY data base and converts the mix of surviving weapon types into a homogeneous measurement of unit strength known as mass. The single weapon system mass value is computed using the killer-victim scoreboards from a number of battle results of various simulations and war games. A system of linear differential equations is solved using Eigen value techniques. The solution contains the capability of each weapon system to remove other systems from the battlefield. Where killer-victim scoreboards are not available for a particular weapon system, the technical characteristics and employment tactics are used to generate its contribution to the battlefield. With the ground games thus aligned, the Air Force gamers run the TALON war game to play interdiction and close air support missions.

14. MEASURES OF EFFECTIVENESS (MOE) GENERATED FROM POSTPROCESSOR. The output from Jiffy gaming is voluminous and consists of detailed unit status reports and game reports. All these reports pertain only to a critical incident (CI). The postprocessor is designed to provide specified game output reports as well as cumulative game output reports. The format of the loss by source-of-loss tables has been expanded to give losses by victim weapon system category in addition to victim weapon system type. The victim weapon system categories are the same as the killer categories. The postprocessor will enhance analyst and gamer efficiency and save time. Some of the specific outputs or MOEs and capabilities from the postprocessor are as follows:

a. Loss exchange ratio (LER) - The ratio of Red losses and Blue losses.

b. The surviving maneuver force ratio (SMFR) - The ratio of a side's surviving maneuver force to the starting maneuver force.

c. The surviving maneuver force ratio differential - Blue SMFR minus Red SMFR.

d. The force exchange ratio (FER) - the loss exchange ratio (LER) divided by the initial force ratio (IFR) (Red and Blue).

e. Initial force ratio.

f. Access the beginning strength record for each sector in the CI.

g. Accumulate the number of weapons by type in given units.

h. Ratio statistics given both by all major systems and by armor systems. Optional loss exchange ratios can be obtained for any set of Blue weapons (detailed discussion is given in the Users Manual, Volume IV).

i. The percent force committed in the armor routine by range band.

j. The percent targets smoked and self-smoked in the armor routine by range band.

k. The force structure by item code totals.

l. The numbers of maneuver units in the sector.

15. LOSS APPORTIONMENT.

a. General. The Jiffy model assessment methodologies determine the numbers of weapon systems lost in combat by each major force. These cumulative combat losses must then be distributed among the individual units in each force. This loss apportionment process is done after all the Jiffy model combat attrition has occurred and has provisions to apportion losses inflicted by tactical aircraft (TACAIR). Since losses to TACAIR are assessed against relatively few units, the losses are apportioned separately from the Jiffy model combat losses. Losses to TACAIR can be apportioned at the beginning of a sector game sequence before the other combat losses, at the end of a sector game sequence after the other losses, or losses can be divided in some manner between the beginning and the end. This allows more realistic simulation of TACAIR strike intensity and times at which strikes occur during a critical incident. All other losses to the units are apportioned as explained below.

b. Combat Intensity Levels. The number of weapon systems lost by each unit is based on a qualitative factor, which is an indicator of the intensity of combat in which the unit has been engaged. Six of these combat intensity levels have been defined as shown in table 56. As can be seen in the table, each combat intensity level has an apportionment factor associated with it. This factor denotes the portion of the weapon systems in the unit that are subject to the loss apportionment. It should be noted that if a unit is specified as being hit by TACAIR, not only is it subject to TACAIR apportionment but it is also considered for the apportionment of the Jiffy model combat losses as a unit in the main battle area.

c. Loss Apportionment Algorithm. The number of weapon systems attrited in each unit is a function of the number of a given type of weapon system lost, the number of that type of weapon system in a particular unit, and the combat intensity level of the unit. The number of a given type of weapon system lost in any particular unit is expressed by the algorithm:

$$NA_{ik} = \frac{N_{ik}\ NL_k}{CIL_i\ D_k} \qquad (15\text{-}1)$$

where, for the kth type weapon system and the ith unit:

NA_{ik} = the number of the weapon systems lost by the unit.

N_{ik} = the number of weapon systems in the unit.

NL_k = the total number of the weapon systems lost to the force.

CIL_i = the value (apportionment factor) of the combat intensity level of the unit.

D_k = the total number of the weapon systems in the force which are subject to loss apportionment and is expressed by:

$$D_k = \frac{N_{ik}}{\sum_{all\ i} CIL_i} \qquad (15\text{-}2)$$

where D_k, N_{ik}, and CIL_i are as defined above. Note that for this apportionment process to be valid, the total kth type weapon systems in a force subject to loss apportionment (D_k) must be greater than the number of the kth type weapon systems lost by a force (NL_k). Also note that if losses to TACAIR are apportioned to a force, the total number of kth type weapon sytems in the force subject to apportionment of the Jiffy model combat losses (D_k(JG)) must be reduced by the number of the kth type weapon systems lost to TACAIR, NL_k (TACAIR); or, in other words:

$$D_k\ (JG) = D_k - NL_k\ (TACAIR) \qquad (15\text{-}3)$$

The apportionment algorithm is used to apportion infantry casualties, their associated materiel losses, and crew-served weapon losses. The personnel lost with the crew-served weapons are calculated, not apportioned. The calculation is identical to that used for the determination of crew losses (paragraph 9d (4) (c)).

16. UNIT EFFECTIVENESS. The ability of a unit to perform its mission in combat is a qualitative assessment known as a unit's combat effectiveness. This measurement is difficult to quantify due to the number of intangible factors that affect it. Among these are troop morale, fatigue, leadership and the number of personnel and equipment operational in the unit. The Jiffy model computes a measure of the firepower remaining in a unit relative to the amount of firepower initially contained in the unit. This measurement is known as the unit effectiveness. The unit effectiveness is determined by the following equation.

$$UEFF_j = \frac{\sum_{all\ i} (N_{ij}\ FPS_i)}{ITFPS_j}(100) \qquad (16\text{-}1)$$

where, for the ith weapon systems of the jth unit:

$UEFF_j$ = the unit effectiveness.

N_{ij} = the number of weapons in the unit.

FPS_i = the firepower score of the weapon.

$ITFPS_j$ = the initial total firepower score of the unit at 100 percent strength.

The effectiveness of each unit is computed at the creation of the unit and updated in accordance with equation 16-1 each time losses are apportioned to the units.

17. RETURN TO DUTY CRITERIA. The Jiffy model calculates the portions of weapon systems lost in combat that are recoverable and nonrecoverable. The nonrecoverable losses are those weapon systems assumed to be destroyed or not able to be recovered due to adversities of terrain or tactical situation. The recoverable weapon systems are those accessible and repairable.

a. Three levels of repair for Blue weapon systems are considered in the Jiffy model.

(1) Division repair - used on equipment that is repairable with divisional maintenance support elements. Divisional mean time to repair is considered to be 2 days.

(2) COSCOM repair - used on equipment that is repairable with nondivisional direct/general support (DS/GS) maintenance level assets. Nondivisional DS maintenance is taken to be able to perform maintenance in either DISCOM or COSCOM areas. Mean time to COSCOM repair is taken as 5 days.

(3) Exceeding theater repair - combat damaged equipment that exceeds the in-country maintenance capability or capacity. Repair time is considered to be extensive. Table 57 contains expected percentages of recoverable and nonrecoverable weapon losses for categories of Blue weapon systems by combat posture and type of fire encountered. The recoverable percentages are subdivided for losses repairable at division, COSCOM, and those that exceed theater repair capabilities.

b. The return to duty criteria for Red weapon systems are classified and may be found in Volume III, appendix B, table B-9. Three levels of repairability are considered in the Jiffy model for Red recoverable weapon systems:

. Light - requires 2 days to repair.
. Medium - requires 5 days to repair.
. Major - requires 10 days to repair.

Table 58 contains a set of unclassified Red return-to-duty criteria developed for unclassified processing and documentation purposes.

Table 1. Unclassified firepower scores.*

Weapon System	Firepower Score
Trucks	5
Small Arms	1
VIPER, RPG-7	5
DRAGON, SPG-9	10
TOW, AT-4 SPIGOT	20
MILAN, PZIG	10
Tanks	100
Heavy Armored Inf Vehicles	75
Heavy Assault Guns	50
Light Armored Vehicles	10
ADA Guns	25
Manpack SHORAD Missiles	10
STINGER POST	20
SA-9	25
Mortars	75
Field Artillery	100
Attack Helicopter-1	20
Attack Helicopter-2	40
Attack Helicopter-3	60
Attack Helicopter-4	80
Light Observation Helicopter	10
Transport Helicopter	5

*The list of weapon systems and firepower scores contained in this table are for purposes of illustration only. See table B-1 in Vol. III of this report for the classified lists of weapons and firepower scores actually used in the Jiffy model.

Table 2. Rates of advance for meeting engagements.

Rates of Advance (kilometers per hour)

COMBAT RATIO (ATTACKER: DEFENDER)	A						B						C						D					
	GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR	
	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M
	Stalemate at less than 1.0:1																							
1.0:1	.5	.9	.3	.4	.2	.4	.4	.5	.2	.3	.1	.1	.3	.4	.1	.2	.1	.1	.1	.2	.1	.1	.1	.1
1.5:1	.9	1.7	.5	.8	.3	.5	.8	1.0	.3	.5	.1	.3	.5	.6	.2	.4	.2	.3	.2	.4	.2	.2	.2	.2
2.0:1	1.3	2.0	.8	1.3	.5	.8	1.0	1.6	.5	1.0	.3	.7	.8	1.2	.4	.8	.3	.5	.4	.8	.3	.4	.3	.4
2.5:1	1.4	2.2	.9	1.4	.7	1.0	1.2	1.8	.7	1.2	.4	.8	.9	1.2	.4	.9	.3	.7	.5	.9	.4	.5	.3	.5
3.0:1	1.6	2.6	1.0	1.6	.8	1.2	1.3	2.1	.8	1.3	.5	.9	1.0	1.3	.5	1.0	.4	.8	.7	1.0	.5	.7	.4	.5
3.5:1	1.7	2.9	1.2	1.7	1.2	1.4	1.4	2.3	.8	1.4	.7	1.0	1.2	1.6	.7	1.2	.5	.9	.8	1.0	.5	.7	.4	.6
4.0:1	1.8	3.1	1.3	1.8	1.3	1.6	1.6	2.6	.9	1.6	.8	1.2	1.3	2.0	.8	1.3	.7	1.0	1.0	1.2	.6	.8	.5	.7
5.0:1	2.1	3.4	1.4	2.0	1.4	1.7	1.7	2.7	1.0	1.7	.9	1.3	1.4	2.1	.8	1.4	.7	1.2	1.2	1.3	.7	.8	.6	.7
6.0:1	2.2	3.9	1.4	2.1	1.6	1.8	1.8	3.3	1.0	1.8	.9	1.4	1.6	2.6	.8	1.6	.7	1.3	1.2	1.3	.7	.8	.7	.8
8.0:1	2.3	4.6	1.6	2.6	1.8	2.0	2.0	3.9	1.2	2.3	1.0	1.7	1.7	3.3	.9	2.1	.8	1.6	1.3	1.4	.8	.9	.8	.9

Terrain *
Visibility
Attacker Mobility
D=Dismounted
M=Mounted

NOTES:

1. Stalemate Ratio: No advance with less than 1:1 ratio. Assumption based on RAC TBM-68.

2. Minefields/Barriers: Reduce rates of advance to 75 percent when mines are played.

* A -- Open terrain
B -- Rolling terrain
C -- Hilly terrain
D -- Mountainous terrain

Table 3. Rates of advance for delaying or withdrawal actions.

Rates of Advance (kilometers per hour)

COMBAT RATIO (ATTACKER: DEFENDER)	A						B						C						D					
	GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR	
	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M
	Stalemate at less than 0.8:1																							
0.8:1	.3	.5	.2	.3	.1	.1	.3	.3	.1	.2	.1	.1	.2	.3	.1	.1	None							
1.0:1	.6	.9	.3	.5	.2	.2	.5	.6	.2	.3	.1	.2	.3	.5	.2	.2	.1	.1	None					
1.5:1	1.0	1.7	.6	.9	.3	.4	.9	1.2	.3	.6	.1	.3	.6	.9	.3	.4	.1	.3	.1	.1	None			
2.0:1	1.5	1.9	.9	1.5	.6	.9	1.2	1.8	.6	1.2	.3	.7	.9	1.3	.4	.9	.3	.6	.4	.9	.3	.4	.1	.3
2.5:1	1.6	2.2	1.0	1.6	.7	1.0	1.3	2.1	.7	1.3	.4	.9	1.0	1.5	.4	1.0	.3	.7	.6	1.0	.4	.6	.3	.4
3.0:1	1.8	2.9	1.2	1.8	.9	1.2	1.5	2.4	.9	1.5	.6	1.0	1.2	1.6	.6	1.2	.4	.9	.7	1.2	.6	.7	.4	.6
3.5:1	1.9	3.2	1.3	1.9	1.0	1.3	1.6	2.6	.9	1.6	.8	1.2	1.3	1.8	.7	1.3	.6	1.0	.9	1.2	.6	.7	.4	.6
4.0:1	2.1	3.5	1.5	2.1	1.2	1.5	1.8	2.9	1.0	1.8	.9	1.3	1.5	2.2	.9	1.5	.7	1.2	1.2	1.3	.7	.9	.6	.7
5.0:1	2.4	3.8	1.6	2.2	1.3	1.6	1.9	3.1	1.2	1.9	1.0	1.5	1.6	2.4	.9	1.6	.7	1.3	1.3	1.5	.7	.9	.6	.7
6.0:1	2.5	4.4	1.6	2.4	1.5	1.8	2.1	3.7	1.2	2.1	1.0	1.6	1.8	2.9	.9	1.8	.7	1.5	1.3	1.5	.7	.9	[illegible]	.7
8.0:1	2.5	5.1	1.8	2.9	1.6	2.1	2.4	4.4	1.3	2.6	1.2	1.9	1.8	3.7	1.0	2.4	.9	1.8	1.4	1.6	.8	1.0	.7	

Terrain * / Visibility / Attacker Mobility: D=Dismounted, M=Mounted

NOTES:

1. Stalemate Ratio: No advance with less than .8:1 ratio. Assumption based on RAC TBM-68, Vol III, pp 48-52.

2. Minefields: When minefields are employed rates of advance are reduced to 75 percent.

3. Attack Against Withdrawing Force: Increase mounted rate by a factor of 1.5. Assumption based on RAC TBM-68.

* A -- Open terrain
B -- Rolling terrain
C -- Hilly terrain
D -- Mountainous terrain

Table 4. Rates of advance for attacks against fortified positions.

Rates of Advance (kilometers per hour)

COMBAT RATIO (ATTACKER: DEFENDER)	A						B						C						D						Terrain*
	GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		Visibility
	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	Attacker Mobility D=Dismounted M=Mounted
	Stalemate at less than 2.0:1																								
2.0:1	.2	.4	.1	.2	.1	.1	.2	.3	.1	.2	.1	.1	.1	.2	.1	.1	.1	.1	----------None--------						
2.5:1	.2	.4	.2	.2	.1	.2	.2	.3	.1	.2	.1	.1	.2	.2	.1	.2	.1	.1	.1	.1	-----None---				
3.0:1	.3	.5	.2	.3	.1	.2	.2	.4	.1	.2	.1	.2	.2	.3	.1	.2	.1	.1	.1	.2	.1	.1	.1	.1	
3.5:1	.3	.5	.2	.3	.2	.2	.2	.4	.1	.2	.1	.2	.2	.3	.1	.2	.1	.2	.1	.2	.1	.1	.1	.1	
4.0:1	.3	.6	.2	.3	.2	.3	.3	.5	.2	.3	.1	.2	.3	.4	.2	.3	.1	.2	.1	.2	.1	.1	.1	.1	
5.0:1	.4	.6	.2	.4	.2	.3	.3	.5	.2	.3	.2	.2	.3	.4	.2	.3	.1	.2	.2	.2	.1	.1	.1	.1	
6.0:1	.4	.7	.2	.4	.3	.3	.3	.6	.2	.4	.2	.3	.4	.5	.2	.3	.1	.2	.2	.2	.1	.2	.1	.1	
8.0:1	.5	.8	.3	.5	.3	.4	.4	.7	.3	.4	.3	.4	.4	.6	.3	.4	.2	.3	.2	.2	.1	.2	.1	.1	

NOTES:

1. Stalemate Ratio: No advance with less than 2:1 advantage. Assumption based on RAC TBM-68.

2. Minefields/Barriers: Table assumes use of mines/barriers.

3. Deliberate defense of a riverline is considered fortified zone.

4. For combat in cities, use basic rate above and reduce to 20 percent if deliberate defense exists.

* A -- Open terrain
B -- Rolling terrain
C -- Hilly terrain
D -- Mountainous terrain

Table 5. Rates of advance for attacks against prepared positions.

Rates of Advance (kilometers per hour)

COMBAT RATIO (ATTACKER: DEFENDER)	A						B						C						D						Terrain *
	GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		Visibility
	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	Attacker Mobility D=Dismounted M=Mounted
	Stalemate at less than 1.7:1																								
1.7:1	.5	.8	.3	.4	.2	.2	.4	.6	.2	.3	.1	.2	.3	.4	.1	.2	.1	.1	.1	.2	----None-----				
2.0:1	.6	.9	.3	.6	.2	.3	.5	.7	.2	.5	.1	.3	.3	.5	.2	.3	.1	.2	.2	.3	.1	.2	.1	.1	
2.5:1	.6	1.0	.4	.6	.3	.4	.5	.8	.3	.5	.2	.3	.4	.5	.2	.4	.1	.3	.2	.4	.2	.2	.1	.2	
3.0:1	.7	1.2	.5	.7	.3	.5	.6	.9	.3	.6	.2	.4	.5	.6	.2	.5	.2	.3	.3	.5	.2	.3	.2	.2	
3.5:1	.8	1.3	.5	.8	.4	.5	.6	1.0	.3	.6	.3	.5	.5	.7	.3	.5	.2	.4	.3	.5	.2	.3	.2	.2	
4.0:1	.8	1.4	.6	.8	.5	.6	.7	1.2	.4	.7	.3	.5	.6	.9	.3	.6	.3	.5	.5	.5	.3	.3	.2	.3	
5.0:1	.9	1.5	.6	.9	.5	.6	.8	1.2	.5	.8	.4	.6	.6	.9	.3	.6	.3	.5	.5	.6	.3	.3	.2	.2	
6.0:1	1.0	1.7	.6	1.0	.6	.7	.8	1.5	.5	.9	.4	.7	.7	1.2	.3	.7	.3	.6	.6	.6	.3	.3	.3	.3	
8.0:1	1.0	2.0	.7	1.2	.6	.8	.9	1.7	.6	1.0	.5	.8	.7	1.5	.4	.9	.3	.7	.5	.6	.3	.3	.3	.3	

NOTES:

1. Stalemate Ratio: No advance credited at less than 1.7:1. Assumption consistent with RAC TBM-68, Vol III, pp 48-52.

2. Minefields/Barriers: Table assumes use of minefields/barriers.

* A -- Open terrain
B -- Rolling terrain
C -- Hilly terrain
D -- Mountainous terrain

Table 6. Rates of advance for attacks against hasty positions.

Rates of Advance (kilometers per hour)

COMBAT RATIO (ATTACKER: DEFENDER)	A						B						C						D						Terrain *
	GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		GOOD		FAIR		POOR		Visibility
	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	D	M	Attacker Mobility D=Dismounted M=Mounted
	Stalemate at less than 1.4:1																								
1.4:1	.7	1.2	.4	.6	.2	.3	.6	.8	.2	.4	.1	.2	.4	.6	.1	.3	.1	.2	.1	.2	----None-----				
1.7:1	.8	1.3	.5	.7	.3	.4	.7	1.0	.3	.5	.2	.3	.5	.7	.2	.4	.1	.2	.2	.4	.1	.2	.1	.1	
2.0:1	1.0	1.5	.6	1.0	.4	.6	.8	1.2	.4	.8	.2	.5	.6	.9	.3	.6	.2	.4	.3	.6	.2	.3	.1	.2	
2.5:1	1.1	1.7	.7	1.1	.5	.7	.9	1.4	.5	.9	.3	.6	.7	.9	.3	.7	.2	.5	.4	.7	.3	.4	.2	.3	
3.0:1	1.2	2.0	.8	1.2	.6	.8	1.0	1.6	.6	1.0	.4	.7	.8	1.0	.4	.8	.3	.6	.5	.8	.4	.5	.3	.4	
3.5:1	1.3	2.2	.9	1.3	.7	.9	1.1	1.8	.6	1.1	.5	.8	.9	1.2	.5	.9	.4	.7	.6	.8	.4	.5	.3	.4	
4.0:1	1.4	2.4	1.0	1.4	.8	1.0	1.2	2.0	.7	1.2	.6	.9	1.0	1.5	.6	1.0	.5	.8	.8	.9	.5	.6	.4	.5	
5.0:1	1.6	2.6	1.1	1.6	.9	1.1	1.3	2.1	.8	1.3	.7	1.0	1.1	1.6	.6	1.1	.5	.9	.9	1.0	.5	.6	.4	.5	
6.0:1	1.7	3.0	1.1	1.6	1.0	1.2	1.4	2.5	.8	1.4	.7	1.1	1.2	2.0	.6	1.2	.5	1.0	.9	1.0	.5	.6	.5	.5	
8.0:1	1.8	3.5	1.2	2.0	1.1	1.4	1.6	3.0	.9	1.8	.8	1.3	1.2	2.5	.7	1.6	.5	1.2	.9	1.0	.5	.6	.5	.5	

NOTES:

1. Stalemate Ratio: No advance is credited against hasty positions unless combat ratio favors the attacker by 1.4 or better. Assumption based on RAC TBM-68, Vol III, pp 48 52.

2. Minefields/Barriers: When mines or barriers are employed, reduce rate of advance to 75 percent.

* A -- Open terrain
B -- Rolling terrain
C -- Hilly terrain
D -- Mountainous terrain

Table 7. Types of tactical situations.

Tactical Situation	Description
1. Meeting Engagement	May be assigned when one side is attacking and the other side counterattacks. Defender has advantage of natural terrain features only.
2. Delaying Action	A retrograde action where the defender exchanges space for time, seeking to delay, deceive, and disorganize attacking formations, causing them to deploy frequently.
3. Withdraw	Defender maintains covering forces in direct contact with the enemy while withdrawing the bulk of his forces to deeper positions.
4. Defend Fortified	Assumes a deliberate defense, and considered the highest degree of defensive posture attainable, requiring extensive preparation time. Includes deliberate defense of urban areas.
5. Defend Prepared	Implies installation of wire, minefields, camouflaged dug-in emplacements for crew-served weapons with minimum overhead cover. An organized defensive arrangement with overhead cover for all combat and combat support personnel concerned.
6. Defend Hasty	Use of natural cover and concealment, limited use of minefields and initiation of dug-in emplacement for crew-served weapons. Preparation time is variable.

SOURCE: <u>SCORES "Jiffy" War Gaming Methodology</u>, July 1975, p. 12.

Table 8. Defender tactical situation adjustment factors for maneuver unit weapons.

Defender's Posture*	Adjustment Factor
Meeting Engagement	1.0
Delaying Action	1.0
Withdraw	0.5
Defend Fortified Position	2.0
Defend Prepared Position	1.5
Defend Hasty Position	1.2

SOURCE: USMC LFWG Rules Manual, VOL XXII.

*See table 7 for definition of postures. At least 50 percent of defender's force must be in the particular posture for which a factor is selected.

Table 9. Attacker tactical situation adjustment factor for maneuver unit weapons.

Tactical Situation	Attacker Posture	Adjustment Factor
Meeting Engagement	Frontal Attack	1.0
Delay Action	Frontal Attack	1.5
Withdraw	Frontal Attack	2.0
Defend Fortified Position	Frontal Attack	0.8
	Single Envelopment*	1.0
	Double Envelopment*	1.2
Defend Prepared Position	Frontal Attack	1.0
	Single Envelopment*	1.2
	Double Envelopment*	1.4
Defend Hasty Position	Frontal Attack	1.0
	Single Envelopment*	1.4
	Double Envelopment*	1.6

SOURCE: USMC LFWG Rules Manual, VOL XXII.
*All defending units in a specific battle must be enveloped. Envelopment is only possible on a flank separated by at least 2 km from flank support.

Table 10. Terrain types.

Type	Description
Open A	a. Elevation changes from 0-50 meters per kilometer. b. Scattered light scrub growth, low bushes, low grasses, or desert. Sinai or Syrian Deserts are examples. c. Permits maximum cross-country movement and excellent fields of fire for maneuver and air defense units. d. Permits excellent surveillance and target acquisition. e. Extremely loose sand, marshes, snow cover exceeding 14 inches or boulder-strewn fields reduce trafficability to rolling type terrain.
Rolling B	a. Elevation changes from 51-200 meters per kilometer. b. Farmland with small, randomly-spaced timber; primarily orchards or small woods. North German Plain between Hannover and Hamburg is an example. c. Permits near maximum cross-country movement and good fields of fire for maneuver and air defense units. d. Permits good surveillance and target acquisition. e. Snow cover exceeding 14 inches, extremely loose sand, marshes or boulder-strewn fields reduce trafficability to hilly type terrain.
Hilly C	a. Elevation changes from 201-400 meters per kilometer. b. Moderate to densely forested with mixed coniferous and deciduous trees and small patches of farmland or high-grass/shrubbery. Terrain around Wildflecken, Spessart or Vogelsberg areas of Germany are examples. c. Permits limited cross-country movement and poor fields of fire for maneuver and air defense units. d. Permits poor surveillance and target acquisition. e. Jungled highlands, snow cover exceeding 14 inches, terraced fields or vineyards, or boulder-strewn slopes reduced trafficability to mountainous terrain.
Mount-ainous D	a. Elevations change from 401-600 meters per kilometer. b. Thickly forested with few scattered open spaces at lower elevations. Appalachians, Korea, or the Bohemian Forest-Sudeten Mountains are examples. c. Permits very poor cross-country movement, limited chiefly to valleys and trails/roads and provides extremely poor fields of fire for maneuver and air defense units. d. Permits very poor target acquisition and surveillance. e. Snow cover exceeding 14 inches, rocky slopes restrict trafficability to existing roads and improved trails.

SOURCE: USMC Land Force Wargame Rule Manual, VOL III, 29 Jan 69, pp 6, 8, 10.

Table 11. Visibility Categories

Category	Meteorological Visibility	Targeting Visibility
1	Beyond 7 KM	Beyond 3500 M
2	Reduced to 7 KM	Reduced to 3500 M
3	Reduced to 5 KM	Reduced to 2500 M
4	Reduced to 2 KM	Reduced to 1000 M
5	Reduced to 1 KM	Reduced to 500 M

Table 12. Percentages of suppression.

SITUATION	ATK OF FORTIFIED SECTOR		ATK VS PREPARED DEFENSES		ATK VS HASTY DEFENSES		MEETING ENGAGE-MENT		DELAYING ACTION		DEFENDER WITH-DRAWAL	
POSTURE	DEF	ATK	DEF	ATK	DEF	ATK	DEF	ATK	DEF	ATK	DEF	ATK
FIREPOWER RATIO (ATTACKER:DEFENDER)												
Less than 1.0:1	1.4	22.5	2.7	15.0	3.0	11.1	2.1	8.3	1.2	7.4	.8	3.7
1.0:1	1.8	14.0	3.6	9.3	3.9	6.6	3.8	3.8	1.8	4.4	1.2	2.2
1.5:1	2.4	9.9	4.8	6.6	4.8	4.5	4.5	3.2	2.7	3.0	1.8	1.5
2.0:1	3.0	8.1	6.0	5.4	6.0	3.6	4.8	3.0	3.6	2.4	2.4	1.2
2.5:1	3.5	7.2	6.9	4.8	6.9	3.0	5.6	2.5	4.2	2.0	2.8	1.0
3.0:1	3.6	6.8	7.8	4.5	7.8	2.7	6.5	2.3	5.1	1.8	3.4	.9
3.5:1	4.5	6.5	8.9	4.3	8.7	2.6	7.3	2.1	5.9	1.7	3.9	.9
4.0:1	5.0	6.3	9.9	4.2	9.6	2.4	8.1	2.0	6.6	1.6	4.4	.8
5.0:1	6.0	5.4	12.0	3.6	11.4	2.1	9.8	1.7	8.1	1.4	5.4	.7
6.0:1	6.8	5.3	13.5	3.5	12.6	2.0	11.3	1.6	9.9	1.3	6.2	.7
8.0:1	9.0	5.0	18.0	3.3	16.8	1.9	14.4	1.5	12.0	1.2	8.3	.6

SOURCES: Gamer adaptation of RAC TBM-68, VOL II, p. 57, Jan 1968 modified by factors from AMSAA Technical Memorandum 142, Proposed Criterion for Assessing the Effects of Neutralization Bombardment(U) Aug 1972 and UK Ministry of Defense Memorandum 7207, Neutralising Effects of Bombardment(U) March 1972.

Table 13. Vulnerability adjustment factors.

Weapon System	Adustment
1. Tanks	1.00
2. Other Armor	2.86
3. SP ADA and FA weapons	2.86
4. Towed ADA and FA weapons	3.52
5. Dismounted antitank weapons	2.86
6. Attack Helicopters	2.86

SOURCE: SCORES "Jiffy" War Gaming Methodology, July 1975, p. 104-105.

Table 14. Operational availability of Blue weapon systems.

Blue weapon Systems	Operational Availability
Small arms, personnel	1.00
Trucks	.83
Ground mounted antitank weapons:	
VIPER	.95
TOW	.93
DRAGON	.81
PARS MILAN, PZIG (RAK) (HOT)	.95
Tanks/Armored Vehicles:	
M113A1, IFV/CFV, ITV, MARDER, M577A1, AVLB, FOV	.81
M60A1, LEOPARD I	.78
XM1, M60A3, LEOPARD II	.78
M60A2	.67
Air Defense Systems:	
STINGER, STINGER POST, REDEYE	.83
ROLAND, CHAPARRAL	.88
PATRIOT, HAWK	.78
VULCAN	.60
DIVAD	.75
*Mortars/Field Artillery:	
60mm, 81mm, 107mm mortars	.94
Towed 105mm HOW, GSRS, LARS	.76
SP 155mm	.76
203mm Gun, Towed 155mm HOW/XM 198	.61
LANCE	.85
Armed Helicopters:	
AH-64, AH-IS	.81
OH-58C, OH-58A	.74
ASH	.80
UH-60A, UH-1H	.76

SOURCES: a. For vehicles--AMSAA Technical Memorandum 102, Joint CDC/AMC M60 Tank Study, Army Materiel Systems Analysis Agency, APG MD, February 1971. b. For artillery--US Army Field Artillery School Department of Gunnery. c. For AD systems--Army Air Defense, Europe 1970-1975, HQ USAREUR/Seventh Army, October 1969. d. For armed helicopters--(C) Army Aircraft Inventory Status and Flying Time (U), US Army Aviation Systems Command, St. Louis, MO, Jan-Dec 76. Reviewed and updated by LOGC, Nov 78.
*Reviewed and updated by Artillery School, Nov 78.

Table 15. Operational availability of Red weapon systems.

Red Weapon Systems	Operational Availability
Small arms, personrel	1.00
Trucks	.83
Ground mounted antiank weapons:	
RPG-7, RPG-7(FO), SPG-9, SPG-9(FO)	.95
SPIGOT, SPIGOT(FO)	.93
100mm T12, T12A	.86
Tanks/Armored Vehicles:	
BMP(A), BMP(R), BMP(FO)	.81
BTR-60, BTR-60(FO), BTR-60 PB	.81
BRDM-2, ASU-85	.81
T80, T72/T64, T62	.78
T55	.62
Air Defense Systems:	
ZSU-23/4, ZSU-57/2, 57mm S60, 14.5mm ZSU-23, ZSU-37/2, ZU-23, SA-6, SA-6(FO), SA-4	.85
SA-7, SA-7B, SA-8, SA-9	.83
Mortars/Field Artillery:	
All towed mortars (82mm, 120mm), Howitzers (122mm, 152mm), Guns (130mm, 203mm)	.76
All SP Howitzers (122mm, 152mm), 240mm SP mortar, Rocket Launchers (122mm, 240mm)	.61
Armed Helicopters:*	
HIND Series	.81
HIP Series	.76

SOURCES: See table 14.

*Red AH availabilities are taken to be the same as for Blue systems.

Table 16. Indirect fire area targets.

Map Index	Target Description	Military Worth Blue of Red	Military Worth Red of Blue	Elements Per Target Blue	Elements Per Target Red	Operational Availability* Blue	Operational Availability* Red
1	Personnel (Attack)	23.1	31.8	49	31	1.00	1.00
2	Antitank team (Attack)	192.0	190.0	10	10	.81 (Dragon)	.95 (RPG-7)
3	Tank (Attack)	148.4	127.2	10	10	.78 (XM1)	.78 (T80)
4	Medium tank (Attack)	148.4	127.2	10	10	.78 (M60A1)	.78 (T72/T64)
5	APC (Attack)	125.0	159.0	10	10	.81 (IFV/CFV)	.81
6	Trucks	11.0	11.0	3	3	.83	.83
7	AD Missile Radar	180.2	180.2	1	1	.78 (Patriot,Hawk)	.83 (SA-8)
8	AD artillery	195.0	169.6	2	4	.75 (DIVAD)	.85 (ZSU 23-4, ZSU 37-2)
9	AD artillery, handheld	106.0	106.0	2	4	.83 (Stinger Post)	.83 (SA-7)
10	Mortars	148.3	148.4	4	6	.94	.76
11	Towed artillery	201.6	201.6	6	6	.61 (Twd 155mm HOW)	.76
12	SP artillery	212.2	212.2	4	6	.76 (SP 155mm HOW)	.61
13	Personnel (Defend)	42.4	42.4	49	31	1.00	1.00
14	Antitank team (Defend)	106.0	106.0	2	2	.81 (Dragon)	.95 (RPG-7)
15	Tank (Defend)	70.8	84.8	10	10	.78 (XM1)	.78 (T80)
16	Medium Tank (Defend)	70.8	84.8	10	10	.78 (M60A1)	.78 (T72/64)
17	APC (Defend	70.4	148.4	10	10	.81 (IFV/CFV)	.81

Sources: Military Worth - Red of Blue values based on values provided by USFAS, NOV 78. Blue of Red values were adjusted from data provided by AMSAA and the LEGAL MIX V Study (reference 2).

Elements per target - USACACDA SCORES "JIFFY" War Gaming Methodology (U), July 1975, CONFIDENTIAL, and gamer judgement.

Operational availability - See table 14.

*The operational availability for a given type of area target was obtained from tables 14 and 15 for the weapon type the gamers have the most of as shown in parenthesis.

Table 17. Tactical positioning factors.

Tactical Situation	Percent Deployed Forward* Attacker	Defender
Meeting Engagement	.67	.67
Delay Action	.67	.50
Withdraw	1.00	.33
Defense of Fortified Position	1.00	1.00
Defense of Prepared Position	1.00	1.00
Defense of Hasty Position	1.00	1.00

SOURCE: SCORES "Jiffy" War Gaming Methodology, July 1975, p.40.

*For CLGP and AH assessments only.

Table 18. Probability of knowledge.

Weapon System	POK Red of Blue	POK Blue of Red
Small arms, dismounted antitank weapons, tanks, armored vehicles, SP VULCAN, DIVAD, ASU 85, ZSU 23-4, ZSU 37-2.	.70	.60
All ADA except front-line ADA listed above.	.40	.50
Towed Mortars	.70	.60
SP mortars and all artillery.	.50	.60
Trucks	.20	.20

Source: See paragraph 9.d.(1).(c).

Table 19. Indirect fire targeting scheme.

Weapon Class	Type Targets Engaged
Light Mortars (60, Automatic 82mm*)	Dismounted infantry, dismounted antitank weapons, mortars.
Heavy Mortars (81, 107, 120, 82*, 240mm)**	Dismounted infantry, dismounted antitank weapons, mortars, ADA automatic weapons, light armor.
Light Artillery (105mm howitzer, towed 122mm howitzer, 240mm multiple rocket launcher, LARS)**	Dismounted infantry, dismounted antitank weapons, mortars, ADA automatic weapons, light armor, trucks, light artillery.
Medium Artillery (152, 155, SP 122, 203mm howitzers, 122 multiple rocket launcher, MLRS)	Dismounted infantry, dismounted antitank weapons, mortars, ADA automatic weapons, SHORAD missiles,trucks, armor, field artillery.
Heavy Artillery (130mm gun, 203mm gun)**	ADA, Field artillery.

SOURCE: SCORES "JIFFY" War Gaming Methodology, July 1975, page 56, updated by gamer judgement to account for weapon changes.

*Different rates of fire place the 82mm mortars in different weapon classes.
**Updated February 1979.

Table 20. Indirect Fire Weapon Systems Rates of Fire.

Weapon	Rate of Fire Rds/Hr/tube Capabilities Max	Sustained	Combat Rates Prep[a]	Cbt Spt[b]	FPF[c]
Blue[b]					
60mm Mortar Imp.	568	480	0	28	379
81mm Mortar Imp.	504	300	0	14	336
107mm Mortar Imp.	360	180	0	18	240
105mm HOWITZER	264	180	180	56	176
155mm SP HOWITZER	96	60	60	22	64
155mm HOWITZER M198	96	60	60	22	64
203mm SP HOWITZER	40	30	30	16	28
LANCE	1	1	0	1	1
MLRS[d]	60	36	36	10	40
LARS[e]	144	72	72	35	97
Red[f]			[g]	[h]	
120mm Mortar (M1943)	300	70	70	80	201
240mm SP Mortar	120	35	35	40	81
82mm (AUTO) Mortar	600	240	240	120	402
82mm Mortar	500	210	210	120	336
122mm SP HOWITZER (M1974)	300	90	90	80	201
122mm HOWITZER (D-30)	360	100	100	80	242
152mm SP HOWITZER (M1973)	168	80	80	60	113
152mm HOWITZER (D-20)	240	90	90	60	161
130mm GUN (M46)	260	100	100	80	174
203mm SP GUN	150	30	30	40	101
122mm MRL (BM 21)	240	160	160	120	161
240mm MRL	64	48	48	40	43

a. Sustained rate of fire for all artillery and large Red mortars.

b. Rate of fire based on estimated resupply rate capability for fire unit assets employing the ammunition transfer point (ATP) concept: Updated by USAFAS, Jan 80. Also assumes movement and other out-of-action times.

c. 67 Percent of maximum rate of fire.

d. SOURCE: USAFAS, Nov 78 and Jan 80.

e. USAFAS Ltr Dated 1979.

f. SOURCE: EUROPE III SCENARIO THREAT: All data, except Red combat support rates, were updated by CACDA, Threats Div, Dec 78, with the following comments:

g. Artillery preparation by doctrine lasts about 30-40 minutes.

h. Red Cbt. Spt. rates furnished by CACDA SWG Directorate April 1980. See also paragraph 9d(1)(e).

Table 21. Blue Artillery Intensity Levels.

Level	Description	Mult (Blue only)
6	Sustained Rate of Fire (This may exceed maximum daily resupply rates if fired for prolonged durations of time).	2.04
5	Rate of Fire based on the daily resupply rate plus the basic load.	1.51
4	Rate of Fire based upon daily resupply rate.	1.00
3	Rate of Fire based on the basic load being fired in one day.	.51
2	Rate of Fire based on 2/3 basic load being fired in one day.	.34
1	Light intermittent rate of fire.	.18

Source: USAFAS January 1980.

Table 22. Number of Tubes per Battery

Blue		Red	
Weapon System	Number of Tubes/Battery	Weapon System	Number of Tubes/Battery
81mm IMP Mortar	3	120mm Mortar	6
107mm IMP Mortar	4	240mm SP Mortar	6
60mm IMP Mortar	3	82mm Mortar	6
155mm SP HOWITZER	8	122mm SP HOWITZER	6
203mm SP HOWITZER	4	122mm HOWITZER	6
105mm HOWITZER	6	152mm SP HOWITZER	6
155mm HOWITZER	6		
		152mm HOWITZER	6
MLRS	9 launchers		
		130mm GUN	6
		203mm SP GUN	6
LANCE	2	122mm MRL (BM-21)	6
LARS	8 launchers	240mm MRL	6

Table 23. Indirect fire fractional damage.*

Target	All Arty/Msl except ICM	ICM
Personnel (Attack)	.005	.2
Antitank Team (Attack)	.005	.2
Tank (Attack)	.005	.2
Medium Tank (Attack)	.005	.2
Armored Personnel Carrier (Attack)	.005	.2
Truck	.005	.2
Air Defense Artillery Missile Radar	.005	.2
Air Defense Artillery	.005	.2
Air Defense Artillery Mcunted	.005	.2
Mortars	.005	.2
Towed Artillery	.005	.2
SP Artillery	.005	.2
Personnel (Defend)	.005	.2
Antitank Team (Defend)	.005	.2
Tank (Defend)	.005	.2
Medium Tank (Defend)	.005	.2
Armored Personnel Carrier (Defend)	.005	.2

*The indirect fire fractional damage data contained in this table are for purposes of illustration only. See tables Vol III Appendix B of this report for the classified fractional damage values actually used in the Jiffy model.

Table 24. Indirect fire mission distribution.

	Type of Mission		
	WP/Smoke/ Illumination	H&I	Other
BLUE:			
Mortars: Light	.03	.00	.97
Heavy	.00*	.00	1.00
105mm Howitzer	.03	.00	.97
155mm Howitzer	.03	.00	.97
203mm Howitzer	.00	.00	1.00
GSRS	.00	.00	1.00
RED:			
82mm Auto Mortar	.40	.00	.60
82mm Mortar	.00	.03	.97
120mm Mortar	.00	.03	.97
240mm Mortar	.00	.00	1.00
122mm Howitzer	.00*	.06	.94
152mm Howitzer	.00	.06	.94
130mm Gun	.00	.06	.94
203mm Gun	.00	.00	1.00
122mm MRL	.00	.00	1.00
240mm MRL	.00	.00	1.00

*Fire smoke on gamer command.

Source: Red mission distribution obtained from CACDA Threats Div., March 1980. Blue mission distribution confirmed by USAFAS March 1980.

Table 25. Manual minefield emplacement.*

[a]Minefield Density	Mines Required Per 100-meter front: Antitank	[b]Antipersonnel	[c]Man Hours Required
1-4-8	164	1836	234
2-4-8	312	1836	279
3-4-8	459	1836	323

a. AT-APF-APB mine density per meter front.
b. AP mines requires combination of AP FRAG and AP BLAST.
c. Man-hours are based on laying rate of 4 AT, or 8 AP FRAG, or 16 AP BLAST Mines per man-hour.
* SOURCE: FM 20-32, Table J-1, p. 204.

Table 26. Mechanical mine planter platoon capabilities.

Force	Minefield Frontage (Meters) (F)	Platoon-Hours Required (HR_r)
Blue	1000	9 (AT & AP)
Blue	2000	6 (AT only)
Red	1000	2 (AT only)

SOURCE: FM 90-7. P. F-4.

Table 27. FASCAM minefield characteristics.

Type of Delivery	Minefield size (meters)	Mine Density* Antitank	Antipersonnel	Density Mines/ Meters Front Antitank	Antipersonnel
Artillery	175 x 175	.006	.003	1.05	.53
GEMSS	250 x 1000	.0013	.0003	.33	.08

SOURCE: Draft training circular for artillery delivered scatterable mines, USAES/USAFAS, Nov 78. Test support package for the ground emplaced mine scattering system (GEMSS) during OTII, USAES, October 1978.

*Since FASCAM minefields are not a constant 150m in width, mine density is given in mines per square meter.

Table 28. Antitank mine tank losses expected in conventional minefields.

Antitank Mine Density Per Meter Front	Expected Percent Tank Losses
.2	9
.5	27
1	52
2	63
3	75

SOURCE: FM 105-5, table H-25, p H-47. M15 AT Mine. No countermeasures.

Table 29. Antipersonnel mine casualties expected in conventional minefields.

AP Mine Density Per Meter Front	Expected Percent Personnel Losses
2	20
4	30
8	40
12	50
16	60
20	70
24	80

SOURCE: FM-105-5, table H-11, p. H-6.

Table 30. FASCAM AT casualties.

AT Mine Density	Expected Percent Casualties
.09	7
.18	18
.25	23
.35	28
.53	39
.88	49
1.05*	56
1.75	64

SOURCE: Combat Development Experimentation Command briefing of TEMAWS final results January 1977.

*1.05 was the only value played in current gaming.

Table 31. FASCAM AP casualties.

AP Mine Density	Expected Percent Casualties
.1	8
.2	18
.3	25
.4	31
.5**	40
.6	48

SOURCE: USAES

**.53 was the value played during current gaming.

Table 32. Acquisition discriminators.

Tactical Situation	Attacker	Defender
Meeting Engagement	.90	.90
Attack Against Delaying/ Withdrawing Force	.75	.90
Attack Against Hasty Defenses	.50	.90
Attack Against Prepared/ Fortified Defenses	.33	.90

SOURCE: Gamer adaption from USACACDA TETAM Effectiveness Evaluation, TM1-74, 26 Apr 74 and USMC LFWG Rule Manual, VOL XII, 14 Dec 71, p. A-I.

Table 33. Relative target acquisition frequencies.

Target Category	Attacker	Defender
Dismounted Antitank Weapons*	0.6	0.6
Blue system: TOW, DRAGON, VIPER, MILAN, PZIG		
Red system: RPG 7, SPG 9, Manpack SPIGOT		
Light Armored Vehicles*	5.7	4.3
Blue system: MARDER, AVL2, SP Vulcan, DIVAD		
Red system: T12, T12A, BMP(R), BTR-60, BTR-60 (FO), BTR-60 (PB), ZSU-37-2, ZSU-23-4, 122mm SP (DF)		
Heavy Armored Vehicles*	7.4	5.3
Blue system: CFV, IFV, FOV/M113A1/M577A1, ITV		
Red system: BMP, BRDM-2, BMP (FC), BRDM (Command), BTR-60 (Command)		
Tanks*	10.0	10.0
Blue system: M60A1, M60A2, M60A3, XM1, LEOPARD 1, LEOPARD 2		
Red system: T62, T72/T64, T55, T80, ASU-85		

SOURCE: Developed from detection/acquisition frequency distributions obtained from the Dynamic Tactical Simulation Model (DYNTACS-X).

*Updated February 1980 by CACDA SWG Dir.

Table 34. Expected number of completed firings for open terrain.

Range (km)	0-.5	.5-1	1-1.5	1.5-2	2-2.5	2.5-3
a. Blue Systems:						
Tanks:						
XM1, M60A1, M60A3 LEOPARD 1, LEOPARD 2	.68	1.30	1.30	.92	.48	.16
M60A2	.35	.64	.64	.48	.24	.06
AT Weapons:						
TOW ATGM	.34	.65	.65	.46	.24	.08
Dragon ATGM	.31	.37	.0	.0	.0	.0
ITV, IFV/CFV	.41	.55	.05	.01	.01	.0
VIPER	.41	.0	.0	.0	.0	.0
b. Red Systems:						
Tanks:						
T55, T62, T72/T64, T80	.53	.71	.71	.58	.30	.10
AT Weapons:						
SPIGOT ATGM, BRDM-2	.35	.64	.64	.48	.24	.06
100mm T12	.68	1.30	1.30	.92	.0	.0
73mm Gun (BMP), SPG-9	.51	.98	.98	.0	.0	.0
RPG-7 ATRL	.51	.0	.0	.0	.0	.0
Assault Guns:						
ASU 85	.68	1.30	1.30	.92	.0	.0

NOTE: The expected number of completed firings data (tables 34, 35, 36, and 37) have been expanded to 16 tables (tables B-10 through B-17). These tables and the source are contained in the classified section Vol. III, of this report. Unclassified data for test and demonstration purposes are given in tables 34, 35, 36, and 37.

Table 35. Expected number of completed firings for rolling terrain.

Range (km)	0-.5	.5-1	1-1.5	1.5-2	2-2.5	2.5-3
a. Blue Systems:						
Tanks:						
XM1, M60A1, M60A3 LEOPARD 1, LEOPARD 2	.34	.78	.48	.46	.24	.08
M60A2	.18	.39	.26	.24	.12	.03
AT Weapons:						
TOW ATGM	.17	.39	.24	.23	.12	.04
Dragon ATGM	.16	.24	.0	.0	.0	.0
ITV, IFV/CFV	.21	.40	.24	.22	.07	.0
VIPER	.21	.0	.0	.0	.0	.0
b. Red Systems:						
Tanks:						
T55, T62, T72/T64, T80	.27	.49	.30	.29	.15	.05
AT Weapons:						
SPIGOT ATGM, BRDM-2	.18	.39	.26	.24	.12	.03
100mm T12	.34	.78	.48	.46	.0	.0
73mm Gun (BMP), SPG-9	.26	.59	.36	.0	.0	.0
RPG-7 ATRL	.51	.0	.0	.0	.0	.0
Assault Guns:						
ASU 85	.34	.78	.48	.46	.0	.0

NOTE: See table 34.

Table 36. Expected number of completed firings for hilly terrain.

Range (km)	0-.5	.5-1	1-1.5	1.5-2	2-2.5	2.5-3
a. Blue Systems:						
Tanks:						
XM1, M60A1, M60A3						
LEOPARD 1, LEOPARD 2	.52	1.58	1.94	1.16	.60	.30
M60A2	.27	.85	1.03	.61	.31	.15
AT Weapons:						
TOW ATGM	.26	.79	.97	.58	.30	.15
Dragon ATGM	.25	.23	.0	.0	.0	.0
ITV, IFV/CFV	.34	.93	1.07	.58	.13	.0
VIPER	.34	.0	.0	.0	.0	.0
b. Red Systems:						
Tanks:						
T55, T62, T72/T64, T80	.33	.99	1.21	.83	.38	.19
AT Weapons:						
SPIGOT ATGM, BRDM-2	.27	.85	1.03	.61	.31	.15
100mm T12	.52	1.58	1.94	1.16	.0	.0
73mm Gun (BMP), SPG-9	.39	1.14	1.46	.0	.0	.0
RPG-7 ATRL	.39	.0	.0	.0	.0	.0
Assault Guns:						
ASU 85	.52	1.58	1.94	1.16	.0	.0

NOTE: See table 34.

Table 37. Expected number of completed firings for mountainous terrain.

Range(km)	0-.5	.5-1	1-1.5	1.5-2	2-2.5	2.5-3
a. Blue Systems:						
Tanks:						
XM1, M60A1, M60A3						
LEOPARD 1, LEOPARD 2	.42	1.48	1.52	1.08	.90	.48
M60A2	.23	.78	.82	.56	.47	.24
AT Weapons:						
TOW ATGM	.21	.74	.76	.54	.45	.24
Dragon ATGM	.20	.25	.0	.0	.0	.0
ITV, IFV/CFV	.28	.87	.87	.52	.14	.0
VIPER	.28	.0	.0	.0	.0	.0
b. Red Systems:						
Tanks:						
T55, T62, T72/T64, T80	.26	.93	.95	.68	.50	.30
AT Weapons:						
SPIGOT ATGM, BRDM-2	.23	.78	.82	.56	.47	.24
100mm T12	.42	1.48	1.52	1.08	.0	.0
73mm Gun (BMP), SPG-9	.32	1.11	1.14	.0	.0	.0
RPG-7 ATRL	.32	.0	.0	.0	.0	.0
Assault Guns:						
ASU 85	.42	1.48	1.52	1.08	.0	.0

NOTE: See table 34.

Table 38. Infantry personnel casualties associated with antitank weapon losses in the Armor routines.

	Infantry Losses
Blue AT Weapons:*	
VIPER	1
Dragon, MILAN	2
TOW, PZIG (HOT)	3
Red AT Weapons:*	
RPG 7	1
SPG 9	2
SPIGOT, 100mm T12	3

SOURCE: SCORES "Jiffy" War Gaming Methodology, July 1975.

*Updated April 1980 by CACDA SWG Dir.

Table 39. Ground combat personnel casualty rate*
(Company or separate platoon per hour)

Tactical Situation	Combat Force Ratio													
	.5 & Under		.6-1.0		1.1-1.5		1.6-2.0		2.1-2.5		2.6-3.0		3.1 & Over	
	Atk	Def	Atk	Def	Atk	Def	Atk	Def	Atk	Def	Atk	Def	Atk	Def
Fortified or Prepared Position	.037	.015	.026	.019	.020	.021	.018	.025	.016	.027	.015	.031	.014	.034
Hasty Position	.027	.019	.017	.018	.013	.022	.012	.024	.010	.029	.009	.033	.008	.035
Meeting Engagement	.025	.018	.015	.016	.012	.020	.010	.021	.009	.025	.008	.029	.007	.032
Delay or Withdraw	.025	.007	.015	.009	.012	.011	.010	.014	.009	.016	.008	.019	.007	.021

* Multiply casualty rate by .5, if force is battalion or larger in size.

SOURCE: Adaptation of USMC LFWG Rule Manual VOL VIII, p. A-30.

Table 40. Ambush personnel casualties.

Maneuver Firepower Ratio	Percent Casualties Ambushed Unit	Percent Casualties Ambushing Unit
.1 - .9:1	10	20
1.0 - 1.9:1	20	15
2.0 - 2.5:1	35	10
2.5 - 3.0:1	50	5
3.1:1 or greater	70	2

SOURCE: Adaptation of USMC LFWG Rule Manual, VOL III, p. A-33.

Table 41. Infantry Materiel Casualty Distribution.

Nomenclature	Loss Rate
Trucks	.017
Personnel	1.000
Rifles	1.000*
Grenade Launcher	.067
Lt MG	.050
Hv MG	.020
Lt AT WP (VIPER, RPG-7)	.050
Med AT WP (PARS MILAN, DRAGON, SPG-9)	.050
Recoilless Rifle (Lt)	.050
Recoilless Rifle (Hv), PZIG, T-12	.020

SOURCE: SCORES "Jiffy" War Gaming Methodology, July 1975, p. 103.

* Military Judgement.

Table 42. Crew losses per Blue weapon systems lost.

Weapon System		Crew Losses
1. Ground:	TOW, MILAN	2
2. Tank:	M60 Series/LEOPARD I	2
	XM-1/LEOPARD II	1
3. Armored Combat Vehicles/Personnel Carriers:		
	M113A1, IFV/CFV, FOV, M577A1	2
	ITV, HOT	3
	MARDER	2
4. Air Defense Systems:		
	SP VULCAN, DIVAD, ROLAND, CHAPARRAL	3
	HAWK	21
	STINGER, STINGER POST, REDEYE	2
	PATRIOT	8
5. Mortars and Field Artillery Systems:		
	60mm MORTAR	4
	81mm MORTAR, M125A1	5
	107mm MORTAR, M106A1	7
	105mm HOW(T)	9
	155mm HOW(T), XM198	11
	155mm SP HOW	10
	203mm SP HOW	13
	GSRS, LARS	3
	LANCE	8
6. Helicopters:		
	AH-64, AH-IS, OH-58A, C, and D, ASH	2
	UH-1H, UH-60A	3

SOURCE: ADMINCEN, Ft Benjamin Harrison, IN. Nov 1978, Reviewed & updated Military Judgment Feb 1979.

Table 43. Crew losses per Red weapon system lost.

Weapon System	Crew Losses
1. Ground:	
SPIGOT(FO)	2
2. Tank:	
T-80	1
T-72/T-64	1
T-62, T-55	3
T-12, T-12A	7
3. Armored Combat Vehicle/Personnel Carriers:	
BMP configurations, BTR-60 configurations	2
BRDM configurations	2
ASU-85	3
4. Air Defense Systems:	
SA-7 IMP	1
SA-9 IMP	2
ZSU-23-4, ZSU-57-2, SA-8 MOD	4
ZSU-37-2, ZSU-23	3
S-60	7
5. Mortars and Field Artillery Systems:	
82mm MORTAR, 120mm MORTAR	5
122mm MRL, 240mm SP MORTAR, 122mm HOW(T), 240mm MRL	7
122mm SP HOW	8
152mm HOW(T), 203mm SP GUN	10
130mm GUN	9
152mm SP HOW	4
6. Helicopters:	
HIP Series, HIND Series	2

SOURCE: CACDA, Threats Div. Feb. 1979.

Table 44. Helicoptar sorties available per hour.

Blue Helicopters:	Sorties Per Hour
AH-64	0.43
AH-1S	0.58
ASH	0.43
OH-58D	0.43
Red Helicopters:	
Hip-C, Hip-E, Hip-F	0.60
Hind-D	0.50
FUTURE AH	0.50
Hind (A)	0.60

Table 45. Helicopter ordnance loads.

	Type Ordnance	Rounds Carried
Blue Helicopters:		
AH-64*	HELLFIRE	16
	30mm HE	1200
AH-IS	TOW MAXI	8
	30mm HE	600
OH-58A, OH-58C, OH-58D	None	None
UH-60A, UH-1H	None	None
ASH	None	None
Red Helicopters:		
HIP-C	57mm Rocket	64
HIP-E	SWATTER	4
	57mm Rocket	128
	12.7mm Gun	2000
HIP-F	SAGGER	6
HIND-D	SPIRAL	4
	57mm Rkt	123
	12.7mm Gun	2000
FUTURE AH	FUTURE ATGM	16
	57mm Rkt	128
	23mm Gun	800
HIND (A)	SWATTER	4
	57mm Rkt	128
	12.7mm	2000

* Loads most desirable for Jiffy Gaming determined by military gaming staff.

SOURCE: Air Force Magazine/March 1980, page 130-131.

Table 46. Number of rounds* fired per helicopter pop-up (if no degradation).

Ordnance	Rounds
Blue	
Hellfire	1
TOW MAX:	1
Red	
FUTURE ATGM	1
SPIRAL	1
SAGGER	1
SWATTER	1
57mm Rocket**	32

Source: Determined by military gaming staff.

*Rounds selected to compute the number of pop-ups.

**Not used in the calculation of the number of pop-ups of the FUTURE AH; however, the 57mm rockets are used to determine the number of pop-ups of other Red helicopters.

Table 47. Probability of line of sight for helicopters using pop-up tactics.

Range in meters to Target	Terrain Category: Open/Rolling		Terrain Category: Hilly/Mountainous	
	Conventional Sight	Mast-Mounted Sight	Conventional Sight	Mast-Mounted Sight
500	.222	.179	.204	.146
1000	.527	.438	.243	.165
1500	.616	.541	.447	.352
2000	.685	.561	.441	.368
2500	.696	.628	.566	.445
3000	.665	.618	.560	.486
3500	.577	.554	.468	.426
4000	.494	.469	.366	.336
4500	.406	.384	.258	.246
5000	.278	.266	.197	.180

Table 48. Classification of Air Defense Systems Committed by Range Factors.

Range	Blue	Red
Short	STINGER	ZSU-23
	REDEYE	ZSU-23-4
	DIVAD	S-60
	VULCAN	100mm AAA
		SA-7, ZSU-37-2, ZSU-57-2
Medium	STINGER (Post)	SA-9
Long	CHAPARRAL	SA-8
	ROLAND	SA-6
	HAWK	SA-4
	PATRIOT	

Table 49. Air defense weapon control factors.

Status	Description	Value
Free	Weapons may fire at any aircraft not positively identified as friendly. This is the least restrictive of the weapons controls.	.8
Tight	Fire only at aircraft positively identified as hostile according to the prevailing hostile criteria.	.6
Hold	Do not fire except in self defense.	.1

SOURCE: "Status" and "Descriptions" were obtained from FM 40-1, para 6-4, p. 6-2. The numerical values were obtained from the SCORES "Jiffy" War Gaming Methodology, July 1975, p. 74, and modified by gamer judgement, August 1978.

Table 50. Number of rounds per burst of air defense systems.

System	Rounds/Burst
Blue:	
SP Vulcan	60
DIVAD	90
Red:	
ZSU-23-4	40
ZSU-37-2	90

Table 51. Fraction of firers and targets not smoked for armor assessments.

TYPE OF SMOKE	Fraction not degraded by smoke: OPTICS PASS 1	OPTICS PASS 2	THERMALS PASS 1	THERMALS PASS 2
None:				
Firers	1	-	1	-
Targets	1	-	1	-
Conventional:				
Firers	PUN(J)	-	PUN(L)	1-PUN(L)
Targets	PUN(L)	-	PUN(L)	1-PUN(L)
Far-IR screening smoke/obscurant:				
Firers	PUN(J)	-	$\mathrm{PUN}(J+2)\left(\frac{\mathrm{PUN}(L)}{\mathrm{PUN}(L+2)}\right)$	$\mathrm{PUN}(J+2)\left(1-\frac{\mathrm{PUN}(L)}{\mathrm{PUN}\ (L+2)}\right)$
Targets	PUN(L)	-	PUN(L)	PUN(L+2) - PUN(L)

where:

PUN(i) = the fraction of side i not obscured by any type of smoke, for i = J, L.

PUN(i+2) = the fraction of side i not obscured by far-IR screening smoke/obscurant, for i = J, L.

Table 52. Fraction of firers and targets not smoked for air defense assessments.

TYPE OF SMOKE	Fraction not degraded by smoke: EYEBALLS OR OPTICS PASS 1	PASS 2	PASS 3	RADARS PASS 1	PASS 2	PASS 3	THERMALS PASS 1	PASS 2	PASS 3
None:									
AD firers	1	-	-	1	-	-	1	-	-
AH targets	1	-	-	1	-	-	1	-	-
Conventional:									
AD firers	PUN(J)	-	-	PUN(L)	1-PUN(L)	-	PUN(L)	1-PUN(L)	-
AH targets	PUN(L)	-	-	PUN(L)	1-PUN(L)	-	PUN(L)	1-PUN(L)	-
Far-IR screening smoke/obscurant:									
AD firers	PUN(J)	-	-	PUN(L)	1-PUN(L)	-	$PUN(J+2)\left(\frac{PUN(L)}{PUN(L+2)}\right)$	-	$PUN(J+2)\left(1-\frac{PUN(L)}{PUN(L+2)}\right)$
AH targets	PUN(L)	-	-	PUN(L)	1-PUN(L)	-	PUN(L)	-	PUN(L+2) - PUN(L)

where:

PUN(J) = the fraction of air defense weapons not obscured by any type of smoke.
PUN(L) = the fraction of attack helicopters not obscured by any type of smoke.
PUN(J+2) = the fraction of air defense systems not obscured by far-IR screening smoke/obscurant.
PUN(L+2) = the fraction of attack helicopters not obscured by far-IR screening smoke/obscurant.

Table 53. Fraction of firers and targets not smoked for attack helicopter assessments.

TYPE OF SMOKE	OPTICS PASS 1	OPTICS PASS 2	THERMALS PASS 1	THERMALS PASS 2
	Fraction not degraded by smoke			
None:				
AH firers	1	-	1	-
AD targets	1	-	1	-
Conventional:				
AH firers	PUN(J)	-	PUN(L)	1-PUN(L)
AD targets	PUN(L)	-	PUN(L)	1-PUN(L)
Far-IR screening smoke/obscurant:				
AH firers	PUN(J)	-	$PUN(J+2)\left(\frac{PUN(L)}{PUN(L+2)}\right)$	$PUN(J+2)\left(1-\frac{PUN(L)}{PUN(L+2)}\right)$
AD targets	PUN(L)	-	PUN(L)	PUN(L+2) - PUN(L)

where:

PUN(J) = the fraction of attack helicopters not obscured by any type of smoke.
PUN(L) = the fraction of air defense systems not obscured by any type of smoke.
PUN(J+2) = the fraction of attack helicopters not obscured by far-IR screening smoke/obscurant.
PUN(L+2) = the fraction of air defense systems not obscured by far-IR screening smoke/obscurant.

Table 54. Reduction of firepower scores.

M	N=1 (Red or Blue) N=3 (Blue only)	N=3 (Red only)	N=2 or N=4 (Both Red and Blue)
1	.40	.00	.00
2	.40	.20	.05
3	.60	.20	.05
4	.70	.40	.10
5	.80	.40	.10
6	.99*	.60	.20

*1.00 in E-War Adaptation to First Battle.

SOURCE: E-War Adaptation to First Battle, CGSC, Fort Leavenworth, KS.

Table 55. EW Missions Required to Jam One Unit.

N	Blue	Red
1(AD)	1	15
2(AH)	3	3
3(ART)	1	7
4(MNV)	1	15

SOURCE: See Table 54.

Table 56. Combat intensity levels.

Description	Apportionment Factor
Uncommitted unit	.001
Unit beyond direct fire	.20
Reserve unit committed late	.50
Unit on perimeter of main battle area	.75
Unit in main battle	1.00
Unit hit by TACAIR	1.00

Table 57. Battlefield equipment recovery and repair percentage matrix (Blue only).

	Losses to Indirect Fire Blue Combat Posture		Losses to Direct Fire Blue Combat Posture	
	Atk	Def	Atk	Def
Tanks				
Non-Recoverable		20		40
Recoverable	100	80	100	60
Div Repair	80	80	71	71
COSCOM Repair	20	20	5	5
Exceeds Theater Repair			24	24
Carrier, ARAAV				
Non-Recoverable		20		40
Recoverable	100	80	100	60
Div Repair	52	52	23	23
COSCOM Repair	48	48	48	48
Exceeds Theater Repair			29	29
Field Artillery & Air Defense Arty				
Non-Recoverable	8	13		
Recoverable	92	87		
Div Repair	52	29		
COSCOM Repair	32	49		
Exceeds Theater Repair	16	22		

SOURCE: Battlefield Equipment Recovery and Repair Variable Percentage Matrix, US Army Ordnance Center, p. 8-2.

Reviewed and updated by LOGC, Jan 80.

Table 58. Red equipment repairability.

Level of Repairability	Days to Repair	Percent Damaged
Recoverable		
Light Damage	2	40
Medium Damage	5	30
Major Damage	10	20
Nonrecoverable	--	10

NOTE: See table B-25 in Vol. III of this report for classified Red equipment repairability values.

Table 59. CLGP aborts vs atmospheric conditions*.

Cloud Height (Feet)	Index	Visibility Index 1	2 or 3	4	5
4500 or more	5	.98	.95	.01	0
3000 - 4499	4	.97	.96	.03	0
2500 - 2999	3	.93	.93	.07	0
2000 - 2499	2	.73	.73	.12	0
1500 - 1999	1	.33	.33	.14	0
under 1500	0	0	0	0	0

SOURCE: AMSAA Monthly Report, June 1976, (U)
page 2-14 (confidential report).

*The entries in the table under the Visibility Index Numbers are the probabilities that atmospheric conditions will not abort CLGP rounds.

Table 60. probability that dust will abort a CLGP round.

Vis*	Light Dust	Heavy Dust
1	.40	.97
2	.40	1.0
3	.40	1.0
4	1.0	1.0
5	1.0	1.0

*Visibility conditions 1, 2, 3, 4, and 5 use respectively 44, 7, 5, 2, and 1km data of the source.

SOURCE: Unclassified data from Confidential USACACDA/COAD/Analysis Division (ATZLCA-CAA) memorandum dated 24 May 1979.

Table 61. Artillery dust levels.

Maximum Dust Number	Dust Level	Description
84 or more	3	Heavy dust effects
37 or more but less than 84	2	Light dust effects
less than 37	1	No dust effects

Table 62. Probability of "TOW" Abort.
Light Dust

Visibility Index*

	-	4, 5	3	2	1	(AH Index)
Range (km)	5	4	3	1,2	-	(Armor Index)
0 - .5	.00	.00	.00	.00	.00	
.5 - 1.0	.29	.00	.00	.00	.00	
1.0 - 1.5	1.0	.22	.08	.04	.00	
1.5 - 2.0	1.0	.40	.21	.18	.12	
2.0 - 2.5	1.0	.62	.32	.27	.20	
2.5 - 3.0	1.0	1.0	.40	.36	.27	
3.0 - 3.5	1.0	1.0	.40	.40	.33	
3.5 - 4.0	1.0	1.0	.62	.54	.39	
4.0 - 4.5	1.0	1.0	1.0	1.0	.40	
4.5 - 5.0	1.0	1.0	1.0	1.0	.40	

Heavy Dust

	-	4,5	3	2	1	(AH Index)
Range (km)	5	4	3	1,2	-	(Armor Index)
0 - .5	.00	.00	.00	.00	.00	
.5 - 1.0	.56	.18	.07	.06	.02	
1.0 - 1.5	1.0	.48	.30	.26	.22	
1.5 - 2.0	1.0	.96	.46	.42	.35	
2.0 - 2.5	1.0	1.0	.59	.54	.45	
2.5 - 3.0	1.0	1.0	.91	.70	.53	
3.0 - 3.5	1.0	1.0	1.0	1.0	.60	
3.5 - 4.0	1.0	1.0	1.0	1.0	.74	
4.0 - 4.5	1.0	1.0	1.0	1.0	.94	
4.5 - 5.0	1.0	1.0	1.0	1.0	1.0	

*In the Armor/Antiarmor routine visibility conditions 3, 4, and 5 use respectively the 5,2 and 1km data from the source, and conditions 1 and 2 both use the 7km data. In the AH subroutine conditions 1, 2, and 3 use respectively the 44, 7 and 5km data, and conditions 4 and 5 both use the 2km data from the source.

SOURCE: Unclassified data from Confidential USACACDA/COAD/Analysis Division (ATZLCA-CAA) memorandum dated 24 May 1979.

Table 63. Probability of Laser Abort (Aerial Round)
Light Dust

Range (km)	Visibility Index* 4, 5	3	2	1
0 - .5	.00	.00	.00	.00
.5 - 1.0	.00	.00	.00	.00
1.0 - 1.5	.10	.00	.00	.00
1.5 - 2.0	.30	.09	.05	.00
2.0 - 2.5	.40	.20	.16	.08
2.5 - 3.0	1.0	.28	.23	.15
3.0 - 3.5	1.0	.37	.31	.20
3.5 - 4.0	1.0	.40	.38	.25
4.0 - 4.5	1.0	.40	.40	.29
4.5 - 5.0	1.0	.67	.40	.34

Heavy Dust

Range (km)	4, 5	3	2	1
0 - .5	.00	.00	.00	.00
.5 - 1.0	.03	.00	.00	.00
1.0 - 1.5	.83	.15	.12	.07
1.5 - 2.0	.57	.31	.26	.20
2.0 - 2.5	1.0	.44	.39	.30
2.5 - 3.0	1.0	.56	.50	.38
3.0 - 3.5	1.0	.74	.58	.45
3.5 - 4.0	1.0	1.0	.77	.51
4.0 - 4.5	1.0	1.0	1.0	.56
4.5 - 5.0	1.0	1.0	1.0	.61

SOURCE: Unclassified data from Confidential USACACDA/COAD/Analysis Division (ATZLCA-CAA) memorandum dated 24 May 1979.

*Visibility conditions 1, 2, and 3 in the table correspond to the 44, 7, and 5km data, respectively, in the source literature. Conditions 4 and 5 correspond to the 2km data in the source literature.

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