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TECHNICAL PAPER
RAC-TP-366

OCTOBER 1969

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The THEATERSPIEL Model

by
Gaming and Simulations Staff

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The THEATERSPIEL Model

by
Gaming and Simulations Staff

RAC Research Analysis Corporation
McLean, Virginia

FOREWORD

The THEATERSPIEL Model is published to provide an understanding of the theater-level computer-assisted war game model, THEATERSPIEL, used by the Gaming and Simulations Department of RAC. The publication describes the operation of the model, the basis and requirement for input data, the assessment routines, and the results.

The THEATERSPIEL Model has been operational for approximately 10 years. During that time the model has undergone a continuing evolutionary process with frequent modification and revisions being made to provide greater scope and flexibility to assessment routines, to generate data required by current game objectives, and to incorporate improvements made possible by advances in the state of the art. This paper reflects the status of the THEATERSPIEL Model on 30 April 1968. Modifications to the model that were planned but not incorporated on that date are classified as "Future Improvements."

Lawrence J. Dondero
Head, Gaming and Simulations Department

CONTENTS

Figures

Tables

RAC

The THEATERSPIEL Model

ABBREVIATIONS

ADA	air-defense artillery
AGZ	actual ground zero
AP	antipersonnel
APC	armored personnel carrier
ASM	air-to-surface missile
AT	antitank
ATG	artillery target grouping
BG	battle grouping
BL	basic load
BLCF	Basic Load Consumption Factor
BLF	Basic Load Factor
CAA	RED combined arms army
CAP	capacity
CDF	Class Distribution Factor
CEP	circular error probable
CF	Consumption Factor
COMMZ (COMZ on printouts)	communications zone
CPP	casualty-producing potential
DGZ	desired ground zero
ECM	electronic countermeasures
EEA	estimated expenditure of ammunition
ELINT	electronic intelligence
FEBA	forward edge of the battle area
FROG	free rocket over ground
FWA	fixed-wing aircraft
H	high air burst
hel	helicopter
HPA	high-performance aircraft
IFP	index of firepower potential
L	low air burst
LA	lethal area
LFR	large free rocket
LGM	large guided missile
LOC	line of communication
LOS	low on supply
LOSF	Low on Supply Factor
LPA	light fixed-wing aircraft
LRC	long-range cannon
MAE	mean area of effectiveness
ME	meeting engagement
MGM	medium guided missile
MRC	medium-range cannon
MRD	RED mechanized rifle division
MSF	Master Status File
NCWS	Nuclear Controller Work Sheet

NDS	nuclear delivery system
OB	order of battle
PBL	present basic load
PDT	Permanent Deployment Table
PERINTREPT	periodic intelligence report
POL	petroleum, oils, and lubricants
RET	retrograde
S	surface burst
SAM	surface-to-air missile
SASP	special-ammunition supply point
SFR	small free rocket
SGM	small guided missile
SLAR	side-looking aerial radar
SNA	system not available
SP	supply point
SRC	short-range cannon
SSKP	single-shot kill probability
SSM	surface-to-surface missile
TKA	RED tank army
TKD	RED tank division
TOE	table of organization and equipment
UTM	universal transverse mercator

ABSTRACT

THEATERSPIEL is a two-sided, closed, computer-assisted, theater-level war game with resolution at division level. The THEATERSPIEL game model consists of the cyclical application of flexible sets of rules, procedures, mathematical expressions, empirical formulas, and military judgments to a specific set of data descriptive of the military units, weapons, and equipment being studied. The purpose of the model is to realistically simulate combat situations in specified environments, producing information that will approximate the results of actual conflict under the same conditions.

The THEATERSPIEL Model is presented in eight chapters. Chapter 1 contains a general description of the model and its submodels and describes the requirements for game preparation and game play.

Chapter 2 explains the computer-processing sequence and the basic element of the THEATERSPIEL Model, the Master Status File. It also discusses the "main link" of the computer program, which brings the "dependent" submodel links into the computer as required.

Chapters 3 to 8 contain descriptions of the computer-assisted submodels: Air, Nuclear, Combat Support, Ground Combat, Logistics and Recovery, and Intelligence. They describe the submodel operations, the sources of input data, the assessment routines, and the expected output data. The sequence of processing each submodel and their interrelations are described.

Chapter 1

GENERAL

INTRODUCTION

Currently RAC has four devices under which theater-level war gaming may be conducted: the RAC Quick Game, the Computerized Quick Game (ATLAS), the Theater Quick Game Model, and the THEATERSPIEL Model. This paper provides an explanation of the THEATERSPIEL Model.

DEFINITION

The THEATERSPIEL Model consists of the cyclical application of flexible sets of rules, procedures, mathematical expressions, empirical formulas, and military judgments to a specific set of data in a specified environment. These data are descriptive of military units, weapons and weapons characteristics, and other military systems with their capability in particular situations and geographical environment. The purposes of the model are to realistically simulate combat situations and to produce information that will approximate the results of an actual conflict of similar units under the same conditions. The THEATERSPIEL program is a computerized program that stores much of the THEATERSPIEL Model in a computer in the form of instructions and data to assist in the rapid assessment, recording, analysis, and printing of the results.

CHARACTERISTICS

General

THEATERSPIEL is a two-sided, closed, computer-assisted game with resolution at division level, usually conducted in 24-hr time cycles. It is a device to assist in drawing tentative conclusions about the relative importance of comparable factors on the theater battlefield. It considers the various ways in which weapons, organizations, and doctrines might meet combat objectives or requirements.

Free vs Rigid Games

War games have been classified as "free" or "rigid" although the line of distinction between the two often is not precise inasmuch as many games have varying degrees of flexibility and freedom of choice.

The rigid war game is governed by detailed rules and precise computations, with the controller having only a limited area in which decisions can be made. In this regard it is like chess, checkers, or football, where the rules are very complete.[1]

The free war game, having few fixed rules, emphasizes tactical freedom and the use of experienced controllers and directors who judge the outcome of military engagements where rules are general.[1]

Although a certain amount of freedom and flexibility is provided in THEATERSPIEL, the game rules, assessment procedures, and assessment data generally are fixed in the computer program. THEATERSPIEL, therefore, tends to be a rigid game.

Two-Sided Game

A two-sided game assesses the results of the application of the firepower and the casualty-producing capabilities of each side against the other.

Closed Game

In a closed game the opposing players are furnished information by the controllers that may or may not be exclusive to each team; however, neither team knows whether it is exclusive. Each player team has complete information as to its own situation but is provided with only that information of the enemy that intelligence operations would be likely to produce.

Computer-Assisted Game

THEATERSPIEL is a computer-assisted game as distinguished from a completely computerized simulation. Orders and decisions of players and controllers' judgment dictate the extent, duration, and intensity of the combat situations and introduce factors influencing the combat results. Orders and decisions are coded and read into the computer. The several submodels then perform assessments based on these data for one cycle of play, and the computer produces a printed copy of the results called a printout. The printout permits players and controllers to analyze the results of that cycle and is a basis for decisions for the next cycle of play.

Resolution

Compatibility and consistency in aggregation and level of resolution are necessary to the production of valid assessments. The selection of the game resolution provides guidance for controllers in their aggregation of the several weapons systems. Consistency and compatibility are largely maintained by the game resolution, which is of three types:

Unit resolution or aggregation specifies the size of units to be played. Normally, unit resolution is at division level for ground-combat units; it is possible, however, to make model adjustments to accommodate gaming of smaller units, such as separate brigades, regiments, and groups.

Time resolution specifies the time period of one cycle of play. In THEATERSPIEL this time is normally a combat period of 24 hr. Generally major changes in the mission of a division cannot be implemented within a 24-hr cycle; thus orders usually are issued to cover a full day. If more discrete or detailed analysis is desired, the cycle may be reduced to a lesser number of hours. Both 6-hr and 8-hr cycles have been conducted successfully.

Space resolution relates the area to be gamed to the map to be used. Normally the smallest area appropriate for map reference in THEATERSPIEL is a square 10 km on each side. A map with a scale of 1:500,000 generally is used. Although this scale does not allow showing the division as it is deployed, it does provide sufficient space for movement and adequate details for tactical, intelligence, and logistic considerations and is suitable for a photographic record of daily actions.

THEATERSPIEL MODEL AND SUBMODELS

General

As previously defined the THEATERSPIEL Model, with its rules, procedures, and data, is designed to produce information as a result of simulated conflict in a specified environment. Contained in the model are seven submodels as follows (see also Fig. 1):

Air Submodel (Prenuclear)
Nuclear Submodel
Air Submodel (Conventional)
Combat Support Submodel
Ground Combat Submodel
Logistics and Recovery Submodel
Intelligence Submodel

Each submodel assesses the results of battle within its sphere of activity. Compatibility and internal consistency are of prime importance if the submodels are to be processed in an orderly manner and in a prescribed sequence.

The Main Link and Master Status File

The integrated interaction of the several models is controlled by an executive program, known as the "main link." This main link, in coordination with dependent links in each submodel, controls the computer processing of the THEATERSPIEL Model. It provides a proper sequencing of machine operations to make available any stored data that are required by the submodels and arranges the output data presentation, which is produced in the form of a printout.

The Master Status File (MSF) is common to all submodels of THEATERSPIEL. It contains many items of information on the status of all units in the theater, including strength, activity, location, and supply situation, to name only a few.

The MSF is a data table that contains information on the current status of all units in the theater: their strength, activity, location, index of firepower potential (IFP), casualty-producing potential (CPP), and supply situation. It is the principal connecting link or means of communication between all the submodels of THEATERSPIEL. Together with special information from the Nuclear (if used), Logistics and Recovery, and Intelligence Submodels, it provides much of the information on which players' decisions and orders are based.

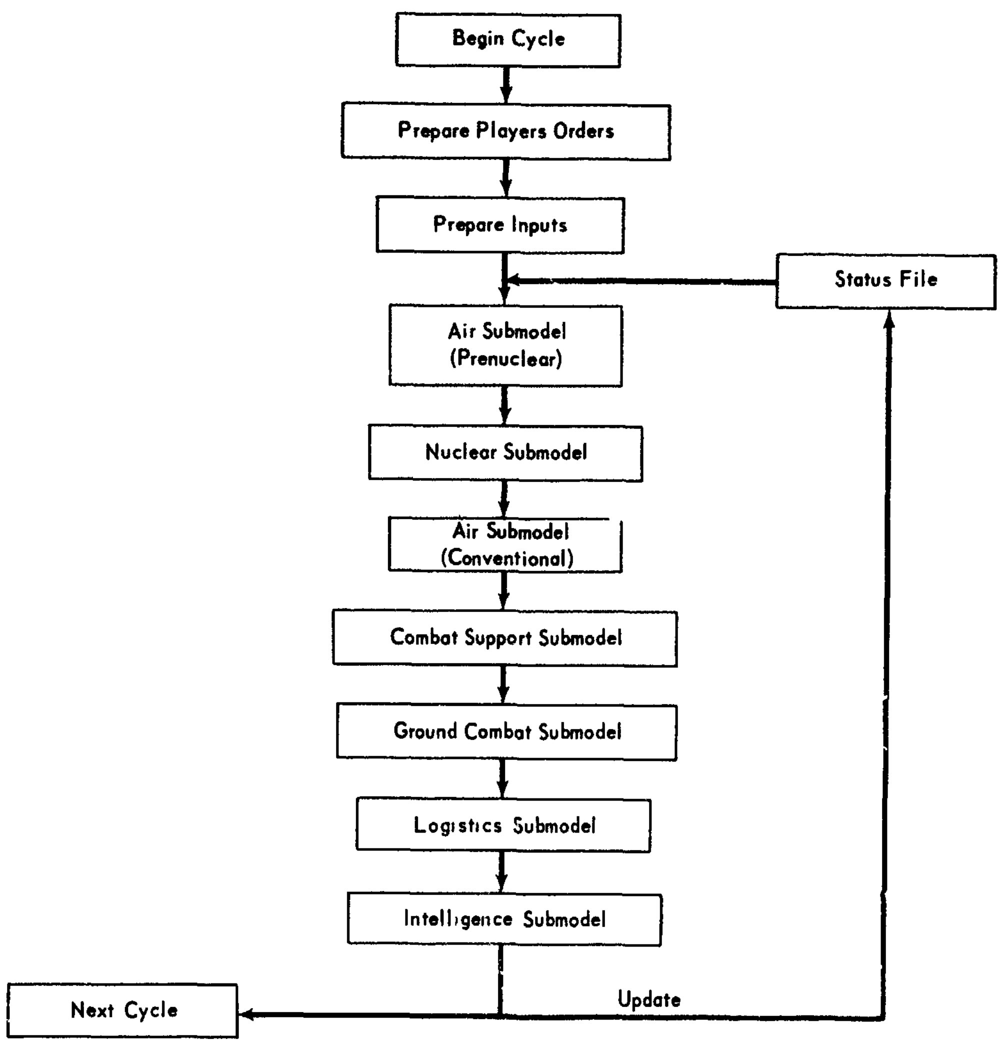

Fig. 1—The THEATERSPIEL Cycle

Those decisions and orders provide the base from which the controller's input data are prepared for the next cycle of play. The MSF is updated, but not printed out, as each submodel is processed. This permits the results of assessment by one submodel to be presented to the succeeding submodel for further assessment and further updating. This process continues until all assessments have been completed, at which time a final updated MSF is printed out.

Sequence of Submodels

The sequence in which submodels are processed by the computer adheres as closely as possible to the initiation and progression of events of an actual battle day. However, a specific sequence must be prescribed for the processing of each submodel and for the computations within each submodel. The prescribed sequence is that those weapons or actions that are of high lethality or mobility, such as those in the Air and Nuclear Submodels, are processed first (see Fig. 1). Usually such weapons or actions are not affected greatly by enemy units and weapons of a low order of lethality or combat effectiveness. The combat requirements for logistics support, recovery, and intelligence are processed at the end of the cycle on the basis that the results of such actions have more effect on combat capabilities for the following cycle than in the cycle in which they occurred.

Description of Submodels

A brief description of each of the submodels, arranged in the order in which they are called in by the main link, follows (see Fig. 1).

Air Submodel (Prenuclear). When nuclear-carrying aircraft conduct missions in game play, the Air Submodel is the first to be processed by the computer to determine whether nuclear-carrying aircraft were lost to enemy action before delivering their weapons on target. Those nuclear carriers that were not lost are passed on to the Nuclear Submodel for assessment of the damage caused by air-delivery nuclear weapons.

Nuclear Submodel. This submodel assesses personnel casualties and other losses and damage sustained by each side due to enemy attacks using nuclear weapons. Assessment is made of the effect of each weapon delivered against a targeted unit. The submodel permits an unlimited number of weapons to be fired against any one target and permits alternate firings by each side (BLUE and RED).

Air Submodel (Conventional). This submodel assesses three types of battle: ground to air, air to air, and air to ground. The principal types of aircraft included are interceptors, tactical fighters, bombers, transports, and helicopters. All primary missions performed by these aircraft are played in the submodel following prescribed service doctrine of employment. Ground-to-air systems include the surface-to-air missile (SAM) systems available to each side. The Air Submodel assesses aircraft losses in the air and on the ground, losses of air-defense systems from air attack, casualties to personnel in ground-combat and combat-support units, and destruction of supplies and equipment by air attack. It also assesses the suppression effect of air attacks on ground-combat and combat-support units that results from shock effect of such attacks.

Combat Support Submodel. This submodel is designed to assess the effects of surface-to-surface fires, other than nuclear, of the general support or nondivisional artillery. Normally the division artillery is played in the Ground Combat Submodel, which does not distinguish the effects of the division artillery fires from the effects of other division weapons systems. If, for any reason, it is desired to obtain data on the effects of division artillery, those units may be withdrawn from the parent unit and played in the Combat Support Submodel.

Ground Combat Submodel. This submodel is designed to assess the results of conventional ground combat, making two principal assessments. First it determines within each battle grouping* the success or failure of the attacker. Second it determines the casualties that are sustained by each ground-combat unit within a battle grouping. The first assessment is made based on the force ratio† of the two forces. The second assessment is based on a casualty percentage factor, as modified by the force ratios and the success or failure of the attacker. The movement of units, based on attacker success or failure, type of unit, type of defense, terrain, and force ratio, is hand assessed.

Logistics and Recovery Submodel. This submodel regulates, records, and reports the quantities of all classes of supply consumed, destroyed, required by, and resupplied to every unit and supply point. Movement capacity over surface lines of communication (LOCs) is also regulated to reflect loss of capacity resulting from enemy action. Supplies consumed, plus losses, determines requirements. Those requirements that cannot be met may reduce the combat effectiveness of the tactical units. This submodel will accommodate airlifts of supplies.

The submodel includes a recovery routine that takes into consideration the number of casualties sustained and the amount of supplies and equipment destroyed. It then, based on designated rates of personnel replacements and resupply, updates the personnel strengths and computes a new IFP and CPP at the end of each cycle of play.

Intelligence Submodels. Currently two intelligence submodels are available to THEATERSPIEL. The first, called the Aggregated Submodel, accomplishes the detection of units and installations through the application of a prearranged detection probability to each unit, based on its type, activity, and distance from the forward edge of the battle area (FEBA). In this submodel the detection probability is an aggregation of all intelligence means employed. The second intelligence submodel, called the Discrete Submodel, accomplishes detections in two parts. First it determines the detection of units and installations by ground intelligence means on the basis of the types of unit and installation and their locations and activities. Second it increases the number and quality of the detections acquired by ground means by the application of detection probabilities resulting from the use of aerial reconnaissance and surveillance means and electronic sensors.

*A battle grouping consists of friendly and enemy units in an active posture that are brought into a conflict situation for assessment purposes by the Ground Controller. It is made up of the forces of both sides, which come in direct conflict with each other, limited to a logical and manageable size. Battle groupings are based on players' orders and the controllers' evaluation of the tactical situation.

†The ratio of the attacker's IFP to that of the defender, adjusted to a specific situation, is termed the force ratio.

GAME PREPARATION

General

When contracts are received RAC policy requires that terms of reference for each proposed game be negotiated and formalized as a part of the agreement to conduct the game. The terms of reference govern the support to be provided by RAC and state specifically the purpose, scope, objectives, input requirements, major assumptions, duration of play, and reporting requirements.

The purpose, scope, and general objectives of the game are generally included in the mission. If no specific objectives are included, they must be deduced. Based on this information a determination can be made whether the model must be modified for any particular game.

Pregame Tasks

The quality of the results of the war game is based largely on the completeness of the pregame preparations. The tasks are detailed and time-consuming. The several pregame tasks will be discussed briefly under the following headings:

- Preliminary Steps
- Development of Rules
- Preparation of Data
- Preparation of Master Status File and Intelligence File
- Test Game

The first four tasks are accomplished by a Game Preparations Group, usually consisting of those who will be controllers during game play. The test game is conducted using those players who will participate in the formal game.

Preliminary Steps. The "Game Concepts" are extracted from the client's directive. They cover the scope, purpose, and objectives of the game; level of resolution; time frame; number of days to be gamed; maps to be used; assumptions; and the requirements for submitting the game report. The client may specify a format for the report; otherwise the RAC format will be used.

A scenario is prepared by the Game Preparations Group to establish the initial situation of the opposing forces, their missions, plan of campaign, constraints, and instructions for players.

When the initial locations of forces are finalized, a list of unit dispositions can then be prepared for inclusion in the MSF and the Intelligence File.

Development of Rules. The development of rules of play and rules of assessment from concepts and factors to a form usable in computer processing is required. Any necessary reprogramming must be effected and checked for accuracy.

Preparation of Data. All data intended for inclusion in the THEATERSPIEL program must be coded by a programmer and inserted in the program for access by the appropriate submodel. In general the preparation of data includes the accomplishment of the following tasks:

(a) Securing tables of organization and equipment (TOEs) and characteristics of equipment.

(b) Construction of troop lists and the assignment of a code number to each unit.

(c) Preparation of data pertinent to each of the several types of unit that will appear in the MSF.

(d) Preparation of logistical data:

- Computation of weights of class II and IV equipment
- Computation of basic loads and basic load factors* for each type of unit and for all classes of supply
- Establishment of supply consumption rates and levels at which units will be considered to be low on supplies
- Preparation of the above data for computer use.

(e) Development of factors for assessing casualties and destruction of materiel.

(f) Development of rates of expected expenditure of ammunition.

(g) Development of IFPs and CPPs.

(h) Preparation of weapons-systems data.

(i) Preparation of intelligence data.

Preparation of MSF and Intelligence File. The MSF is the basic data table in the THEATERSPIEL program. In order to prepare the status file, it is necessary to have both BLUE and RED orders of battle and the disposition of troops. The TOE for each type of unit to be played is required so that the strength, organization, number and types of weapons and vehicles, and pertinent data pertaining to vehicle and weapons characteristics will be known.

Within the MSF all units are placed in one of six categories: air, SAM, combat support, ground combat, logistics, and supply points. Chapter 2 of this document includes a detailed description of the items included in the MSF.

The Intelligence File comprises a listing of the units that have been detected and the quality of detection. At the beginning of the game it is necessary for the Intelligence Controller to prepare manually the BLUE estimate of RED dispositions and vice versa. For succeeding days the intelligence listings will be one of the printed products of computer operations.

Test Game. After all preparations have been completed, a test game or dry run is conducted to test the interactions of the data that have been stored in the computer and to test the several submodels. After completing the test under game conditions, any required adjustments and corrections are then made, and the model is retested if necessary, after which the model is considered operational for record play of the game.

GAME PLAY

General

Gaming operations are designed around the basic time resolution of the game, normally a 24-hr combat day. This is known as a cycle of play. From

*The basic load factor is a one-man slice of the five classes of supply in a unit basic load, expressed in pounds.

16 to 32 working hours are required to play one combat day depending on the complexity of weapons employed.

The following paragraphs set forth a general sequence of the actions that occur during one gaming cycle.

The Printout

The printout presents controllers and players with statistical data pertaining to the play of the previous day. Although it contains no actual analysis, it contains all the information required by controllers to make their own analysis and evaluations. It also allows them to present the players with data on which the latter will be able to base their orders for the next combat day. Included in the printout are:

(a) The updated MSF
(b) A list of units detected by BLUE and RED
(c) Losses of materiel and personnel casualties
(d) The results of conflict within battle groupings
(e) The results of all types of air actions
(f) The adjusted strengths, IFPs, and CPPs of units
(g) The loss and consumption of supplies and the amount of resupply received

Initial Controllers' Actions

When the printout is received, the controllers determine whether the assessments are free from possible errors in input data. If they are acceptable, each player team is given that portion that applies to its own forces.

Meanwhile the Ground Controller makes adjustments within the battle groupings to reflect the outcome of the ground combat during the previous day (cycle). He promptly establishes a new FEBA to permit the Intelligence Controller to commence preparation of zone input data, which the computer requires to determine in which intelligence zone each unit is located, based on the unit's distance from the FEBA.

The Ground Controller, in coordination with the Combat Support Controller, then completes the movement of units based on an assessment of the data received in the printout. He is guided by the force ratios of opposing units (as modified by the several submodels) applied to prearranged rules, curves, and tables. When the moves are completed, the updated situation in map-overlay form is given to player teams as it pertains to their own units (but not the enemy) as of the end of the battle day.

The Intelligence Controller, using the intelligence printout as a guide and considering the after-battle moves made by the Ground Controller, prepares a BLUE estimate of RED dispositions and a RED estimate of BLUE dispositions. The former is given to BLUE players and the latter to RED players. The Intelligence Controller also prepares a periodic intelligence report containing significant intelligence data resulting from the previous day's play.

The Air Controller allocates the percentage of aircraft of the several types that may be employed during the next combat day and monitors their employment to ensure conformance with air force doctrine.

Players' Actions

On receipt of the updated situation and intelligence data, the players finalize their plans and prepare orders for the ensuing combat day. These are mission-type orders covering the proposed employment of ground forces. Orders covering the use of combat-support forces, nuclear fire orders, and logistical moves are submitted in more detail. Each player team also submits its intelligence requirements for the next combat day.

Further Controllers' Actions and Decisions

On the receipt of the players' orders, each controller determines the combat situations or events that will occur owing to the interactions of the orders for the opposing forces.

Ground Controller. The Ground Controller considers the orders of both player teams for the administrative movement of the ground forces and makes the desired moves based on predetermined rules.

The Ground Controller then considers the players' orders, troop dispositions, terrain, and weather and creates appropriate battle groupings, each consisting of those ground-combat and combat-support units that will oppose each other during the coming combat day. Within each battle grouping he indicates the attacker and the posture of the defender, specifies a terrain factor, and determines the appropriate factor, if any, to be applied for maneuver, shock, and surprise.

The portion of the updated situation map applicable to its own forces is then given to each player team.

Air Controller. Simultaneously the Air Controller is setting up the air battles. He reviews the players' orders in view of weather conditions, the ranges of aircraft, the appropriateness of the targets selected, and the feasibility of the missions. He selects the air-defense systems that can be expected to react to each air mission. In consonance with player orders, he creates the air-to-air, air-to-ground, and ground-to-air engagements that are to be assessed.

Nuclear Controller. If nuclear weapons are gamed, the Nuclear Controller analyzes each nuclear mission submitted by the players in view of the tactical situation and the range of the delivery system; the nature of the target and its posture, dispersion, and intelligence level; and the yields of the weapons selected. When requested by a player team, the Nuclear Controller selects targets of opportunity to be engaged and for which nuclear munitions have been allocated by the players.

Combat Support Controller. The Combat Support Controller reviews player orders and moves combat-support units as requested by the players, consistent with the tactical situation. Artillery target groupings (ATGs) are formed to assist in the assessment of the exchange of artillery fires in those areas in which there is no significant ground-combat action. (ATGs are discussed in Chap. 5.)

The Combat Support Controller reviews and approves discrete fire missions requested by the players in view of the tactical situation, ranges of delivery systems, and the posture of targeted units.

Logistics Controller. The Logistics Controller evaluates the player orders to determine their effect on the logistics systems. He apprises the Ground Controller of the ground-combat units that are low on supplies. He also advises the Combat Support Controller with respect to combat-support units that may be low on ammunition or that may have a reduced number of delivery systems. He accomplishes any transfers of personnel or materiel ordered by the players and establishes or eliminates supply points if such action is indicated.

Intelligence Controller. The Intelligence Controller publishes the weather conditions. This action permits players not only to consider weather in tactical planning but also to envision restrictions on the acquisition of intelligence, especially by aerial means.

If the Discrete Submodel is being used, he then finishes the preparation of zone cards (data)* for the forthcoming day and then prepares a "mission input." These latter data assign a specific number of aircraft to search specific intelligence zones with designated sensors and under specific weather conditions. When the Aggregated Submodel is used, rather than the Discrete Submodel, the detection probabilities are stored in the computer, and no "mission input" is required.

Preparation of Inputs to the Computer

On completion of the analyses and controllers' actions described in the foregoing, each controller prepares input data for the computer. As the data are completed by each controller, they are reviewed by a designated member of the war-gaming staff (the Input Coordinator) for correct format and content and are punched on cards for computer processing.

The outputs of the various submodels are produced as a printout by the computer, and the entire cycle starts anew.

*Zone cards (data) introduce map segments 25 km square into the computer and align segments of the map with the predetermined intelligence zones.

Chapter 2

THEATERSPIEL COMPUTER PROGRAM

INTRODUCTION

The THEATERSPIEL computer program is composed of a main link and 19 dependent links. The main link provides the means to bring the dependent links into the computer as each is required by the THEATERSPIEL Model for the computer-processing phases of a submodel. The dependent links contain the assessment procedures of the various submodels.

The Master Status File (MSF) is a basic element of the THEATERSPIEL Model. It is prepared during the pregame analysis, and after the game begins it is maintained on tape and disk as a basic data table by the THEATERSPIEL computer program. The MSF is a systematic listing of specific data pertaining to each military unit and supply point in the war game. The listing contains statistics such as the unit location, activity, strength, combat effectiveness, status of supply, or other specific items of interest. An important function of the MSF is to provide current data to the computer during the computer-processing phase of each submodel and then to reflect the updated information for each unit at the end of each cycle of play.

GENERAL DESCRIPTION OF MODEL

In general the THEATERSPIEL Model includes a data-processing operation that develops statistics comparable with those that could be expected as a result of battle. The model is responsive to the combat orders and the decisions of players and controllers. It performs its task through a series of operating instructions within each submodel, through the storage of a large volume of reference data, and through a system of daily inputs that represent the player actions for the day's operations. The selection and use of appropriate data, the mathematics of the computations, the accumulation of resultant data, and the printout of final results are performed through the detailed instructions of the program.

A large volume of data is stored in the submodels for use as reference during the assessment procedures. TOEs, weapon characteristics, consumption factors, weights and measures of expenditures, and personnel-replacement factors are illustrative of the types of reference data used in the submodels. All data required in the assessment procedures must be stored in the appropriate submodel or the MSF or be introduced as an input at an appropriate time during assessment.

Inputs are introduced into the data processing at the beginning of each cycle of play. They normally consist of player inputs, control inputs, and technical inputs designed to provide the proper data processing during the next cycle. Player inputs originate usually as a written order that reflects the reaction of the players to the tactical and logistical situation. The orders, along with any additional data or modifications as determined by the controllers, are keypunched on appropriate forms. Control inputs usually consist of new data applicable to the next cycle, such as the latest weather conditions, terrain factors, targeting data, or revised statistics in the MSF. Changes desired in the technical instructions for the data processing are prepared by the programmers. When all inputs are assembled, the data are entered on machine punch cards, which are placed in proper sequence and become the input deck for the next cycle of play.

When the THEATERSPIEL computer program has been entered into the computer, the computer gives control to the main link of the program. The dependent links are called into the computer by the main link as necessary to accomplish the computer-processing phase of each submodel. During these operations the information in the MSF and in other data arrays is modified to reflect the results of the computer processing. The last dependent link generates a printout that lists the preponderance of assessment results and a copy of the updated MSF. The sequential order of the submodels and typical results obtained during the data processing are shown in Fig. 2.

The printout contains all the pertinent output data needed for the controllers to present an adequate after-battle situation to each player team. Parts of the printout containing statistics relating to its own forces are given to each team. Sufficient information is available for the player team to prepare orders for the next cycle of game play.

COMPUTER-PROCESSING SEQUENCE

The main link of the computer program normally arranges for the processing of the submodels shown in Fig. 2 in the following sequence:

(a) Air Submodel (for prenuclear air assessment)
(b) Nuclear Submodel (all nuclear assessments)
(c) Air Submodel (for conventional air strikes)
(d) Combat Support Submodel
(e) Ground Combat Submodel
(f) Logistics and Recovery Submodel
(g) Intelligence Submodel

The processing of each additional submodel that may subsequently be developed would involve only minor changes to the main link. Dependent links of the program, of course, would have to be prepared to accomplish the computer-processing phase of the new submodels. Additional programming routines added to the present dependent links would have only minor impact on the main link. In the event that the computer-processing phase of one or more submodels is not required during a cycle of play, the main link would not call the dependent links associated with those submodels into the computer.

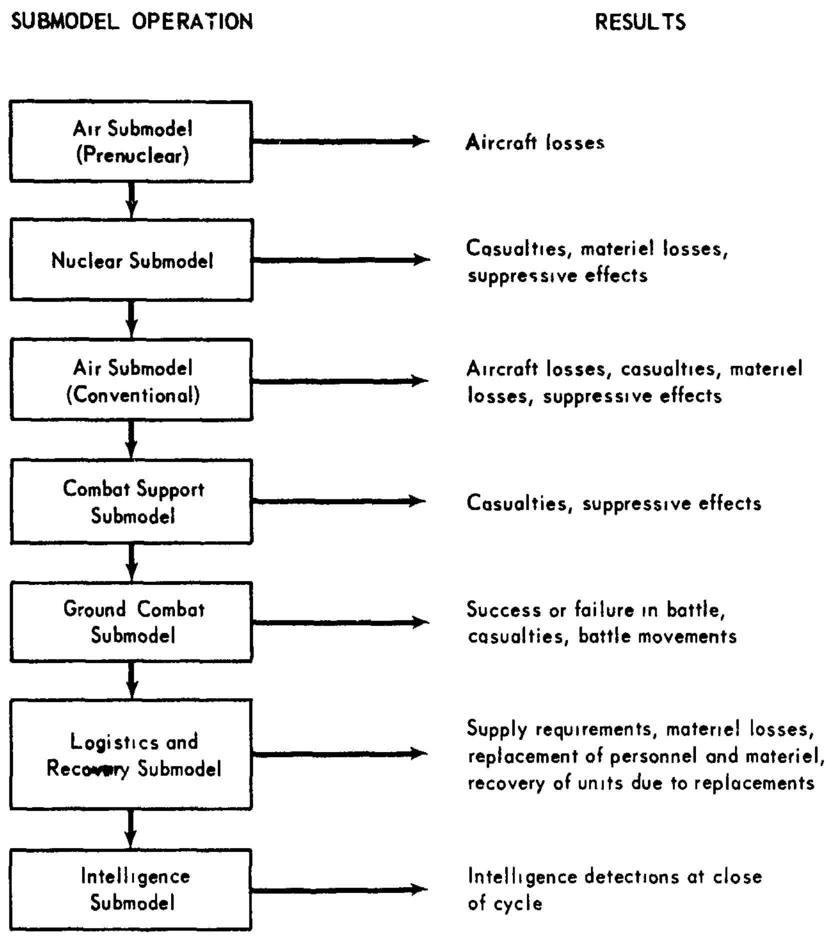

Fig. 2—Sequence and Results of Submodels

It may be noted that in nuclear war the Air Submodel is processed twice. The first processing of the submodel considers only those combat actions involving the aircraft that are carrying nuclear weapons. The assessments at this time determine the number of nuclear-armed aircraft that reach their assigned targets. The second processing of the submodel performs all assessments related to conventional air strikes. If nuclear weapons are not employed, neither the prenuclear air routine of the Air Submodel nor the Nuclear Submodel need be processed by the computer, and, consequently, the main link will bypass the call to those dependent links needed for the processing of the Nuclear Submodel.

MASTER STATUS FILE

General

The MSF contains statistical data pertaining to each unit and supply point of the forces in the game. There are at present 22 line items of information for each unit. Different categories of units may have different items of information in the file. The following discussion describes only the items in the file; their uses in the assessment procedures are presented later in the explanation of the various submodels.

The 22 line items of information are described in the order of their listing in the MSF.

Item 1: Unit Designation

The coded designation for all units is the letter "B" or "R" followed by four numerals. The letter B or R identifies the unit as belonging to either the BLUE or RED force.

The first digit of the four numerals of the unit is used to identify the category of the unit. There are six categories of units with an identifying numeral as indicated in Table 1.

TABLE 1

Identification for Unit Categories

Initial numeral	Category
0	Air
1	SAM
2	Combat support
3	Ground combat
4	Logistical and headquarters
5	Supply point

A unit with the designation B3 is therefore a BLUE ground-combat unit, and B5 indicates a BLUE supply point.

The second digit in the unit name is used to identify the nationality of the unit, if desired. For instance, if the numeral 2 is selected to denote units of French origin, then the unit B32 would represent a BLUE French ground-combat unit. The second digit may be used for some identification other than national origin.

The third and fourth digits are used to identify the numerical designation of the unit. Normally for security reasons and game management purposes, actual troop unit designations are not used. If, in the preceding example, the numerical designation of the unit is 14 and that number has been allocated to mechanized divisions, then B3214 identifies the BLUE 14th French Mech Div.

For all computer uses and in the printout the initial letter and four numerals, e.g., B3214, is the method of designating a unit. In game play the unit is referred to as the 14th Mech Div, and the unit symbol on the map will show an appropriate type symbol with the identifying number 14. Similarly the unit shown by the map symbol as the 23d bomber wing of the RED force would have a unit designation of R0023. Unit map symbols are colored BLUE or RED to distinguish the force to which they belong.

Aggregation of Units. As currently designed, the THEATERSPIEL computer program will not accept more than 300 military units and supply points for either BLUE or RED forces. As there are usually more than 300 units to be considered in the orders of battle, certain aggregation of like units is necessary. For example, artillery groups may comprise several battalions; air squadrons may be aggregated into air wings; and air-defense groups may contain several air-defense battalions.

Category of Units. Each unit or aggregation of units is placed in one of the six categories indicated in Table 1. Normally all air force units other than senior headquarters are placed in the air category. Army aircraft may also be placed in the same category. All SAMs and other air-defense artillery not organic to divisions are placed in the SAM category. Corps and army tube artillery and surface-to-surface missile (SSM) units are placed in the combat-support category. The ground-combat category contains major separate combat units such as divisions, brigades, and sometimes regiments. The type of unit may vary, e.g., infantry, armored, mechanized, airborne, and armored cavalry. Major headquarters, such as army group, army, corps, or senior air headquarters, and large logistical organizations, such as field army support command or a chemical brigade, are placed in the logistics category. Supply points, including those stocked with nuclear weapons, are in the supply point category.

Unit Subtypes. Current programming imposes a limitation of 99 units in any single category. Thus, for a war game in which identification beyond the general category is desired, the use of subtypes will usually satisfy the requirement. The number of subtypes within each category may be changed from game to game and need not be the same for opposing sides. Table 2 shows a typical grouping of units by category and subtype.

Thresholds. Numerical thresholds are used to identify a specific subtype within a category of units. As there are only 99 numbers available for assignment, the upper limit for any subtype is 99. Within that limit, blocks of numbers may be set aside to represent any specific subtype of unit.

An example in the use of thresholds is shown in Table 3. If there are 20 Hawk battalions, 15 Nike Hercules battalions, and 7 Chaparral battalions in the BLUE force, an assignment of unit numbers might be as shown in Table 3.

Thus the Hawk battalions are numbered from 1 to 20—more numbers are available if additional Hawk battalions are introduced into the game. The Nike Hercules units are numbered from 41 to 55 and there are 10 spare numbers. The Chaparral units are numbered 66 to 72 with 27 spare numbers.

Extracts from a sample BLUE order of battle are shown in Fig. 3.

When the order of battle for each force is complete, the unit designations are established and become the initial entries in the MSF. The format for the MSF is shown in Fig. 4. An example of each item for each category of unit in the MSF is shown in Fig. 5.

TABLE 2

Unit Categories and Subtypes

Subtype	Category
	0: Air Units
1	Interceptor
2	Reconnaissance
3	Fighters
4	Bombers
5	Transports
6	Helicopters
	1: SAM Units
1	Hawk
2	Nike Hercules
3	Chaparral
	2: Combat-Support Units
1	Short-range cannon
2	Medium-range cannon
3	Long-range cannon
4	Large free rocket
5	Small guided missile
6	Medium guided missile
7	Large guided missile
	3: Ground-Combat Units
1	Armor
2	Mechanized
3	Airborne
4	Infantry
5	Armored cavalry
6	Air assault
	4: Headquarters and Logistic Units
1	Headquarters
2	Port logistical
3	Rear logistical
4	Forward logistical
	5: Supply Points
1	Supply point
2	Special-ammunition supply point (SASP)

TABLE 3

Example of Thresholds

SAM unit	Subtype	Threshold
B1001–B1020	1	40
B1041–B1055	2	65
B1066–B1072	3	99

ORDER OF BATTLE
BLUE
(EXTRACT)

		SUB-TYPE	NATIONALITY	THRESH-OLD
AIR UNITS				
B0001 - B0005	Interceptor (5-120 A/C ea)	1	0	10
B0011 - B0013	Reconnaissance (3-150 A/C ea)	2	0	19
	x x		x x	
SAM UNITS				
B1001 - B1018	HAWK (5 Regt - 2Bn, 16 F.U. ea)	1	0	25
B1026 - B1030	Nike Hercules (18 Bn-4 F.U. ea)	2	0	65
	x x		x x	
COMBAT SUPPORT				
B2001 - B2009	155mm H (9 Regt - 2Bn, 36 Tube, ea)	1	0	55
B2056 - B2077	Honest John (22 Bn - 4 Lchr, ea)	2	0	86
B2387 - B2397	Sergeant (11 Bn - 2 Lchr ea)	3	3	99
	x x		x x	
GROUND COMBAT				
B3001 - B3002	Armored Div (2)	1	0	10
B3011 - B3014	Mechanized Div (4)	2	0	30
B3231 - B3233	Infantry Div (3)	3	2	40
	x x		x x	
LOGISTICS AND HEADQUARTERS				
B4001 - B4002	Army Group Headquarters (2)	1	0	20
B4320 - B4321	FASCOM (2)	2	3	30
	x x		x x	
SUPPLY POINTS				
B5001 - B5040	Supply Points (40)	1	0	50
B5051 - B5086	SASP (36)	2	0	99
	x x		x x	

Fig. 3—Extract from Sample Order of Battle

	AIR UNITS 0	SAM UNITS 1	CS UNITS 2	GC UNITS 3	LOG UNITS 4	SUPPLY PTS 5	
1	Unit Desig	Unit Desig	Unit Desig	Unit Desig	Unit Desig	Unit Desig	1
2	Location	Location	Location	Location	Location	Location	2
3	Activity	Activity	Activity	Activity	Activity	Activity	3
4	Input LOC 1	Input LOC 1	Input LOC 1	Input LOC 1	Input LOC 1	Input LOC 1	4
5	Input LOC 2	Input LOC 2	Input LOC 2	Input LOC 2	Input LOC 2	Input LOC 2	5
6	Input CAP 1	Input CAP 1	Input CAP 1	Input CAP 1	Input CAP 1	Input CAP 1	6
7	Input CAP 2	Input CAP 2	Input CAP 2	Input CAP 2	Input CAP 2	Input CAP 2	7
8	Priority	Priority	Priority	Priority	Priority	Priority	8
9	Pres Str	Pres Str	Pres Str	Pres Str	Pres Str	Pres Stg Cap	9
10	Prior Str	Prior Str	Prior Str	Prior Str	Prior Str	Auth Stg Cap	10
11	Auth Str	Auth Str	Auth Str	Auth Str	Auth Str	Class Dist	11
12	OH Supply 1	OH Supply 1	OH Supply 1	OH Supply 1	OH Supply 1	OH Supply 1	12
13	Other 2 and 4	Other 2 and 4	Other 2 and 4	Other 2 and 4	Other 2 and 4	Other 2 and 4	13
14	POL	POL	POL	POL	POL	POL	14
15	No Rds COFR	No Msls	No Rds/Msls	AMMO	AMMO	AMMO	15
16	No Rds HE	No Lnchrs	No Del Sys	No Tanks	No Tpts	Wt of Armor	16
17	No Sorties	No Msl Fired	No Rds Fired	IFP/Base			17
18	Pres Pers	Pres Pers	CPP/Auth	IFP/Auth Base			18
19	Prior Pers	Prior Pers	CPP/Pres	IFP/Retrogrd			19
20	Auth Pers	Auth Pers		IFP/Defense			20
21				IFP/Atk/Ret			21
22				IFP/Attack			22
23			Status	Status			23

Fig. 4—Report Format for the Master Status File

RAC

	AIR UNITS 0	SAM UNITS 1	CS UNITS 2	GC UNITS 3	LOG UNITS 4	SUPPLY PTS 5	
1	B0022	B1014	B2036	B3046	B4113	B5010	1
2	FT70	MU75	ND 68 2	TQ 90 0	MB 69	MA85	2
3	Active	Active	Active	PP	Active	COMZ	3
4	374	354	22	264	196	222	4
5	0	0	0	0	0	230	5
6	6000	113	148	3100	496	12439	6
7	0	27	60	0	52	11678	7
8	10	10	10	10	10	10	8
9	54	2	798	16005	6542	6607	9
10	56	3	1222	16320	7077	14300	10
11	153	4	1230	16674	7585	03050	11
12	28	4	8	1567	54	66	12
13	32656	1563	2298	36479	6451	2934	13
14	6477	6	20	552	485	501	14
15	4883	46	5922	1997	12	3629	15
16	1630	1	22	197	0	0	16
17	33	11	606	45			17
18	2694	1760	72	49			18
19	2703	1815	65	296			19
20	2712	1932		296			20
21				296			21
22				296			22

Fig. 5—Typical Data for Different Categories of BLUE Units

Item 2: Location

The location of a unit is usually given in terms of the universal transverse mercator (UTM) grid coordinates to the nearest 10 km, as X A 47. The grid location represents the approximate center of the general area in which the unit is tactically deployed. All units are given coordinates in the MSF except those that for some reason decided by control will not participate in the next cycle. Units outside the combat zone or for other reasons not participating in the next cycle are marked zero in place of the coordinates for location.

Terrain. The nature of terrain in which a ground-combat or combat-support unit is deployed is indicated by a single digit following the UTM grid location. The terrain digit may be the numeral 0, 1, 2, or 3. The numeral 0 or 1 indicates that the terrain offers no impediment to tactical movement. The numeral 2 indicates the terrain is of such a nature as to cause some impediment to tactical movement. Terrain 3 indicates terrain in which movement is difficult. The penalty placed on a unit operating in terrain 2 or 3 is assessed in the Ground Combat and the Logistics and Recovery Submodels.

The coordinates of the location of a unit and the nature of the terrain in which the unit is deployed are placed in the MSF by controllers. It is a direct input to the MSF.

Item 3: Activity

This item is entered in the MSF to indicate either the activity or the combat posture of all units. The entry is either a direct input by a controller or the result of the unit concerned having been engaged in a casualty-assessment procedure.

The term "active" or "inactive" applies to air, SAM, combat-support, ground-combat, and logistics units. Active units are those actively functioning in their primary mission, regardless of location. Inactive units are those not actively engaged in their primary mission; they remain relatively dormant during the cycle. "Administrative move" is a term used to indicate a unit moving from one location to another without any intentional contact with the enemy. A unit is given an administrative move status only by the direct input to the MSF by a controller. The effect of an active, inactive, or administrative move is important in both the Intelligence and the Logistics and Recovery Submodels. The detection probability of a unit and the logistical consumption of a unit will vary according to its activity.

Ground-combat units that are engaged with the enemy are designated by their activity. Units attacking are listed as "attack." Units defending are listed according to their defensive posture. The defense postures used are:

Static
Withdrawal
Delay
Meeting engagement
Hastily prepared position
Prepared position
Fortified position

These postures are listed in the MSF for information and also for use in determining the supplies consumed by the unit during assessment in the Logistics and Recovery Submodel.

Supply points may have one of two possible entries for Item 3. "COMZ" indicates that the supply point stocks all classes of supplies required for its consumers, except nuclear weapons. "SASP" is used to denote a special-ammunition supply point where nuclear ammunition is stored.

When the location of a unit is changed to zero in Item 2, the entry in Item 3 pertaining to the units activity is changed to "inactive."

Item 4: Input LOC 1

This entry in the MSF indicates the principal LOC from supply point to the unit served. The number contains either 2 or 3 digits and identifies the connection between the supply point and a customer. The digit or digits to the left of the right-hand numeral identify the numerical designation of the supply point serving the military unit. Thus the number 245 listed in Item 4 under a military unit designation indicates that the unit is supplied over LOC 5 from SP 24.

Item 5: Input LOC 2

Item 5 refers to a secondary supply route. The numerals entered in the MSF have the same meaning for supply points as do the numerals discussed in Item 4. As units are normally supplied over only one LOC, this item usually has applicability only to LOCs between supply points. For units other than supply points, a zero is normally entered for this item.

Item 6: Input CAP 1

For military units (not supply points), Input CAP 1 represents the assumed capacity of the LOCs between the unit and the supply point. The capacity is expressed in short tons.

For supply points, Input CAP 1 indicates the aggregated capacities of all surface means of transportation, in tons, located within the general area of LOC 1 and available for its support. Its use is described in the Logistics and Recovery Submodel.

Item 7: Input CAP 2

Usually this item applies only to supply points. It represents the aggregated capacities, in tons, of all surface means of transportation located wihin the general vicinity of LOC 2 and available for its support. This item may be used to indicate the tonnage transported by aircraft to a unit on a given day. The item is further described in Chap. 7, "Logistics and Recovery Submodel."

Item 8: Priority

Each unit and supply point is given a resupply priority on each LOC serving it. Thus the numeral 10 would indicate first priority on LOC 1 and no priority on LOC 2. It is necessary to use the priority when a supply point is low on supplies and when some of the units that it is serving have a more critical need for supplies than others. The use and description of this item are fully described in Chap. 7.

Item 9: Present Strength (or Present Storage Capacity)

The meaning of this item varies among the different categories of units in the MSF.

For air units, present strength indicates the number of aircraft on hand in the unit to include those that are not available for missions because of a need for maintenance.

For SAM units, Item 9 refers to the number of fire units available for the day's operation. A fire unit is a self-contained firing system capable of independent action. It includes fire-control radar and fire-direction equipment with the associated missile launchers and missiles.

For units of combat support, ground combat, and logistics to include large headquarters, Item 9 represents the current personnel strength of the organization.

In supply points, the item indicates the current storage capacity of the supply point expressed in tons.

Changes in Item 9 result from the assessments in the Air, Nuclear, Combat Support, Ground Combat, and the Logistics and Recovery Submodels. Changes may also be made by appropriate direct inputs from players or controllers.

Item 10: Prior Strength (or Authorized Storage Capacity)

For air, SAM, combat-support, ground-combat, and logistical units, numbers in this space represent the previous cycle's unit strength in aircraft, fire units, or personnel according to category as outlined in Item 9. In each cycle the change is accomplished by transfer of the data from the previous cycle's Item 9.

For supply points, Item 10 refers to the maximum authorized storage capacity, expressed in tons, for all classes of supply. This figure is determined before game play based on the number and type of units serviced by the supply point, their total requirements, the distance between the supply point and the FEBA, and consideration of any special requirements within the game objectives.

The maximum storage capacity is developed for each supply point. The number of days of supply support to be maintained in the supply point for each unit and other supply point is established by the controller. Calculations are then made for each unit customer to determine, by class of supply, the weight of a specified number of days of supply to be stocked at each supply point. The total weight of all classes of supply provides the basis for the maximum storage capacity of the supply point. A rounded figure is entered in Item 10 of the MSF and provides the limit on supplies available at the supply point. The limit may be reduced if the capacity is reduced as a result of enemy air or nuclear strikes.

Item 11: Authorized Strength (or Class Distribution)

Except for supply points, this item refers to aircraft, fire units, or personnel as discussed in Items 9 and 10. For supply points, the item is called a Class Distribution Factor and refers to the distribution of the various classes of supply within a particular supply point.

The Class Distribution Factor is established after the maximum storage capacity is determined. First the tonnage of each class of supply for all units served by the supply point is totaled. Then a ratio is determined by the weight of each class of supply to the maximum storage capacity and expressed as a percentage. The percentage becomes the Class Distribution Factor for that class of supply. The entry is a 5-digit number composed of the 10 percentage values (intervals of 0 to 9) that are representative of each class of supply. From left to right the Class Distribution Factors refer to classes I, II and IV, III, V, and Special Class (an item that may be selected). For example, a Class Distribution Factor 03240 would indicate the classes of supply in a supply point were as shown in the accompanying tabulation:

Class	Value, %
I	Not greater than 9
II and IV	30, but not greater than 39
III	20, but not greater than 29
V	40, but not greater than 49
Special	Not greater than 9

Precise percentages are entered in the Logistics and Recovery Submodel for use during assessment routines.

Item 12: On-Hand Supply of Class I

For all categories of units shown in Fig. 4, this item indicates, in tons, the amount of class I supply (rations) on hand within a unit. The number of tons is determined initially as a pregame computation. During the play of the game the figure is subject to revision by the consumption and resupply assessment of the Logistics and Recovery Submodel and by damage that might be assessed in the Nuclear and Air Submodels.

Item 13: On-Hand Supply of Class II and IV

This item refers to the tonnage of individual, organizational, and technical supplies and equipment exclusive of gun tanks, aircraft, and delivery systems reported elsewhere. The number placed here indicates the tons of class II and IV supply on hand in the appropriate unit. The entry in the MSF is subject to revision as a result of assessments in the Nuclear, Air, and Logistics and Recovery Submodels.

Item 14: POL

For all units, Item 14 refers to the number of tons of petroleum, oil, and lubricants (POL) on hand. It is subject to revision through assessments of the Air, Nuclear, and the Logistics and Recovery Submodels.

Item 15: Ammunition

This item has different meanings depending on the category of the unit concerned. In air units, the item represents the number of bombs of Special Conventional ammunition on hand. In SAM units, it represents the number of SAMs on hand. It represents either artillery rounds or missiles on hand in combat-support units, depending on the type of artillery. For ground-combat and logistical units, the item refers to the number of tons of conventional ammunition of all types on hand. In supply points, the figure usually refers to the tonnage of ammunition on hand, excepting nuclear weapons and Special Conventional ammunition for air units. In SASPs the item refers to the tonnage of nuclear weapons in stock. All inventories are subject to revision daily as a result of assessments by the Logistics, Air, and Nuclear Submodels.

Item 16

This item has varied meanings within the different categories. For air units, it represents the total number of high explosive bombs in the unit. SAM units use this item to account for the number of launchers available. For combat-support units it represents the number of delivery systems. The item represents the tanks on hand in a ground-combat unit, and for supply points it may be used to record the tonnage of special equipment or supply not included elsewhere but being played as part of the war game. Logistical and headquarters units do not use this item at present. All data shown in this item are responsive to updating as a result of assessments in appropriate submodels.

Item 17

Similar to Item 16, Item 17 data contained under each category of unit are different. Air units record the total number of sorties flown by the unit during the past cycle. SAM units record the number of missiles fired during the last cycle, and combat-support units record either the missiles or rounds fired according to the type of artillery. The base index of firepower potential (IFP) (discussed fully in Chap. 6) for ground-combat units is carried in this space. The item is not used for logistical units and supply points. Data in Item 17 are subject to changes reflected in the appropriate assessments in the Air, Nuclear, and Logistical and Recovery Submodels.

Item 18

Air, SAM, combat-support, and ground-combat units are the only users of this item. The present personnel strengths of air and SAM units are shown in this space. For combat-support units the authorized casualty-producing potential (CPP) (discussed fully in Chap. 5) of the unit is entered, and for ground-combat units their authorized base IFP is recorded. All entries are updated to reflect the most recent assessments relating to the data.

Item 19

Entries are used in this item for air, SAM, combat-support, and ground-combat units only. For air and SAM units the unit personnel strength at the beginning of the cycle just completed is recorded. In combat-support units it indicates the present CPP of the unit. In ground-combat units it represents the IFP of the unit in a delaying action or a withdrawal. The data are automatically maintained up to date through the processing of the submodels in assessing battle results and placing revised data in the MSF.

Item 20

For air and SAM units this item indicates the authorized personnel strength of the unit. Ground-combat units indicate the IFP of the unit for a defense posture. No other category of unit uses this space at present.

Item 21

Only ground-combat units use this space. It represents the IFP for an attacker who is opposed by an enemy in the delaying or withdrawal posture only.

Item 22

This space is used to indicate the IFP of a ground-combat unit in an attack posture and opposed by an enemy defending in some manner other than delaying or in withdrawal. No other category of unit uses this space.

Item 23

Although not carried as an item in the MSF in the computer, the updated percentage of authorized strength on hand in each ground-combat and combat-support unit is calculated at the end of the THEATERSPIEL computer operations and appears in the printout of the MSF.

Items 24 to 27

These spaces are used for temporary storage of information pertaining to the unit developed during the Logistics and Recovery Submodel computer-processing phase and do not appear in the MSF printout.

FUTURE IMPROVEMENTS

The MSF has two limitations that will be eliminated when the status file is revised. At present, the MSF will not permit more than 300 units on each side of the war game at any one time. Also only 27 items of data may be tabulated in the file for each unit.

Having only 300 units on a side may require an aggregation of units in order to play all the forces in the game. This aggregation is undesirable as the units that become aggregated are less susceptible to discrete examination. A greater flexibility in providing appropriate levels of resolution for different types of unit is afforded when the number of units played is not restrictive. For example, in a theater game in which the division is the main level of resolution, discrete data may be gathered for certain types of battalion or brigade by carrying them separately in the MSF. With no restriction as to the number of units gamed, the degree of discrete examination of selected units could be improved without affecting the level of resolution of other units.

Similarly it is desirable not to be limited to only 27 items of data for each unit in the MSF. However, increasing the number of items beyond 27 and increasing the number of units beyond 300 for each side involve basic programming changes and their achievement will require extensive reprogramming in the main link of the computer program, the MSF, and all submodels.

Other future improvements in the THEATERSPIEL Model are indicated in the discussions pertaining to each submodel.

Chapter 3

AIR SUBMODEL

INTRODUCTION

The Air Submodel is the first of the THEATERSPIEL submodels to be processed in the computer after Master Status File (MSF) updating is completed. The main link of the THEATERSPIEL computer program calls in dependent links necessary for the computer processing phase of the Air Submodel. When nuclear air-delivery missions are scheduled, input data pertaining to those missions are processed first to determine those nuclear carriers that reach assigned targets. Processing of air-unit data is then terminated, and the main link calls in dependent links that are required to process input data pertaining to the Nuclear Submodel. After the Nuclear Submodel has completed damage assessment inflicted by nuclear weapons, including those air delivered, the main link again calls in the dependent links that are required to process the remaining input data pertaining to the Air Submodel. At this time the remaining air-mission input data pertaining to conventional weapons and associated actions are processed. Then the dependent links of the Combat Support Submodel are called. In the event there are no nuclear missions during a cycle of play, conventional air-mission assessments are completed first, followed by the dependent links of the Combat Support Submodel.

PURPOSE AND SCOPE

War games played by THEATERSPIEL are primarily designed to meet Department of Army needs, and the testing of air plans and operations is complementary to the plan of action for ground warfare. Thus the Air Submodel is a tool to assist the ground commander in simulating ground warfare in a realistic environment that includes tactical air forces. This creates an awareness of the effects and impact that tactical air forces, opposing and supporting, have on the ground operations. In a more direct sense the Air Submodel assists the Army planner in evaluating the effectiveness of the active and passive air-defense means provided him and the significance of tactical air support to his ground operations.

The THEATERSPIEL Air Submodel is designed to assess the effects of tactical air forces and ground air-defense weapons systems, including aircraft, SAMs, air-to-surface missiles (ASMs), and antiaircraft gunfire, in all types of air action involving offensive, defensive, and airlift support operations.

METHODOLOGY

General

The Air Submodel assesses the effects of air and air-defense systems in their broad categories, i.e., interceptor, tactical fighter, bomber and transport aircraft, helicopters, SAMs, and ground fire, which includes both air-defense artillery (ADA) and small-arms fires.

The submodel includes several computer routines and is designed to allow players considerable latitude and flexibility in planning tactical air support and air defense without the necessity for planning detailed tactical air operations. To do this, and still retain validity of assessed results, first a degree of aggregation is established within the air order of battle (OB) furnished the player, and second a considerable body of air doctrine and detailed computations of expected values of battle assessments are programmed in the computer. For example, a tactical-fighter strike on a ground-combat or combat-support unit automatically receives ground fire from the ground unit under attack; thus air-defense reaction is automatically applied. The submodel is designed to allow the Air Controller to specify the sequence in which events are to occur for each tactical air mission. Air-defense reaction to a tactical air strike, including SAM fire, interceptor engagement, ground fire, or any combination thereof, may be designated to occur in any order desired. If no sequence of action is specified, the submodel will automatically perform ADA and SAM fire assessment first and air intercept assessment second and will finally assess effects of air-delivered conventional munitions. The assessment routines employ constant assessment factors such as those for abort, detection and control, operability, and single-shot kill probability (SSKP). Where an assessment is made of an action that experience has shown produces a broad range of results, chance determination by random number achieves the expected variation of results.

Submodel Routines

The Air Submodel includes four routines, which are described briefly below. They are used in the sequence prescribed by the Air Controller for each air battle grouping except that the airlift routine is only used when a unit is airlifted behind enemy lines. Detailed descriptions of these routines are contained in "Description of the Submodel."

Surface-to-Air. This routine evaluates SAM fire by SAM units and also assesses the effects of ASM directed against SAM sites.

Air-to-Air. This routine assesses the effects of air-to-air combat when attacking aircraft are intercepted by defending aircraft.

Air-to-Ground. This routine assesses the effects of close air support and interdiction missions against ground-combat and combat-support units, SAM units when attacking aircraft employ munitions other than ASMs, logistics and headquarters units, and supply points. Losses incurred by attacking aircraft as a result of ADA and small-arms fire are also assessed in this routine. Losses inflicted on overflying aircraft, occasioned by ADA and small-arms fire, are assessed by a separate subroutine.

Airlift. This routine is called in only when a unit is being airlifted and is subject to attack by air-defense units. It assesses personnel losses and the resulting reduction in the index of firepower potential (IFP) of the airlifted unit.

Elements of the assessments made in the four routines are transmitted to the MSF to update it and are reflected in the Air Submodel printouts.

When nuclear weapons are employed, the elements of the Air Submodel that are called by the main link to initiate functioning of the THEATERSPIEL Model are the air-to-air and surface-to-air routines, as well as the ground-fire subroutine of the air-to-ground routine. The Air Submodel assesses effects of conventional and special conventional weapons, and the Nuclear Submodel assesses effects of all air-delivered nuclear weapons with only one exception. Effects of nuclear-armed air-to-air missiles are determined by the Air Submodel.

Levels of Aggregation

Air Units. The level of aggregation in the strength (number of aircraft) of air units is conditioned by two factors. First the present THEATERSPIEL Model is limited to a total of 300 units of all types on each side. Second the number of air units is further limited by the number of individual units an air player can effectively plan for and control during a playing period. In a theater-level game, in the NATO area, the number of units involved could easily exceed the capacity of the model. Therefore, although the smallest tactical-fighter air unit is normally a wing of approximately 75 aircraft, it is often necessary to reduce the number of wings and increase wing aircraft strength to as many as 200 aircraft for game purposes. In this manner the full weight of the air order of battle (OB) is accounted for in total number of aircraft. Regardless of the strength of an air wing, the submodel provides flexibility in that the player may order air strikes or air-defense action of less than wing size by specifying a fraction of the unit to act. In the above instance, by designating 5 percent of the 200-aircraft unit to engage in close air support, the player would call up 10 aircraft for that mission.

Another aggregation involves the different types of aircraft; all aircraft of a specified type are accorded the same performance characteristics. For example, all NATO interceptors do not possess the same performance characteristics, but those characteristics that are significant to the Air Submodel are weighted and averaged according to the number of each different type interceptor in the air OB and a "composite" interceptor characteristic is developed for the game. The same procedure is followed for tactical fighters, bombers, transports, and helicopters for both BLUE and RED forces.

Aircraft weapon load is another area where aggregation is employed. Different types of tactical fighters carry different amounts and types of weapons. As in the case of aircraft performance, a weighted average weapon load is developed for the tactical fighters, based on the numbers of each type of tactical fighter in the OB. The weapon load is also adjusted to compensate for missions flown against personnel and missions flown against materiel. Thus the weapon load of the composite tactical fighter is a weighted average of aircraft load-carrying capability and mission objective. For example, the assessment of terminal effects of aircraft attacking ground-combat units is based on a weapon load weighted in favor of a preferred antipersonnel and area target loading. The assessment of terminal effects of aircraft attacking a supply point is based on a weapon load weighted in favor of a preferred antistructure or point target loading. In this manner a variety of loadings are possible within the submodel. The preferred loads are never weighted to the extent that they become ideal loads. This provides for results something less than optimum, and a more logical assessment is accomplished.

Transport aircraft are also aggregated into one composite type for each side. The airlift capability is a weighted average for total tonnage of supply and number of combat troops that may be carried per aircraft.

SAM Units. SAM air-defense units are aggregated with respect to the number of fire units assigned. The unit of resolution of SAM units is generally the battalion. One Nike Hercules battalion might normally consist of three batteries of one fire unit each. However, because of OB unit space limitations it may be necessary to assign more fire units to a Nike Hercules battalion. As in the case of the overstrength aircraft wings, the entire SAM unit strength need not be employed in any one action. Instead a specified number of fire units, from one up to the full fire unit strength of the aggregated battalion, may be designated to fire.

ADA. ADA is not played as discrete ADA systems, e.g., separate 57-mm, 20-mm, and 90-mm gun systems, in the manner that SAM systems are played by individual-type SAMS, such as Nike Hercules, Hawk, or Chaparral. Instead all ADA systems capability is aggregated into one overall aircraft loss factor for ADA fire. The ADA assessment factor includes the capability of the ground-combat or combat-support unit organic antiaircraft weapons, small-arms fire, and possibly organic SAM systems such as Redeye. The effect of this ground fire against attacking or overflying aircraft is modified in each instance by a random number selection to draw one of four credible loss factors, which is applied to the aircraft attacking or overflying.

DESCRIPTION OF SUBMODEL

Pregame Preparations

General. Pregame tasks begin with those preparatory actions required by the special situation described in the game scenario and specific objectives of the client. These pregame preparations may require development of new assessment factors and the drafting of message, recording, and reporting forms, the format for which is influenced by the rules of play and client requirements. Other forms for daily play are designed by the players and controllers as required to facilitate play of the game, to reflect only necessary data, and to satisfy client requirements.

The Air Controller reviews all pregame preparations to ensure that:

(a) Client requirements pertaining to air operations will be met, including specific objectives and topics of special interest.
(b) Rules of play are understood and documented.
(c) Assessment factors for the Air Submodel are completed and the THEATERSPIEL computer program and the MSF are updated.
(d) Air and SAM OBs are verified.
(e) Maps and charts are available and posted.
(f) Special instructions are issued.
(g) Forms are prepared and issued.

Preparation of the MSF. The MSF is discussed in detail in Chap. 2, "THEATERSPIEL Computer Program." Although the Air Controller is not responsible for preparation of the MSF, he must be thoroughly familiar with the air and SAM OBs and with the basic data associated with each. The Air Controller also provides those preparing the MSF with the UTM grid locations and unit personnel strengths of air and SAM units. Fuel-consumption factors for aircraft and other logistic data for air units are provided the Logistic Controller by the Air Controller.

The air OB for each side may be furnished by the client or prepared by the Game Preparations Group.

The aircraft strength of air units is held as low as possible within restrictions imposed by limitations on the total number of air units. This facilitates mission planning and simplifies input preparation. In no case are air unit aircraft types mixed, only one type being assigned to each air unit. One air unit may be distributed over three or four airfields; however, only one address in UTM grid coordinates is shown in the MSF for each unit. Player and control manually maintained records reflect the strength, by number and type of aircraft, of each occupied airfield.

The Air Submodel is currently capable of playing six types of aircraft: interceptors, tactical fighters, bombers, reconnaissance, transports, and helicopters.

A single composite or notional aircraft is played for each type of aircraft included in the actual air OB. Therefore, if four types of tactical fighters are included in the BLUE air OB, then for game purposes one composite tactical fighter is developed, its characteristics being a weighted average of the same characteristics of each of the four types. Development of the notional aircraft is as follows.

First the type and number of aircraft are determined as shown in the accompanying tabulation.

Aircraft	Number
F-105	250
F-4C	100
F-111	50
F-104	100
Total	500

Next a hypothetical weapon load for the composite tactical fighter is computed as shown in Table 4.

TABLE 4

Computation of Weapon Load for BLUE Composite Tactical Fighter

Type of aircraft (1)	Number of aircraft (2)	Percent of force (3)	Weapon load per aircraft, lb (4)	Weighted weapon load, lb (Col 3 × Col 4)
F-105	250	50	9,000	4500
F-4C	100	20	9,000	1800
F-111	50	10	15,000	1500
F-104	100	20	3,000	600
Total				8400

Thus each BLUE composite tactical fighter is assumed to have a weapon load capability of 8400 lb. A similar calculation is then accomplished for the other required characteristics for the composite tactical fighter, such as the following:

Range: high, low, high-low-high
Speed: high, low
Fuel consumption: average per sortie (for Logistics and Recovery Submodel)
Weight: combat

The same procedure is followed for each category of BLUE and RED aircraft in the respective air OBs.

The SAM OB may include four types of SAM systems for each side. A total of eight SAM (system) types can be played discretely in the Air Submodel. Comments pertaining to the MSF aggregation requirements with respect to the air OB also apply to the SAM OB. SAM types are played with their own specific characteristics. Numerous performance characteristics are required for each type of SAM system in the OB. With these performance characteristics the Air Controller is able to develop the necessary burst diagrams from which burst tables and kill probabilities are derived. The method of developing burst diagrams and burst tables is described later in the section "Assessment Factor Requirements."

Operational Requirements. Special rules of play imposed by the client may include specific restraints placed on nuclear air strikes, limitations on conventional or special ammunition, the establishment of sanctuaries, and restrictions on boundaries and targeting. In practically all cases special rules influence the deployment and employment of the air forces and air-defense systems involved.

The deployment of air and SAM units may be determined by the client or by the Game Preparations Group. Although the special situation or special rules of play may dictate initial deployment, as the game progresses the developing situation governs subsequent redeployment.

The deployment of air force units is compatible with airfield capacity, runway dimensions, load bearing capacity, and LOC capabilities. It is assumed that service and maintenance facilities, communications, and navigational aids are provided and adequate.

The deployment of SAM units is done on an aggregated basis, i.e., individual SAM fire units are not discretely located. The SAM unit map designator is centrally located among the ground-combat units, combat-support units, or other target areas that are defended by that SAM unit.

Aircraft sortie rates may be established by the client or by the Game Preparations Group. Sortie rates are established for each type of aircraft for each side. For game purposes, a sortie rate is the number of sorties per day per possessed aircraft by type, for specified periods of time. For example, tactical-fighter aircraft may be assigned a sortie rate of 3 per day from D-day to D + 6, 2 sorties/day/possessed aircraft from D + 7 through D + 15, and a sustained sortie rate of 0.9 sorties/day to the end of the game. An increased sortie rate may be allowed for one playing cycle whenever the air unit has not flown for 1 full day.

The aircraft-utilization factor is related to aircraft operability and reliability.

Operability. Operability is defined as the probability that an individual aircraft is flyable throughout the playing cycle. It takes into account quality of maintenance, availability of spare parts, and the general overall condition of equipment. Recognizing that operability may vary during the play of a game, three operability conditions are established.

(1) D-day or stand-down condition is assumed when a maximum maintenance effort could bring the aircraft in commission rate up to a high level. This condition could produce an operability factor of 0.9 to 0.95.

(2) A post-D-day condition is assumed lasting for 6 days (D + 1 through D + 6) when aircraft are still in good operational condition but require increased maintenance. This condition may suggest an operability factor from 0.8 to 0.9.

(3) A sustained condition is assumed when all the aircraft have been actively employed over a period of time and the maintenance and support capability of the unit is fully utilized. No additional support capability exists. Sustained operability factor could be from 0.65 to 0.8.

The three operability values, one for each condition, are established for both BLUE and RED air forces.

Reliability. Reliability is defined as the probability that a single aircraft in position for takeoff, will take off, reach its target, and deliver its weapons if no enemy action interferes. The opposite to this is an aborted mission. The possibilities of engine failure, system failure, and incorrect target identification are taken into account. Reliability may vary from 0.75 to 0.95. This factor is usually held constant throughout the play of the game.

Individual operability and reliability factors may be set for as many as 10 nationalities on each side. Operability and reliability factors are obtained from official US Air Force and US Army sources.

Both detection and control are the product of a nation's air-defense system. Detection and control factors are based on the ability of the air-defense system to detect and track intruding aircraft and to control defending interceptors sufficiently well to lead them into a firing pass.

The number and types of radars, quality of radar operator training, degree of experience, terrain, weather, and radar countermeasures all influence the factors for detection and control. Two factors for detection and control are established, one for a high-altitude flight above 500 ft and one for low-altitude flight at 500 ft and below. Different values are applied to different nationalities as appropriate. Detection and control factors of one nationality might be as shown in the accompanying tabulation.

Flight altitude	Intruder detection factor	Interceptor control factor
High	0.90	0.95
Low	0.35	0.55

Assessment Factor Requirements. Assessment factors are derived from data provided by the client or developed by the Military Gaming Department at RAC.

The special objectives, topics of special interest, and the OB will require that the Air Controller develop specific assessment factors for the various routines of the Air Submodel. These are, for the most part, kill probabilities (P_k) or attrition factors employed in each of the assessment equations. It is the responsibility of the Air Controller to procure or develop the required assessment factors for each new or changed weapons system in the air and SAM OB and to include these factors in the Air Submodel program. All assessment factors shown are illustrative only and are not to be taken as accepted values.

Air-to-air probability of kill factors. The SSKP factors in the Air Submodel routine, applied when aircraft are engaged in air-to-air combat, are determined by matching energy maneuver performance characteristics of one aircraft with those of the opposing aircraft. Rather broad assumptions may be necessary when dealing with future weapons systems whose performance characteristics are based solely on qualitative materiel requirements established for that weapons system. Sources from which SSKPs have been obtained are official US Air Force and US Army documents.

Table 5 shows a representative listing of SSKPs for intercept actions.

TABLE 5

Kill Probabilities for Air-to-Air Engagements

Type of interceptor	Tactical fighter		Bomber		Transport		Helicopter	
	High	Low	High	Low	High	Low	High	Low
Broadcast control, conventional warhead	0.20	0.08	0.23	0.16	0.38	0.22	—	0.10
Broadcast control, nuclear warhead	0.31	0.23	0.34	0.28	0.61	0.39	—	0.24
Close control, conventional warhead	0.42	0.29	0.62	0.48	0.87	0.61	—	0.19
Close control, nuclear warhead	0.87	0.68	0.91	0.73	0.95	0.78	—	0.61

SAM probability of kill factors. The determination that an aircraft is lost to SAM fire is based on the SSKP of one salvo killing one aircraft. In some cases two missiles are fired in one salvo, depending on the firing doctrine of the particular SAM system. One SSKP is applied to aircraft flying high profile (above 500 ft), and another is applied to aircraft flying low profile (500 ft and below). In addition to the SSKP of the specific SAM system, the number of salvos per fire unit, based on the probability the flight may proceed directly over the fire unit, must be determined. Also, a probability is developed for determining (a) the distance the flight passes to one side of the fire unit and (b) the reduction of salvos due to this track effect, which reduces the period the flight is within range of the fire unit. The following discussion describes how these values are determined.

First the following performance characteristics of the radar and guidance systems of each SAM system must be known.

(1) Maximum high-altitude range
(2) Maximum low-altitude range
(3) Maximum number of targets that can be engaged simultaneously
(4) Degradation factors for electronic countermeasures (ECM), decoys and centroid (center of mass) effect expressed in terms of either time delay, distance degradation, or SSKP degradation
(5) Time in seconds for:
   (a) System reaction
   (b) Missile reaction
   (c) Any interrogation taking place between firings to determine whether each missile achieved a successful kill
   (d) Reload
   (e) Delay between shots
   (f) Maintenance down time
   (g) Evacuate: relocate and ready for fire time

(6) Reliability of system
(7) Reliability of missile
(8) Radar horizon limitations, i.e., 0 deg horizon or 1 deg horizon
(9) Number and general positioning of vans, power equipment, and antennas and their relative position to launchers
(10) Dead zone of fire
(11) Missile requirements:
  (a) Weight
  (b) Maximum range
  (c) Maximum altitude
  (d) Flight speed
  (e) Type of warhead: conventional or nuclear
  (f) SSKP: one missile or two missiles depending on firing doctrine
(12) Number of missiles per launcher
(13) Number of launchers per fire unit
(14) Number of fire units per battery
(15) Number of batteries per battalion
(16) Basic load per fire unit
(17) Troop requirement per fire unit
(18) Rate of fire
(19) Sustained rate of fire (24 hr)

With this information a graph of the sequence of events can be developed, as shown in Fig. 6. The assumed data used in developing the graph example are shown in Table 6.

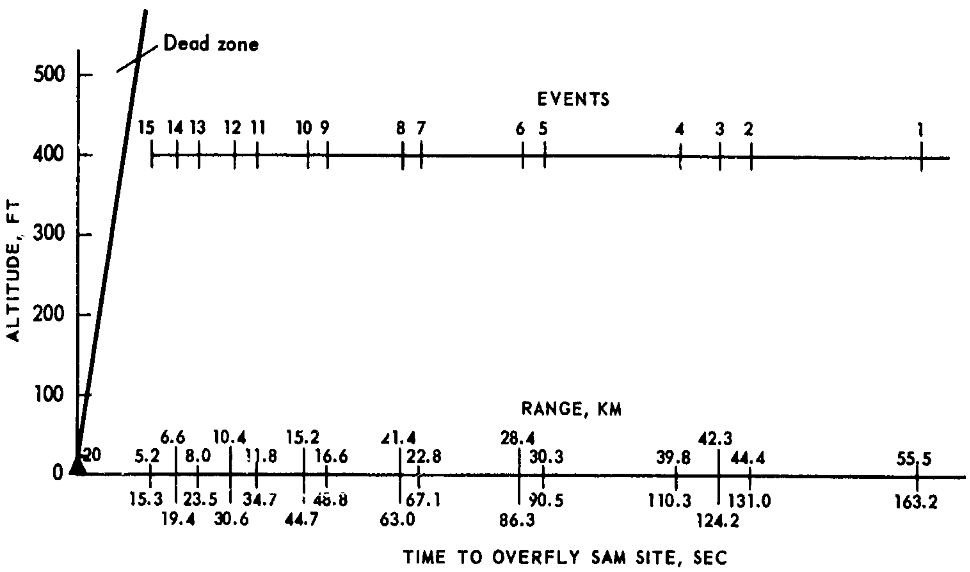

Fig. 6—Events Graph: One SAM Battery vs One Aircraft

Events numbered as shown below are indicated by the top row of figures on the graph in Fig. 6. The second row of figures shows the distance, in kilometers, the aircraft is from the fire unit as each event occurs. The bottom row of figures indicates flight time of the aircraft, in seconds, to the fire unit as each event occurs.

(1) Maximum detection range without ECM
(2) Detection range with ECM 25 percent factor assumed
(3) Normal reaction time without decoys
(4) Additional reaction time due to decoys (20 percent degrading factor); first missile fires
(5) First intercept
(6) Assessment; if no kill, second missile fires
(7) Second intercept
(8) Assessment; if no kill, third missile fires
(9) Third intercept
(10) Assessment; if no kill, fourth missile fires
(11) Fourth intercept
(12) Assessment; if no kill, fifth missile fires
(13) Fifth intercept
(14) Assessment; if no kill, sixth missile fires
(15) Sixth intercept: additional time delay for dead zone overflying and the next intercept will occur after overflight; the capability to fire more missiles will depend on the results of the air strike if the mission was directed at the site

TABLE 6

Data for Developing Events Graph

(Kill assessment completed 4 sec after intercept)

Item	Amount
Aircraft speed, Mach	1 (0.34 km/sec)
Closing velocity, km/sec	1.5
Aircraft altitude, ft	400
Radar height, ft	20
Reaction time, sec	6
Radar line of sight, km	$4/2 \sqrt{\text{aircraft altitude, m}} + \sqrt{\text{radar height, m}}$

From the sequence-of-events graph, a burst diagram can be constructed as shown in Fig. 7. For more precise location of burst points, computation can be accomplished on the computer with the use of the following quadratic equation using only the positive roots

$$(1 - B^2)\, d^2 + \left[(2 B^2 t V) - 2x \right] d + x^2 + b^2 - B^2 t^2 V^2 = 0$$

where d = distance from previous burst to next burst point, km
V = velocity of target, km/sec
B = Vmh/V (dimensionless)
Vmh = horizontal velocity of missile, km/sec
t = recycle time
b = track offset from center track, km
x = previous burst point position, km

When $b = 0$ the quadratic in d has two roots, the negative root reduces to the linear equation for zero track offset, viz, $d = (x + BtV)/(1 + B)$.

In the sample burst diagram (Fig. 7), thresholds for determining the number of salvos fired at the aircraft are established at 25 percent increments

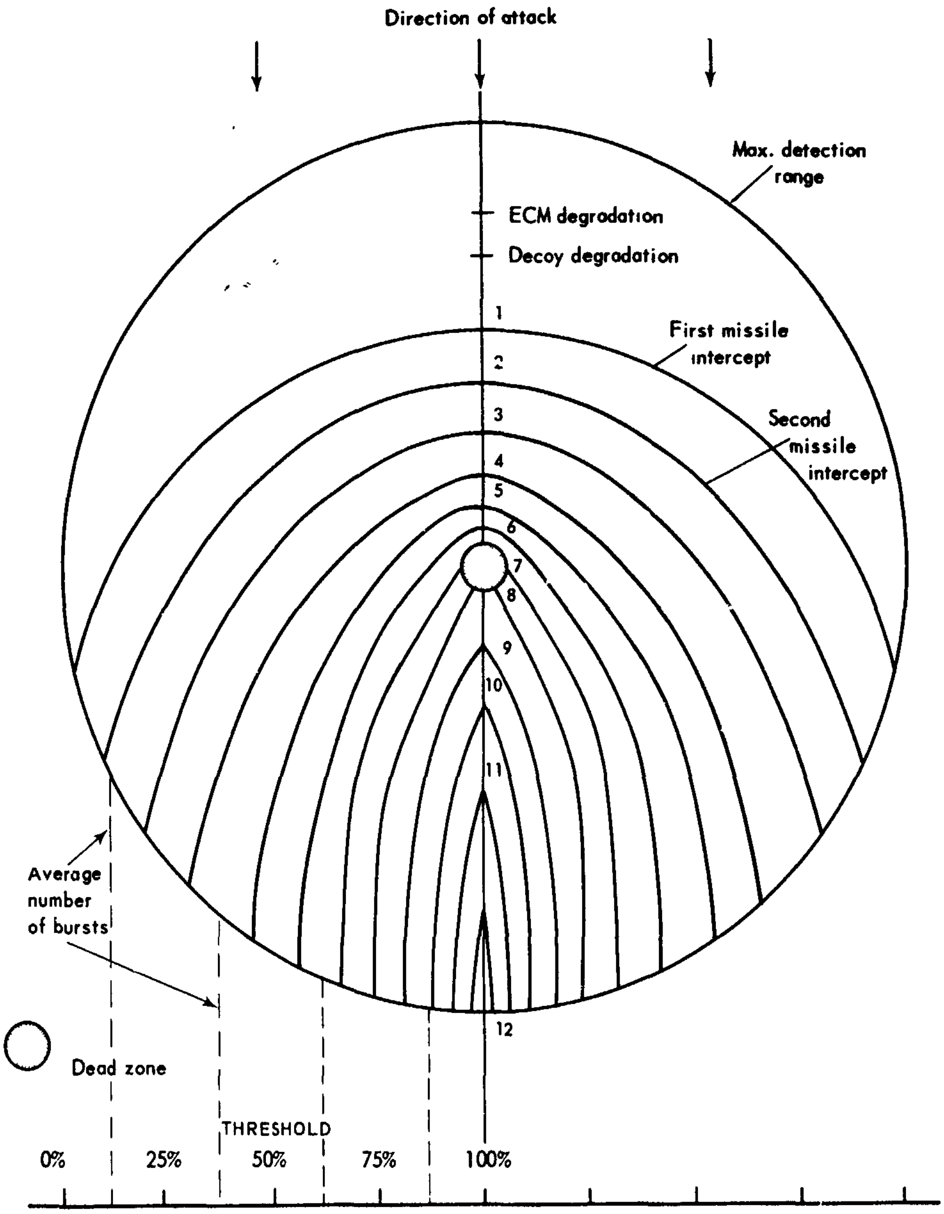

Fig. 7—Sample Burst Diagram

of the maximum distance from the fire unit the aircraft could fly and still be engaged. Since this offset flight-path distance is not discretely played, random number determination of the offset distance is made. This permits determination of the expected number of bursts the aircraft is exposed to as shown in the example and in the accompanying tabulation.

Random number	Average number of bursts each flight exposed to
00–24	2.3
25–49	4.7
50–74	6.8
75–00	10.9

ASM factors. The determination of the number of fire units destroyed by ASM attacks is conditioned by three factors: (a) ASM reliability, which includes both missile system and warhead reliability; (b) the number of ASMs carried per aircraft; and (c) the vulnerability of specific SAM systems to the type of ASM being used. Data are obtained from official US Army and US Air Force publications.

Parked aircraft kill factor. This factor is required for both tactical fighters and bombers to take into account the difference in weapon load. The type of weapon, type of attack, circular error probable (CEP), and mean area of effectiveness (MAE) are all taken into consideration. Here again a degree of aggregation is accepted in that only one kill factor is applied even though aircraft parked on an airfield may have varying degrees of concealment or protection. The kill factor used in this assessment is computed from the average for concealment or protection possibilities within the theater. Specific equations and nomograms for determining the value of this factor are obtained from official US Air Force and Department of Defense documents.

Ground-fire aircraft kill factor. Practically all ground-combat and combat-support units have organic antiaircraft weapons. These weapons may consist of rapid fire guns such as 20- and 57-mm, individual hand-held missiles such as Redeye, and small arms. Considering the multiplicity of possible weapon mixes and varying numbers that may be assigned the many different types and sizes of unit, it is impractical to play the antiaircraft fire effects of all the possible weapons in a discrete manner.

In determining an attrition factor for aircraft destroyed by ground fire, a weighted average of the SSKP for each organic type of SAM plus a weighted average weapon effect for all gun-type weapons is determined. These two are combined into one average factor and applied against the number of attacking aircraft. Two factors are developed, one for combat-support units and the other for ground-combat units. Although the kill factors used are a gross synthesis of all the ground-fire systems that may be brought to bear on attacking or overflying aircraft, the values used and the resulting aircraft loss rate are compared with historical data in an effort to ensure relative accuracy. Representative values used in determining these attrition constants may be derived from "TACSPIEL War Game Procedures and Rules of Play."[2]

Personnel casualty and materiel destruction factors. Attrition factors for personnel and materiel destroyed per bombing run are developed for the various types of unit being gamed. These factors are based on air-delivered-munitions effectiveness against personnel and materiel densities and vulnerabilities for appropriate postures. An example of the derivation of these factors is described in the following paragraphs.

It is assumed that personnel in a mechanized infantry unit attacking a hastily prepared defense position are 25 percent standing, 25 percent prone, and 50 percent partly protected in tanks or armored personnel carriers (APCs). The average size of target brought under air attack is company-sized and occupies an area of 1 sq km. It is also assumed that in most close air support missions against ground-combat and combat-support units the targets are either visually observed or are marked by forward observers. Also, one-half the area, or 50 hectares, would be identified as void of targets because of squad and platoon clusters.

Assuming that a company-sized unit consisting of 166 personnel attacking a hastily prepared defense position occupied 50 hectares, the average troop density is 3.32 personnel/hectare. Assuming a tactical-fighter munitions load with a 0.95 kill probability against personnel standing and an area coverage of 1.86 hectares/aircraft, standing personnel casualties become 3.32 x 1.86 x 0.95 x 0.25 = 1.47 per attacking aircraft. Similarly, prone and protected personnel casualties and materiel casualty factors may be developed.

The same rationale is used in determining factors for personnel and materiel attrition in combat-support, SAM, and logistic and headquarters units.

Supply loss factors. The loss of on-hand supplies caused by interdiction missions that attack supply points is assessed by the following expression:

$$\Delta OH = OH\left[1 - \exp\left(\frac{-K_1 A}{OH}\right)\right]$$

then

$$1 - \frac{\Delta OH}{OH} = \exp\left(\frac{-K_1 A}{OH}\right)$$

and

$$\ln\left(\frac{1 - \Delta OH}{OH}\right) = \frac{-K_1 A}{OH}$$

finally

$$K_1 = \frac{-OH}{A} \times \ln\left(1 - \frac{\Delta OH}{OH}\right)$$

where ΔOH = loss of supply, tons
OH = supply on hand, tons
K_1 = attrition constant for on-hand supplies
A = number of aircraft attacking
ln = natural or Napierian logarithm of a number

Information required for development of the attrition constant K_1 may be derived from FM 101-10-1[3] and the Army War College manual.[4] FM 101-10-1 provides information concerning area occupied and tonnages of classes of supplies stocked in supply points. The Army War College manual contains data concerning the percentage of supplies in a supply point that will be destroyed by various tonnages of conventional bombs delivered. The following assumption is representative only. It may be assumed that a tactical fighter will deliver approximately 4.2 tons of conventional bombs on a supply point. Also, 30 tons of bombs might destroy 15 percent of the supplies in a typical supply point carrying 3000 tons of supplies. The attrition constant for on-hand supplies can then be developed as follows:

$$K_1 = \frac{-3000}{7} \times \ln\,(1 - 0.15) = -429\,(-0.16) = 69 \text{ tons/aircraft}$$

Cycle Inputs

Play of any cycle of the air battle is initiated by issuance of an appropriate Air Allocation Order from the Air Controller to BLUE and RED air players.

Air Allocation Order. The Air Allocation Order permits the Air Controller to provide appropriate air doctrine guidance for BLUE and RED teams by directing the respective air forces to accomplish certain tasks with a specified weight of effort. This guidance is very broad in nature and may follow the form shown in Fig. 8. The Air Allocation Order provides a means to (a) ensure that appropriate air doctrine is followed by each team, (b) inject into each cycle any special air requirements required by the client, and (c) maintain a proper aircraft-utilization (sortie) rate.

Mission Planning. Close coordination is maintained between the air player and ground-combat player to determine distribution of sorties, targets, weight of effort, and timing. Six types of air missions are provided for. They are:

(1) Close air support
(2) Interdiction
    (a) Discrete targets
    (b) Armed reconnaissance
(3) Air superiority
    (a) Air defense
(4) Reconnaissance
(5) Airlift
(6) Escort

Six types of targets may be brought under attack. They are:

(1) Ground-combat units
(2) Combat-support units
(3) Air units
(4) SAM units
(5) Headquarters (logistic) units
(6) Supply points

Weather Restrictions. Even though all-weather capabilities of aircraft have improved, close air support, armed reconnaissance, interdiction against targets of opportunity, and airborne and paratroop operations are still affected by weather, and this must be taken into consideration when planning missions.

Where differences in aircraft, pilot skill, and special equipment make it feasible for one side to operate under lower minimum weather conditions than the other,

AIR ALLOCATION ORDER

Blue Team D+ 3

	PERCENT/TYPE AIRCRAFT
AIR DEFENSE	100 Interceptors 15 Tac. Fighters
CLOSE AIR SUPPORT	15 Tac. Fighters
TRANSPORT	100
RECONNAISSANCE	100
OTHER	
COUNTER AIR OPERATIONS	40 Tac. Fighters
INTERDICTION	10 Tac. Fighters
ARMED RECONNAISSANCE	10 Tac. Fighters
ESCORT	0
BOMBING	50 Lt. Bomb (Counter-Air)

REMARKS 10% Tac. Fighters held on Nuc. Alert
50% Lt. Bomb Force on Nuc. Alert

Fig. 8—Example of Air Allocation Order

different weather air operations minimums are established for each side. When the opposing air forces are reasonably comparable in equipment and training, weather minimums are assumed to be the same. For game purposes the current weather and 24-hr forecasts are provided by the Intelligence Controller (see Chap. 8, "Intelligence Submodel"). An example of weather restrictions that might be played is shown in Table 7.

TABLE 7

Minimum Operational Conditions for Aircraft

Aircraft	Operation	Day: Ceiling, ft	Day: Visibility, statute miles	Day: Wind, knots	Day: Remarks	Night: Ceiling, ft	Night: Visibility, statute miles	Night: Wind, knots	Night: Remarks
					Army				
Fixed wing	Troop and cargo landing	1000	2	20	—	1000	3	20	—
		500	½	20	Instrument landing system available	800	1	20	Instrument landing system available
	Reconnaissance	500	1	—	—	1000	2	—	No visual
Helicopter	Fire support	500	1	—	—	500	1	—	—
		250	½	—	50% effective	—	—	—	—
	Troop and cargo landing	300	1	30	—	500	1	30	—
		150	½	30	Double time required	300	1	30	Double time required
	Reconnaissance	300	1	—	—	500	1	—	No visual
		150	½	—	50% effective	—	—	—	—
					Air Force and Navy				
High-performance aircraft	Fire support	1000	2	—	—	1000	3	—	—
		500	2	—	50% effective	—	—	—	—
	Intercept	1000	2	—	—	1000	2	—	—
		400	½	—	50% effective, instrument landing system available	600	1	—	50% effective, instrument landing system available
	Bombing	800	2	—	—	1000	3	—	—
		400	½	—	Radar-fixed targets, instrument landing system available	600	1	—	Radar-fixed targets, instrument landing system available
	Troop and cargo landing	1500	2	30	—	1500	3	30	—
		500	½	30	Instrument landing system available	600	1	30	Instrument landing system available
	Reconnaissance	1000	2	—	For visual and photo	1000	3	—	No visual but photo flash
		400	½	—	Electronic only, instrument landing system available	600	1	—	Electronic only; instrument landing system available
	Paratroop operation	1000	3	14	—	2000	4	14	—
		1000	3	14–23	10% casualties	—	—	—	—
		1000	3	14–23	20% casualties	—	—	—	—
	Air drop of emergency supplies	1000	2	14	—	2000	3	14	—
		800	2	14+	20% of supplies lost	1000	2	14+	20% of supplies lost

RAC

Air Operation Order. The air player prepares the Air Operation Order after studying current and forecast weather conditions, the Air Allocation Order, and the team chief's operations plan. The Air Operation Order includes sufficient information for the Air Controller to interpret the order and translate the actions into proper form on input data preparation sheets. The Air Operations Order may take the form shown in Fig. 9 and is submitted to control. Figure 10 contains a legend to be used when preparing the Air Operation Order.

BLUE AIR OPERATIONS ORDERS

DATE D+3

Game X

Unit	Type Mission	% Unit	Task	T.O.T.	Nuclear (No./KT.)
B0001	AD	100	Maintain strip alert 0600 - 0600		
B0002	AD	100	Maintain 30% strip alert 15% Air alert orbit QX15 0800 - 1400		
			15% Air Alert Patrol YZ01 to XT45 0400 - 1000		
B0029	CAS IND	25 25	On call -18 Armd Div LOC NM 00 - MC 48 - LD 62	0600	
	CA	50	Destroy SAM sites in vicinity PQ 74 - PQ 82- PQ45	0730	
B0030	E	50	Support B0088 Airborne Operation Column Cover	0630	
	CAS	50	Suppressive fire in area of airborne operations. Isolate drop zone	0600	
B0031	CA	50	Strike airfield XY 22 Concentrate on SAM and AA defenses.	0530	
	CA(N)	10	Strike airfield XY 22	0545	2/15
	CA	40	Cover nuclear carriers and deliver suppressive fire along route.		

Fig. 9—Example of Air Operations Order

Air Controller Procedures. The Air Controller reviews both BLUE and RED player orders and ensures conformance with game rules, restrictions, and limitations. Using the ground control and intelligence maps, the Air Controller examines the flight path and profile of each missio. The Air Controller determines enemy capability to interfere with the missic, i.e., which air-defense systems will engage each flight (SAM and interceptors). The amount of air-defense effort reacting to each attack mission must be weighted against all other mutually supporting or detracting actions. The Air Controller next

LEGEND

Unit	Air Unit Number
Type Mission	
CA	counter air
CAS	close air support
B	bomber
E	escort
AD	air defense
T	air transport or troop carrier
AR	armed reconnaissance
IND	interdiction
% of Unit	Percent of the unit to be engaged in this action e.g., 100%, 50%.
Task	Designate target, if known, or show grid location. Show grid location of turning points of armed reconnaissance and interdiction missions, or patrol or orbit area of air defense missions.
T.O.T.	Time over Target - The time the mission will arrive over the target, e.g., 0530, 1800.
Nuclear (No./KT)	Number and size of nuclear weapons, if used in this action.

(NOTE: Printing a legend similar to the above on the reverse side of the Air Operations Order form is helpful.)

Fig. 10—Legend for Air Operations Order

identifies targets. Some of the targets are discrete preplanned targets selected by the players on the basis of intelligence; other armed reconnaissance targets must be selected for the players by the Air Controller based on assigned missions and Air Operations Orders.

The Air Controller selects those targets which he feels would logically be detected and attacked along the designated flight route or in the area designated in the operations order. Close reference is made to the air OB and the ground control and intelligence control maps. After the target selections have been made, the Air Controller prepares the Input Data Sheet, translating all the air actions and interplay into digital form to be punched on cards for processing in the computer.

Input Data Sheet. All the aircraft and units involved in a single related mission or air effort and all their actions and counteractions are placed in one air battle grouping. The air unit designation of the attacker, information indicating parameters of operation, the target unit designation where appropriate, and the air battle grouping number must be specified for each unit in the grouping. The Air Controller completes the "Air Battle Grouping Input Data Sheet" shown in Fig. 11, inserting the required information in appropriate format for translation to punch cards. Entries on the Air Battle Grouping Input Data Sheet are as follows:

The standard five-character THEATERSPIEL unit designation is placed in cols 1 to 5 for each unit in the air battle group (see Chap. 2). Column 11 is used to specify the mission of the designated unit by a digit from 0 to 9 corresponding to the following mission code:

0: passive defense
1: escort
2: air defense (interception)
3: airlift
4: attack mission (including close air support and interdiction)
5: SAM fire
6: nuclear strike
7: nuclear strike
8: unassigned
9: reconnaissance

Column 12 is reserved for a digit that allows the Air Controller to specify the order in which the interactions are to be assessed, using digits 1 to 9 to indicate the sequential order. For example, if it is desired that an air unit strike a ground target before interception, this is accomplished by placing a 1 in col 12 opposite the attack unit and a 2 in col 12 opposite the intercepting unit. For an air unit escorting another air unit on an attack mission, the digit specified must be the same for both attacker and his escort. In the foregoing example, 1 would be placed in col 12 for the escorting unit as well as for the attacking unit. If col 12 is left blank, the assessment order is first SAM and ADA fire, second air intercept, and finally conventional-munitions air-to-ground effects.

Column 13 specifies the flight profile. The letter L or H is inserted to denote a low- or high-flight profile. If this column is left blank, a low profile is assumed.

Column 14 specifies the percentage of attack or escort aircraft armed with ASMs for use against SAM sites. If this column is blank or zero, one of the aircraft will be so armed; otherwise the digit inserted will be multiplied by 10 to obtain the percentage of aircraft armed with ASMs. For example, 2 means that 20 percent of the aircraft are armed with ASMs.

Column 15 is used to specify the percentage of the strike aircraft that are to attack aircraft of an air unit that is caught on the ground when the target is an airfield; the remaining strike aircraft attack airfield facilities. Digits from

Theaterspiel Battle Grouping

INPUT DATA SHEET

Game X

Date

PARAMETERS

	Unit Desig.					1						2							3						Battle grouping		
Card Col.	1	2	3	4	5	11	12	13	14	15	16	19	20	21	22	23	24		27	28	29	30	31	32	38	39	40
Unit 1	R	0	9	4	3	6	3	L			5	5	0	1		6		*	B	3	2	0	6		A	2	6
2	R	0	9	5	1	1	3	L	3			3	0	1					R	0	9	4	3		A	2	6
3	R	0	9	5	2	1	3	L	3			6	0	1					R	0	9	4	3		A	2	6
4	B	1	0	1	7	5	1	L					2	1					R	0	9	5	2		A	2	6
5	B	1	0	1	5	5	2	L					3	1					R	0	9	4	3		A	2	6
*6	B	3	2	0	6																				A	2	6
7	R	0	9	4	3	6	3	L			5	5	0	2		6			B	3	0	4	3		A	2	6
8	R	0	9	5	1	1	3	L	3			7	0	2					R	0	9	4	3		A	2	6
9	B	1	0	1	7	5	1	L					3	2					R	0	9	4	3		A	2	6
10	B	0	0	0	3	2	2	L				2	0	2			N		R	0	9	4	3		A	2	6
11	B	3	0	1	4	7	4	L			2			2					R	0	9	4	3		A	2	6
12	B	3	0	4	3																				A	2	6
13																											
14	R	0	9	4	4	4	1	H			3	2	5	5		1	6		B	3	0	4	5		A	2	7
15	B	3	0	4	5																						
16																											
17																											
18																											
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30																											

Fig. 11—Air Battle Grouping Input Data Sheet

Target unit listed in both unit designation columns as well as in Parameter 3 to permit computer processing.

1 to 9 are used, and the digit inserted is multiplied by 10 to obtain the percentage. For example, the digit 3 indicates that 30 percent of the strike aircraft will attack aircraft on the ground and 70 percent will attack airfield facilities. If no number appears in this column, all attack aircraft will strike aircraft on the ground.

Column 16 is reserved for three purposes:

(a) When the unit designated in cols 1 to 5 is a tactical fighter or bomber unit, the mission code in col 11 is 4 or 6, and when the target is a ground-combat or combat-support unit, a number from 1 to 9 is inserted in col 16 to designate the percentage of the target unit subject to attack. A zero or blank indicates that 100 percent of the target is subject to attack.

(b) When the unit designated in cols 1 to 5 is a transport or helicopter unit, the mission code in col 11 is 3 indicating airlift, and when the airlifted unit is a ground-combat division, a number from 1 to 9 is inserted in col 16 to designate the percentage of the combat unit that is lifted in that mission. A zero or blank indicates that 100 percent of the unit is being lifted.

(c) When the unit designated in cols 1 to 5 is a ground-combat or combat-support unit and the mission code is 7 in col 11, a number in col 15 is used to designate how many units of that type are being overflown and are firing at the penetration aircraft. For example, if the unit designated in cols 1 to 5 is a ground-combat division and a number 7 is placed in col 11, then a number 2 placed in col 15 means that two ground-combat divisions are overflown and both fire at the overflight aircraft.

Columns 19 and 20 are reserved for two purposes:

(a) They are used to specify the percentage of the air unit that is to attack. For example, if the entry in these columns is 25, then 25 percent of the aircraft currently available to the air unit designated in cols 1 to 5 are to be used for the specified mission. Blanks or zeros in these columns indicate that 100 percent of the unit is to be utilized.

(b) When the unit designated in cols 1 to 5 is a SAM unit and the mission code is 5, cols 19 and 20 are used to designate the number of SAM fire units that will fire on the attacking or overflying aircraft. For example, a 4 in col 20 means that 4 fire units of the designated SAM unit are to fire on the penetrating aircraft.

Column 21 is used to identify and segregate the concurrent actions of each of the missions within one air battle grouping. For instance, an Air Battle Grouping Input Data Sheet may include four or five separate missions all placed within that battle grouping. Since each individual mission consists of a number of actions and counteractions, these must be identified as pertaining to that specific mission. All the actions and counteractions associated with the first mission of a battle grouping are designated by a 1 in col 21; those associated with the second mission in that battle grouping are designated by a 2.

When the mission code in col 11 is 6, indicating a nuclear strike, entries in cols 22 and 23 designate the number of nuclear carriers in the flight. If these columns are left blank when the mission code is 6, one nuclear carrier is assumed to be in the flight.

When the target unit in cols 27 to 31 is ground combat or combat support and the mission code in col 11 is 4, indicating an attack mission, cols 23 and 24 are used to indicate the posture of the target unit as shown in Table 8.

TABLE 8

Posture Codes for a Target Unit

Posture	Codes for target unit	
	Defending	Attacking
Static	00	00
Withdrawal	01	11
Delay	02	12
Meeting engagement	03	13
Hastily prepared position	04	14
Prepared position	05	15
Fortified position	06	16
Administrative move	07	07
Reserve or assembly	08	08

Thus an entry of 05 in cols 23 and 24 indicates the target unit is defending in a prepared position. Also an entry of 16 indicates the target unit is attacking a fortified position.

Column 24 is also used to specify that an escorting air unit is armed with nuclear air-to-air missiles by placing an N in that column. If the letter N is not present, conventional armaments are assumed.

Columns 27 to 31 are used for the unit designation of the target. Column 32 is left blank. Every unit designation that appears in this parameter must also appear at least once on a line under unit designation in cols 1 to 5 in the same battle group because of computer program requirements.

Columns 38 to 40 are reserved for the number of the battle grouping. Any combination of letters and numbers may be used to specify this number, but it cannot vary within the battle grouping.

The unit entry numbers appearing vertically on the left side of the input sheet represent the total number of units or actions allowed in one air battle grouping. It is important to note that although 30 lines are numbered, no more than 29 entries may be included in any one battle group because the last-used position is reserved for an "End of Battle Group" signal card.

A typical air battle grouping input is illustrated by the 12 lines shown in Fig. 11. One card is punched for each line of data. This grouping has two separate air missions indicated by the third digit, col 21. The first six lines specify the actions of Mission 1; the next six lines specify the actions of Mission 2.

RED air unit R0943 mission is a nuclear strike, indicated by the number 6 in col 11, against BLUE units B3206 and B3043, indicated by the unit designations in cols 27 to 31 for Missions 1 and 2. Fifty percent of the attacking unit is being used for each strike as indicated by the first 2 digits of cols 19 and 20. Six aircraft in each strike are nuclear-weapon carriers as indicated in col 23. Fifty percent of the target unit is taken under attack in both instances as indicated by the 5 in col 16.

The target units B3206 and B3043 are also listed in the unit designation columns 1 to 5, at the end of the respective missions. No further entries are needed on this line other than the battle grouping number.

In Mission 1 the nuclear strike is being escorted by the RED air units R0951 and R0952, indicated by a 1 in col 11. Note that the unit being escorted appears in cols 27 to 31 opposite the escort units. Thirty percent of R0951 aircraft are utilized for this mission, indicated by the 2 digits in cols 19 and 20. The strike is also being escorted by 60 percent of RED air unit R0952. In Mission 2 the strike is being escorted by 70 percent of RED air unit R0951. Thirty percent of the aircraft in these missions are armed with ASMs, indicated by the digit 3 in col 14.

Three SAM missions are included in this grouping indicated by mission code 5 in col 11. BLUE SAM unit B1017 orders 2 fire units to fire on R0952, and B1015 orders 3 fire units to fire on R0943, indicated by 2 and 3 respectively in col 21. The target unit is specified in cols 27 to 31.

Only one air intercept action occurs in this air grouping, indicated by the digit 2 in col 11. The interceptors are armed with nuclear-tipped air-to-air missiles, indicated by the N in col 24. Twenty percent of the air unit's strength is assigned to this intercept mission, specified by the 2 digits in cols 19 and 20.

One ground-fire action takes place in the second mission. Two ground-combat divisions (col 16), represented by one of the units (B3014) in the unit designation columns, deliver ground fire shown by mission code 7 in col 11 on R0943. Flight profiles are indicated by the letter L in col 13, designating low-profile flight. The sequence of events for each mission within the battle group is specified by the numbers 1 to 4 in col 12.

The entry on line 14 is used to depict an air strike on a ground-combat unit with conventional weapons. In this case R0944 is attacking, mission code 4 in col 11, BLUE B3045. B3045 posture is indicated by 16 in cols 23 and 24, indicating it is attacking a fortified position.

On completion of the Input Data Sheet the Air Controller gives it to the computer-processing group for transposing onto keypunch cards. When this step has been completed, the air-mission cards are joined with the other combat action input cards for that cycle of play, and the computer processing begins.

Assessments

The Air Submodel uses four major routines to compute results of actions and interactions. These major routines, each consisting of one or more subroutines, are the surface-to-air, air-to-air, air-to-ground, and airlift routines. routines.

RAC

Surface-to-Air Routine. The surface-to-air routine assesses the effects of SAM fire on aircraft and the effects of ASM fire on SAM sites. The routine includes two subroutines, one to assess four types of BLUE SAM systems and four types of RED SAM systems, and one to assess the ASM effects.

The range and altitude capability of the SAM system is not discretely played. The Air Controller, in preparing the input data sheets, has visually determined whether the intruders come within range of a SAM unit by comparing the general flight path of the aircraft and the location of the SAM units. He has also determined the flight profile and ordered either a low- or high-altitude encounter. Only those SAM systems with the appropriate low, high, or combination capability will be exercised in any one engagement. Degrading effects on SAM capability (decoys and ECM), although not played discretely, have been considered and are applied in the overall SAM kill capability. The instructions entered on the Input Data Sheet have:

(a) Identified the SAM unit that is to fire
(b) Stated the number of fire units that will fire
(c) Identified whether it is a low- or high-altitude engagement
(d) Identified the target

At this point a random number is computed, and reference is made to a burst-threshold table (Fig. 7) to determine the number of salvos to which the flight will be subjected. Aircraft losses to a given SAM site will be

$$\Delta AC = AC \left[1 - \exp\left(\frac{-P_k N_s}{AC} \right) \right]$$

where ΔAC = number of aircraft destroyed
AC = number of aircraft in flight
P_k = probability of missiles' killing an aircraft per salvo
N_s = number of salvos

N_s is calculated by

$$N_s = \frac{M_r M_{s\ell}}{M_s}$$

where M_r = missile reliability
$M_{s\ell}$ = number of missiles successfully launched
M_s = number of missiles per salvo per aircraft

The number of missiles expended is computed for each engagement by determining the number of salvos per fire unit and the number of missiles per salvo multiplied by the number of fire units directed to engage the target. Checks are made to ensure that the number of missiles expended do not exceed the number on hand and the number of fire units engaging the target do not exceed the number of active fire units in the firing organization.

The surface-to-air routine also provides for assessment of SAM fire unit losses due to air attack employing ASMs. In this action it is assumed that the ASMs are launched before the SAM unit can engage the aircraft. An option of allowing a specified percentage of the attacking air group to carry ASMs is provided. Tactical fighters or fighter escorts may carry four ASMs each and eight may be carried by each bomber. This is a pregame determination. Escort aircraft carrying ASMs are capable of engaging interceptors after launching their ASMs On attack missions the attackers launching ASMs are subtracted from the mission, and survivors return home; the surviving attackers not carrying ASMs proceed to target on their primary mission. The only targets for ASMs are SAM units that have been designated by the Air Controller to engage the flight. Any given successful launch of a single ASM is assumed to have some SSKP of disabling a SAM fire unit.

The number of successful ASMs fired is obtained by

$$M_\ell = A_f A_n A_r M_r M_a$$

where M_ℓ = ASMs successfully launched
A_f = percentage of aircraft carrying ASMs (input percentage)
A_n = number of aircraft in flight
A_r = aircraft reliability
M_r = missile reliability
M_a = number of missiles per aircraft

The attrition of SAM defenses to ASM fire is then computed by

$$\Delta F_u = F_u \left[1 - \exp\left(\frac{-M_\ell P_k}{F_u} \right) \right]$$

where ΔF_u = number of fire units destroyed
F_u = number of fire units engaging the flight
M_ℓ = number of ASMs launched
P_k = SSKP against a specified SAM type

The surviving fire units of the SAM defenses that have been under attack and the fire units not under attack are then allowed to fire at the attacking aircraft. In many instances strikes against SAM sites will be made with conventional bombs, guns, and dispenser munitions rather than ASMs. In this case the results are assessed in the air-to-ground routine.

Air-to-Air Routine. The air-to-air routine assesses the effects of three types of air combat engagements:

(1) Interception of an escorted mission
(2) Interception of an unescorted mission
(3) An "air duel" engagement between tactical fighters

The intruder in types 1 and 2 may be tactical fighters, bombers, transports, reconnaissance aircraft, or helicopters. In type 2, if tactical fighters are designated as the intruder, they are considered capable of jettisoning their bombs and engaging the interceptors. This engagement then becomes type 3. Bombers, transports, reconnaissance aircraft, and helicopters are given no capability for destroying interceptors.

Values used for the combined probability of the air-defense system of detecting the intruder and guiding the interceptor aircraft to the target and of the interceptor capability of making a firing pass against the intruder are derived from official US Air Force war-planning and war-gaming documents.

Factors for SSKP are applied under four different conditions: high-altitude close-control interception (CC SSKP); high-altitude broadcast-control interception (BC SSKP); low-altitude CC SSKP; and low-altitude BC SSKP. Close-control interception is defined as an interception in which the interceptor is under continuous control and direction by a surface or airborne station. Broadcast-control interception is an interception in which the interceptor is given only the general area and direction of flight of the intruder by a surface or airborne station and the interceptor effects the interception without further control or instructions.

Detection and control are constants that usually hold throughout play of a game; however, they may vary for different theaters of operation and are readily changed for each game. When not otherwise provided, information on which these factors are based is obtained from official US Air Force documents. Tactical fighter and interceptor aircraft are allowed a maximum of two firing passes. Intercept probability for all first passes by interceptors is assumed to be under close control. Once the air battle is joined, if a second pass is attempted, it is assumed to be under broadcast control. All escort or attacker passes against interceptors are assumed to be under broadcast-control conditions.

The order of firing passes in the air engagement routine is determined on the basis of the type of attacker, whether the attacker is escorted or unescorted, and the number of interceptors compared with attackers and escort.

Two conditions are assumed: the intruder is bomber, transport, reconnaissance aircraft, or helicopters; or the intruder is a tactical-fighter flight. Either of these types of attackers may be escorted or unescorted. When escorted the escort may or may not outnumber the interceptor. When tactical fighters are the attacker, some or all of them will drop their bomb loads and participate in their defense.

The formula for determining the number of intruders surviving per intercept is

$$A_s = A_e \left[(1 - \mathrm{SSKP} \times I_n)^{\frac{I_e}{A_e}} \right]$$

where A_s = number of intruders surviving
A_e = number of intruders intercepted
SSKP = single interceptor kill probability selected for altitude and type of control
I_n = reliability
I_e = number of interceptors

The number of interceptors surviving is determined in a similar manner.

When the intruding flight is escorted, the loss of escorts is also determined in a similar manner. When the intruders are escorted, a random number computation is made to determine whether the escort or the interceptors initiate the second air action. During an air duel when the intruding aircraft are tactical fighters, a ratio of two attackers to one interceptor may be used to determine the number of tactical fighters that jettison their bomb load and engage the interceptors. Attacking tactical fighters not engaged in the air duel continue on their primary mission.

Air-to-Ground Routine. The air-to-ground routine determines the appropriate subroutine to be called in by reference to the target type. The types of target on which assessments are made are air, SAM, ground combat, combat support, logistic units (headquarters), and supply points.

Air-unit target assessment subroutine. For each air mission attacking an airfield the air player or controller indicates the percentage of attackers that will attack aircraft on the ground. The remaining aircraft will automatically be played against airfield facilities. If no percentage is indicated, all attackers are played against aircraft on the ground. This is done because airfields may be targeted in order to deny enemy use of the airfield and facilities even though no air unit is present.

The number of aircraft on the ground at the time of attack is determined by random number computation, which might be as shown in the accompanying tabulation.

Random number	Percent of aircraft assigned to the field
01–15	25
16–40	20
41–60	15
61–85	10
86–00	5

The number of aircraft destroyed on the ground is then calculated by the following formula

$$\Delta A = A\left[1 - \exp\left(\frac{-\mathrm{SSKP} \times A_a}{A}\right)\right]$$

where ΔA = number of aircraft destroyed
A = number of aircraft on the ground
SSKP = probability that one tactical fighter or one bomber will destroy an aircraft on the ground
A_a = number of attacking aircraft

SAM-unit target assessment subroutine. Attacks on SAM units employing weapons other than ASMs are assessed in the air-to-ground routine. In this case the terminal effect is assessed on the basis of a preferred weapon load developed during pregame preparation. This preferred load might be two dispensers of special ammunition, two canisters of napalm, and the amount of 20-mm ammunition expended in one firing pass.

The destruction of a SAM site or fire unit is determined by use of the following formula

$$\Delta F_u = F_u \left[1 - \exp\left(\frac{-SSKP \times A}{F_u} \right) \right]$$

where ΔF_u = SAM fire units destroyed
F_u = number of fire units remaining in the SAM unit attacked
SSKP = probability that one tactical fighter or bomber flying high or low profile attacking a specific SAM type will destroy a fire unit
A = number of attacking tactical fighters or bombers

Ground-combat assessment subroutine. The ground-combat assessment subroutine assesses three effects on the ground-combat unit under attack: casualties, loss to the base IFP, and a suppression effect. The combat-support assessment subroutine assesses casualties and loss to casualty-producing potential (CPP).

Casualties in each instance are computed as a linear function based on an assumed personnel density and the probability of kill within the area of effectiveness of a single aircraft munition load. The personnel density varies with one of eight possible attack or defense postures of a targeted unit. The Air Controller indicates the posture of a targeted unit on the input data sheet. A casualty limit is calculated to be not greater than 20 percent of the target unit's present strength. Casualties for the various postures are calculated according to the formula

$$\Delta P = \min (K_a \times A_g , 0.2P)$$

where ΔP = casualties
min = use the minimum resultant of the two calculations
K_a = casualties per bombing run for ground-combat unit in 1 of 16 possible postures
A_g = number of aircraft attacking the ground-combat unit
P = present personnel strength

The loss to the IFP is computed on the basis of casualties, thus

$$\Delta IFP = \frac{\Delta P}{P} \text{ base IFP}$$

where ΔIFP = permanent loss to IFP
ΔP = air-inflicted casualties
P = present personnel strength
base IFP = present base IFP

Air attacks will create some temporary disorganization and disruption of effectiveness of small units. These factors are considered by application of a temporary loss of IFP that is returned to the unit at the end of the 24-hr cycle. Temporary loss of IFP is considered to be equal to the loss of base IFP and is subtracted from unit posture IFP before ground-combat assessments are made.

Temporary loss to a combat-support-unit CPP is not assessed because the unit will retain a capability to sustain a rate of fire by increasing rates from other tubes or launchers.

Both ground-combat and combat-support units are given a capability of destroying attacking aircraft with organic ADA and small-arms fire. During pregame preparations, factors for the probability that various types of unit will destroy attacking or overflying aircraft are determined. These probability factors are applied as a percentage to the number of aircraft attacking or overflying, and results are modified by random-number computation.

Thus

$$\Delta A = A_n \times P_k + 0.01 \times R_n$$

where ΔA = number of aircraft lost
A_n = number of aircraft attacking
P_k = probability that a ground-combat or combat-support unit can destroy an attacking or overflying aircraft
R_n = random number

Logistic and headquarters unit target assessment routine. Personnel casualties inflicted by air attack are assessed in the same manner described previously for ground-combat and combat-support units, and the same 20 percent limit is placed on the number of casualties that may be inflicted. Thus, this calculation is

$$\Delta P = \min (K \times A, 0.2P)$$

where ΔP = personnel casualties
min = use minimum resultant of two calculations
K = kills per single aircraft bombing run for the population density and vulnerability of a logistics unit
A = number of aircraft attacking
P = present personnel strength

Supply point assessment subroutine. Assessment of tons of supplies lost in a supply point is based on constants that are determined as part of pregame preparation (see "Pregame Preparations"). The loss of supplies is calculated by use of the following exponential formula

$$\Delta S = S\left[1 - \exp\left(\frac{-K_1 A}{S}\right)\right]$$

where ΔS = tons of supplies lost
S = tons of supplies on hand
K_1 = destruction factors for either a tactical fighter or bomber, depending on type of attacking aircraft
A = number of attacking aircraft

(See discussion on supply loss factors for deriving K_1 factors and an example of application.) The class of supply destroyed is then determined on the basis of the relation between the vulnerability of the various classes of supply and the percentage of the total storage space occupied by each class of supply. An input capacity reduction is assessed in the Logistics Submodel based on tons of supplies lost. In this manner those air interdiction missions that would normally be directed against LOCs (bridges, railroads, marshaling yards) associated with the supply point are taken into consideration and their effects are accounted for even though these types of targets are not discretely attacked.

Airlift Routine. The airlift routine assesses personnel losses to the unit being lifted and reduction in combat effectiveness of that unit as a result of the personnel lost. After the airlift aircraft losses have been assessed, personnel losses are determined using the equation

$$\Delta P = F_a \times F_g \times P$$

where ΔP = personnel casualties
F_a = fraction of transport aircraft lost out of the number launched
F_g = fraction of ground unit personnel strength lifted in this mission
P = present strength of personnel of airlifted unit

The loss to combat effectiveness of the ground unit is then computed as a fraction of the personnel loss

$$\Delta IFP = \frac{\Delta P}{P} IFP$$

where ΔIFP = loss of combat effectiveness
IFP = present combat effectiveness of the unit
ΔP = number of personnel lost
P = present personnel strength

The prenuclear air assessment routine uses only those assessment routines of the Air Submodel that determine aircraft destruction in the air. These include the entire air-to-air and surface-to-air routines and the ground-fire assessment of the air-to-ground routine. Terminal effects are assessed in the Nuclear Submodel. The purpose of the prenuclear air assessment is to determine loss of nuclear carriers due to SAM fire, ground fire, and air intercept. Information concerning the nuclear carriers that are successful in reaching their targets is then passed to the Nuclear Submodel for weapons effects assessments.

Hand Assessments. It has been previously mentioned that manual assessment operations must be employed on occasion. A case in point is the discrete destruction of bridges, tunnels, and marshaling yards by air attack. These targets are obviously prime objectives of interdiction strikes, and, in many areas of the world, their destruction would have a significant effect on the ground battle. Therefore, when it appears advisable, the Air Controller hand-assesses the destruction of these types of targets. The actual air-to-air and surface-to-air actions involved are played in the Air Submodel. The input data sheets contain full details of the mission with the exception of target entry. The output data reflect the aircraft losses due to air intercept, SAM fire, and ground fire. The terminal effects of the aircraft successfully reaching the targets are assessed in accordance with procedures set forth in the Defense Intelligence Agency's "Physical Vulnerability Handbook."[5]

Airfield capacity or capability to support flight operations after attack is hand-assessed. Factors for assessing airbase-facility damage caused by conventional weapons are currently contained in the US Army War College's "Analysis Seminar Control Manual."[4] This manual also provides one source of area of effect of various-sized nuclear weapons when employed against airfields. Unit personnel strength compared with numbers of aircraft authorized by TOEs provides a basis for determining effects of personnel loss on airfield capability. Personnel and aircraft on the ground losses are assessed by submodel routines.

Additional hand-assessment methods for use in measuring the effects of interdiction missions against railroad lines, highways, specific elements of SAM sites, and airfields may be found in "Game Models for Tactical Air Operations in Theater War Games."[6]

Cycle Outputs

Computer Outputs. The Air Submodel assessment results appear in several computer printouts. These start with a printout of the Air Battle Grouping input data, Fig. 12. This printout provides a means for checking the actual input data fed into the computer. This is followed by casualty printouts, which include Air Action Assessments, Air Assessment Reports, Casualty Assessment Summary for Air Battles, and the Summary Report of Battle Assessments for Air and SAM units.

The foregoing casualty printouts contain the following information by unit designation for each battle group mission and in summary form:

(a) Aircraft losses by cause
(b) Number of sorties flown and the number successfully attacking the target
(c) Losses of nuclear carriers
(d) SAM fire units lost and cause
(e) Number of SAM missiles fired
(f) Personnel casualties inflicted on ground-combat, combat-support, and logistics and headquarters units
(g) Tons of supply, by class, destroyed in each supply point

The format and content of the various printouts listing casualties and related losses may be changed before each game to meet requirements of that game. Figures 13 to 17 are examples of the various printouts and the information they provide.

Manual Outputs. Computer printout data seldom satisfy both analysis and client requirements. Neither do these data reflect the full significance of the day's actions with respect to the tactical situation and the impact on the commander's plan of battle. Consequently, for the chronologist and the analysts and ultimately for the client, these data are related to the plan of battle in a narrative summary and are further transcribed onto statistical summary report forms.

THEATERSPIEL AIR GROUPINGS FOR TR-1 D+5

	UNIT DESIG	PARAMETERS 1	2	3
AIR GROUPING A1	B0042	42L	252	R2938
	B0042	41L	251	R3904
	B0050	42L	254	R2923
	B0050	42L	253	R3911
	R0902	22L	201	B0042
	R0903	21L	204	B0050
	R0943	21L	73	B0050
	R0943	21L	102	B0042
	R2923			
	R2938			
	R3904			
	R3911			
AIR GROUPING A2	B0042	41L	251	R3907
	B0042	41L	252	R3908
	B0044	41L	255	R3908
	B0044	41L	253	R3905
	B0044	41L	254	R3907
	R0902	22L	151	B0042
	R0943	22L	85	B0044
	R3905			
	R3907			
	R3908			
AIR GROUPING A3	B0044	41L	251	R3962
	R3962			
AIR GROUPING A4	B0045	41L	331	R3976
	R0903	23L	251	B0045
	R1919	52L	21	B0045
	R3976			
AIR GROUPING A5	B0045	42L	331	R2993
	B0048	41L	333	R3929
	B0048	41L	334	R3931
	B0048	41L	332	R3930
	R0901	22L	203	B0048
	R0903	22L	202	B0048
	R0903	21L	201	B0045
	R0948	22L	174	B0048
	R1919	53L	11	B0045
	R2993			
	R3929			
	R3930			
	R3931			

Fig. 12—THEATERSPIEL Air Battle Grouping Input Data

```
AIR GROUPING NO. A15                    AIR ACTION ASSESSMENTS

2    B1046 FIRED   9 MISSILES DESTROYING  1 AIRCRAFT OF R0943 .

1    B1080 FIRED   8 MISSILES DESTROYING  1 AIRCRAFT OF R0943 .

1      4 AIRCRAFT OF B0002  INTERCEPTED  6 AIRCRAFT OF R0943
                                   BC002 SUFFERED THE LOSS OF  1 AIRCRAFT.
                                   R0943 SUFFERED THE LOSS OF -0 AIRCRAFT.

2    B1043 FIRED   4 MISSILES DESTROYING  1 AIRCRAFT OF R0943 .

2      4 AIRCRAFT OF R0943 ATTACKED B1046
1      3 AIRCRAFT OF R0943 ATTACKED B1080
2      4 AIRCRAFT OF B0002  INTERCEPTED  4 AIRCRAFT OF R0943
                                   BC002 SUFFERED THE LOSS OF  1 AIRCRAFT.
                                   R0943 SUFFERED THE LOSS OF -0 AIRCRAFT.

1    OVERFLYING OF B3010 RESULTED IN THE DESTRUCTION OF  0 OF  6 AIRCRAFT OF R0943
```

Fig. 13—Air Action Assessm.nt

RAC

AIR GROUPING A15 , BLUE UNITS THEATERSPIEL AIR ASSESSMENT REPORT FOR TR-1 D+5

UNIT DESIGNATION	B0002	B0002	B1043	B1046	B1080	B3010
STR LOSS TO AIR	1	1	0	2	2	0
STR LOSS TO SAM	0	0	0	0	0	0
STR LOSS TO GROUND	0	0	0	0	0	0
POTENTIAL LOSS	0	0	0	0	0	0
SORTIES/MISSILES	4	4	4	9	8	0
SORTIES OVER TGT.	0	0	0	0	0	0
SAM UNIT AC KILLS	0	0	1	1	1	0
ACTION CODE	1	2	2	2	1	1

AIR GROUPING A15 , RED UNITS THEATERSPIEL AIR ASSESSMENT REPORT FOR TR-1 D+5

UNIT DESIGNATION	R0943	R0943
STR LOSS TO AIR	-0	-0
STR LOSS TO SAM	2	1
STR LOSS TO GROUND	0	0
POTENTIAL LOSS	0	0
SORTIES/MISSILES	6	7
SORTIES OVER TGT.	4	3
SAM UNIT AC KILLS	0	0
ACTION CODE	2	1

Fig. 14—Air Assessment Report

BLUE UNITS THEATERSPIEL CASUALTY ASSESSMENT SUMMARY FOR TR-1 D+5

***** AIR BATTLES ONLY *****

	AIR UNITS	SAM UNITS	SUPPORT UNITS	GROUND UNITS	LOGISTICS UNITS	SUPPLY POINTS
LOSS OF PRESENT STRENGTH	36	23	0	1640	0	0
LOSS OF POTENTIAL(AFLD CAP)	0	0	0	3	0	0
SORTIES FLOWN/MSLS FIRED	691	196	0	0	0	0

RED UNITS THEATERSPIEL CASUALTY ASSESSMENT SUMMARY FOR TR-1 D+5

***** AIR BATTLES ONLY *****

	AIR UNITS	SAM UNITS	SUPPORT UNITS	GROUND UNITS	LOGISTICS UNITS	SUPPLY POINTS
LOSS OF PRESENT STRENGTH	48	16	284	3808	64	0
LOSS OF POTENTIAL(AFLD CAP)	33	0	7	11	0	0
SORTIES FLOWN/MSLS FIRED	503	47	0	0	0	0

Fig. 15—Casualty Assessment Summary: Air Battles Only

SUMMARY REPORT OF BATTLE ASSESSMENTS

AIR UNITS

UNIT DESIGNATOR	STR LOSS TO AIR	STR LOSS TO SAM	STR LOSS TO GND	STR LOSS TOTAL	TOTAL SORTIES
B0001	4	0	0	4	71
B0002	2	0	0	2	28
B0003	1	0	0	1	20
B0041	0	2	2	4	83
B0042	2	0	0	2	52
B0044	0	0	3	3	43
B0045	0	2	2	4	70
B0046	3	1	0	4	64
B0047	2	1	0	3	52
B0048	1	0	2	3	55
B0049	0	3	0	3	75
B0050	0	0	3	3	78

Fig. 16—Summary Report of Battle Assessments: Air Units

SAM UNITS

UNIT DESIGNATOR	F U LOSS TOTAL	MISSILE FIRED	AIRCRAFT KILLS
B1031	2	9	1
B1032	0	9	1
B1033	2	15	2
B1035	2	13	1
B1038	0	9	1
B1039	0	19	2
B1040	0	8	1
B1041	2	14	1
B1043	0	4	1
B1046	2	18	1
B1051	0	10	2
B1053	0	4	0
B1075	0	5	1
B1076	3	1	0
B1080	2	10	1
B1081	0	6	0
B1084	0	3	0
B1085	0	1	0
B1086	4	10	1
B1089	0	1	0
B1090	0	6	1
B1091	3	13	1
B1092	0	1	0
B1094	0	1	0
B1096	1	6	2

Fig. 17—Summary Report of Battle Assessments: SAM Units

The narrative summary, prepared by the Air Controller, describes the day's air actions in sufficient detail to enable anyone not actively participating in the game to visualize the nature and extent of the actions. The statistical summary of the casualty printout data is designed to satisfy the analyst and client requirements.

The BLUE and RED teams are given the results of each day's actions of which they would normally be aware or might reasonably detect through intelligence means. Each side would know his own losses in personnel, aircraft, and SAM fire units. From intelligence and pilot reports they would have some knowledge of the success or failure of their air strikes. The Intelligence Submodel provides the means for determining the amount and type of information passed to the player teams. The Air Controller provides the Intelligence Controller with pilot report information, which is transmitted to the players by the Intelligence Controller in the periodic intelligence report (PERINTREPT) (see Chap. 8, "Intelligence Submodel").

Coordination. Conduct of a closed two-sided war game requires close and constant coordination with the various controllers as well as with player teams. Most coordination with player teams is accomplished through game messages in order to maintain the atmosphere of a closed game. Within the control organization, coordination must be of the highest order if the game is to progress satisfactorily and rapidly. Some of the specific responsibilities of the Air Controller in this respect include the following:

(1) Coordination with the Ground Controller.

(a) Current or pending air actions that may have direct impact on the outcome of the ground battle.

(b) Air interdiction missions that may affect movement of ground units.

(c) Relative strength of each air force and the amount of close air support effort allocated both sides for each day's operation.

(d) Timing of air strikes against frontline units and combat-support units.

(e) Losses of troop carriers and personnel losses of airlifted units.

(2) Coordination with the Intelligence Controller.

(a) Daily allocation of reconnaissance aircraft, reconnaissance aircraft sortie rate, aircraft operability factors, and interceptor SSKPs against all types of air reconnaissance vehicle for both high- and low-profile missions.

(b) Number of combat sorties scheduled by each side, and area by grid coordinates covered by each daylight mission for use in visual intelligence reporting.

(c) Reconnaissance aircraft augmentation received by either side.

(d) Losses of reconnaissance aircraft destroyed on the ground by air or SSM attack.

(e) Air and SAM OB and location of units by grid coordinates.

(f) SAM SSKP for each type of SAM unit against reconnaissance aircraft for both high and low flight profiles.

(3) Coordination with the Nuclear Controller.

(a) Identity of targets under nuclear air attack, including number of nuclear carriers per target, number of weapons and kiloton yield per carrier, air-unit number, and target-unit number.

(b) Number of nuclear-capable strike aircraft available to each side.

Use of Other Submodel Outputs. All the THEATERSPIEL Submodels have been designed to complement one another. They are mutually supporting and only through their collective use can a realistic theater-level game be played. The Air Controller must refer to outputs of the other submodels for significant information affecting play of the air war.

Nuclear Submodel. The results of nuclear air strikes are assessed in the Nuclear Submodel; thus its output must be referred to in order to determine the results of air-delivered nuclear weapons. Destruction of air units and SAM units may be brought about by nuclear SSM fire. These results are also found in the Nuclear Submodel outputs. Although the MSF reflects total destruction or loss to an air or SAM unit, it does not indicate cause of the loss.

Intelligence Submodel. The Intelligence Submodel produces the intelligence information passed to both player teams regarding the type, size, and location of units, including spurious units. Spurious units may be discretely targeted, therefore the Air Controller must refer to both the intelligence map and the ground control map when locating targets that the players have selected. If the target is spurious or is not on the ground control map in the location given by the player, or if flight conditions or timing make it unlikely that the target will be detected, the mission is launched against a blank target number. The mission will then receive all the normal defense reaction but produce no target results. The Intelligence Submodel also produces the daily and forecast weather conditions used in the play of air operations.

Ground Combat and Combat Support Submodels. The Ground Combat Submodel provides data on which the Ground Controller posts the ground situation map. This is the basic reference map used by the Air Controller in selecting targets for close air support, interdiction, and counter air missions. The Combat Support Submodel also produces results of conventional SSM strikes against SAM sites and airfields, the results of which are of direct concern to the Air Controller.

Logistics Submodel. The Logistics Submodel reflects losses in input capacity of air units due to the destruction of supply points servicing a particular air unit or the interdiction of LOCs between the supply point and the air unit. If this destruction is sufficiently severe, it may materially reduce the capability of the air unit and must be taken into consideration by the players in air-mission planning or by the Air Controller in reviewing player air-mission orders.

FUTURE IMPROVEMENT

The air-to-ground routine is currently being revised to incorporate area target assessment procedures paralleling those described under "Future Improvements," Chap. 5. The Air Submodel will utilize target density, vulnerability, and intelligence factors employed in the Combat Support Submodel.

Munitions lethality data applicable to specified aircraft loads will be employed in lieu of artillery munition data in the Combat Support Model. This will provide a common basis for, and ensure compatibility of, terminal effects assessments made in the two submodels.

Chapter 4

NUCLEAR SUBMODEL

INTRODUCTION

The Nuclear Submodel is employed when nuclear weapons are used in the game. The Air Submodel processes all scheduled air-delivered nuclear missions of the current cycle in order to determine the success or failure of each mission. The Nuclear Submodel then assesses the effects of the successful air-delivered nuclear strikes along with the effects of all successfully delivered surface-to-surface artillery nuclear attacks against targets on the ground.

PURPOSE AND SCOPE

The Nuclear Submodel is designed to assess casualties, materiel losses, and the resultant degradation of combat potential [index of firepower potential (IFP) and casualty-producing potential (CPP)] sustained by each opponent due to enemy attacks using nuclear weapons. The results of blast, shock, and nuclear radiation are assessed, but thermal effects are not considered. Assessments are made based on the deployment, posture, and density of the target units within the nuclear area of damage of the target units. The submodel permits unlimited firing inasmuch as there are no inherent limitations on the number of missions fired, the number of units targeted, or the number of missions fired against a single target. The submodel permits the alternating of firings between BLUE and RED. Damage to structures and the assessment of results of fallout, if played, are assessed by hand.

METHODOLOGY

Computer Assessments

The Nuclear Submodel is divided into four routines. As each routine is processed, the information contained therein is stored and passed to the next routine.

The first of the four routines extracts certain items of information from the Master Status File (MSF) and prepares these data for later use. The information taken from the MSF is the unit designation, the present strength, or, in the case of supply points, storage capacity and the amounts of various classes of supplies on hand. These amounts of supplies are further tabulated to reflect the number of tanks, trucks, APCs, conventional artillery pieces, nuclear delivery systems, and the maximum amount of nuclear firing capability available to a unit for the day or cycle.

The second routine brings in two types of inputs and prepares them for later use. The first of these inputs consists of changes and additions to the internally stored deployments, which are then updated. The remaining inputs describe the missions in terms of mission number, firing unit, target unit, intelligence level, zone, delivery system, number of shots, yield and height of burst, target type, and deployment number. These inputs are coded and stored in a table for future use. Also stored in this table are losses to nuclear carriers previously reported by the Air Submodel and the number of aborts calculated by this routine.

Using the data resulting from the two previous routines, the third routine assesses casualties and materiel losses for all completed air- and ground-delivered nuclear missions. Each mission is assessed in sequence and the results are stored on tape.

The fourth and last routine updates the MSF, reflecting for each affected unit the losses sustained. It also recalculates all IFPs for ground-combat units and CPPs for combat-support units. For IFP the normal computation of loss is doubled to account for the temporary shock of having been subjected to nuclear fire. This shock effect continues only for the duration of the cycle. This final routine also produces a summary of damage for later use in the Logistics Submodel.

Hand Assessments

Most hand assessments must await the end-of-cycle printout to determine whether the scheduled nuclear bursts were delivered. Radiation effects from fallout are measured graphically by the use of templates. These effects are expressed as a denial of an area for a period of time and the imposition of casualties if transit of the area or evacuation is too slow. Damage to bridges, marshaling yards, and other facilities of military significance not listed in the MSF is determined graphically. The circular error probable (CEP) is considered as well as possible location error due to faulty intelligence. Details of these hand assessments are discussed later.

DESCRIPTION OF SUBMODEL

General

The computerized portion of the Nuclear Submodel assesses losses in the types of unit shown in Table 9.

Total casualties are the sum of separate assessments against personnel who are exposed, protected, or in APCs.

Division areas are divided into four zones for purposes of nuclear targeting. The zones reflect the tactical deployment of the division, and each type of artillery is fixed within the appropriate divisional zone. Combined arms brigades cover two zones. All other units are in one zone. This approach is necessitated by the limitations of the MSF.

TABLE 9

Losses Assessed by Nuclear Submodel

Type of unit	Losses assessed
Air	Casualties and aircraft on the ground
SAM	Casualties and loss of fire units
Combat support	Casualties, trucks, APCs, conventional artillery, and nuclear artillery
Ground combat	Casualties, tanks, trucks, APCs, conventional artillery, and nuclear artillery
Logistics units and headquarters	Casualties, trucks
Supply points	Storage capacity and special category and classes I, II, III, IV, and V supplies
SASP	Storage capacity and class V supplies

The "special category" assessed in supply points is an elective, such as tanks or other items of special interest.

The class V losses in supply points refer to conventional munitions, whereas class V losses in SASPs are nuclear munitions.

Submodel Premises

The formula employed to make all computer-assisted assessments is based on the following premises:

(1) A unit cannot deploy and space personnel and materiel evenly over its entire area and still maintain unit integrity. It must cluster personnel and materiel in order to operate effectively.

(2) Within a deployed division the density of subordinate units decreases as the units increase in size.

(3) When a unit moves from a conventional to a nuclear posture more personnel are protected, and the density of personnel and materiel decreases as the unit's area or the division zonal area increases.

(4) Within a division, when a platoon moves from a conventional to a nuclear posture, its density decreases slightly, whereas the decrease in density for companies, battalions, and brigades (regiments) is markedly greater.

(5) Players select the nuclear weapon appropriate to the type and size of the target to be engaged.

(6) Targeted units are located in predetermined zones. In pregame preparations the personnel and materiel in divisions are distributed into four zones.

The size of the zones varies with the posture of the unit. Separate combined arms brigades are in two zones while all other units have one zone. If the size of the zone and its population in personnel and materiel is known, the zonal density can be determined.

(7) If a very-high-yield weapon is delivered in a division zone, the density of personnel and materiel in the areas of damage is considered to be dispersed to the maximum. The high-yield weapon will cover at least one zone of a division, and clusters are no longer significant. If a fractional kiloton weapon is employed, its target is roughly of platoon size and of high density. A platoon has the highest density of all units in a division and is the smallest target worthy of nuclear attack.

(8) Faulty intelligence, inaccuracies of delivery systems, and relative distance from the FEBA tend to reduce the effects of nuclear fires.

(9) For targets with very small area, provision is made for partial coverage rather than complete coverage by each shot. For various reasons a shot will seldom detonate over the exact center of the target area.

The Assessment Formula

The overall assessment formula is stated as

$$\text{Loss}_{\text{item}} = \pi R^2_{D_{\text{item}}} \begin{pmatrix}\text{Zonal}\\ \text{density}\\ \text{item}\end{pmatrix} (1 + GY)$$

where

item = target element being assessed

π = constant

$R_{D_{\text{item}}}$ = radius of damage for target element being assessed according to the yield and height of burst

$\begin{pmatrix}\text{Zonal}\\ \text{density}\\ \text{item}\end{pmatrix}$ = number of like target elements per square kilometer in the zone or unit

$(1 + GY)$ = density adjuster

G = ratio of standard platoon density to the zone density of all personnel; this is downgraded by imperfect intelligence and inaccuracies in the delivery system

Y = a factor to decrease the density within the area of damage as a unit moves from a conventional to a nuclear posture

The Density Adjuster

If the radius of damage appropriate for a target and the yield and height of burst employed are known, losses can be calculated. However, this is valid only if the entire zone or target area is within the area of damage. For large target areas, such as divisions, complete coverage can exist only when very-high-yield weapons are employed. As smaller yields are used there must be a factor to gradually increase the zonal density. The value of that factor is influenced by the target's level of detection, its distance from the FEBA, and inaccuracies in the delivery system. The factor developed to embrace these considerations is called the "density adjuster."

The density adjuster appears in the basic assessment formula as

$$1 + GY$$

where 1 = a constant digit used to avoid a zero solution

G = 2 (platoon density) − [zonal density (personnel)] / [zonal density (personnel)] T

Y = a factor to decrease the density within the area of damage as a unit moves from a conventional to a nuclear posture

T = a factor indicating the effect of imperfect intelligence, relative distance of targets from the FEBA, and inaccuracy of delivery systems; also contains a degrading subfactor to account for near misses resulting in partial coverage of very small targets

Although G in the formula (1 + GY) is indicated as being a variable, in the case of supply points and SASPs an arbitrary value of 10 is used for G. This number is greater than the value of G assessed in other more dispersed units. The higher figure for G is based on the consideration that supplies are not dispersed as thinly as tactical units.

The value of Y in the formula (1 + GY) is determined by solving the following exponential equation[7]

$$Y = e^{-x} - \left(\frac{e}{2}\right) - 2x$$

where e = the Napierian base

x = $(0.7 + 0.3C)\, R_D$ (the value of x can expand from R_D to $2.2\, R_D$)

C = the concentration factor denoting the targeted unit's posture; its value is 1 for conventional posture and increases by whole numbers to 5 as a unit expands its area on shifting to a nuclear posture

R_D = the radius of damage for the category of personnel or materiel to be assessed for the yield and height of burst employed

From inspection of the foregoing Y equation, it is seen that $0 \leq Y \leq 0.5$, because the larger the value of x becomes, the smaller the value of Y becomes. For the smallest value of x (zero) the value of Y becomes 0.5 because any integer raised to the zero power is unity. A graphic representation of the equation is shown in Fig. 18.

It can be seen that when a unit is in a conventional posture (C = 1) and is attacked by a weapon with a yield appropriate to the size of the target, the value of Y is greater than when the same unit moves to a nuclear posture (C = 5). This difference is not so marked for weapons of very large or very small yield.

The value of x in the Y equation, if the target is a supply point or SASP, changes from $(0.7 + 0.3C)\, R_D$ to $(0.9 + 0.1C)\, R_D$. This reduces the expansion capability of R_D, which, in turn, reduces the drop in the value of Y when a unit passes from a conventional to a nuclear posture, i.e., when the factor C in the formula moves from 1 to 5. This restricts the dispersal possibilities for supply points and SASPs compared with other units.

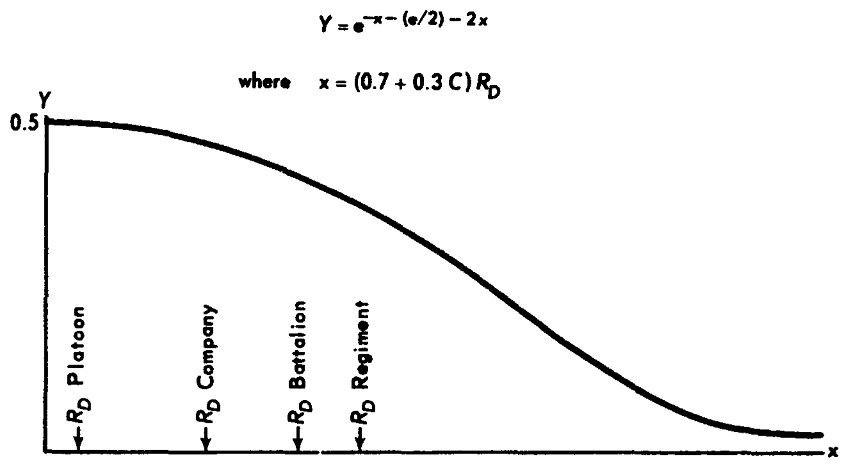


Fig. 18—Schematic Representation of Determining Personnel Density

Criteria for Weapons Effects

The weapons-effects criteria used in this submodel are based on those in FM 101-31-2,[8] modified to facilitate computer processing and, in the lower yields, adjusted to include 300 rem as a casualty criterion. The damage radii in the submodel are derived from the following type formula. The figures in the formula are hypothetical. For a low air burst, the type formula is

for yields < 600 KT $\quad R_D = (K_1)\,1.75\,(Y/10)^{.33}$

for yields > 600 KT $\quad R_D = (K_2)\,4.225\,(Y/1000)^{.45}$

where R_D = damage radius
K = factor relating to the item being assessed
Y = yield of the weapon

The 1.75 and 4.225 represent base values for R_D, in kilometers. Hypothetical K factors are shown in Table 10.

TABLE 10

Hypothetical *K* Factors for Assessing Damage Radius

Item assessed	K_1	K_2
Exposed personnel	0.500	0.500
Protected personnel	0.393	0.233
Personnel in APCs	0.442	0.302
Supply points	0.107	0.233
Tanks and artillery	0.150	0.302
APCs	0.217	0.405
Trucks and launchers	0.280	0.510
Aircraft on ground and communication equipment	0.781	1.030

Casualties represent those personnel who within 4 hr become unfit for duty because of any single effect or combination of effects, other than thermal, of a nuclear weapon.

Abort Rates

These rates are expressed in percentages and are derived from established weapons characteristics. Normally cannon have no aborts whereas missiles and rockets have abort rates of up to 25 percent.

Examples of Use of the Assessment Formula

The overall assessment formula has been established as

$$\text{Loss}_{\text{item}} = \pi R^2_{D_{\text{item}}} \begin{pmatrix} \text{Zonal} \\ \text{density} \\ \text{item} \end{pmatrix} (1 + G\,Y)$$

To illustrate the working of the formula at the two extremes of yields, first assume that a division in a conventional posture (component of Y = 1) is attacked by a fractional kiloton weapon in a forward zone with a density of 30 personnel/sq km. Consider the T component of G to be at unity and all personnel are exposed to the same degree. The Y now is at or near its largest value and the computation appears as

$$\begin{aligned} \text{casualties} &= \pi R^2_D (30) \left[1 + 2 \left(\frac{300 - 30}{30}\right) \times 0.5\right] \\ &= \pi R^2_D (30) (1 + 18 \times 0.5) \\ &= \pi R^2_D (30) (10) \\ &= \pi R^2_D (300) \end{aligned}$$

The density within the area of damage has been adjusted to that of a platoon, the highest density played in the submodel, and the platoon is the appropriate target for a fractional kiloton weapon.

Conversely, if a very-large-yield nuclear weapon is delivered on the same division, the R_D is so large that the value of Y approaches zero. Now the computation appears as

$$\begin{aligned} \text{casualties} &= \pi R^2_D (30) \left[1 + 2 \left(\frac{300 - 30}{30}\right) \times (0)\right] \\ &= \pi R^2_D (30) \end{aligned}$$

The zonal density has not been increased. This is appropriate because when a very-high-yield weapon is used the division's zonal density involves all personnel regardless of degrees of protection.

Pregame Preparations

General. Rules for nuclear play, with any necessary restraints, are developed to keep the game within the parameters of the objective of the game.

New data, not previously approved, are derived, validated, and presented to the client for approval. Instructions to players on methodology are prepared and issued. Data are prepared for insertion in the Permanent Deployment Table (PDT), which is a portion of the computerized part of the submodel.

Permanent Deployment Table

Division areas are divided into four zones numbered 1 to 4 from the FEBA to division rear. Any nuclear strike against a division must state which zone is being hit, and only the elements of the division consigned to that zone in the PDT are susceptible to assessment. Combined arms brigades cover two zones, but all other types of unit are considered to be in one zone, their assigned zonal numbers roughly corresponding to the divisional zone the unit occupies. All units in rear of the division rear boundary are considered as those in Zone 4. The word "zone" as used in the Nuclear Submodel is not synonymous with the term "intelligence zone" used in the Intelligence Submodel.

The term "concentration" (or cluster) factor is used in the PDT. This is the factor C that is included in the "density adjuster," which was described earlier. A unit with a concentration factor of 5 is in a nuclear posture whereas 1 indicates a conventional posture. The numbers between 1 and 5 are used as factors for intermediate stages of unit transition between nuclear and conventional postures. As stated earlier the concentration factor for a nuclear posture decreases the density of personnel and materiel within the weapon's radius of damage while the concentration factor 1 does not alter the density.

Figure 19 illustrates the details of a BLUE mechanized division in a nuclear defense posture that are required to complete one deployment on the Nuclear Controller Work Sheet (NCWS) (see Fig. 20). The NCWS shows type deployments in the form used by the programmer to construct the PDT for computer use. Divisions may have six or more postures. Units in a single zone may be given as many postures as desired. Although the PDT has a capacity of 200 deployments, any one of these can be overridden by the insertion of a temporary deployment, which is valid only for the current cycle of play.

Figure 20 illustrates three deployments for a BLUE mechanized division as it moves from a conventional defense to a nuclear defense posture. As the concentration factors move from 1 to 5 the zonal dimensions become larger, and in each zone a smaller proportion of personnel is exposed as a nuclear posture is approached.

Cycle Inputs

Two types of cyclical inputs are necessary in the Nuclear Submodel. The first is the construction of a NCWS for any temporary deployments desired during a cycle. The second type of input is the mission requests of the players, which are completed by the Air and Nuclear Controllers. Figure 21 illustrates a RED player input. Under "Mission No." missions are numbered consecutively. The code number of the firing unit is placed under "Firing Unit." Entries under "Target Unit" are completed by the controller. The intelligence level is obtained from the intelligence printout and is entered in col 19. The target zone to be attacked is shown in col 20. The number of shots is entered in the column

Units	Pers in Zone					Tanks in Zone					Trucks in Zone					APCs in Zone					Conv Arty in Zone					Nuclear Delivery System in Zone				
	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total	1	2	3	4	Total
Div Hq & Hq Co				142	142									42	42															
MP Co				189	189									52	52															
Avn Bn				318	318									52	52															
Engr Bn		239	239	478	956							48	48	97	193		9	9	18	36										
Sig Bn		144	144	287	575							47	47	94	188											Davy Crockett	155 mm How	8" How	Honest John	
Armd Cav Sqdn				816	816				18	18				93	93				95	95		All artillery is nuclear capable								
Support Comd		528	528	1056	2,112							133	133	265	531				5	5										
Bde Hq (3)		280	140		420							84	42		126															
Mech Inf Bn (7)	3652	1826	913		6,391	8	4	2		14	296	148	74		518	280	140	70		490						14				14
Armd Bn (3)		1150	575		1,725		112	56		168		162	81		243		72	36		108										
Div Arty Hq				205	205									41	41															
155 mm How Bn (3)		1374			1,374							279			279		36			36							54			54
155/8" How Bn		483	109		592							75	26		101		6	3		9							18	4		22
HJ Bn				245	245									73	73														4	4
AWSP Bn		140	140	141	421							33	33	33	99		11	11	12	34	Total Arty pieces					14	72	4	4	
Totals	3652	6164	2788	3877	16,481	8	116	58	18	200	296	1009	484	842	2631	280	374	129	130	813	Total Arty tons					42	1584	104	68	1798
Percent	22	37	18	23	100	4	58	29	9	100	11	38	19	32	100	35	33	16	16	100	Percent tons					2	88	6	4	100

Blue Mech Div in nuclear defense (36 × 40 km) Concentration factor = 5 Deployment number 002

Piece-Launcher	Weight (tons)
Davy Crockett	3
155 mm How	22
8" How	26
Honest John	17

	Zones				Total
	1	2	3	4	
Depth of Zone (km)	5	15	8	12	40
% Personnel exposed	3	5	2	6	16
% Personnel protected	17	25	15	15	72
% Personnel in APCs	2	7	1	2	12
Total percent	22	37	18	23	100

Fig. 19—Division Breakout by Zone

Nuclear Controller Work Sheet

Deployment number | Concentr. factor | Unit width kms | ZONE 1: Depth in kms, % pers. exposed, % pers. protected, % pers. in APCs, % tanks, % trucks, % APCs, % non-nuc. arty., % NDS | ZONE 2: Depth in kms, % pers. exposed, % pers. protected, % pers. in APCs, % tanks, % trucks, % APCs, % non-nuc. arty., % NDS | ZONE 3: Depth in kms, % pers. exposed, % pers. protected, % pers. in APCs, % tanks, % trucks, % APCs, % non-nuc. arty., % NDS | ZONE 4: Depth in kms, % pers. exposed, % pers. protected, % pers. in APCs, % tanks, % trucks, % APCs, % non-nuc. arty., % NDS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
0	0	0	1	2	5		5		9	1	1		2		4	1	1	3	5				2		8	1	4	1	6		7	5	8	3	8	3	3			8	8		7		8		9		1	2	9	1	9	1	6				6	1	0	1	1	1	0		2		9	3	2	1	6				4		
0	0	1	3	3	0		5		6	1	4		2		4	1	1	3	5				2	1	2	1	0	2	0		7	5	8	3	8	3	3			8	8		8		6	1	1		1	2	9	1	9	1	6				6	1	0		8	1	3		2		9	3	2	1	6				4		
0	0	2	5	3	6		5		3	1	7		2		4	1	1	3	5				2	1	5		5	2	5		7	5	8	3	8	3	3			8	8		8		2	1	5		1	2	9	1	9	1	6				6	1	2		6	1	5		2		9	3	2	1	6				4		
0	2	1	1	3	6		7	3	0	3	0	3	0	9	9	6	5	9	0			9	9		3		6		2		2			3	5	1	0																																US Mechanized Division										
0	2	2	3	3	6		7	2	2	3	3	3	5	9	9	6	5	9	0			9	9		3		5		3		2			3	5	1	0		(BLUE Armored Cavalry Brigade)																																								
0	2	3	5	3	6		7	1	5	3	5	4	0	9	9	6	5	9	0			9	9		3		3		4		3			3	5	1	0																																								
0	5	2	5		5		(155 mm How Bn)																		5	4	0	3	5	2	5			9	9	9	9			9	9																																						
0	5	4	5		4		(8" How Bn)																																				4	4	0	3	5	2	5			9	9	9	9			9	9																				
0	5	7	5		4		(Honest John Bn)																																																						2	1	5	6	0	2	5			9	9					9	9		
0	8	0	5		2		(XV Corps Hq)																																																						2		4		4		4												
1	0	6	5		4		(Air Unit at 50% Strength)																																																						4	5	0																
1	2	8	5	1	2		(Supply Point of 30,000 to 60,000 tons capacity)																																																					1	2			9	9			9	9	9	9	9	9	9	9	9	9		
1	[illegible]	0	5		2		(SASP)																																																						4			9	9											9	9		
1	1	3	5		5																				5																		5																		5																		

A device to expend a round with no assessment—e.g., a dud or malfunction in flight

Fig. 20—Nuclear Controller Work Sheet, Type Deployments

RAC

THEATERSPIEL
NUCLEAR MODEL INPUTS

GAME RAD-2 BLUE ____ RED ✓ DATE 1 Mar 1968, D + 4 (AM) PAGE 1 of 3

Card Col	Mission No. (1 2 3)	Firing Unit (7 8 9 10 11 12)	Target Unit (13 14 15 16 17 18)	Intell Level (19)	Zone (20)	Del Means (21 22 23 24)	No. Shots (25 26 27)	Yield (28 29 30 31 32 33)	HOB (34)	Target Type (35 36)	Deploy Number (37 38 39)	Intel Symbol	Tgt No.	Tgt Coord*
	1	R 3 9 1 7		2	2	L F R	3	3.0 0	L	C S		C	7	
	2	R 2 7 7 1		3		M G M	1	5.0 0					29	
	3	R 3 9 6 0		1	1	L F R	1	1 0.0 0		G C			5	
	4			1	2		1	1 5.0 0		C S				
	5			1	3		1	5.0 0						
	6			1	4		1	2 0.0 0		C S				
	5 1	R 2 8 8 0		1	4	S G M	1	5.0 0	L			AF	3	
	5 2	On					1	1 0.0 0						
	5 3	Call					1	1 0.0 0						
	5 4						1	1 0.0 0						
	A 1	R 0 9 2 1		1	4	A I R	2	5.0 0	L			AF	46	
	A 2	Inter-					1	5.0 0						
	A 3	diction					1	5.0 0						

Fig. 21—Mission Request Sample (RED)

*Enter coordinates only when controller directs.

(RAC)

"No. Shots." The yield of each shot is shown in the column "Yield." The height of burst is entered in col 34. Under "Target Type," for divisions the player can enter either CS (combat support) or GC (ground combat). CS permits a higher loss in artillery, but a smaller tank loss is assessed in comparison. The use of GC has the reverse effect. The intelligence symbol of the target is placed immediately after col 39, followed by the target number. This number is extracted from the intelligence printout. Target coordinates are not entered unless the controller so directs.

After submission by players the controllers complete the inputs form. The code numbers of the targeted units are inserted. Zones that are unknown to players and target deployment numbers are entered by the controller. The controller also enters appropriate targets for target of opportunity and air interdiction missions when they are requested by the players.

The information on the completed input forms of both RED and BLUE is punched on mission cards. These are arranged by the controller in proper chronological order of firing, based on player orders and governed by response times and rates of fire. The cards are then placed in the input deck for computer assessment.

Assessments

Computer Assessments. Using the inputs on the mission cards and referring to the stored tabular data, the submodel extracts data necessary to solve the basic assessment formula. Described in detail earlier, the formula is repeated here.

$$\text{Loss}_{\text{item}} = \pi R^2_{D_{\text{item}}} \begin{pmatrix} \text{Zonal} \\ \text{density} \\ \text{item} \end{pmatrix} (1 + GY)$$

Assessments are made for each category of personnel and each type of materiel being assessed in each mission.

After assessing the results of each mission, the submodel draws a random number to determine from a distribution curve the positive or negative adjustment to be made. This permits the possibility, particularly for small-yield weapons, of inflicting no losses.

Hand Assessments. Two types of hand assessments are accomplished in the Nuclear Submodel. The first type of assessment determines the areas denied to units for occupancy or transit because of radiation from fallout due to a surface burst. It also assesses casualties on units that remain too long in a contaminated area. The second type of assessment is used to determine damage to structures such as bridges.

To assess the effects of fallout, the controller determines the location of the actual ground zero (AGZ) of the surface burst. Referring to the map, the unit(s) within the area of effect of the fallout are determined. Because the map symbols do not depict the actual areas occupied by divisions, a base template is used that shows the four zones of a division with a large scale (see Fig. 22). The larger scale of the base template facilitates graphic analysis of affected areas. Predictor templates drawn to the same scale as the base template are used in conjunction with the base template (see Fig. 22). Predictor templates are prepared for the various wind velocities and weapons yields that may be used in the game. These templates are based on the "simplified fallout prediction" described in TM 3-210.[9] The arcs for the downwind maximum range

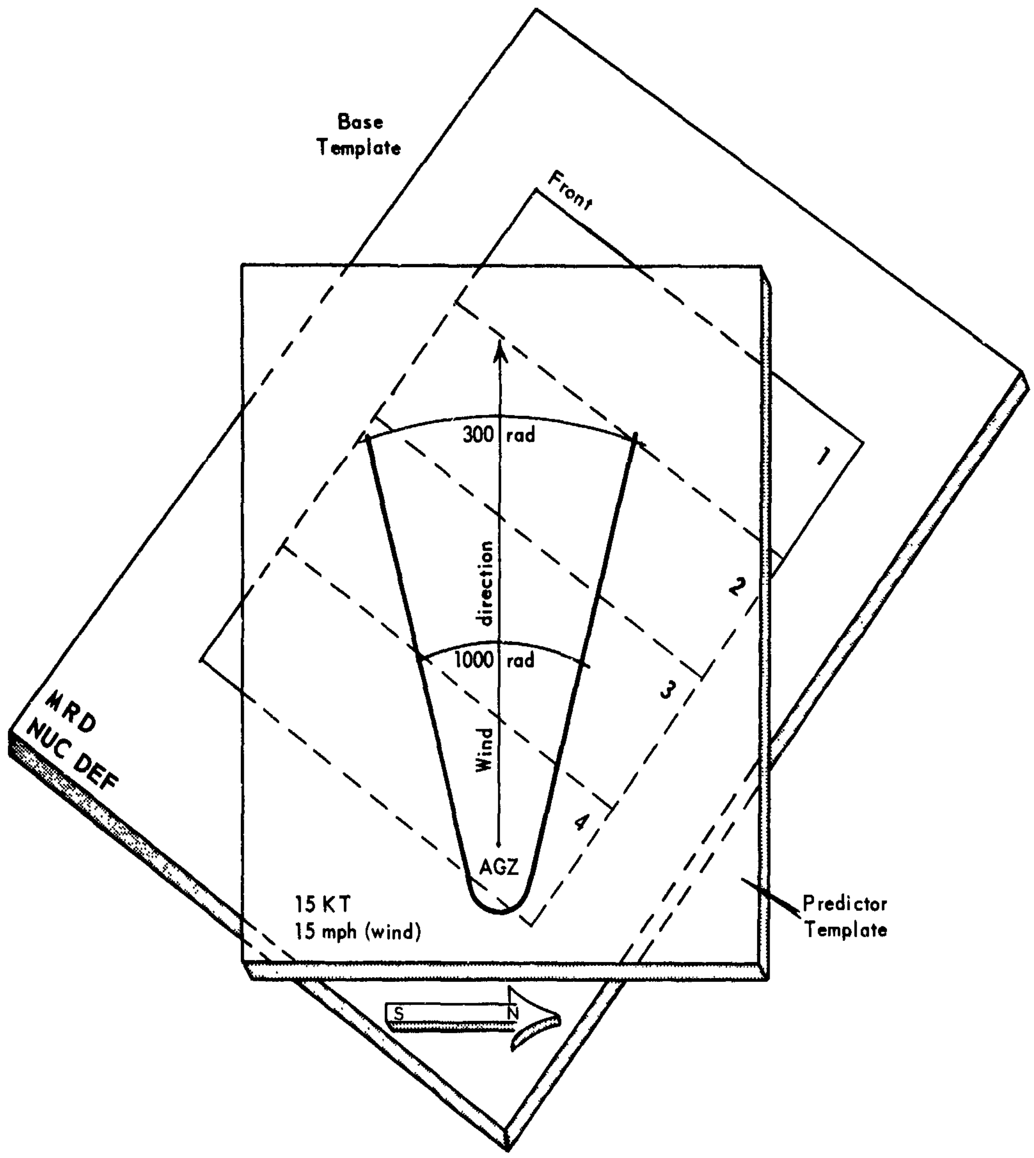


Fig. 22—Schematic Illustration of Template Use in Assessing Fallout Casualties

from the AGZ are for 300 and 1000 rad.[10] These arcs designate the limits for the maximum dose received in a 72-hr period. Casualty factors, scaling factors to account for time in area less than 72 hr, and "wait-to-traverse" times are contained in Table 11.[10]

TABLE 11

Casualty Criteria, Scaling Factors, and Delay Times

a. Casualty/Dosage Relation

Dose, rad	Casualties, %
100–300	—[a]
300–1000	80
> 1000	100

b. Scaling Factors

Normalizing factor	Time of exposure, days
0.37	1/8
0.56	1/4
0.70	1/2
0.84	1
0.89	1 1/2
0.93	2
0.97	2 1/2
1.00	3

c. Wait-to-Traverse Times

Angle of crossing	Intensity of radiation, rad					
	300–1000		1000–3000		> 3000	
	Mode of travel					
	Foot, days	Vehicle, hr	Foot, days	Vehicle, hr	Foot, days	Vehicle, hr
Parallel to crosswind	1	0	2	3	4	6
Along long axis	7	0	15	9	30	18
Any other angle	4	0	8	6	16	12

[a]The effects of radiation between 100 and 300 rad vary greatly in description, physiological reaction, and recovery; but about 30 percent of personnel are affected by vomiting and nausea for about 1 day, without permanent effects. Sickness and vomiting will affect the combat effectiveness of the unit but to what degree is uncertain.

To illustrate the use of the templates, consider that a fallout-producing burst occurred in Zone 4 of a RED division (Fig. 22). The controller determines the orientation for direction of that division from the operations map. Using the appropriate base template for the deployment of the division, the controller positions the north indicator. The AGZ is then placed on the base template. The predictor template proper for the yield and wind velocity is placed over the AGZ and oriented to the wind direction. In this example, approximately 25 percent of the division area is covered by the portion of the fan bounded by the 300- and 1000-rad arcs. With a division strength of 12,000, 3000 personnel (12,000 x 0.25) would receive an average radiation dose of 650 rad [(1000 300) / 2] over a 72-hr period. If the RED standing operating procedure requires units to evacuate such areas in 3 hr, the actual radiation received is determined from Part b of Table 11 as 0.37 x 650, or 240 rad. Referring to Part a of Table 11, the controller estimates that 30 percent of the 3000 affected personnel are not fit for duty. Therefore he assesses 900 fallout casualties (3000 x 0.30).

Approximately 10 percent (1200) of the division personnel receive a dose of 1000 rad. Again using a factor of 0.37 from Part b, Table 11, the average dose is 370 rad (1000 x 0.37). The casualty criterion from Part a, Table 11, indicates a casualty rate of 80 percent for such a dosage. Nine hundred and sixty personnel (0.80 x 1200) therefore, are fallout casualties. The total casualties in the 300 and 1000 rad areas are 1860.

If nondivisional units are located in the affected division area, they are assessed in the same manner as the division. Similarly, units not in a division area are assessed based on the size of the area they occupy, the portion of the area affected, and their strength.

Player teams whose units are affected are notified of the fallout assessment, and the unit strengths are adjusted by a nomodel change before the start of the next cycle of gaming.

To hand-assess damage to structures, bridges, or transitory targets not listed in the MSF, two templates are used. The first is a target template containing the area of the target drawn to scale. The second template, drawn to the same scale, is used to determine target-location error and the relation of desired ground zero (DGZ) with the AGZ (see Fig. 23). Two random number determinations are used in conjunction with the templates. The first is a 2-digit random number to determine the error in target location due to faulty intelligence. The second is a 3-digit random number used to determine the position of the AGZ with reference to the DGZ.

Fixed structures such as permanent bridges and marshaling yards are not subject to location error. For other types of target, Table 12 contains a set of location errors based on the intelligence level of the target and a random number drawing.

Table 12 illustrates how error in target location and the location of the AGZ is determined for a delivery system with a CEP of 250 m. A random number (76) was drawn for a target with an intelligence level of 3. As shown in Table 12, the location of the target was 1000 m in error. This error was placed on the template (Fig. 23), which was then placed over the center of the target on the target template. Next a 3-digit random number (160) was drawn. The first digit (1) locates the AGZ in sector 1 of the 10 sectors shown on the template. The last two digits (60) locate the AGZ between the 0–49 and 50–94

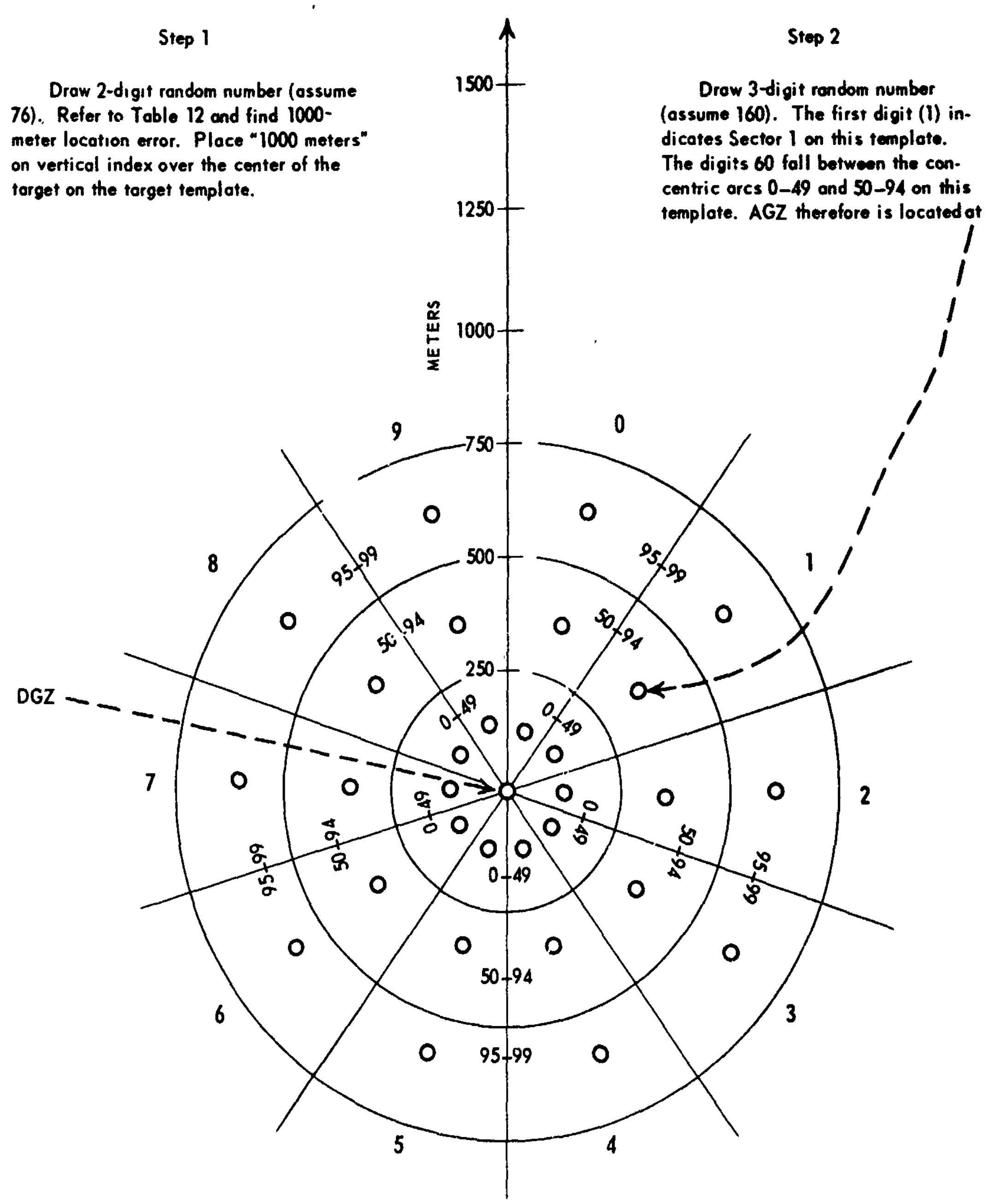


Fig. 23—Example of Use of Template To Determine AGZ

CEP = 250 meters.
Intelligence level 3.
Place this template over target template to same scale.
DGZ is the center of the concentric circles.

Msn No. (1)	Fire Unit (2)	Target Unit (3)	Intel (4)	Zone (5)	NDS (6)	No. of Shots (7)	Yield (8)	HOB (9)	Tgt Type (10)	Deploy No. (11)	No. Abt (12)	Sys Lost (13)	SNA (14)	Effect Shots (15)	Strength Lost (16)	Tanks (Specl) (17)	Trucks (Cl-1) (18)	APCs (Cl-2–4) (19)	Arty (Cl-3) (20)	NDS (Cl-5) (21)
1	R3943	B3043	3	3	LFR	3	30.00	L		08	1	0	0	2	161	1	15	6	0	27
2	R3953	B3046	2	2	LFR	2	30.00	L		08	0	0	0	2	282	2	31	5	21	0
3	B0022	R3943	1	2	AIR	3	10.00	L	CS	116	0	0	0	3	444		38	18	44	0
4	B2283	R3956	3	3	LGM	1	200.00	L		42	0	0	0	1	76	1	7	3	23	14
5	R2669	B3001	2	3	SGM	3	10.00	L	GC	05	1	0	1	1	70	7	11	3	0	0
6	R0921	B2026	1	4	AIR	5	5.00	L		151	0	1	0	4	228	0	68	10	6	0
7	R2658	B1016	2	4	SGM	3	10.00	L		57	2	0	0	1	1					
8	R2991	B0021	1	4	LRC	1	1000.00	L		102	0	0	0	1	13					
9	R2660	B5012	3	4	SGM	1	30.00	L		99	0	0	0	1	283	0	14	149	8	80
10	R0931	B5027	1	4	AIR	2	200.00	L		129	0	0	0	2	3302	41	34	1622	374	1761
11	R2665	B4112	1	4	SGM	3	15.00	L		159	0	0	0	3	535					
12	B2499	R5982	1	4	LRC	1	350.00	L		100	0	0	0	1	6850					6523

Fig. 24—Illustrative Assessment Printout

indexes on the radial scale. Figure 23 shows the final location of the AGZ. Having located the AGZ, the controller uses the appropriate radius of damage of the nuclear burst to assess damage.

TABLE 12

Target Location Error Determination as a Function of Intelligence Level and Random Number

(For mobile targets)

Intelligence level	Error of location, m						
	0	250	500	750	1000	1250	1500
1	0–75	76–97	98–99	—	—	—	—
2	0–35	36–60	61–77	78–90	91–99	—	—
3	0–20	21–40	41–56	57–72	73–87	88–99	—
4	0–3	4–10	16–30	31–53	54–73	74–90	91–99

Cycle Outputs

The assessment portion of the printout for the Nuclear Submodel is in the general form shown in Fig. 24, on which illustrative assessments are shown.

Entries for cols 1 to 11 are taken directly by the computer from the nuclear-mission input cards. Column 12 lists the aborts, and col 13, "Systems Lost," lists the number of nuclear aircraft carriers lost en route to the target as determined by the earlier partial run of the Air Submodel. Column 14 lists the "Systems Not Available," when either a weapon or launcher is not available for any reason. Column 15, "Effective Shots," is col 7 less the sum of the entries in cols 12, 13, and 14. Column 16 lists personnel losses. For air and SAM units, the entries in col 16 represent planes and fire units lost respectively. For supply points and SASPs, col 16 represents the tonnage loss in storage capacity. Column 17 shows the tonnage loss in supply points for whatever "special category" of supply is being played. For other than supply points, col 17 indicates tanks lost. The entry in col 18 indicates the number of trucks lost except in supply points, where the figure listed indicates the tons of class I supplies lost. Similarly, col 19 indicates the loss of APCs. For supply points, however, the entry signifies tons of classes II and IV supplies lost. Column 20 has a twofold significance. First, against ground-combat units it shows conventional artillery lost. Second, against supply points it lists the tons of class III supplies lost. Column 21 shows nuclear-delivery systems lost. Against supply points it lists tons of conventional ammunition lost, and against SASPs it shows tons of nuclear weapons lost.

Chapter 5

COMBAT SUPPORT SUBMODEL

INTRODUCTION

Within the sequence of the THEATERSPIEL Model computer operations, the Combat Support Submodel follows the Air Submodel and is in turn followed by the Ground Combat Submodel. The Combat Support and Ground Combat Submodels are closely related.

PURPOSE AND SCOPE

The Combat Support Submodel is designed to assess the effects of nondivisional artillery on targets receiving its fire. These effects are expressed in terms of casualties and loss of combat effectiveness or casualty-producing potential (CPP) due to those casualties.

The submodel has a considerable degree of flexibility and can be adjusted to meet specific situations or requirements. For example, if it is desired to examine the effectiveness of a new type of ammunition, the division artillery, which is normally incorporated in the Ground Combat Submodel, can be withdrawn from that submodel. It may be played in the Combat Support Submodel, permitting its effects to be evaluated more discretely.

METHODOLOGY

The submodel assesses casualties from nondivisional artillery fires by the application of the combat-support units' CPP to targeted units. Based on unit casualties, the loss of combat effectiveness in each unit attacked by artillery fires is determined by the submodel.

The CPP of a combat-support unit is the expected number of enemy casualties per day its fires will cause under a given set of conditions. During pregame preparations an authorized CPP* is calculated for each combat-support

*Authorized CPP of a combat-support unit is the expected number of casualties per day produced by the unit's fires when it is at authorized strength and is firing against an enemy defending in a meeting engagement.

unit. To meet any specific situation, the CPP is modified by the successive application of various factors or multipliers.

The factors pertaining to assessments are rates of fire, terrain, fire distribution, target intelligence, target density, target vulnerability, and percentage of authorized unit strength of the targeted unit. The first six factors, or multipliers, are described in "Pregame Preparations." Percentage of authorized strength of the targeted unit is obtained by dividing present strength by authorized strength, both figures being obtained from the Master Status File (MSF).

After each of the foregoing factors has been applied successively to the CPP, the modified figure is the number of casualties in the targeted side of the battle grouping (BG). The casualty rate is then calculated and applied to the strength of each unit. The product for each unit is the number of unit casualties. The permanent and temporary losses of the index of firepower potential (IFP)* are then determined for each targeted ground-combat unit. The temporary loss in unit IFP, which is not carried forward to the next cycle, represents the suppressive effects of artillery on targeted ground-combat units. For each targeted combat-support unit the submodel calculates the loss of CPP, based on casualties.

The determination of the factors mentioned previously and the calculation of CPPs are discussed in "Pregame Preparations." Assessment procedures are explained in detail in "Assessments."

DESCRIPTION OF SUBMODEL

Pregame Preparations

General. As with the other submodels, the scope of pregame tasks is dictated by the special objectives prescribed by the client. An analysis of these requirements will determine specific reporting requirements, the need for new or revised report forms, and the need for revision or modification of the submodel and its supporting computer program.

Specific pregame tasks that must be performed include:

(a) Determination of data pertinent to combat-support units for inclusion in the MSF. Units may be individual battalions, or several battalions of identical type, combined into groups.

(b) Determination of weapons characteristics such as maximum effective range and daily estimated expenditure of ammunition (EEA).[11]

(c) Calculation or verification of assessment factors for incorporation in the assessment routine of the computer program.

(d) Development of rules of play that conform to the special situation and specific game objectives.

(e) Preparation and reproduction of data recording forms used to facilitate reporting.

(f) Posting of combat-support units on situation overlays.

*IFP is the relative effectiveness of ground-combat units under specified conditions of engagement.

Computation of CPPs. The capability of a combat-support unit to inflict casualties on and to reduce the effectiveness of enemy units is determined by the application of its calculated CPP to targeted units. The procedure for computing the CPP is described in the following paragraphs.

First the mean lethal area[11] per round is determined for a weapon J against personnel in target posture* K (meeting engagement).

$$\overline{LA}_{JK} = \sum_{i=1}^{n} \left[(LA_s)_i \times (T_s)_k + (LA_p)_i \times (T_p)_k + (LA_f)_i \times (T_f)_k \right] F_i$$

where $\overline{LA}_{JK}$ = mean lethal area, weapon J, target posture K

$(LA_s)_i, (LA_p)_i, (LA_f)_i$ = lethal area of ith munition vs personnel standing, prone, in foxholes

$(T_s)_k, (T_p)_k, (T_f)_k$ = fraction of personnel standing, prone, in foxholes, posture K

F_i = fraction of ith munition in weapon ammunition mix

Next, a unit's authorized CPP is determined by the formula

$$\overline{LA} \times N \times D \times W$$

where $\overline{LA}$ = mean lethal area per round fired against an infantry unit defending in a meeting engagement

D = density of an infantry unit defending in a meeting engagement

N = number of rounds fired (EEA) per weapon per day in a meeting engagement

W = number of weapons in the delivery unit

(If the delivery unit has more than one weapon type, unit CPP is calculated as the sum of the effects of the different types.)

Data Tables. Based on data provided by the client or available within RAC, the following data tables are prepared. The application of the factors contained in the tables is described in "Assessments."

Rate Table contains factors for the EEA per day for each artillery unit type,† for each posture, for RED and BLUE. For example, the EEA factor for all artillery subtypes for a meeting engagement is 1.0. If the EEAs for a 155-mm howitzer are 70 rds for a meeting engagement and 85 rds for attack of a hastily prepared position, the rate factor for the latter posture is 85/70 or 1.21.

Cover Table contains factors relating to munitions effectiveness in built-up or wooded areas[12] for each type of artillery of RED and BLUE. The table is applied to a unit's CPP to reflect the degradation of the effects of artillery ammunition in varying conditions of cover.

*Target postures are discussed in Chap. 6, "Ground Combat Submodel."

† Types of combat-support units for any given game might be, for example, 105-mm howitzer, 155-mm howitzer, 8-in. howitzer, 175-mm gun, Mars rocket, Lance guided missile, and Pershing guided missile.

Fire Distribution Table is a table of weighted numerical values given to each type of ground-combat and combat-support unit on each side in a BG or artillery target grouping (ATG). The value given to each type of unit in the table represents its estimated relative threat to the enemy based on its total firepower capability.[13]

A sample of a Fire Distribution Table is shown in the accompanying tabulation.

Unit	Value
Armored (tank) division	5
Mechanized (motorized) rifle division	4
Infantry division	3
Mechanized (motorized) brigade	2
Artillery group	1

The fire distribution factor is used in distributing artillery fires between targeted ground-combat and combat-support units. The manner in which this factor is used is described later in "Assessments."

Intelligence Table provides a list of factors that reflect the effects of various intelligence levels of targeted units. A typical table is shown in the accompanying tabulation.

Intelligence level	Factor
1	1.0
2	0.8
3	0.6
4	0.4

Density Table contains factors that reflect the differences between the unit density for each type of target[14] for each posture and the density of an infantry unit defending a meeting engagement. For example, assume that the density of an infantry division in defense is 30 men/sq km for a meeting engagement and 40 men/sq km for a hastily prepared position. The factor to be applied for an infantry division defending in hastily prepared positions is then 40/30, or 1.33.

Vulnerability Table contains factors that reflect the relative vulnerability of personnel in the various postures, as opposed to the vulnerability of personnel in a type of unit defending in a meeting engagement. Vulnerability is determined by the percentages of personnel standing, prone, and in foxholes in the various postures.

Rules of Play. For each game special rules of play must be developed and published. These may include limitations on use of special munition types, boundary and targeting restrictions, criteria for effective and ineffective combat-support units, and criteria for reconstitution of ineffective units.

Cycle Inputs

The first step in the functioning of the submodel is the submission of player orders and requests for discrete artillery fires on the Discrete Mission Request Form, Fig. 25.

DISCRETE MISSION REQUEST

GAME OVERLOOK I DATE D + 2

BLUE √ RED ______

Delivery Unit	Percent Fires	Targets		
		Type	Intelligence Level	Location
B2071	70	MRD	2	MA51
	30	SSM	3	MB63
B2073	50	MRD	2	MB92
	50	TKD	2	MB31
B2081	50	MRD	3	NA51
	25	SSM	1	NA95
	25	SSM	2	NC27

Fig. 25—Example of a Discrete Mission Request

Fires of a delivery unit not to exceed 100% of its EEA.

Next, based on evaluation of player orders, the Ground Controller, assisted by the Combat Support Controller, establishes BGs on the situation map. (BGs are discussed in Chap. 6, "Ground Combat Submodel.") The Combat Support Controller then establishes ATGs on the map along the FEBA.

ATGs thus formed provide a means for evaluating the exchange of artillery fires in those areas where neither side is conducting ground attacks. This type of ATG, composed of a group of BLUE and RED units facing each other in a static situation, is known as a FEBA ATG. An example of the forming of a FEBA ATG is shown in Fig. 26.

In the next step the Ground Controller prepares those portions of the Input Data Sheet (Fig. 27) that reflect data obtained from BGs. Concurrently the Combat Support Controller prepares those portions of the Input Data Sheet that use data obtained from ATGs and Discrete Mission Requests. The Combat Support Controller fills in cols 1 to 5, 13, 21, 23, 24, 39, and 40 for all ATGs. In col 13, for BGs as well as ATGs, he enters 1, 2, or 3, depending on the degree of tree cover in the ATG target area—lightly, moderately, or heavily wooded. He enters the intelligence level in col 21. In cols 23 and 24 the entry is always 00, which is the code for a static situation in which there is no ground-combat action. He enters the ATG number in cols 39 and 40. In this connection, it is essential that ATG numbers not duplicate BG numbers. An example of a FEBA ATG is shown in Fig. 26 and lines 1 to 10 of Fig. 27.

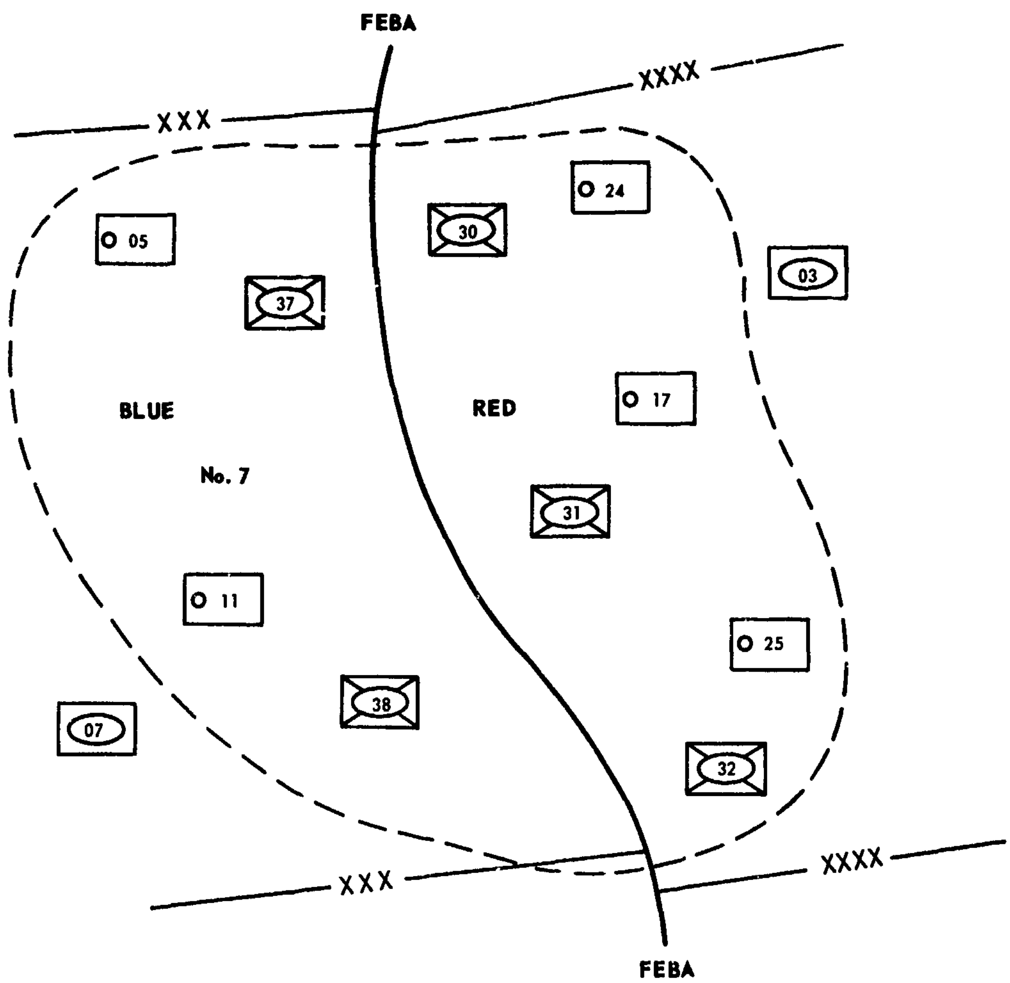


Fig. 26—Illustration of an Artillery Target Grouping

Neither side is attacking.

ATGs established for the purpose of processing discrete fires differ from FEBA ATGs in several respects. First, discrete fire ATGs are not normally enclosed by a line on the situation map. In many cases this would be more confusing than helpful, since this type of ATG will frequently overlap BGs and FEBA ATGs. Second the delivery unit is always entered on the line immediately

THEATERSPIEL GROUND COMBAT BATTLE GROUPING

INPUT DATA SHEET

Game OVERLOOK I

Date D + 2

Parameters

Card Col.	Unit Desig. 1	2	3	4	5	Ter-rain 12	Cov-er 13	Tactical Factor 15	16	Percent Fires 19	20	Intel. Level 21	Atk.-Def. Posture 23	24	Battle Grouping 38	39	40
Unit 1	B	3	0	3	7		2					1	0	0			7
2	B	3	0	3	8		2					2	0	0			7
3	B	2	0	0	5		2					2	0	0			7
4	B	2	0	1	1		2					3	0	0			7
5	R	3	9	3	0		1					2	0	0			7
6	R	3	9	3	1		1					1	0	0			7
7	R	3	9	3	2		1					1	0	0			7
8	R	2	9	2	4		1					2	0	0			7
9	R	2	9	1	7		1					2	0	0			7
10	R	2	9	2	5		1					3	0	0			7
11																	
12	B	2	0	7	1					7	0		0	0			8
13	R	3	9	6	5		2					2	0	0			8
14	B	2	0	7	1					3	0		0	0			8
15	R	2	9	8	1		2					3	0	0			8
16	B	2	0	7	3					5	0		0	0			8
17	R	3	9	7	0		1					2	0	0			8
18	B	2	0	7	3					5	0		0	0			8
19	R	3	9	4	2		1					2	0	0			8
20	B	2	0	8	1					5	0		0	0			8
21	R	3	9	5	1		2					3	0	0			8
22	B	2	0	8	1					2	5		0	0			8
23	R	2	9	5	5		2					1	0	0			8
24	B	2	0	8	1					2	5		0	0			8
25	R	2	9	5	7		3					2	0	0			8
26	R	2	9	8	9					7	5		0	0			8
27	B	3	0	2	1		1						0	0			8
28	R	2	9	8	9					2	5		0	0			8
29	B	2	0	8	5		2						0	0			8
30																	

Fig. 27—Ground-Combat Battle Grouping Input Data Sheet

above its target unit on the Data Input Sheet. A discrete fire ATG consists of one or more pairs of BLUE and RED units, each pair consisting of a delivery unit and a target unit. In each pair the delivery unit is listed first, and the target unit is listed on the line below. As can be seen in Fig. 27, a delivery unit frequently will have more than one target. In such cases, the delivery unit is listed separately for each target.

The third difference between discrete fire ATGs and FEBA ATGs concerns the percentage of EEA to be fired. For discrete fire ATGs only, the Combat Support Controller enters for delivery units in cols 19 and 20 the percentage of the unit's EEA that is to be fired against the target unit that appears on the line below. He obtains this percentage from the Discrete Mission Request, Fig. 25. For example, on the player's Discrete Mission Request he has planned 70 percent of the EEA of B2071 against a RED mechanized rifle division (MRD) at MA51, and 30 percent of that unit's EEA against an SSM unit at MB63. In this case, after identifying the RED target units on the map, the Combat Support Controller enters 70 percent on line 12 of the Input Data Sheet against R3965 and 30 percent on line 14 against R2981. Note that in no case does the ammunition allotted for each delivery unit exceed 100 percent of the EEA.

An example of a discrete fire ATG is shown in lines 12 to 29, Fig. 27. Note that there are several instances in which entries are not made. Column 13, for this type of ATG, applies only to targeted units. The cover factor is determined from map inspection. Columns 19 and 20 apply only to delivery units. Column 21 applies only to targeted units.

The data contained in the Input Data Sheet are transferred to punch cards for input into the computer program. The assessment routines in the program then perform the required calculations to determine the results of artillery fires in both BGs and ATGs.

Assessments

General. There are two assessment routines in the computer program for the Combat Support Submodel. The first is the aggregated assessment routine. It assesses the exchange of fires within BGs and FEBA ATGs. The second routine is the discrete fire assessment routine. It assesses the results of fires within discrete fire ATGs.

Aggregated Assessment Routine. Within each BG and FEBA ATG, the effects of the exchange of artillery fires are assessed by the aggregated assessment routine. Assessments are made by the successive application of the factors described in "Pregame Preparations" to CPPs of delivery units. The principal data produced by the assessment routine are casualties, loss of combat potential, and munitions expenditures.

The steps in the assessment routine for BGs or FEBA ATGs are summarized in the following paragraphs. The summary is confined to the fires of BLUE delivered against RED. Procedures for the return of fires by RED are identical.

First the total CPPs for each subtype are modified in turn by application of the rate factor obtained from the Rate Table for the specific posture of the firing units.

Next, the modified subtype CPPs are added to form one composite CPP for the BG or FEBA ATG.

The routine then turns to the RED target units of the BG or FEBA ATG to determine the interaction between the composite CPP and the characteristics of the target units.

The fires of the delivery units, represented by the composite CPP, are divided with a portion delivered against each of two groups, ground-combat units and combat-support units. For example, it is assumed that on the RED side in the BG or FEBA ATG there are six MRDs, two RED tank divisions (TKDs), and three artillery units. Using the values given in the Fire Distribution Table, the RED units have a total weight of 37. Of this number, 34 represent ground-combat units and 3 represent artillery units. Accordingly, $^{34}/_{37}$ or 92 percent of the composite CPP will be applied in fires on ground-combat units and $^{3}/_{37}$ or 8 percent to combat-support units.

These percentages are then applied to the composite CPP. The portion of the CPP to be applied to targeted ground-combat units is designated CPP_{GC}. The part to be applied to combat-support units is CPP_{CS}.

Next the portion of CPP_{GC} to be applied to each ground-combat unit will be designated CAS_{TU} (casualties in the unit that is targeted) and is determined by the use of the formula

$$CAS_{TU} = CPP_{GC} \times \frac{\text{present unit IFP}}{\text{total BG IFP}}$$

In dividing CPP_{GC} into elements that will be applied against individual target units, the IFPs provide a more realistic basis than strengths. Thus the relative threat that one targeted unit presents to the enemy can best be represented by the quotient of the present IFP of the target unit divided by the total IFP of the BG on the targeted side.

CAS_{TU} is then modified by multiplying it in turn by the intelligence, cover, density, and vulnerability factors, which are obtained from their respective tables.

$$\text{Final } CAS_{TU} = CAS_{TU} \times \frac{\text{present targeted unit strength}}{\text{authorized targeted unit strength}}$$

Final CAS_{TU} is the number of casualties in the targeted unit caused by artillery fires.

The permanent loss of IFP in the targeted unit is determined by the formula

$$\text{IFP loss} = 2 \times \frac{\text{unit casualties}}{\text{present strength}} \times \text{base IFP}$$

The use of the factor 2 in the formula is based on the logic that the majority of the casualties inflicted within a division by artillery fires are ground-combat personnel. These personnel constitute approximately 50 percent of the division's strength and contribute the larger part of the unit's IFP. Accordingly the rate of IFP loss is approximately double the personnel loss rate.

Permanent loss of IFP is doubled to include a representation of the temporary suppressive effect of artillery fires. However, only the permanent loss is carried forward to the next cycle.

The foregoing procedures are repeated until all ground-combat units in the BG or FEBA ATG have been processed. Ground-combat casualties are then totaled.

The same procedures are used to assess casualties in combat-support units. When CPP_{CS} has been determined, the portion of the delivery unit's composite CPP to be applied to each targeted combat-support unit is calculated by the formula

$$CAS_{TU} = CPP_{CS} \times \frac{\text{unit CPP}}{\text{total CPP}}$$

Note that CPP_{CS} applies to delivered fires whereas "unit CPP" and "total CPP" refer to targeted units.

CAS_{TU} is then multiplied in turn by the intelligence, cover, density, and vulnerability factors, as discussed earlier for ground-combat units. CAS_{TU} is finally modified by using the formula

$$\text{Final } CAS_{TU} = CAS_{TU} \times \frac{\text{present unit strength}}{\text{authorized unit strength}}$$

Again, the final resultant CAS_{TU} is the number of unit casualties caused by artillery fires.

Loss of unit CPP is determined by the formula

$$\text{CPP loss} = \frac{\text{unit casualties}}{\text{present strength}} \times \text{CPP}$$

Combat-support-unit casualties for the BG or FEBA ATG are totaled. This total is then added to the artillery-inflicted ground-combat casualties to obtain the total casualties in the BG or FEBA ATG caused by artillery fires.

Discrete Fire Assessment Routine. The assessment procedures for each pair of units, delivery unit and target unit, in a discrete fire ATG are summarized in the following paragraphs.

First the delivery unit's CPP is multiplied by the appropriate target unit posture factor from the Rate Table.

Next the modified delivery unit CPP is multiplied by the appropriate factors from the Intelligence, Cover, Density, and Vulnerability Tables.

The resulting CPP is then multiplied by the factor "present target unit strength divided by authorized target unit strength." The resultant is target-unit casualties.

Next, loss of IFP or CPP for the target unit is determined as described previously in "Aggregated Assessment Routine."

The steps just described are repeated for each pairing of a delivery unit and a targeted unit in the discrete fire ATG. The casualties in the ATG are then totaled, and subsequently the casualties for all discrete fire ATGs are totaled.

In both the aggregated and the discrete assessment routines the number of rounds fired by each combat-support unit is determined. The total rounds fired by each subtype in each BG and ATG are then calculated.

The new unit strengths, IFPs, and CPPs resulting from the foregoing assessments are fed by the computer into a data table in the program, which is used by both the Combat Support and Ground Combat Submodels. The Ground Combat Submodel extracts the new strengths and IFPs from the table for use in that submodel. When the Ground Combat Submodel completes its operation, new unit strengths and developed IFPs are utilized to update the MSF for those line items for each unit in the BGs. Concurrently the new CPPs and ammunition expenditures developed in the Combat Support Submodel are used to update those items in the MSF.

The CPP of each combat-support unit, adjusted to reflect personnel casualties resulting from assessments made in the Air and Combat Support Submodels, is further adjusted in the Logistics and Recovery Submodel to reflect replacement of personnel, equipment, and supplies. The resulting CPP, printed in the MSF as "Present CPP," is the basis for making assessments in the Combat Support Submodel during the following cycle.

Cycle Outputs

The assessment results of the Combat Support Submodel are reflected in three printouts: the MSF, the Casualty Assessment Report, and Battle Grouping Results.

The MSF reflects new personnel strengths, new CPPs for combat-support units, new IFPs for ground-combat units, and expenditure of ammunition by unit.

The Casualty Assessment Report prints out by unit the following assessments:

(a) Loss of personnel strength.
(b) Loss of IFP (permanent and temporary) for ground-combat units.
(c) Loss of CPP for combat-support units.

The Battle Grouping Results report prints out, by BG and ATG, the following assessments:

(a) Casualties, by conventional and special ammunition, caused by artillery.
(b) Rounds fired by type of weapon for nondivisional artillery.

Of immediate concern to players and the Combat Support Controller are the effects of assessments on the CPPs of combat-support units. Examination of present CPP listed in the MSF will indicate the degree of support that can be expected during the next cycle of play from combat-support units.

FUTURE IMPROVEMENTS

General

There are several areas requiring improvement in the present submodel. First, division artillery is normally played in the Ground Combat Submodel, in a highly aggregated manner, and not in the Combat Support Submodel. Second, the submodel assesses only casualties and does not assess materiel losses. Finally, assessments can be made only against ground-combat and combat-support units. A submodel now under final development will correct these deficiencies.

There are four major differences between the present submodel and the one now under development. First, the present concept of beginning the assessment routine with an authorized CPP, and modifying it with successive application of factors relating to the type and posture of the target unit, is not used. Instead, data relating to lethal areas, rates of fire, target densities, and other pertinent factors are extracted from data tables in a logical sequence. The product of these data ultimately produces target-unit casualties and losses in materiel.

Second, a different group of data tables is used. These tables will be discussed in the following section.

Third, losses of selected items of materiel are assessed in targeted units. The manner in which these assessments are made will be discussed later in "Assessment Procedures."

Fourth, personnel and materiel losses are assessed in all types of units. This is done by incorporating in the various tables pertinent data on which to base assessments in these units.

Data Tables

Four new data tables have been incorporated in the revised submodel.

(a) Master Status File provides artillery weapons availability and artillery ammunition status for both ground-combat units and combat-support units.

(b) Mix Table carries the percentage of artillery weapons by type for ground-combat and combat-support units.

(c) Lethality Table contains the lethal areas for an average round for each weapon type against personnel standing, prone, and in foxholes; against unarmored, lightly armored, and heavily armored vehicles; and against grounded aircraft.

(d) Equipment Table provides the authorized allocations of selected categories of materiel in the various types of units.

In the Rate, Density, and Vulnerability Tables the same general types of information are provided as in the present submodel but in a different form. In the present submodel these tables contain factors that provide a comparison between data for a target unit defending in a meeting engagement and similar data for a unit in all other postures. The tables in the revised submodel provide the raw data pertaining to all postures. For example, assume that the personnel density of a mechanized division on the defense is 30 men/sq km in a meeting engagement and 25 men/sq km in a delaying action. In the present submodel, the density factor for a meeting engagement, the base posture, is 1.0, and the density for a delaying action is $^{25}/_{30}$ or 0.83. In the Density Table in the submodel under development the actual densities, 30 and 25, are given.

The Cover, Fire Distribution, and Intelligence Tables in the revised submodel are identical to those in the present submodel.

Assessment Procedures

Aggregated Assessment Routine. The chronological steps in the aggregated assessment routine described below pertain to one side's firing against the other in one BG or FEBA ATG. Some of the steps are the same as in the present routine. However, for continuity and clarity the entire sequence of assessment procedures is given.

For the first firing unit, the number of available weapons is determined from the MSF. For example, assume that the unit has 76 artillery weapons.

From the Mix Table, the fraction of each type of weapon authorized for this type of unit is determined. In this example, assume that the percentages are 71 percent 105-mm howitzer, 24 percent 155-mm howitzer, and 5 percent 8-in. howitzer.

The total number of available weapons by type for this unit is calculated

76 x 0.71 = 54 105-mm howitzers
76 x 0.24 = 18 155-mm howitzers
76 x 0.05 = 4 8-in. howitzers

The first three steps are repeated for all other firing units in the BG or FEBA ATG.

Weapons by type are totaled for all firing units in the BG or FEBA ATG.

For the first weapon type, lethal-area data are obtained from the Lethality Table. These data are lethal areas per round against personnel standing, prone, and in foxholes; against unarmored, lightly armored, and armored vehicles; and against grounded aircraft.

For the first weapon type and the current posture of the firing side, the EEA is obtained from the Rate Table.

The total lethal areas for the first weapon type are then calculated as the products of the lethal areas per round, the EEA from the Rate Table, and the number of weapons of this type.

The preceding three steps are repeated for all other weapon types in the BG or FEBA ATG.

For the firing side in the BG or FEBA ATG, the lethal areas for personnel standing, personnel prone, personnel in foxholes, unarmored vehicles, lightly armored vehicles, armored vehicles, and grounded aircraft are added.

The latter action completes the routine's functioning as it pertains to delivery units. The routine now turns to the targeted units.

First the artillery fires of the firing side, represented by the total lethal areas as determined previously, are distributed between targeted ground-combat and combat-support units as done currently in the present submodel. The Fire Distribution Table is used to accomplish this.

Next the fires are distributed among the specific ground-combat and combat-support units as now done in the present submodel. The portion of the fires to be directed against each specific target unit is designated LA_{TU}. This portion varies with each target unit, depending on the type of unit and the value of its IFP.

The routine now assesses personnel losses in each target unit.

For the first target unit, the fractions of personnel standing, prone, and in foxholes are determined. These data are obtained from the Vulnerability Table for the current target posture. The fractions are designated F_s, F_p, and F_f.

Next the density of personnel D is determined for this type of unit, for the current target posture, from the Density Table.

The cover factor C and intelligence factor I are obtained from the Cover and Intelligence Tables.

The present and authorized strengths of the target unit are determined from the MSF, and the factor present strength/authorized strength (PS/AS) is calculated.

The casualties in the target unit among personnel standing (CAS_s) are computed as the product of:

Fractional part of fires: LA_{TU}
Fraction standing: F_s
Personnel density: D
Cover factor: C
Intelligence factor: I
Present strength/authorized strength: (PS/AS)

The preceding step is repeated for personnel prone and personnel in foxholes to determine unit casualties in those categories (CAS_p, CAS_f).

The total personnel casualties for this unit are totaled ($CAS_s + CAS_p + CAS_f$).

The IFP loss for the unit is determined as now done in the present submodel.

The target unit assessment steps are repeated for all other target units, and the personnel casualties are totaled for the targeted side in the BG or FEBA ATG.

The routine now assesses materiel losses in each unit of the targeted side.

From the Density Table, the density of the first category of materiel D_M for the first target unit is determined for the current posture.

Next the vulnerability factor V_M for this category of materiel, related to target posture, is determined from the Vulnerability Table. The intelligence factor I is obtained from the Intelligence Table.

The on-hand amount (OH) of this category of materiel is obtained from the MSF, and the authorized allocation (AA) is obtained from the Equipment Table. The factor OH/AA is then calculated.

The losses of this type of materiel in the first unit are then computed as the product of:

Fractional part of fires: LA_{TU}
Materiel density: D_M
Vulnerability factor: V_M
Intelligence factor: I
On hand/authorized allocation: (OH/AA)

The four steps for assessing materiel losses are repeated for the other categories of materiel in the first target unit.

The preceding five steps are then repeated for all other target units.

Finally the total losses of each type of materiel are determined by adding the losses incurred in each target unit. This action completes the functioning of the aggregated assessment routine.

Discrete Assessment Routine. The assessment procedures for each pair of units, one delivery unit and one target unit, are the same as employed in the aggregated assessment routine, with the following exceptions:

(a) The percentage of the firing unit's EEA to be fired against the target unit is obtained from cols 19 and 20, Input Data Sheet, Fig. 27.
(b) All steps referring to more than one delivery unit and more than one target unit are omitted.

Chapter 6

GROUND COMBAT SUBMODEL

INTRODUCTION

Large-scale operations are fought at corps and field army levels in the Ground Combat Submodel. The operations of individual combat divisions contribute to the outcome of operations of the larger forces. Theater-level operations can be realistically portrayed and evaluated by assessing the results of battles between numbers of opposing divisions. Large battles normally extend over a minimum of several days. Changes in the concepts of operations by either side are not likely to have significant effect on the results of operations during the day on which decision is made to effect a change.

In accordance with the foregoing concept, the submodel establishes the combat division as its unit of resolution, employs numbers of logically opposing divisions in each of its battles, and employs a 24-hr period for its normal cycle of play. The submodel may, however, play shorter or longer periods by the introduction of adjusted assessment factors.

The first sections of this chapter discuss the submodel in a general way. They do not cover the specifics or values of factors used in assessing results. All such items are explained and illustrated in the section, "Description of the Submodel."

PURPOSE AND SCOPE

The purpose of the submodel is to assess the results of interactions between ground-combat units at theater level.

Results are assessed only in areas where ground attacks are occurring. The Combat Support Submodel assesses the results of artillery fires in those areas where neither side is conducting ground attacks. In areas where ground attacks are occurring, the Ground Combat Submodel assesses four results:

(1) Success or failure of the attacker.
(2) Number of casualties suffered by each engaged ground-combat unit of each side.
(3) Extent of advance of the successful attacker.

(4) Impact of casualties on the strength and combat capability of each ground-combat unit of each side.

METHODOLOGY

The Nuclear, Air, and Combat Support Submodels are exercised sequentially before assessments are made by the Ground Combat Submodel. Each of the submodels, based on the losses it assesses, revises the strength and combat capability of ground-combat units before the next submodel is exercised.

After assessments are made by the Ground Combat Submodel, the Logistics and Recovery Submodel determines total losses and gains in materiel and supplies. The Logistics and Recovery Submodel then recomputes the end-of-cycle strength and combat capability of units, based on all losses and gains in personnel, materiel, and supplies. These end-of-cycle data reflect each unit's combat capability for the start of the next cycle of play.

The methodology employed in the Ground Combat Submodel implements the concept of large battles by using battle groupings (BGs) for assessing results. Each grouping encompasses directly opposing units that logically would become engaged in the same ground battle. Each grouping usually consists of several combat divisions and the supporting artillery of each side. The formation of BGs is explained later in the paragraph, "Formation of BGs."

Information pertaining to each grouping is entered on input data sheets by the Ground Controller. The computer program uses this information in conjunction with stored information in making its assessments.

Assessment Factors

Various conditions that affect the combat capability of units and have an impact on the results of ground battles are considered in assessment procedures. They are discussed in the following paragraphs.

Posture of Defender.[10] Six postures, reflecting differing degrees of effectiveness and vulnerability, are played.

(1) Withdrawal. In this posture, the defender maintains covering forces in direct contact with the enemy while withdrawing the bulk of his forces to deeper positions.

(2) Delaying Action. In this posture the defender is capable, tactically, of forcing the attacker to deploy frequently from his advancing formations. The defender is either unable or does not wish to hold his position but retains his tactical integrity.

(3) Meeting Engagement. The defender has the advantage of natural terrain features only.

(4) Hastily Prepared Position. This posture assumes the initial stages of a hasty defense as defined in AR 320-5[15] and consumes 4 hr in preparation. It includes two-man uncovered foxholes and machinegun and rocket-launcher emplacements. It may be accomplished while in contact with the enemy.

(5) Prepared Position. This posture assumes the completion of a hasty defense as defined in AR 320-5[15] and consumes 48 hr in preparation without enemy interference. It visualizes an organized defensive arrangement with overhead cover for all combat and combat-support personnel with emplacements for all weapons except tanks and APCs. It provides for minimum requirements with regard to minefields, wire, and other obstacles within the assigned frontage.

(6) Fortified Position. This posture assumes a deliberate defense as defined in AR 320-5[15] and is considered the highest degree of defensive posture attainable, requiring many weeks of preparation. This posture, if existent, will be introduced in the scenario rather than being developed during the play of a game.

Terrain. The handicaps imposed by difficult terrain on ground operations are recognized. Three classes of terrain are played. Class 1 is considered suitable for all types of ground operations, class 2 is less suitable, and class 3 is the least suitable. In terrain of classes 2 and 3 the attacker and armor are handicapped to a greater extent than are the defender and infantry. The three classes of terrain are defined as follows.[10]

Class 1. Determining features* are:

(a) Generally open, flat, or rolling (elevation change varies from 0 to 150 m/km)
(b) Sparse to moderately sized and spaced stands of timber, vegetation (grass, low brush)
(c) Desert or desert-type terrain
(d) Permits maximum cross-country rates of movement and maneuver
(e) Fourteen inches of snow reduces cross-country mobility of wheeled vehicles to class 2
(f) Permits maximum surveillance, target acquisition, and air-defense capabilities

Class 2. Determining features are:

(a) Hilly to low mountainous (elevation change varies from 150 to 300 m/km)
(b) Moderate to heavy stands of spaced timber, medium vegetation (high grass, heavy brush)
(c) Requires a significant reduction in cross-country rates of movement and armored maneuver
(d) Fourteen inches of snow restricts wheeled vehicles to roads and trails except for very short distances
(e) Requires a significant reduction in surveillance, target acquisition, and air-defense capabilities

Class 3. Determining features are:

(a) Mountainous (elevation change varies from 300 m or more/km)
(b) Thickly wooded with few and irregular open spaces

*Terrain is identified by its most difficult feature, e.g., flat terrain with jungle growth would be class 3.

(c) Rain forest or jungle

(d) Swamps, marshes (increase extensive hard-frozen marshes to class 2)

(e) Cross-country movement of foot troops significantly reduced, vehicular movement restricted to roads and trails

(f) Fourteen inches of snow requires use of snow-removal equipment on roads and trails for vehicular movement

(g) Permits minimum surveillance, target acquisition, and air-defense capabilities

Maneuver or Surprise. Credit is given to either side that exploits a maneuver or surprise capability.

Mobility. The differing mobility capabilities of infantry and armor are recognized. Mechanized and motorized units are considered to have the same mobility as armor. Airborne and heliborne units, when moving on the ground, have the same mobility as infantry.

Force Ratios. The force ratio of the attacker to the defender is considered in all assessment procedures. In computing the force ratio, consideration is given to the benefits a side may derive from a maneuver or surprise capability and to the handicaps imposed by difficult terrain.

Imponderables of Warfare. The submodel recognizes that, regardless of force ratios, each side faces certain imponderables of the battlefield. These include leadership, state of training, and morale, for which no satisfactory quantification can be assigned. The impact of these may result in a side's unexpected victory or defeat. For this reason, determination of the victor in each BG is contingent, in part, on the draw of a random number.

Consideration of Assessment Factors in Assessing Results

Four assessment routines are used in determining results. Each of these is listed below showing those factors, previously enumerated, employed in the routine.

Success or Failure Assessment Routine. An attacker's success or failure is based on:

(a) His probability of winning, which is contingent on the force ratio and the posture of the defender

(b) The draw of a random number

Casualty Assessment Routine. Casualty assessments differ for the attacker and defender and are contingent on:

(a) Success or failure of the attacker

(b) Force ratio

(c) Posture of defender

Extent of Advance Routine. The distance an attacker is permitted to advance is contingent on:

(a) Success of the attacker

(b) Force ratio

(c) Posture of defender

(d) Terrain
(e) Mobility of attacker (infantry or armor)

Reduction in Effectiveness Routine. Reductions in the strengths and combat effectiveness of units are based on casualties.

DESCRIPTION OF SUBMODEL

Pregame Preparations

Most pregame preparations necessary to initiate play of a game are made by a Game Preparations Group and are discussed in Chap. 1.

Player Preparations. Players must become familiar with all written material pertaining to their play. They must know the employment doctrine and organization of their forces. The Game Director, in pregame instructions, informs players of specific pregame requirements. For ground operations these include players' concept of operations for the entire war game and mission-type operations orders for the first day of battle. The concept of operations is supplemented by an overlay showing objectives, main and secondary efforts, locations of planned defensive positions, and time phasing. Operations orders need not follow a prescribed format but must show the mission and assignment of ground-combat and combat-support units for each BLUE corps and for each RED army.

Ground Controller Preparations. Because other submodels mesh with the Ground Combat Submodel, many of the preparations made by the Game Preparations Group are of special interest to the Ground Controller. He must become thoroughly familiar with all information pertaining to each side. Missions, force structure, organization of units, and employment doctrine are items of particular interest to him.

Specific Pregame Actions. These may vary from game to game, but usually include the following five actions.

(1) Check the Ground Controller's pregame operations overlay, usually prepared by the Game Preparations Group, to ensure that all ground-combat units have been posted and located in accordance with the scenario and order of battle (OB). All ground-combat, combat-support, SAM, air, and corps or larger headquarters units are usually posted on the Ground Controller's operations overlay. The boundaries for corps- and larger-sized commands are shown. Division boundaries may be shown if desired. Maps showing the location of units and installations not shown on the Ground Controller's overlay, such as logistics units, are maintained by other controllers. Each player team maintains an overlay identical to that of the Ground Controller's for units of its side.

(2) Have pictures taken and transparencies made of operations overlays showing the initial disposition of forces of each side. Transparencies of both sides are provided the Intelligence Controller for use in determining initial intelligence that will be given to player teams.

(3) Analyze terrain of the combat zone and designate on the map all areas determined to be class 2 or class 3 terrain. A picture is taken of the terrain map and transparencies made. One transparency is provided each player team.

(4) Assist the Game Preparations Group in the preparation of rules required in the play of ground-combat units. Rules are usually required pertaining to movement rates for units in rear areas, restrictions on the employment of understrength units, and the use of the residual resources of critically depleted units.

Units moving by organic transportation in rear areas and unhampered by enemy action usually are permitted to move at a maximum rate of 100 km/day.

Restrictions on the employment of understrength units are based on the current strengths of units. In most past gaming, a ground-combat unit at 87 percent or more of its authorized strength has been considered "effective" and capable of offensive and defensive operations. Units with a strength of 75 to 87 percent have been classified as limited effective and considered capable of defensive-type operations only. Units with a strength of less than 75 percent have been considered ineffective and have been restricted from participating in any type of combat operation.

In games extending over several weeks the combined residual resources of two or more similar and ineffective units have been used to reconstitute one of the units to an effective status. The rule for this, like most other rules, is usually coordinated with the client for each particular game.

(5) Review the section of the pregame printout of the Master Status File (MSF) that pertains to ground-combat units. Ensure an understanding of and the correctness of those entries that affect the play of ground-combat units. These entries are shown in Fig. 28 and discussed in the following paragraphs. The

Line No.	Title	Entry
1	UNIT DESIG	B3033
2	LOCATION	PA32 0
3	ACTIVITY	INACT
	*	*
9	PRES STR	16484
10	PRIOR STR	16484
11	AUTH STR	16484
	*	*
17	IFP/BASE	49
18	IFP/AUTHBASE	49
19	IFP/RETROGRD	365
20	IFP/DEFENSE	365
21	IFP/ATK/RET	365
22	IFP/ATTACK	365
23	% AUTH STR	100

Fig. 28—Extract from Pregame Printout of Master Status File

assumed data shown in the figure are for illustrative purposes only. For any particular game, the initial input data must be prepared by the Game Preparations Group.

Line 1: The unit designation is shown as B3033 and indicates that this section of the printout pertains to the BLUE 33d US Mech Div.

Line 2: The entries on this line show the map coordinate location of the unit and the class of terrain at that location. The map location is shown first. A space appears between the map coordinate and the class of terrain indicator. In Fig. 28 the class of terrain is indicated by a zero. Either a 0 or a 1 indicates class 1 terrain. A 2 indicates class 2 terrain, and a 3, class 3 terrain. After play starts, the entries on this line reflect cycle input data pertaining to location and terrain. They show information applicable at the beginning of the cycle covered in the printout.

Line 3. Before the start of a game, all units are shown as "INACT," meaning inactive. After play starts, the entry reflects cycle input data and is descriptive of what the unit was doing during the cycle. If the unit was attacking, the entry will show "ATTACK." If it was defending, it will show the posture of the defender. Units that are not in contact with the enemy are shown in one of three types of activity. "ADMIN" means the unit was making an administrative or tactical move behind the FEBA. "ACTIVE" indicates the unit was performing its primary mission as in the case of a corps headquarters or a SAM unit. "INACT" indicates the unit was stationary and was not performing its primary mission, e.g., a nuclear-delivery unit waiting under cover for nuclear warfare to start.

Line 9: The personnel strength of the unit at the start of a game is shown on this line. For most games, it may be expected to be the same as the authorized strength entry, line 11. After a game starts the entry on line 9 reflects the end-of-cycle strength of the unit. It reflects the impact of all losses and gains in personnel that occurred during the cycle. The entry informs players and controllers of the strength available for the next cycle of play.

Line 10: Prior strength. This entry shows the strength of the unit as of the end of the previous cycle. The entry should be the same as entry line 9 for the preceding cycle.

Line 11: The entry shows the authorized personnel strength of the unit.

Lines 17 to 22: The meaning and use of the entries on these lines are discussed in the paragraphs following comments pertaining to line 23.

Line 23: The entry on this line is the percentage of the authorized personnel strength that is present in the unit at the end of the cycle. It is the result of dividing the entry in line 9 by the entry in line 11.

The index of firepower potential (IFP) values on lines 17 to 22 are computed by the Game Preparations Group in accordance with guidance provided by the client. They may be expected to vary for each different type of unit listed in the OB. The entries on lines 19 to 22 reflect the total IFP value of the unit. They are employed as the means of comparing the relative combat capabilities of differing types of unit. Documents that provide guidance on computing IFP include the following: US Army Combat Developments Command, "Interim Report, Measuring Firepower Potential and Combat Effectiveness (U),";[16] "Final Report, Measuring Combat Effectiveness (U)," Vol III, "Weapon and Unit Firepower Potentials (U)";[13] "Final Report, Measuring Combat Effectiveness (U)," Vol 1, "Firepower Potential Methodology (U)";[11] and RAC, "Development of Indexes of Combat Effectiveness (U)," App A, Vol II of TBM-68.[17]

To determine the IFP of a unit, the IFP of each type of weapon in the unit must be computed first. The unit IFP is determined by summing the IFP of all weapons in the unit. The IFP value of each type of weapon is contingent on its type and the number of rounds of ammunition it fires and on the troop density and vulnerability of targets that are fired on. These factors vary for differing postures. Accordingly, differing IFP values can be computed for each of the differing postures. However, the THEATERSPIEL Model, in order to simplify the computation and use of IFP, employs meeting engagement IFP values for determining force ratios. The impact of the differing rates and effectiveness of fires for other postures are assessed and reflected in the results determined by each assessment routine. Because of this method of assessment, the initial IFP, as shown on lines 19 to 22, have equal values. The values on these lines are called posture IFP. The "IFP/RETROGRD" entry on line 19 shows the IFP value of the unit when defending and engaged in a withdrawal or delaying action. The "IFP/ATK/RET" entry on line 21 shows the IFP value of the unit when attacking and opposed by a withdrawal or delaying action. The "IFP/DEFENSE" entry on line 20 shows the IFP value of the unit when deployed in one of the defensive position postures. The "IFP/ATTACK" entry shows the IFP value of the unit when attacking a unit deployed in one of the defensive position postures. During the play of a game these values are decreased or increased at uniform rates in accordance with losses or gains in personnel and equipment. However, losses in supplies reduce some of the posture IFP at different rates. For example, a low level of POL limits the capability of an attacker to keep pressure on a withdrawing defender. A unit defending in a prepared position, with an ample supply of ammunition, may not be critically affected by its level of POL. For the impact of levels of supply on posture IFP, see Chap. 7.

The IFP values on lines 19 to 22 reflect the sum of three categories of IFP, each of which is based on the IFP values of separate families of weapons. Each of the categories and the types of weapon that contribute to their IFP are shown below.

Base IFP. This IFP is based on the values of weapons that can physically be carried by the troops: rifles, machineguns, small-bore mortars on mounts (81-mm BLUE and 82-mm RED), rocket launchers (3.5-in., 66-mm), and recoilless rifles (90-mm, 75-mm).

II and IV IFP. This is based on the values of the remainder of the weapons in a unit less primary and secondary tank armament. The weapons normally include: recoilless rifles (106-mm), unit artillery (towed and self-propelled), self-propelled mortars, Entacs (truck mounted), machineguns on the APCs, and howitzers (towed).

Armor IFP. This IFP reflects the sum of the IFP of tank weaponry, including OEM machineguns.

Of the three categories of IFP, only the base IFP is shown as a separate entry in the MSF. The authorized base, reflecting the IFP of a unit with all its authorized hand-carried weapons, is shown on line 18. The base IFP, showing the value of those weapons actually present in a unit, is shown on line 17. During play, the value of the base IFP fluctuates with the changing strength of a unit. Casualties assessed by the Ground Combat Submodel result in a reduction in the base IFP of a division at three times its casualty rate. Under ground-combat conditions, units in contact provide most of the actual fighting capability and suffer the greatest number of casualties. Consequently the combat effectiveness of a unit in contact is reduced at a faster rate than the quantitative casualties of a division indicate. It has been assumed that the direct fighting capability of a combat division is concentrated in one-third of its personnel. Accordingly casualties among troops in contact and the resultant loss in base IFP are considered as being three times the casualty rate assessed against the total strength of a division. For the impact on the base IFP resulting from casualties and the suppressive effects assessed by other submodels, see the Nuclear, Air, and Combat Support Submodels. For changes resulting from the receipt of replacements, see the Logistics and Recovery Submodel. During play, changes in the base IFP are reflected in the posture IFP shown on lines 19 to 22. The "II and IV" and "Armor" IFP categories are used internally in the Logistics and Recovery Submodel. As explained in that submodel, their values depend on the number of weapons on hand. During play, changes in the IFP of these two categories are assessed in the Logistics and Recovery Submodel and are reflected in the posture IFP shown on lines 19 to 22 of the MSF.

After the Ground Controller has completed his review of the MSF and taken the other actions previously indicated, he is ready to receive players' orders and to initiate the first cycle of play.

Cycle Inputs

Players' operations orders are required for each cycle of play.

Formation of BGs. The Ground Controller, using player orders and his knowledge of the situation, determines where ground attacks will occur. He determines what units will become engaged in the same ground battles during the cycle. He portrays this by forming BGs, enclosing each with a grease-pencil line on a transparent (acetate) overlay over his situation maps. Each grouping encompasses a number of attacking divisions, including their supporting artillery, and the directly opposing divisions, including their supporting artillery. Consideration is given to terrain compartments, location, and unit missions as assigned by the players. Each BG is formed so that all or nearly all the elements in the grouping are in the same class of terrain.

Reserve units that have been ordered into the attack or defense and that could reach the battle area before the hour of attack are moved on the overlay to reflect their location as of the hour of attack. For example, assume a 24-hr battle cycle ends at 2000. Player orders cover the period from 2000 that day until 2000 the next day. The RED Commander orders a combined-arms army to attack at 0600. A reserve division of the army is included among the divisions that are ordered to attack. Before the BG for that army is set up, the reserve division is moved on the overlay to the area where it could be expected to be at 0600.

An example of how BGs may be formed is illustrated in Fig. 29. Each BG must contain at least one ground-combat unit of each side. A maximum of 29

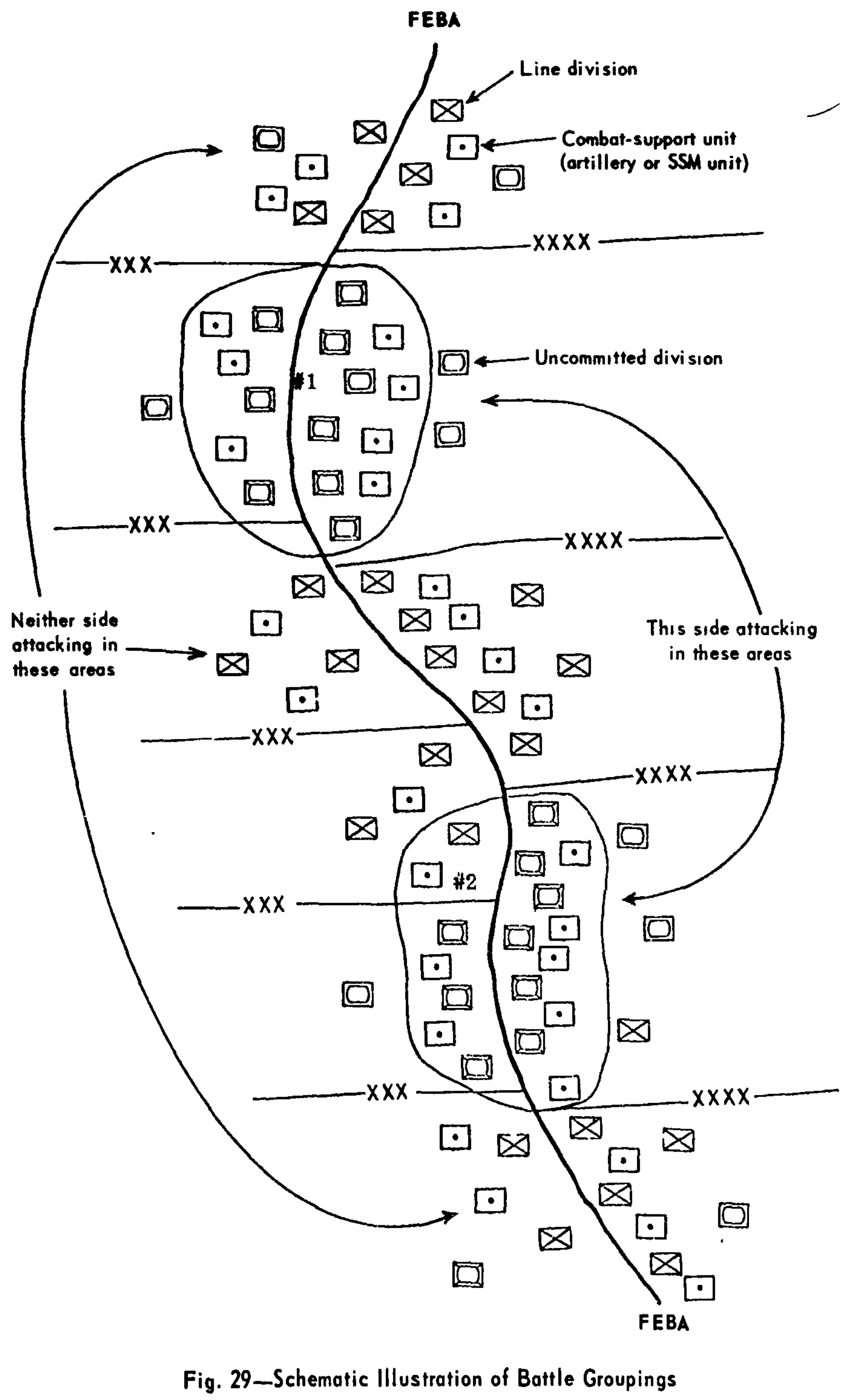


Fig. 29—Schematic Illustration of Battle Groupings

ground-combat and combat-support units, including those of both sides, may be included in a single grouping. Up to a total of 29 groupings may be played.

Each BG is numbered for assessment and record purposes. It should be noted that corps and army artillery units supporting attacking and defending ground-combat units are included in BGs. This is done to simplify input data for the Combat Support Submodel, which assesses the results of their fires.

Factors Affecting Combat Capability. Factors having an impact on the combat capability of units in BGs are determined by the Ground Controller. Notations to indicate them are placed on the BGs overlay. The factors considered are discussed in the following paragraphs. Figure 30 is an illustration of a BG after the notations have been completed.

The posture of the defender in each BG is indicated on the overlay. It is determined from players' orders and the Ground Controller's knowledge of the situation. One of the six postures defined in the "Methodology" is applicable. In the illustration in Fig. 30, a prepared position (PP) is indicated.

The type of the preponderance of the attacker's force is shown on the overlay. Ground-combat units are classified as infantry or armored. Mechanized and motorized units are classified as armored; airborne and heliborne units as infantry. Figure 30 indicates an armored attack.

The handicaps imposed by difficult terrain are considered. If a grouping is in terrain class 2 or 3, the appropriate terrain factor is taken from Table 13 and shown on the overlay. The factors in Table 13 reflect the resultant effect on the combat capability of the attacker after the handicaps imposed on both attacker and defender by difficult terrain have been considered. Figure 30 does not show a terrain factor, thereby indicating terrain class 1.

TABLE 13

Terrain Factors Applied to Attacker's IFP[10]

Class terrain	Armor[a] attacking infantry	Armor attacking armor	Infantry attacking infantry	Infantry attacking armor
2	0.6	0.8	0.9	1.1
3	0.5	0.7	0.8	1.2

[a]Armor includes mechanized and motorized divisions.

Maneuver and surprise factors are then considered. These may vary from 1.1 to 3.0. They are used to increase the IFP of a ground-combat unit during a cycle of play when that unit has an obvious maneuver or surprise advantage. The combat value of the unit is increased by multiplying the IFP of the unit by the credited factor. In this way the combat value of a unit can be increased by as much as three times its normal value. In battle the use of maneuver and surprise is a basic ingredient of combat success. However, in aggregated map play, it is often difficult to determine when and where these capabilities are present. Most BGs do not require use of maneuver factors.

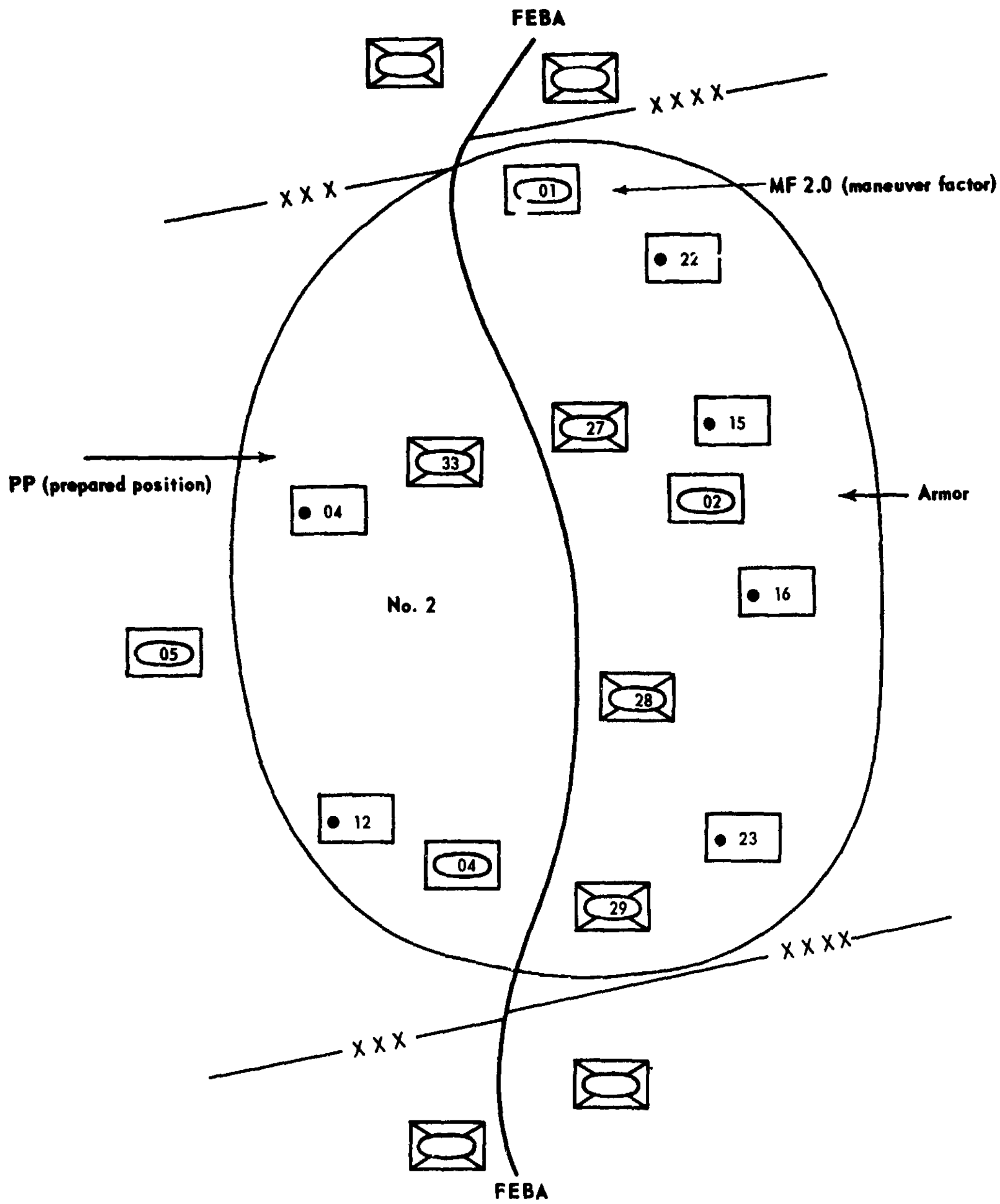


Fig. 30—Schematic Illustration of a Battle Grouping after Ground Controller Has Completed Notations on Overlay

When a maneuver capability is apparent, it will rarely warrant a factor for more than one, or possibly two, of the total number of attacking divisions in a BG. When a maneuver or surprise situation is evident, the selection of the appropriate factor is a matter of professional judgment and depends on the type of unit and the nature of the operation. For example, an infantry division attacking an enemy's flank might be given a maneuver factor of 1.5. An armored division making the same attack might be given a factor of 2.0 because of its greater shock effect. An armored unit attacking an enemy's rear might be given a factor of 3.0. A unit making a successful helicopter landing behind the FEBA might be given a surprise factor of 1.7. A parachute-landed unit, under the same conditions, might be given a factor of 1.5, or less, because of its greater dispersion when reaching the ground. A schematic sketch showing situations where maneuver factors appear justified is shown in Fig. 31.

The values in Table 14 may be used as a guide in the selection of appropriate factors. A factor, when credited, is shown on the overlay in grease pencil to indicate the unit to which it is credited. In Fig. 30 a maneuver factor of 2.0 is given the 301st Tank Div.

TABLE 14

Maneuver/Surprise Factors[10]

Type of attack	Factor
Armor unit in rear	3.0
Infantry unit in rear	2.0
Helicopter-landed unit in rear	1.7
Airborne-landed unit in rear	1.5
Infantry unit on flank	1.5
Armor unit on flank	2.0
Surprise chemical attack[a]	2.0
Initial attack with nuclear weapons[a]	3.0

[a]Appropriate factor should be credited to all ground-combat units of the initiator in all areas where initiated.

Preparation of Computer Input Data. Pertinent BG information is transferred from the BG overlay to "THEATERSPIEL Ground-Combat Battle Grouping Input Data Sheets." An example of a partly completed input data sheet is shown in Fig. 32. The data shown in the figure are based on the BG information shown in Fig. 30.

In Fig. 32 it is assumed that BG 1 encompassed 12 units, requiring 12 line entries.

The name of the game being played is entered on the line titled "Game." In the example, the assumed name "Keydet" is shown.

The battle day is entered in the space titled "Date."

The "Parameters," card column numbers, are those used to reflect BG information.

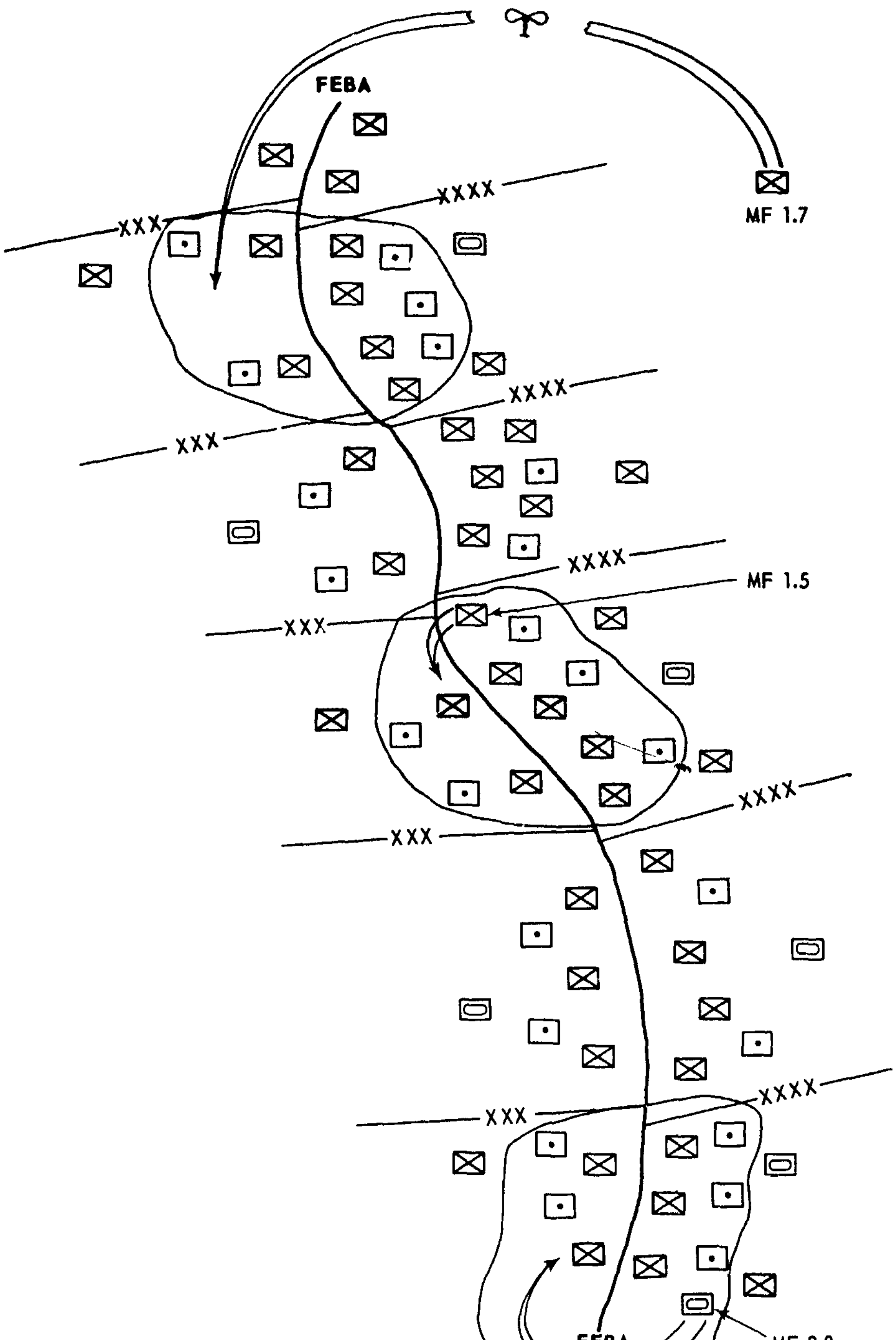


Fig. 31—Schematic Illustration of Situations Where Maneuver/Surprise Factors Appear Appropriate

Columns 1 to 5. These columns are used for entering the OB designations of all ground-combat and combat-support units in BGs. Each unit is

THEATERSPIEL GROUND COMBAT BATTLE GROUPING

INPUT DATA SHEET

Game Keydet Date D + 2

Parameters

	Unit Desig.					Terrain	Cover	Tactical Factor		Percent Fires		Intel. Level	Atk./Def. Posture		BG No.	
Card Col.	1	2	3	4	5	12	13	15	16	19	20	21	23	24	39	40
Unit 1																
13	B	3	0	3	3								0	5		2
14	B	3	0	0	4								0	5		2
15	B	2	0	0	4								0	5		2
16	B	2	0	1	2								0	5		2
17	R	3	0	0	1			2	0				1	5		2
18	R	3	0	2	7								1	5		2
19	R	3	0	2	9								1	5		2
20	R	3	0	0	2								1	5		2
21	R	3	0	2	8								1	5		2
22	R	2	0	2	2								1	5		2
23	R	2	0	1	5								1	5		2
24	R	2	0	1	6								1	5		2
25	R	2	0	2	3								1	5		2

Fig. 32—Example of Use of THEATERSPIEL for Ground-Combat Battle Grouping

entered on a separate line. In the example, the first unit in BG 2 is entered in these columns on line 13. The side to which the unit belongs is entered in col 1, in this case B for BLUE. As explained in Chap. 2, OB designations are prefixed by a B or R, indicating BLUE or RED, and have 4-digit numbers. The full OB designation of each unit, with the prefix and the 4-digit number, must be entered on the Input Data Sheet. Map symbols are shown in Fig. 30 as having 2-digit numbers. However, each map symbol contains sufficient information to readily identify it with its OB designation. Note that all combat-support units in a BG, although not assessed in the Ground Combat Submodel, must be included on the input sheet. Information pertaining to these units is extracted by and used in the Combat Support Submodel.

Column 12, terrain. This column is used when the units in a BG are operating in terrain class 2 or 3. If operating in terrain class 2, the number 2 is entered in the column opposite each unit. The number 3 is the indicator for terrain class 3. No entry is necessary for units operating in terrain class 1. The information in this column is not employed in the Ground Combat Submodel. It is extracted from the Ground Controller's input information by the Logistics and Recovery Submodel and used in that submodel in making its assessments. Later comments pertaining to cols 15 and 16 explain how terrain is played in the Ground Combat Submodel.

Column 13, cover. The entries in this column pertain to the effects that artillery ammunitions have in built-up, wooded, and other similar areas. The entries are made by the Combat Support Controller, who works closely with the Ground Controller. The information is not employed by the Ground Combat Submodel. It is extracted by, and used in, the Combat Support Submodel.

Columns 15 and 16, tactical factor. Maneuver, surprise, or terrain factors are entered in these columns. Assume a decimal point between cols 15 and 16. If no entry is made, a factor of 1.0 is automatically applied. In Fig. 32 the RED 301st Tank Div is given a maneuver factor of 2.0. Terrain factors, when applicable, are entered in the same manner. Note that an entry is not required when units in a BG are operating in terrain class 1. When units are operating in terrain class 2 or 3, the appropriate entry is determined from Table 14. For example, if the factor was 0.8 the entry would be 08. When units in a BG are operating in terrain type 2 or 3, the appropriate factor must be entered for each unit of the attacking force.

Columns 19 and 20, percentage of fires; and col 21, intelligence level. The entries in these columns, like the entries in col 13, are not played in the Ground Combat Submodel. They are made by the Combat Support Controller and are extracted by, and used in, the Combat Support Submodel.

Columns 23 and 24. Posture code numbers, taken from Table 15 and identifying the attacking and defending units, are entered in these columns.

Columns 39 and 40 in Fig. 32 are used to show the BG number.

The completed input data sheets provide all the information that, together with stored information, is required by the computer program in making its assessments. Input data sheet information is transferred to punch cards for processing.

Assessments

The computer program assesses three results for each BG:

(a) Success or failure of the attacker.
(b) Casualties inflicted in each ground-combat unit.
(c) The impact of casualties on the IFP of each ground-combat unit.

TABLE 15

Posture Code Numbers

Defense posture	Defender's code	Attacker's code
Static[a]	00	00
Withdrawal	01	11
Delay	02	12
Meeting engagement	03	13
Hastily prepared position	04	14
Prepared position	05	15
Fortified position	06	16

[a]This posture is not played in the Ground Combat Submodel. It is played in the Combat Support Submodel for assessing the results of artillery fires in areas along the FEBA where ground attacks are not occurring.

Success or Failure of the Attacker. For each side in each BG, the program extracts from the MSF the appropriate posture IFP for each ground-combat unit. The IFP of each unit is multiplied by the unit's maneuver, surprise, or terrain factor shown in cols 15 and 16 of the "Ground-Combat Battle Grouping Input Data Sheet" (Fig. 32). If no factor is shown, the factor used is 1.0. The force ratio in each BG is determined by dividing the sum of the attacker's IFP by the sum of the defender's IFP. Force ratios of less than 0.25 to 1 are computed as 0.25 to 1, those above 6 to 1 as 6 to 1.

A determination is then made of the probability of success of the attacker in each BG. By use of an equation based on force ratios and posture factors, the computer program determines probabilities of success, which are consistent with those shown in Fig. 33.[16] The equation used in the computer program is

$$P = (0.5)^{1/N}, \text{ when } N \geq 1$$

or the equation

$$P = 1 - (0.5)^{N}, \text{ when } N < 1$$

P is the probability of winning; N is the product of the force ratio and the appropriate posture factor. Posture factors are stored in a table of the computer program and are shown in Table 16.

After the probability of success has been determined, a random number from 00 to 99 is drawn. If the number is less than the probability of success, the attacker is successful.

The program prints out a brief typewritten message, "Battle Results," which is used to inform the Ground Controller of the results of these assessments. Use of this message is explained later.

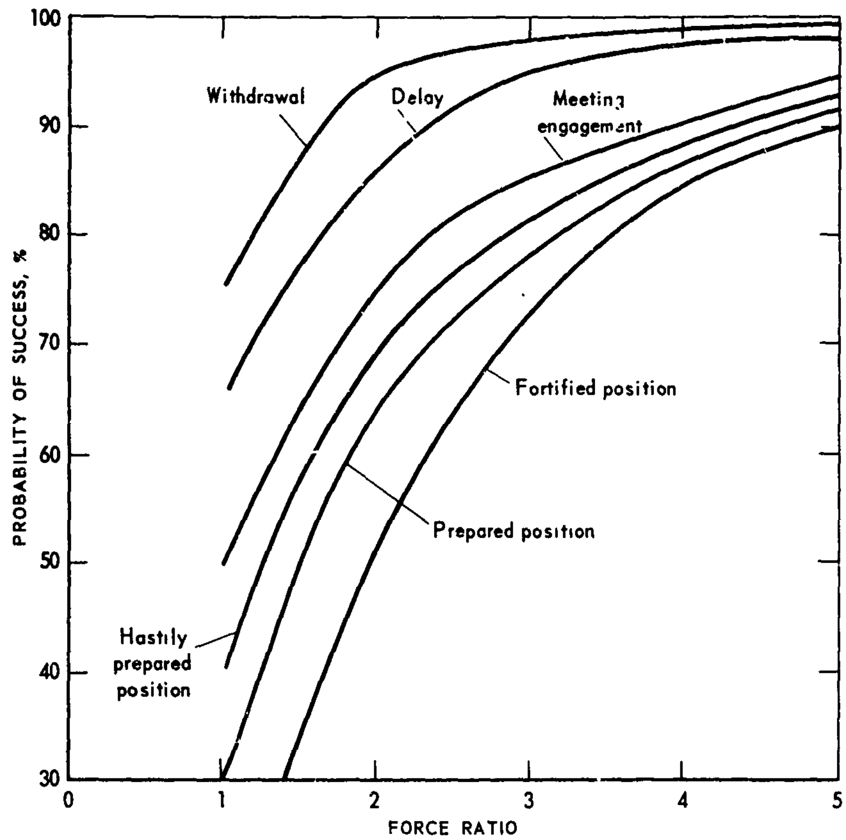


Fig. 33—Attacker's Probability of Success[18]

TABLE 16

Posture Factors for Use in Determining Probability of Success[18]

Defense posture	Posture code	Factor
Static[a]	00	0.00
Withdrawal	01	1.95
Delay	02	1.35
Meeting engagement	03	1.00
Hastily prepared position	04	0.90
Prepared position	05	0.68
Fortified position	06	0.46

[a]This posture is not used in the Ground Combat Submodel but is included as it is employed in the Combat Support Submodel.

Casualties. The program assesses casualties for each ground-combat unit in each BG by determining the percentage of casualties each side in a BG suffers. The percentage for each side is then applied against the current strength of each combat division of the side.

Using BG input data, the program selects base casualty percentages for the attacker and defender from stored information, which are shown in Table 17.

TABLE 17

Base Casualty Percentages[3]

Defense posture	Defense code	Attacker	Defender
Withdrawal	01	1.6	1.0
Delay	02	2.0	0.8
Meeting engagement	03	2.2	1.3
Hastily prepared position	04	2.7	1.8
Prepared position	05	3.1	2.0
Fortified position	06	3.5	2.2

The base casualty percentages in Table 17 reflect average rates applicable to ground-combat divisions of all types when the force ratio of the attacker to the defender is 2 to 1. They are based on historical data, which do not differentiate between the success or failure of the attacker. Accordingly, the base rates must be adjusted to reflect applicable rates for conditions that vary from those on which the base rates were determined. Three adjustments are necessary.

(1) Base rates must be adjusted to reflect those applicable for force ratios that are higher or lower than 2 to 1. An attacker with a more favorable force ratio should be expected to suffer a lesser rate, and the defender a higher rate than shown in the table. The reverse should apply when the attacker's force ratio is less than 2 to 1. To provide for this, an adjustment factor, based on actual force ratios, is derived from Fig. 34. The adjusted rate for the at-

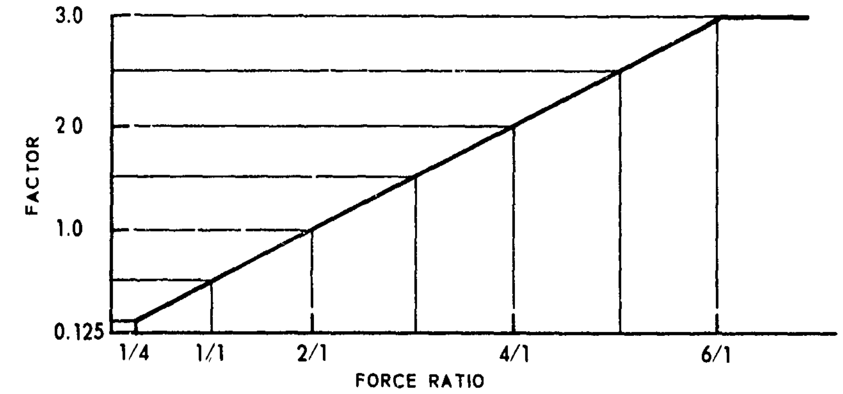


Fig. 34—Factor by Which Base Casualties Are Multiplied for the Defender and Divided for the Attacker

tacker is determined by dividing the base rate by the adjustment factor. For the defender, the adjusted rate is determined by multiplying the base rate by the adjustment factor. This adjustment ensures that the casualty rate of each side is proportional to its comparative firepower capability.

(2) Adjustments must be made based on the success or failure of the attacker. A successful attacker should be expected to suffer fewer casualties than an unsuccessful one. An unsuccessful attack should result in fewer casualties to the defender than a successful one. To allow for this, when an attack is successful, a representative factor of 3/4 is applied to the previously adjusted casualty rate of the attacker, and a representative factor of 4/3 to that of the defender. When an attack fails, this procedure is reversed.

(3) A final casualty adjustment is made for units of less than division size. The percentage of personnel who become engaged and subjected to becoming casualties is higher in small-sized units than in divisions. Accordingly division rates are modified for smaller-sized units by factors shown in Table 18.

Impact of Casualties on Strength and Combat Capability of Ground-Combat Units. After the number of casualties for each unit has been determined, the program deducts them from the current strength of the unit as then recorded in the MSF.

TABLE 18

Casualty Adjustment Factors Applicable to Units of Less Than Division Size [10]

Unit	BLUE		RED	
	Strength	Factor	Strength	Factor
Brigade	4000–8999	1.5	2500–6999	1.5
Regiment	1500–3999	2.0	500–2499	2.0
Battalion	0–1499	2.5	0–499	2.5

The loss in IFP is then computed and deducted in the MSF as explained in the discussion of Fig. 28.* Base IFP is not adjusted to a value of less than zero.

Extent of Advance. This determination is made by the Ground Controller. It is based on computer-assessed results that are reported to the Ground Controller by typewriter message after the computer has determined the success or failure of the attacker in each BG. The message reaches the Ground Controller before receipt of the printout covering the results of all operations during the cycle.

The contents of the "Battle Results" message are similar to the following:

"BG No. 1, Attacker Loses, FR [force ratio] is 1.6"
"BG No. 2, Attacker Wins, FR is 2.5"

The battle results are given for each BG.

*This assessment is not essential for a 24-hr cycle of play as the Logistics and Recovery Submodel, which is exercised next, recomputes the IFP values based on the losses and gains during the period. However, the assessment is necessary for a period of play of less than 24 hr because the Logistics and Recovery Submodel is not exercised until the full day has been completed.

If the attacker loses, no advance is permitted. To determine the extent of advance of a successful attacker, the Ground Controller notes the information in the message, the posture of the defender, the type of attacking force (infantry or armor), and the class of terrain. He then refers to the appropriate advance curve of those shown in Figs. 35 to 40.

Cycle Outputs

After the "Extent of Advance" assessments have been completed, the Ground Controller moves all units in BGs in accordance with advances that are made. Other units are moved in accordance with players' orders as restricted by rules of play or by situations known to the Ground Controller. SAM units normally are moved by the Air Controller.

Immediately after all moves are completed, the Ground Controller establishes a new FEBA. The Intelligence Controller transfers the location of the new FEBA to his overlay.

Computer Printout. Several sections of the printout provide information that is used by, or is of interest to, the Ground Controller. A discussion of each of these follows.

The "Master Status File" is an updated report that reflects end-of-cycle data pertaining to each unit in the OB. On receipt of it the Ground Controller checks the current strength of each ground-combat unit. The percentage of each unit's authorized strength present in the unit is shown on line 23 of the printout. Units that, under the rules of play, have a limited effective or an ineffective operational capability are noted. Changes in the effectiveness status of units are indicated on the Ground Controller's operations overlay by placing a small sticker patch on a corner of the symbol of each affected unit. A triangular patch is used for limited effective units, and a square is used for ineffective units. The Combat Support Controller posts changes in the status of combat-support units, and the Air Controller in that of SAM units. As soon as the overlay reflects all changes that occurred during the cycle, the legend on the overlay is changed to show the hour and battle day it portrays. A picture is taken of the situation for each side. Transparencies of the pictures are made. One, showing the RED situation, is given the RED team. Another, showing the BLUE situation, is given the BLUE team. One of each side is given the Intelligence Controller.

The "Battle Groupings Report" lists each unit in each BG. For each unit the posture and the value of any credited tactical factor are shown.

The "Casualty Assessment Report" shows personnel and IFP losses for each unit in each BG. Losses caused by air, combat-support, and ground action are listed separately.

The "Summary Report of Battle Assessments" lists all units that suffered casualties resulting from conventional air and ground actions. Casualties, by cause, are shown for each unit. Total casualties are shown by type of receiving unit, e.g., air SAM, combat support, ground combat, logistics, and supply points.

The "Nuclear Mission Results" lists casualties and other losses resulting from nuclear fires for each unit.

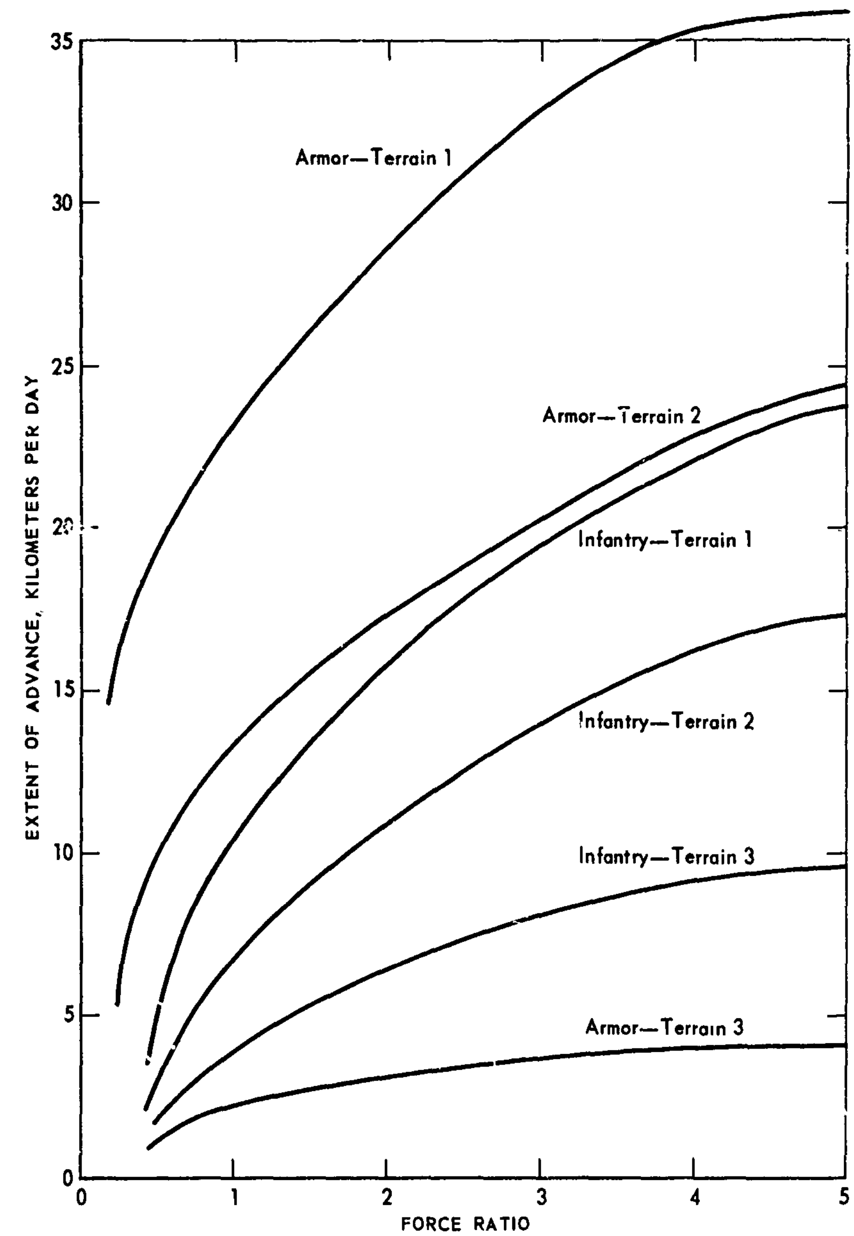


Fig. 35—Advances against Withdrawal[10]

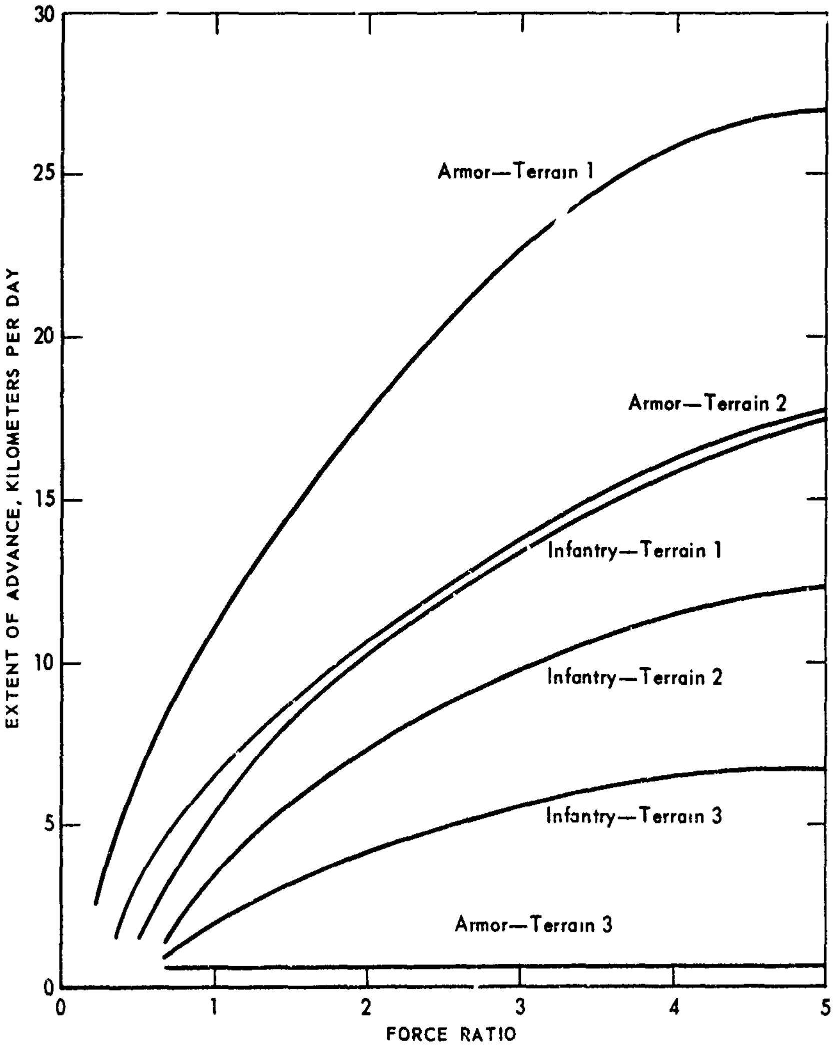


Fig. 36—Advances against Delay [10]

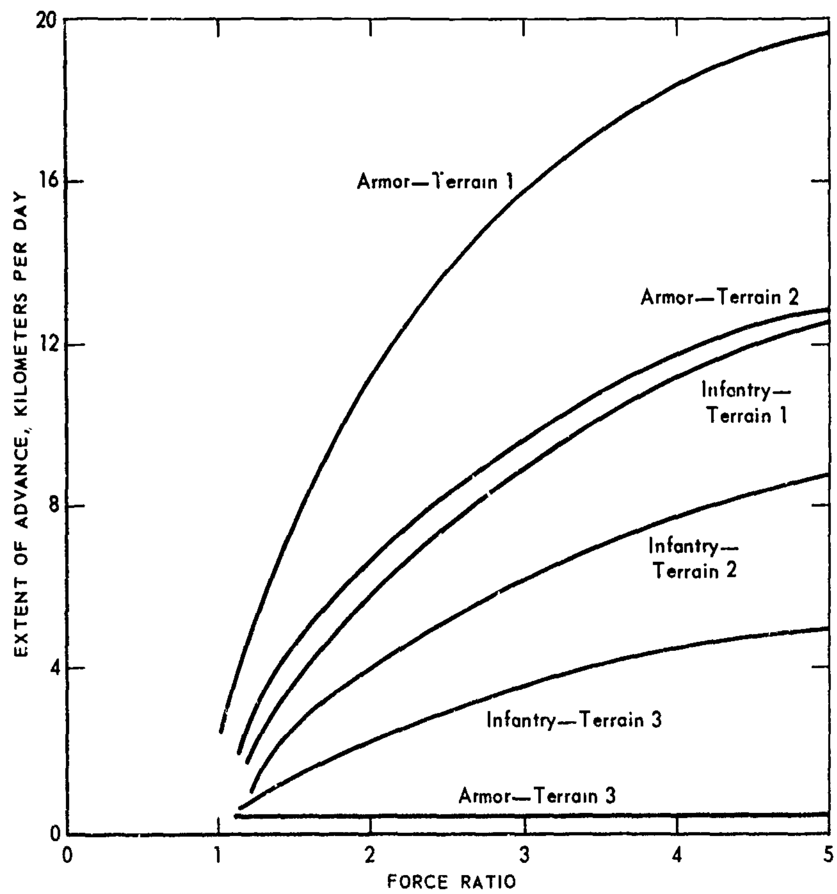


Fig. 37—Advances in a Meeting Engagement [10]

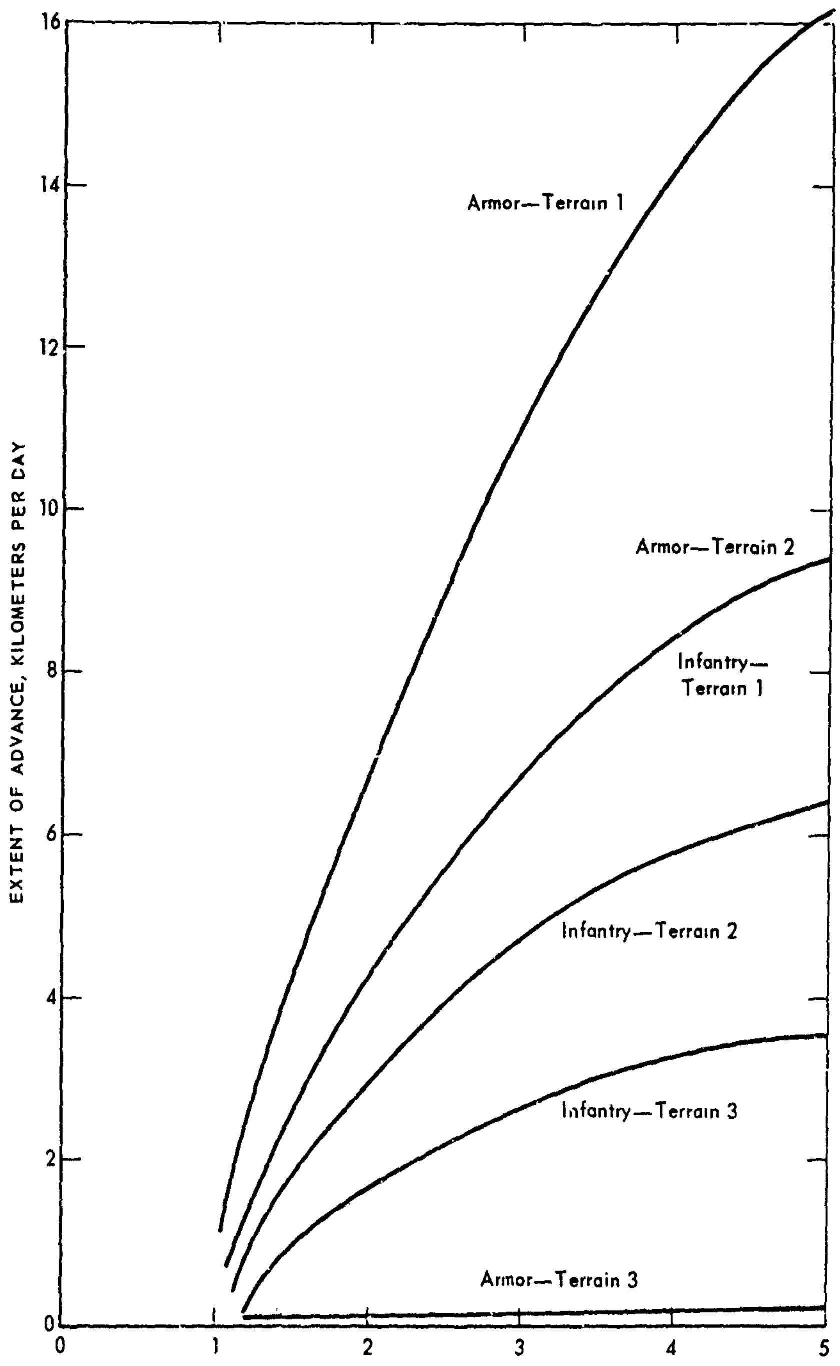


Fig. 38—Advances against Hastily Prepared Position[10]

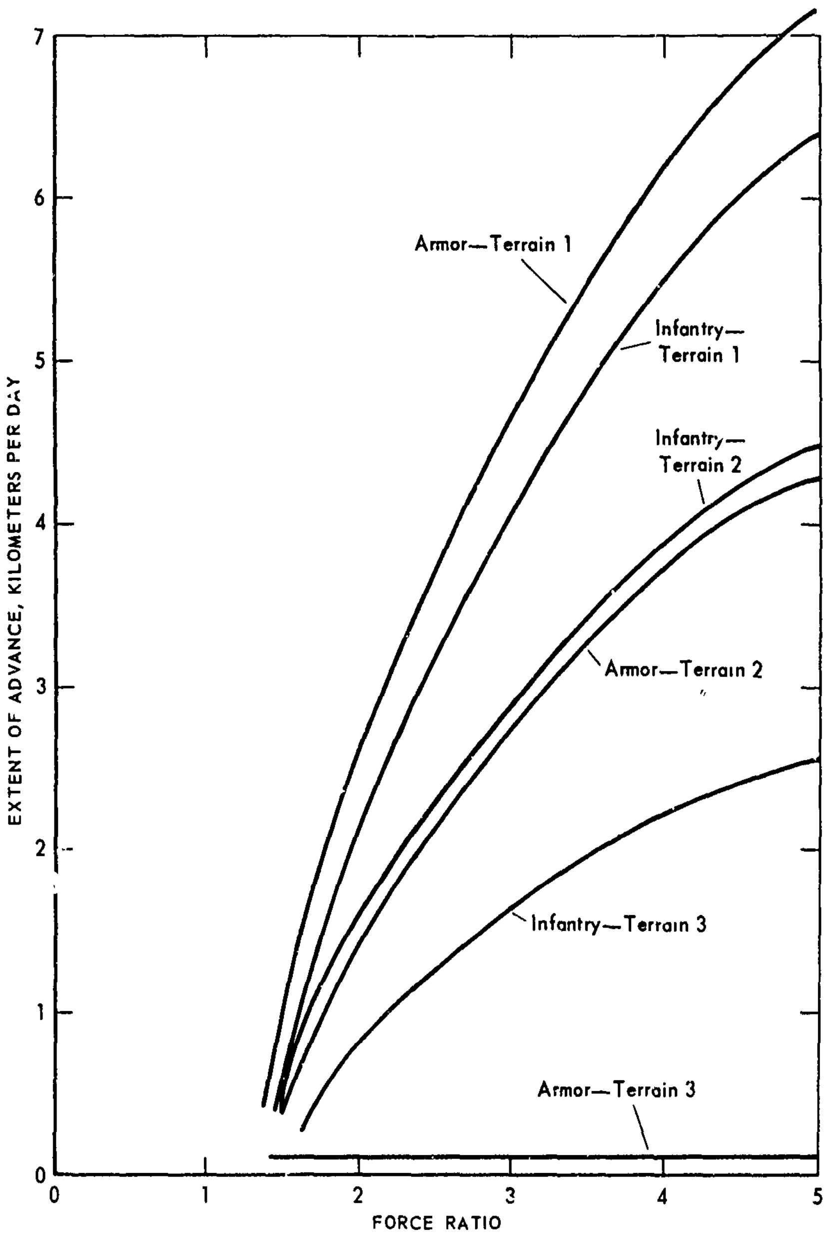


Fig. 39—Advances against Prepared Position[10]

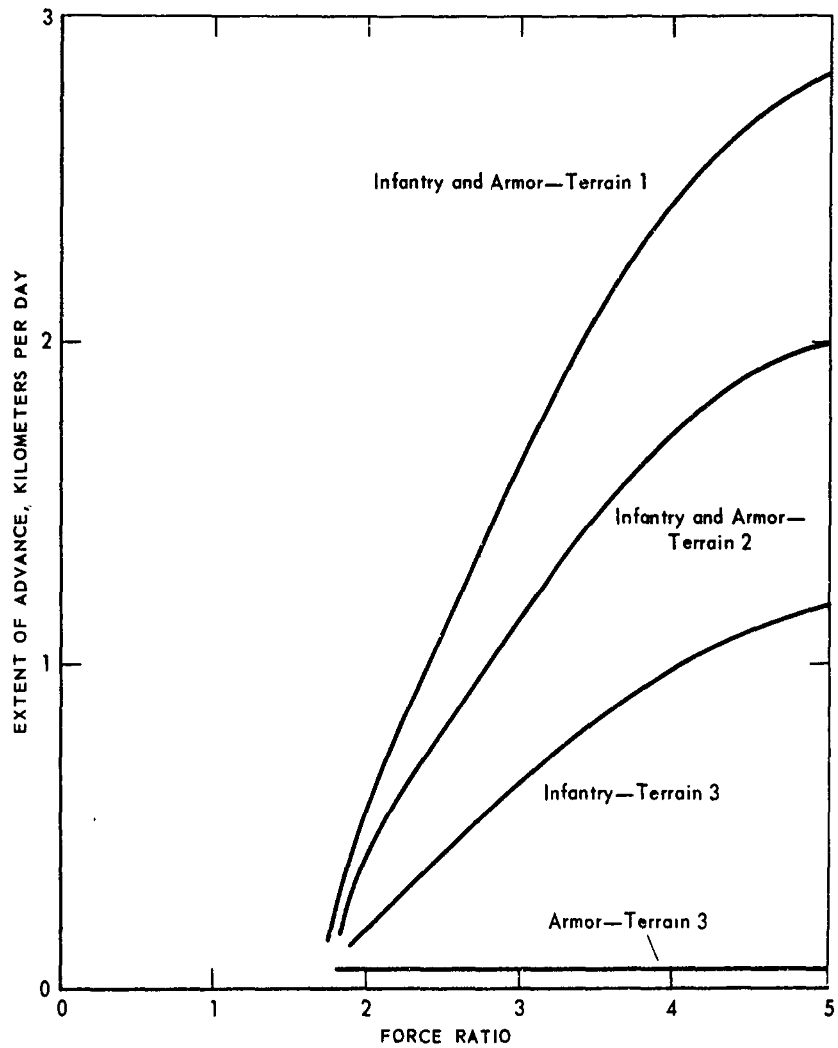


Fig. 40—Advances against Fortified Position[10]

The preceding reports provide information that is useful to the Ground Controller in checking results and in preparing his summary of operations and such other reports as may be required.

Subsequent Cycles

Shortly after receipt of the printout, of which players receive only those sections pertaining to their forces, the Intelligence Controller provides players with updated intelligence information. Players then complete their operations orders for the next cycle and submit them to Control. Implementation and assessment actions follow the same pattern as previously described.

FUTURE IMPROVEMENTS

The submodel is being revised to (a) permit greater flexibility in the use of assessment factors, (b) extend assessments to include materiel losses in addition to personnel losses, and (c) improve the validity of assessed results. Six major changes are being made.

(1) The results of division organic artillery fires, like those of corps and army artillery, will be assessed in the Combat Support Submodel. This will permit greater flexibility in the use of division artillery and will provide a uniform basis for assessing the results of all artillery fires.

(2) A routine is being introduced to provide a more realistic basis for assessing the results of tank and antitank fires.

(3) An improved methodology will be employed for assessing the results of antipersonnel fires.

(4) Assessed losses, in addition to personnel casualties, will include tanks, antitank weapons, APCs, and antipersonnel weapons.

(5) Additional and revised factors are being introduced in assessment routines to improve the validity of assessed results.

(6) The methodology for computing and using IFPs is being revised to provide flexibility and consistency with current thinking and guidance on this subject. This item is of dominant importance to the Ground Combat Submodel because the validity of its assessments is directly related to the content and use of IFP.

Indexes of Firepower Potential

The redesigned submodel will employ an antipersonnel (AP) IFP and an antitank (AT) IFP. Different combinations of AP and AT IFP will be used in the different assessment routines.

Assessment factors being introduced in the submodel, but which can be changed for any particular game, are related to the methodology discussed herein for computing and use of IFP. This section discusses the methodology for computing and recording IFP for assessment purposes. The use of their values is discussed later under assessment routine headings.

In computing the IFP values of a division, only the weapons of those elements with a primary mission of engaging the enemy in ground action or of providing fire support to such elements will be considered.

The computation of the IFP for the total number of a type of weapon in a unit will be based on the assumption that the EEA reflects an average expenditure for the type of weapon. Some weapons would fire at a higher rate, others at a lower rate, and some might not fire at all.

For each type of division, and for each type of separate and lesser-sized ground-combat unit, five categories of IFP will be computed. They are:

(1) The AP IFP of AP weapons such as rifles, machineguns, and mortars.
(2) The AT IFP of tanks when employed in an AT role.
(3) The AP IFP of tanks when employed in an AP role.
(4) The AT IFP of AT weapons other than tanks when employed in an AT role.
(5) The AP IFP of AT weapons other than tanks when employed in an AP role.

Each type of unit will have two sets of IFP values, one for use in the attack and one for use in the defense. Each set will show values for six different defense postures. These data will be recorded in a table for use in the computer assessment program. A format reflecting the type of data to be recorded for each type of unit is shown in Fig. 41.

Column 1 will reflect the AP IFP value of AP weapons.

Column 2 will reflect the AT IFP value of one tank when it is employed in an AT role.

Column 3 will reflect the AP IFP value of one tank when it is employed in an AP role.

Column 4 will reflect the AT IFP of AT weapons other than tanks when those weapons are employed in an AT role.

Column 5 will reflect the AP IFP of AT weapons other than tanks when those weapons are employed in an AP role.

IFP values for use in the assessment routines will be calculated by multiplying the appropriate values, reflected in Fig. 41, by the current status of weaponry, which will be recorded in the MSF. The content of the MSF will be changed to include the information shown in Fig. 42. The line numbers shown in the figure are for illustrative purposes only. They may not reflect the use of the line in the final revision of the MSF.

The entries on lines 20 to 22, reflecting current strengths when used in conjunction with the stored information reflected in Fig. 41, will provide all the information necessary in updating IFP values for use in assessment routines.

Assessment Routines

Four assessment routines will be employed. Each of these, together with factors influencing assessed results, is discussed in the following paragraphs. Each assessment routine will be exercised in the order listed.

Success or Failure Assessment Routine. The success or failure of the attacker in each BG will be based on:

(a) His probability of success, which will be contingent on his force ratio and the posture of the defender.
(b) The draw of a random number.

Type Unit: BLUE Mech Div

IFP Values When Attacking					
Defender's posture	(1) AP IFP AP wpns	(2) AT IFP of one tank	(3) AP IFP of one tank	(4) AT IFP AT wpns	(5) AP IFP AT wpns
Withdrawal					
Delay					
Meeting Engagement					
Hastily prepared pos.					
Prepared position					
Fortified position					
IFP Values When Defending					
Defender's posture	AP IFP AP wpns	AT IFP tanks	AP IFP tanks	AT IFP AT wpns	AP IFP AT wpns

Fig. 41—Format Reflecting Type of IFP Values To Be Recorded in a Table of the Computer Program

This part of the table will show applicable values when the unit defending is in each of the six postures.

Posture IFP, the benefits of maneuver and surprise, and the handicaps imposed by difficult terrain will be considered in computing the force ratio. The procedure for determining the force ratio in a BG is explained in detail. It will consist of eight steps for each BG. The THEATERSPIEL Battle Grouping Input Data Sheets, together with stored information reflected in Figs. 41 and 42, will provide all data necessary for making these computations.

Step 1. Determine the total AT IFP available to each side. Do this for one unit at a time.

(a) Multiply the AT IFP of one tank, as reflected in col 2, Fig. 41, by the total number of tanks on hand as carried in the MSF and reflected on line 20, Fig. 42.
(b) Multiply the AT IFP of other AT weapons, as reflected in col 4, Fig. 41, by the percentage of those weapons on hand as carried in the MSF and reflected on line 21, Fig. 42.

(c) Sum the AT IFP of tanks (a) and the AT IFP of other AT weapons (b). Multiply the sum by the tactical factor (maneuver, surprise, terrain) if such a factor is shown on the input data sheet as applicable to the unit.

(d) After (c) has been completed for all units in a BG, sum the unit AT IFP values for each side.

Step 2. Determine the available AT IFP force ratio by dividing the available AT IFP, (d) in step 1, of the attacker by that of the defender.

Step 3. Determine the AT IFP each side is employing against tanks. The percentage of each side's available AT IFP being so employed will be obtained from a table, which is being developed. The type of information to be included in the table is illustrated in Table 19. The data in the table are for illustrative purposes in explanations on how the table is to be used. The table will show data resulting from current research on this subject. Using the force ratio established in step 2, the player extracts from the table the applicable percentage for each side. In Table 19 the percentage for the attacker is shown in

Line No.	Title	Entry
1	UNIT DESIG	B3043
*	*	*
9	PRES STR	16254
*	*	*
12	% AUTH STR	98
*	*	*
18	ARTY PCS OH	79
19	APCS OH	588
20	TANKS OH	351
21	% AT WPNS OH	97
22	% AP WPNS OH	98
*	*	*

Fig. 42—Extract from Revised Printout of Master Status File

col 1, and the percentage for the defender is shown in col 2. Multiply each side's percentage by its available AT IFP as determined in (d) of step 1.

Step 4. Determine the AP IFP value of the fires of tanks and other AT weapons that are being directed at personnel. Do this first for tanks and then for other AT weapons.

(a) For each unit in the BG, determine the AP IFP value of its tank fires that are being directed at personnel. Obtain from Table 19 the percentage of AT fires the unit's side in the BG is directing at personnel. These percentages are shown in col 3 for the attacker and in col 4 for the defender. Multiply this percentage by 80 percent.* To the result, add 20 percent.* Multiply the resultant percentage by the AP IFP value of one tank of the unit as shown in col 3,

*Eighty percent is used because the current EEA of tanks consists of 80 percent AT munitions. The AT IFP of a tank is computed on this basis. The other 20 percent of the EEA consists of AP munitions, which have no AT IFP value. As AT munitions have both an AT and AP IFP value, 100 percent of a tank's EEA is computed in its AP IFP. These factors can be changed in the submodel to reflect any pregame change in the EEA mix.

Fig. 41. Multiply the result by the number of tanks on hand in the unit as carried in the MSF and shown on line 20, Fig. 42.

(b) For each unit in the BG, determine the AP IFP value of its AT fires, other than tanks, that are being directed at personnel. Obtain from Table 19 the percentage of AT fires the unit's side in the BG is directing at personnel. These percentages are shown in col 3 for the attacker and in col 4 for the defender.* Multiply the percentage by the AP IFP of the AT weapons of the unit as shown in col 5, Fig. 41. Multiply the result by the percentage of AT weapons on hand as carried in the MSF and shown on line 21, Fig. 42.

(c) For each unit add the AP IFP values determined in (a) and (b).

Step 5. Determine, for each unit in the BG, the AP IFP of its AP weapons. Multiply the unit's AP IFP as shown in col 1, Fig. 41, by the percentage of AP weapons on hand as carried in the MSF and shown on line 21, Fig. 42.

Step 6. Determine each unit's total AP IFP. Add the AP IFP determined in (c) of step 4 and the AP IFP determined in step 5. Multiply the total by the tactical factor if such factor is shown on the input data sheet as applicable to the unit.

Step 7. After step 6 has been completed for all units in a BG, sum each side's AP IFP.

Step 8. Determine the BG force ratio. For each side, sum its AT IFP as determined in step 3 and its AP IFP as determined in step 7. Divide the attacker's total IFP by the defender's total IFP.

After the force ratio in each BG is determined, the success or failure of the attacker will be determined in accordance with current procedures.

Antitank Assessment Routine. This routine will assess the results of those tank and AT fires that are employed against opposing tanks and AT weapons. Assessed losses will include tanks, APCs, AT weapons (other than tanks), and casualties.

Losses will differ for the attacker and defender and will be contingent on:

(a) The success or failure of the attacker as determined in the "Success or Failure Assessment Routine."

(b) The AT IFP force ratio, based on the AT IFP values of those tank and other AT weapons that are employed by each side in an AT role. It will be determined by the computations in step 3 of the "Success or Failure Assessment Routine."

(c) The posture of the defender.

Losses, based on tables being developed for storage in the program, will be assessed by BGs and distributed among units in the grouping.

After losses are assessed, information in the MSF, as reflected under the entries on lines 9, 19, 20, and 21, will be updated.

Antipersonnel Assessment Routine. This routine will assess the results of AP fires, including those of tanks and other AT weapons that are employed

*Note that an adjustment of these percentages is not necessary; 100 percent of the munitions in the EEA of AT weapons have both an AT and AP IFP value.

in an AP role. Assessed losses will include casualties, APCs, AP weapons, and AT weapons other than tanks.

TABLE 19

Example of Data To Be Included in a Table Showing Distribution of AT IFP by Type of Target

Available AT IFP force ratio	Available AT IFP to be employed, %					
	Against tanks		Against personnel		Against other targets	
	Attacker (1)	Defender (2)	Attacker (3)	Defender (4)	Attacker (5)	Defender (6)
5	20	49	55	26	25	25
4	22	44	53	31	25	25
3	26	42	49	33	25	25
2	30	40	45	35	25	25
1	36	38	39	37	25	25
0.5	45	35	30	40	25	25

Losses will differ for the attacker and defender and will be contingent on:

(a) The success or failure of the attacker as determined in the "Success or Failure Assessment Routine."

(b) The AP IFP force ratio, based on the sum of AP IFP values of AP weapons and of AP IFP values of those AT weapons, including tanks, employed in an AP role. It will be determined by the computations in step 7 of the "Success or Failure Assessment Routine."

(c) The posture of the defender.

(d) The size of a unit, if less than division size.

(e) The type of unit (infantry, armored, or mixed).

Casualties will be assessed by BGs and distributed among units in accordance with current procedures, except:

(a) Current rates are being revised to reflect changes being made in the submodel.

(b) Additional factors are being developed to be applied to different types of unit in a BG. Three types are being considered: infantry, armored, and mixed.

(c) Additional factors are being developed to be applied to casualty rates when either side is in a nuclear or transition posture.

Materiel losses will be related to casualties.

After all losses are assessed, entries on lines 9, 19, and 22 of the MSF, Fig. 42, will be updated.

Extent of Advance Assessment Routine. The force ratio on which this assessment is based will be determined as indicated in step 8 of the "Success or Failure Assessment Routine." No other changes in the factors considered, or in the procedures for making this assessment, are proposed.

Changes in Output Data

The submodel program will be adjusted to provide printout data reflecting the results of all assessments.

Chapter 7

LOGISTICS AND RECOVERY SUBMODEL

INTRODUCTION

After successive processing of game data in the Air, Nuclear (if played), Combat Support, and Ground Combat Submodels, further processing takes place in the Logistics and Recovery Submodel.

PURPOSE AND SCOPE

The purpose of the Logistics and Recovery Submodel is to simulate logistics activities and some of the constraints imposed by logistics on theater operations.

The scope encompasses intratheater stockage, movement, distribution, consumption, and loss of supplies; determination of requirements; identification of current supply deficiencies; and forecasting future deficiencies.

METHODOLOGY

Before gaming, a logistical situation and a logistics support system for each player side are devised by the Game Preparation Group. These are consonant with the game scenario and national doctrines. Data developed in this phase are stored in data tables of the computer program and in the Master Status File (MSF) for use in processing the Logistics and Recovery Submodel.

In general, the data items stored are of two broad types. The first type is quantitative, such as authorized strengths, tonnage of basic loads, LOC capacities, and indexes of firepower potential (IFPs) for units at authorized strength. Second, there are data items for use as factors. Examples are consumption rates, loss or damage factors, replacement rates, and recovery factors.

A third type of data for use in processing is furnished by cyclic outputs of other submodels. Examples are targets engaged, rounds fired, bombs dropped, and units engaged.

During the computer processing of the submodel the three types of data interact. The results of the interactions are printed out as indications of effects of logistics on operational aspects and the effects of operations on logistical aspects.

DESCRIPTION OF SUBMODEL

Pregame Preparations

General. When the Game Preparations Group has posted the initial situation map and developed complete order of battle (OB) data, a theater logistics system to support tactical deployments can be skeletonized. Such a system (less consumer units) is schematically represented in Fig. 43.

Figure 43. The circles shown on Fig. 43 enclosing the numerals 01 to 42 represent supply points in the operational areas of the corps and the army plus some communications zone (COMMZ) supply points.* Supply points or dumps of divisions and lower units are not shown. Divisions and lower units are treated as consumers only. Operation of their internal supply system is not gamed.†

The maximum number of supply points played in any one game is usually between 35 and 45 on each side, a range that experience has shown to be adequate and workable if the entire COMMZ is not gamed. It will be noted that only 42 supply points are indicated on Fig. 43.

For the corps level of supply points it is customary to compute stockage of 3 days of supply for each customer. In the army forward, army rear, and COMMZ supply points, customary stockages are, respectively, 6, 12, and 21 days of supply for each of their customers.‡

On Fig. 43 the lines connecting supply points represent aggregated surface LOCs actually existing. The figures along each line represent the aggregated capacity in tons per day of that LOC. Supply points, except the rearmost, are provided with two input LOCs. This reduces the degree of aggregated capacity in an area and provides alternative supply channels.

The LOC capacities are developed in pregame preparations. The actual terrain and available intelligence surveys are used to determine the usable tons per day§ capability of rail, highway, pipeline, or waterway facilities.

*The corresponding levels for RED forces are combined arms or tank army, front, and theater.

†Within divisions and lower units it is assumed that initially there are 3 days of supply "in the hands of troops." This constitutes what is termed the unit's "basic load." Maintenance of this supply level is a logistic objective. If a unit drops below 2 days of supply, its operational effectiveness is penalized. Details of the penalty assessment are in the discussion of the recovery routine.

‡Unit customers are not indicated on Fig. 43.

§If game cycles of less than 24 hr are played, adjustment must be made. Either the submodel is operated only once every 24-hr interval, or LOC capabilities are reduced to match the cycle duration.

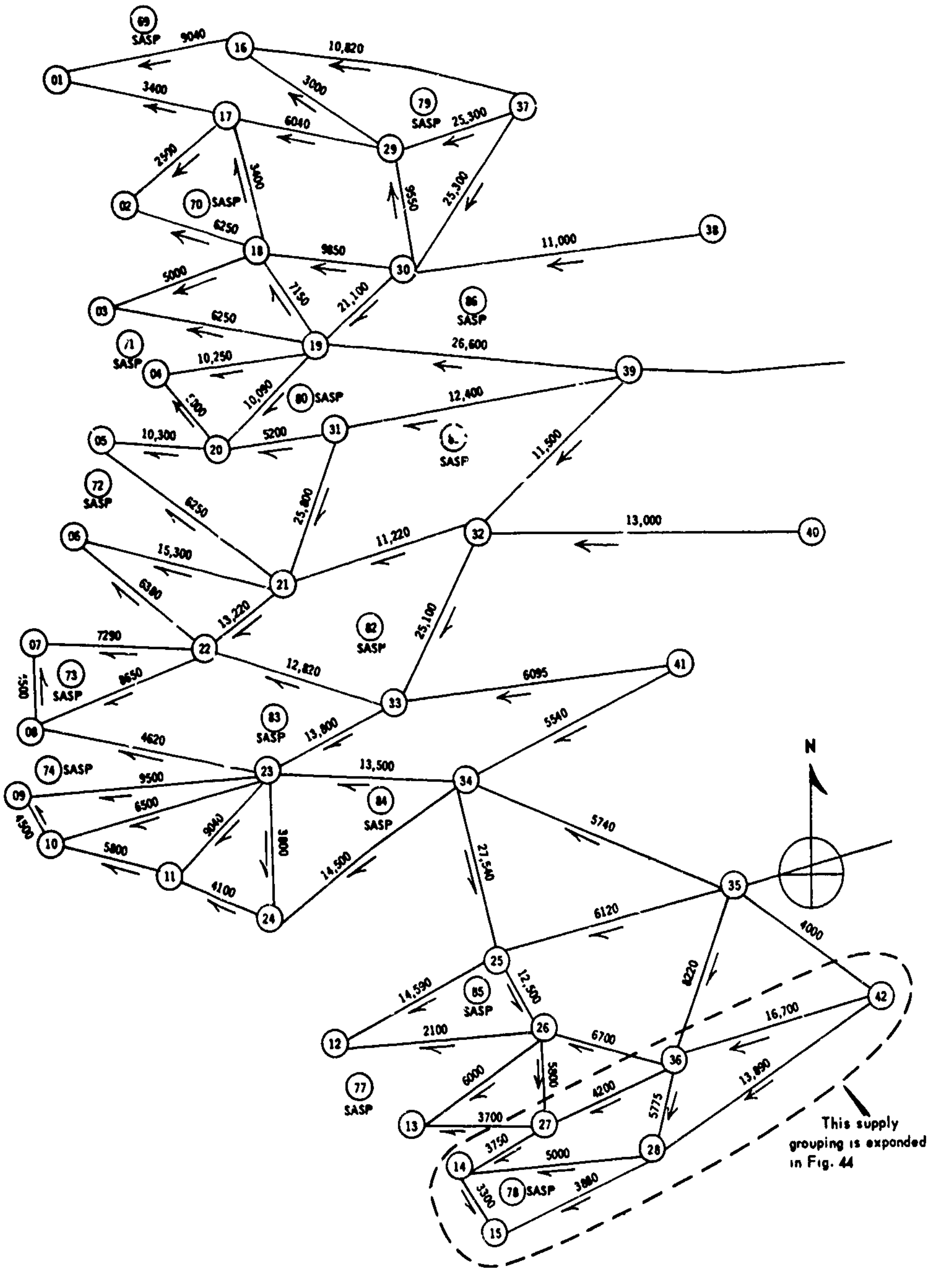


Fig. 43—A Typical RED Logistics System

The circles enclosing numbers, such as 06 and 21, represent supply points.

The lines connecting supply points, such as 06—21, represent the aggregated surface LOCs between supply points.

The numbers above the lines and the arrows below, such as 06 15,300 ← 21, indicate respectively the daily capacity, in tons, of the aggregated LOC and the direction of supply flow over the LOC.

The supply points labeled SASP, such as 77 SASP, represent special-ammunition supply points.

LOCs are not indicated because special-ammunition supply is normally by helicopter.

Unless some reason to the contrary exists, it is assumed that initially there are sufficient vehicles or rolling stock to allow full use of route capacity.

Figure 44. In Fig. 44, a part of Fig. 43 is expanded to connect by schematic LOCs some consumer units to their supporting supply points. The part of Fig. 43 selected for expansion is the supply grouping comprising SPs 42, 36, 28, 27, 15, and 14, to which are added some supported units and their LOCs from the supporting supply points.

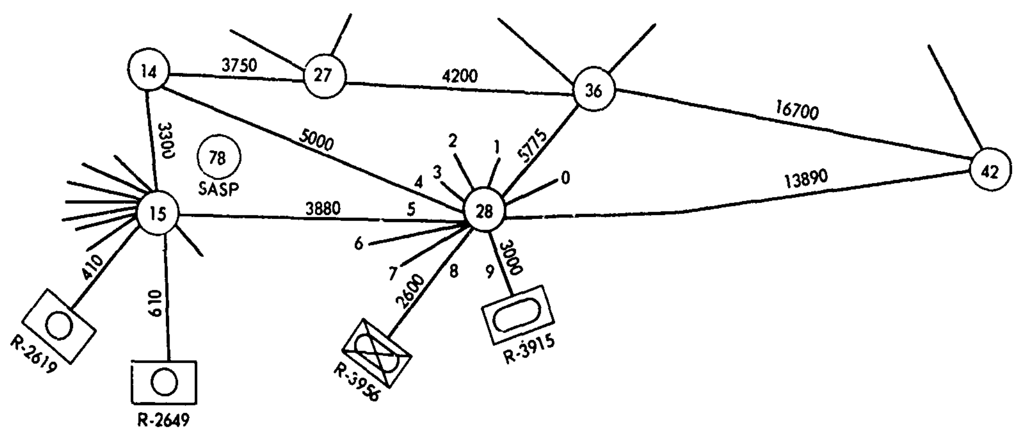


Fig. 44—Partial Expansion of RED Logistics System To Include Selected Consumer Units

Figure 44 shows that each consumer unit represented is supported by only one supply point and shows only one LOC from that supply point to the unit supported. One LOC serving a unit has proved generally adequate for game purposes. An additional air LOC may be assigned if required. (Air LOCs are discussed in the section on "Airlift.")

The figures alongside the LOCs to consumer units are known as "input capacities" of the unit. They represent the approximate tonnage of 1½ days' supply for that unit, as derived from information supplied by the client or from manuals and intelligence documents. They are a daily capacity indication, selected as the probable average resupply tonnage capability of the surface vehicles of the unit during one 24-hr period up to a distance of 50 km. The input capacities act as a ceiling or brake for surface movement of supply into a consumer unit in the same manner that LOC capacity restricts movement of supply into a supply point.

As noted in discussing Fig. 43, the consuming unit is the end of the THEATERSPIEL supply line. No output LOCs are indicated or required to units below the unit of resolution.

The expansion of SP 28 on Fig. 44 also indicates six unassigned output LOCs. They are available as input LOCs to any six consumer units that may be assigned to the supply point for support.

Owing to submodel limitations, a supply point may support a maximum of 10 customers (may have no more than 10 output LOCs).

Thus, the four assigned LOCs out of SP 28 are:

To SP 14: 5000 tons (actual, aggregated) per day
To SP 15: 3880 tons (actual, aggregated) per day
To R3915: 3000 tons [approximately $1\frac{1}{2}$ days' supply for one RED tank division (TKD)] per day
To R3956: 2600 tons [approximately $1\frac{1}{2}$ days' supply for one RED mechanized rifle division (MRD)] per day

This leaves six unused LOCs available from SP 28.

The two assigned LOCs from SP 15 are:

To R2619: 410 tons (approximately $1\frac{1}{2}$ days' supply for a 130-mm gun group) per day
To R2649: 610 tons (approximately $1\frac{1}{2}$ days' supply for a 152-mm howitzer group) per day

This leaves eight unused LOCs available from SP 15.

Assigning Units to Supply Points. Figure 43 does not portray the LOC connection between all consumer units and their supporting supply points. However, the data pertinent to all these connections are a pregame requirement. To satisfy this requirement, the form "Assignment of Units to Supply Points" is filled in, as has been done illustratively in Fig. 45.

Under the unit designation of the various supply points are entered the designations of consumer units and other customer supply points. Thus it is indicated that SP 5901 supports unit 4916 over LOC 1 out of the supply point. This is the only place unit 4916 will appear, for it is supplied by only one supply point and over only one LOC, as is standard practice for consumer units.

The designation 5901, on the other hand, is listed under SP 5910 (LOC 9) and again under SP 5911 (LOC 8). This is because 5901 is the designation of a supply point, which is supported by two other supply points, each using one of its 10 LOCs for the purpose. Thus, SP 5901 has two LOCs supplying it, as opposed to only one LOC for consumer units.

These data are provided to key-punch operators in a convenient form for transfer to cards. The work sheet is available to Logistics Controllers and players as a ready and often needed reference as a game progresses and as the data are updated.

Supply Point Stockage. With all units assigned to supply points, it is practical to compute supply point stockage, i.e., the number of tons of each class of supply that must be placed initially in each supply point.

The first step is to categorize supply into classes that will satisfy game requirements and meet game objectives. A typical classification would be as follows:

(a) Class I: rations.
(b) Classes II and IV: these two classes, not separated in THEATERSPIEL,

ASSIGNMENT OF UNITS* TO SUPPLY POINTS

No. of LOC Out	Unit Designation of Supply Points											
	5901	5902	5903	5904	5905	5906	5907	5908	5909	5910	5911	5912
0		2930	1945	2931	2991	2942	3985	2932			5903	5904
1	4916	4941	4917	4919	4943	2939	4920	4922	4923	4918		5905
2	2921	1921	2922	2924	3937	1942	2925		2928			5906
3	2944	3958			3969	3952	2945	2703		1905	2938	3946
4	3901	3959	3905	3913	3970	2702	3917		3929			3903
5	3902	3960	3906	3914	3971	2805	3918		3930		2804	3948
6	2803	3961	3907	3915	3972	2908	3919	3927	3931			2911
7	3904		3908	3916	3939	2990	3920	3928	3932		2987	2841
8	3955		3956	3966	3912	1905	3967	3977	3978		5901	1955
9					3943	3924	1943	2943		5901	5902	

*The assignment of supply points to their supporting supply points is also indicated on this form.

Fig. 45—Example of Assignment of Units to Supply Points

include individual and organizational supplies and equipment. They exclude gun tanks and such other items as may be covered in "Special Class."

(c) Class III: POL.

(d) Class V: ammunition (excluding special munitions such as nuclear warheads, which are to be treated individually).

(e) Special Class: gun tanks, APCs, trucks, aircraft, launchers, tubes, or other items so classified in order to satisfy specific game requirements.

The next step is the development of consumption rates for all classes of supply and for different types of unit. These rates are based on information furnished by the client or researched from available manuals and intelligence reports.

Consumption rates indicate the daily amount (in pounds, gallons, rounds) of any class of supply that is expected to be consumed or expended per man, per launcher/tube, or per vehicle in ground-combat, combat-support, SAM, and logistics and headquarters units or per aircraft in air units.

The class I consumption rate, for example, is on the order of 7 lb/man/day. The class III rate would be expressed in pounds per day per aircraft or vehicle in the unit. The rate for class V would be pounds, rounds, missiles, or bombs per day, per tube, launcher, or aircraft, depending on accounting procedures.

With consumption rates available it is practical to compute the quantity of each class of supplies consumed per day in each type of unit. For example, class I consumption per day would be

$$\frac{\text{Strength of unit} \times \text{class I consumption rate, lb, per man}}{2000} = \text{one day's consumption,* tons}$$

Similar computations for other classes are complicated by the effect of unit activity and posture on consumption rates. Whereas class I consumption remains fairly stable whatever the unit activity and posture, this does not hold in other classes. For example, historically the ammunition consumption rate is greater for a unit in defense than it is for the same unit in attack. The reverse is true regarding POL. However, in this pregame phase the consumption rate ascribable for attack or defense posture, whichever is greater, is generally the consumption rate used. This is done to provide for those instances when defense may change to counterattack, attack may turn into a withdrawal, and similar contingencies.

When, as a result of the foregoing computations, class totals and overall totals for each customer of a supply point have been developed, a separate data sheet for each supply point is prepared. Its format is shown in Fig. 46.

Figure 46. The entries in the two left columns of Fig. 46 concerning designation and location are self-explanatory. The LOC and capacity entries in the same columns of the figure are discussed in the third and sixth paragraphs below.

The entries under "Supply Points and Units Supported" indicate the customers of the supply point being tabulated (R5912, SP 12). These data are

*One day's consumption (as the term is used here) equals one-third of the unit's basic load. Basic loads and their utility are discussed in greater detail later in this text.

taken from the column headed "5912" on Fig. 45. It is important that the customers be listed in the same order as they appear on Fig. 45 to keep LOC assignments the same on both figures.

The "6 Days of Supply in Supply Point" entry at the top of Fig. 46 indicates that SP 12 would stock 6 days of supply for its customers. In the third column from the right, however, there is a column headed "Days of supply." The first three entries in this column appear to contradict the 6 days entry. In explanation it is necessary to recall that supply points are supported by two other supply points. Thus the 6-day backup stockage for a supply point is split between its two supporting supply points, in any convenient ratio such as 3 days in each, 1 day in one, with 5 days in the other and so on. For example, the first customer listed for SP 12 is SP 04 (R5904) and in the "Days of supply" column the figure 1 is set opposite SP 04. This indicates that SP 12 stocks only 1 day of supply for SP 04 and the remaining 5 days are stocked in the other supporting supply point (not shown).

Input LOC entries appear in the two left columns of Fig. 46, and output LOC entries are in the right two columns. In considering these LOC entries it should be borne in mind that supply points have two input LOCs, designated Input LOC 1 and Input LOC 2. Supply points also have up to 10 output LOCs numbered 0 to 9. These output LOCs are identified by suffixing the numbers 0 to 9 to the last 2 digits in the supply point's numerical designation. For example, SP R5925's 10 output LOCs would be designated as 250, 251, 252, to include 259.

Output LOC designations for issuing supply points also assist in identifying a receiving supply point's two input LOCs. This is accomplished by indicating the number of the input LOC, either 1 or 2, and following it by the designation of the output LOC from the issuing supply point. For example, if SP 12 is supplied over its Input LOC 1 by SP 25, which uses its Output LOC 0 for the purpose, then LOC 1 for SP 12 is designated LOC 1-250. If SP 12 is supplied over its Input LOC 2 by SP 31, which uses its Output LOC 2 for the purpose, then LOC 2 for SP 12 is designated LOC 2-312.

It will be noted that Fig. 46 indicates only 9 of 10 possible customers for SP 12. The output LOC designation 129 is therefore not used. It remains available to accommodate another customer for SP 12, should the necessity develop.

The input LOC designations and capacities in cols 1 and 2 respectively of Fig. 46 can be taken from Fig. 43, which was prepared earlier in pregame preparations. The output LOC designations and capacities in the two right columns of Fig. 46 as they relate to output LOCs to other supply points can also be taken from Fig. 43. In the case of output LOCs to consumer units, the capacity figure to be filled in represents the rounded off tonnage of $1\frac{1}{2}$ days of supply for the unit.

The entries under the heading "Tonnage required" can now be computed for those corps-level supply points that have unit customers only (no supply point customers). This is done by multiplying 1 day's consumption for the unit supported by the number in the "Days of supply" column. When this is

SUPPLY POINTS, STOCKAGE

(Six days of supply in supply point)

SP designation	Location	Supply points and units supported	Tonnage required at the supply point, by class of supply						Days of supply	Output LOCs	
Input LOC	Capacity		I	II and IV	III	V	Spec.	Total		Desig.	Capacity
R5912	Munich	5904	108	3,900	1,946	4,211	0	10,165	1	120	5100
		5905	456	20,156	10,521	20,929	0	52,062	5	121	5210
	Coord: PU93	5906	106	3,900	1,946	4,211	0	10,163	1	122	5100
		3946	91	4,617	1,815	2,720	0	9,243	6	123	2284
Input LOC 1–250	Cap. 9850	3903	73	3,953	2,009	4,351	0	10,386	6	124	2668
		3948	91	4,617	1,815	2,720	0	9,243	6	125	2294
		2911	14	422	77	3,477	0	3,990	6	126	1112
		2841	14	635	85	3,100	0	3,834	6	127	1094
Input LOC 2–312	Cap. 7150	1955	16	144	1,064	427	0	1,651	6	128	466
		Total weight	964	42,344	21,273	46,146	0	110,737	(111,000)*		
	Class distribution factor, %		1	37	20	42	0				
	Master status file entry (Line 11):		0	3	2	4	0				

*Maximum storage capacity.

Fig. 46—Data Sheet for Supply Point Stockage

done, computations can be made for any corps-level supply points that do have other supply points as customers in addition to unit customers. This is accomplished for the unit customers as described previously. Then the total for unit customers is added to the requirement imposed by the supported supply point(s). In the latter step it must be borne in mind that two supply points share the stockage responsibility for the supply point customer in question.

After corps supply point computations are completed, the army forward (6-day) supply points can be processed, then the 12-day army rear supply points, and finally the 21-day COMMZ depots. Although understanding of the foregoing is essential, it will be seen later, when basic loads are discussed in detail, that the process is facilitated by basic load computations.

The "Maximum Storage Capacity" entry represents the maximum storage authorized for SP 12. The grand total of 110,737 tons is rounded off for convenience.

The "Class Distribution Factor" is discussed later.

On Fig. 43, in addition to supply points and their schematic network of interconnected and rated LOCs, there is also indicated a dispersed complex of SASPs.

The pregame tasks associated with SASPs are to (a) designate them as indicated in the order of battle, (b) locate them in accordance with doctrine, deployments, and operational concepts, and (c) stock them according to doctrine.

Inasmuch as issues from and supply to SASPs are normally by helicopter no surface LOCs for SASPs are specified.

SASPs are highly mobile, highly transitory, and widely dispersed both internally and with respect to other installations. They operate according to national doctrine.

Maximum storage for any one SASP is strictly regulated by both RED and BLUE in accordance with the latest information regarding their doctrine on that subject. The limitations, which are different on respective sides, are imposed on the number of warheads of all yields that may be stocked. Expenditures of and general accounting for nuclear warheads are reported for game data analyses in terms of numbers.

Stockage of warheads in a SASP is expressed in tons. All SASPs, both RED and BLUE, are given arbitrarily an initial stockage of 13,500 tons. This accomplishes two things. First it expresses stockage in the same unit of measurement for all supply points. Second it establishes, for damage assessment by the Nuclear Submodel, a hypothetical area of consideration comparable with the area utilized by a forward supply point to disperse 13,500 tons of ordinary supplies. The assessment routine is described in Chap. 4.

Logistics Factors. After Fig. 46 is filled out, except for entries concerning Class Distribution Factors, the logistic data basic to game initiation are now arrayed in formats convenient for and familiar to key-punch operators, controllers, players, and programmers. Certain empirical factors, which must be applied to the basic data, are also required for computer processing of the Logistics Submodel. These are:

(a) Class Distribution Factors
(b) Basic Load Factors
(c) Consumption Factors
(d) Low on Supply Factors

Class Distribution Factors (CDFs). The CDF indicates for each supply point the percentage of total stockage devoted to each separate class of supply stocked. For example, in Fig. 46, SP 5912 has a total stockage of 110,737 tons. Of that total, 969 tons is class I; this is less than 1 percent, but it is entered as 1 percent as no allowance is made for fractional percentages. Class V stockage, 46,146 tons, is roughly 42 percent of total stockage. In this fashion percentages are worked out for entry in the "Percentage" line on Fig. 46 for all classes, in the order from left to right, classes I, II and IV, III, V, and Special. These are the percentages used in the data processing of the submodel.

These percentages are rounded and entered in the "Master Status File" entry line of Fig. 46 as a rough indicator for players and controllers. Here an entry of 0 means less than 10 percent, 1 means 10 to 19 percent, 2 means 20 to 29 percent, etc. The CDF on this basis for SP 5917 becomes 03240. Only the tens digit is printed in the MSF. This indicates that less than 10 percent of overall stockage is class I, between 30 and 39 percent are classes II and IV, between 20 and 29 percent is class III, etc. The units digits are not printed, but the total of individual percentages equals 100 percent stockage for each supply point.

Basic Load Factors (BLFs). Thus far in this text, stockage of supplies has been expressed by class, in tons, and in days of supply. This has been adequate for development of initial data requirements. To arrive at factors to apply to certain items of the initial data when game processing is under way, it is useful to adopt still another measurement of stockage, the basic load (BL).

In THEATERSPIEL usage a BL for any unit is the tonnage of 3 days of supply for that unit. It is the sum of the BLs of classes I, II and IV, III, V, and Special for the unit. In the earlier example of supply echelonment it was cited that 3 days of supply, a BL, would be in the hands of troops. Maintenance of this level is a logistics objective and prevents penalties on operational effectiveness due to supply deficiency.

For computing resupply requirements the tonnage of a unit's BL is considered to fluctuate with the unit's personnel or equipment strength. For example, the BL of rations depends on the number of men actually present on the day in question whereas the BL of POL for air units varies with the number of aircraft currently on hand. In computing fluctuating BLs a "one man slice" of the BL is useful as a multiplier for "present strengths" to produce present BLs. This "slice" is called the Basic Load Factor (BLF). It is derived by dividing a unit's BL for authorized strength, in pounds, by authorized strength. For example, in a division with an authorized strength of 16,000 the class I BL is 168 tons. Then

$$\frac{168 \times 2000}{16,000} = 21 \text{ lb}$$

is the class I BLF for the division, and if the division has 1000 casualties, reducing the present strength to 15,000, then

$$\frac{21 \text{ lb} \times 15{,}000 \text{ strength}}{2000 \text{ lb}} = 157.5$$

or 158 tons is the present BL of class I for the reduced strength division.

Basic Load Consumption Factor (BLCF). The BLCF (not to be confused with consumption rates) is the percentage of a unit's BL that experience indicates will be consumed each day. In the case of rations it is 33.3 percent since the BL equals 3 days' supply and a unit consumes 1 day of supply of rations each day with little regard for varying circumstances or conditions. In other classes, however, consumption varies widely with unit activity. To accommodate that fact, three activity categories are used: administrative move, inactive, and active. If a unit is moving administratively or is inactive, BLCFs, which are developed before the game, are used in the submodel to determine consumption by class within the moving or inactive unit on the day in question. If the unit is active, BLCFs for various postures (such as attack, defense of hastily prepared positions), which are determined before the game, are used in the submodel to determine the unit consumption incident to the unit's current posture.

BLCFs vary widely, and it is possible for a unit to consume half its BL of one class, while consuming practically none of another. The impact on resupply requirements is obvious.

The utility of the BLCF in computing daily supply consumption is illustrated below.

Given

$$\text{Present BL, in tons} = \frac{\text{present strength} \times \text{BLF}}{2000}$$

then

$$\text{Tons consumed} = \text{present BL} \times \text{BLCF}$$

It is apparent that heavy casualty losses on any day may make stocks on hand exceed the BL for the unit at its reduced strength. In this case no resupply is made. If stocks on hand are less than present BL, then an attempt to resupply is made to satisfy the difference, according to priorities, availabilities, and LOC capacities.

It should be borne in mind that the preceding paragraphs concern consumption only. They do not cover loss, destruction, abandonment, or capture, which are treated later in this text.

Low on Supply Factors (LOSFs). When supplies on hand in a unit drop to a certain percentage of its present BL, degradation of unit effectiveness is assessed. The critical percentage selected is the LOSF. For example, if it is determined that a unit's attack effectiveness is to be degraded when class V stocks on hand drop below 65 percent of the unit's present basic load, then 65 becomes the LOSF for class V in that unit.

The critical percentages are developed from available experience data for each class of supply by unit type and subtype. For supply points they are percentages of authorized storage capacity and indicate limited availability of supplies for issue.

Figure 47. When the data just discussed have been developed, a basis exists for filling in items 1, 2, 4 to 8, 10, 11, 18, 21, and 23 of Fig. 47. These items are numbered to correspond to the lines of the MSF printout, Fig. 4, which is reproduced here for the reader's convenience. They constitute the minimum data to enable an initial computer processing and printout, preliminary to any cycle assessments. The items left blank are 3, 9, 12 to 17, 19, 22, and 24. Before cyclic assessments take place in the various submodels, the data for these blanks are produced for the corresponding line of the initial MSF printout. This is accomplished by cyclic inputs, as in the case of item 3, which is "Activity" on line 3 of the MSF printout, or by computer computations. An example of the latter would be item 9, which is "Pres Storage Cap" on line 9 of the MSF printout. Here, because there has been no loss of capacity reported for assessment against item 10, "Auth Storage Cap," item 10 and item 9 would be identical by the computer, on lines 9 and 10 of the initial MSF printout. Item 12, which corresponds to line 12 of the MSF printout "On Hand Class I," would be item 10 "Authorized Storage Capacity of Supply Points" multiplied in the computer by the percentage for class I in the supply point's CDF.

An explanation of items filled in follows.

Item 1, unit designation. Example, R3946.

Item 2, unit location. Example, KV39.

Item 4, Input LOC 1. This is the designation of an LOC from a supply point to a consumer unit or another supply point. These data are available from Fig. 45 and may be transferred from Fig. 45 to Fig. 47.

Item 5, Input LOC 2. This is the same as item 4 except that it has application to supported supply points since supply points have two input LOCs whereas units usually have only one. The data for this entry are also available from the completed Fig. 45. For example, in the column headed 5910, it is indicated that SP R5901 is supported by SP R5910 over its Output LOC 9. Thus Input LOC 1 for SP R5901 is 109. At the same time in the column headed 5911 it is indicated that SP R5901 is also supported from SP R5911 over Output LOC 118. Then LOC 2 for SP R5901 is 118.

Item 6, Input Capacity 1. This is the daily capacity in tons of Input LOC 1. Data for this entry are available from the completed Fig. 46. For example, on Fig. 46 RED SP 5904 is shown to be supported by Output LOC 120, so Input Capacity 1 is 5100 tons, the indicated capacity on Fig. 46 for LOC 120. If the customer is a unit, the entry would be the tonnage of 1½ days of supply for that unit.

Item 7, Input Capacity 2. Same as item 6 except it has application to supply points only. When a supply point appears for the second time on Fig. 46, its Input LOC 2 is indicated with its daily capacity.

Item 8, priority. Generally all units being played actively are given priority 1. Priority for supply points must be assigned to both input LOCs and generally is "1" on both. If lower priorities such as 2 or 3 are assigned to

GAME ________ BLUE ________ DATE ________

	Card Col 1	7	13	19	25	31	37	43	49	55	61	67
1st unit	Unit Desig	Location		Input LOC 1	Input LOC 2	Input Cap 1	Input Cap 2	Priority		Auth stg* Cap S/pts	Auth str* Sup dist	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
						CPP, Auth IFP, AB		Auth personnel strength**	Max inp *Cap No 1		Max inp Cap No 2	
	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)

2d unit ____________________

3d unit ____________________

*For supply points only.
**For air and SAM units only.

Fig. 47—Initialize Status File Data Sheet

	AIR UNITS 0	SAM UNITS 1	CS UNITS 2	GC UNITS 3	LOG UNITS 4	SUPPLY PTS 5	
1	Unit Desig	Unit Desig	Unit Desig	Unit Desig	Unit Desig	Unit Desig	1
2	Location	Location	Location	Location	Location	Location	2
3	Activity	Activity	Activity	Activity	Activity	Activity	3
4	Input LOC 1	Input LOC 1	Input LOC 1	Input LOC 1	Input LOC 1	Input LOC 1	4
5	Input LOC 2	Input LOC 2	Input LOC 2	Input LOC 2	Input LOC 2	Input LOC 2	5
6	Input CAP 1	Input CAP 1	Input CAP 1	Input CAP 1	Input CAP 1	Input CAP 1	6
7	Input CAP 2	Input CAP 2	Input CAP 2	Input CAP 2	Input CAP 2	Input CAP 2	7
8	Priority	Priority	Priority	Priority	Priority	Priority	8
9	Pres Str	Pres Str	Pres Str	Pres Str	Pres Str	Pres Stg Cap	9
10	Prior Str	Prior Str	Prior Str	Prior Str	Prior Str	Auth Stg Cap	10
11	Auth Str	Auth Str	Auth Str	Auth Str	Auth Str	Class Dist	11
12	OH Supply 1	OH Supply 1	OH Supply 1	OH Supply 1	OH Supply 1	OH Supply 1	12
13	Other 2 and 4	Other 2 and 4	Other 2 and 4	Other 2 and 4	Other 2 and 4	Other 2 and 4	13
14	POL	POL	POL	POL	POL	POL	14
15	No Rds COFR	No Msls	No Rds/Msls	AMMO	AMMO	AMMO	15
16	No Rds HE	No Lnchrs	No Del Sys	No Tnks	No Tpts	Wt of Armor	16
17	No Sorties	No Msls Fired	No Rds Fired	IFP/Base			17
18	Pres Pers	Pres Pers	CPP/Auth	IFP/Auth Base			18
19	Prior Pers	Prior Pers	CPP/Pres	IFP/Retrogrd			19
20	Auth Pers	Auth Pers		IFP/Defense			20
21				IFP/Atk/Ret			21
22				IFP/Attack			22

Fig. 4—Report Format for the Master Status File

Reproduced here for reader's convenience.

units they must wait until all higher-priority units in their supply grouping are supplied. In the case of supply points the low-priority input LOC will not be used until higher-priority customers are served.

Item 10, authorized storage capacity for supply points. This is a rounded figure totaling the tons of supply required for all customers according to prescribed supply echelonment. It is taken directly from the total column/line on Fig. 46.

Item 11, authorized strength. TOE strength of logistics units. CDF for supply points.*

Item 18, for combat-support units, casualty-producing potential (CPP) authorized. For ground-combat units, IFP authorized base.

The derivation and meaning of these entries are explained in other parts of this text.

Item 20, authorized personnel strength. This applies to air and SAM units only.

Items 21 and 23, maximum Input Capacities 1 and 2. At the beginning of a game these entries are the same as items 6 and 7. As the game progresses items 6 and 7 will fluctuate as damage occurs and restoration is accomplished whereas items 21 and 23 remain constant. The degree of restoration allowed in any one day is 10 percent of the constant maximum input capacity but cannot exceed 1000 tons.

Cycle Inputs

There are four Logistics and Recovery Submodel inputs: Supply Point Order Cards, Resupply Control Factors, Airlifts, and Grid Nuclear.

Supply Point Order Cards. It is assumed that supply points cannot issue supplies on the same day they are received. Thus issues on any one day must be limited to stocks on hand at the close of the previous day. To ensure that issues are not made from supplies received that same day, it is necessary that supply points be called on for issues before they have been resupplied themselves. To this end supply points are listed in a sequence that subjects them to filling daily demands before their own daily requirements are met. A sample listing is shown in Fig. 48. Figure 49 illustrates the echelonment of supply points to accomplish the listing. Other arrangements are workable and can be determined to fit cases and convenience.

Resupply Control Factors. Normally when resupply is being simulated it is done on a basis of the BL of the supported unit or the authorized storage capacity in the case of supply points. Priority is determined by the greatest relative need. For example, if Unit A has 50 percent of its basic load on hand and Unit B has only 25 percent, then Unit B requirements are resupplied first and Unit A may get none or a reduced amount if there are insufficient stocks to fill all needs.

To change this routine, when desired, resort is made to Resupply Control Factors, a type of input submitted in a format illustrated in Fig. 50. By this

*This is the CDF described on Fig. 46 as "Master Status File" entry. It may be taken directly from Fig. 46 accomplished in game preparation and entered as item 11 for supply points.

input, each player team can increase resupply of selected classes, to designated members of a supply grouping, to an extent that will not make the increased total tonnage exceed 110 percent of the BL in the classes selected. For supply points the resultant tonnage must not exceed 110 percent of authorized storage of the selected class.

SUPPLY POINT ORDER CARD

Game MR-2 RED ~~BLUE~~ Cycle 1st Date ______

INSTRUCTIONS

List supply points in the order they are to issue supplies. All active supply points *must* be listed.

This list *must* be submitted for each cycle.

Supply point listings are by inspection of Fig. 43 and must ensure that no supply point will be able to issue supplies it has received that same day.

SPs In Order

	SPs In Order	
	R-5901, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 24, 12, 13, 15, 14.	Note 1: These corps-level SPs issue first. Thus they cannot receive from the rear before issuing. Within the group the listing ensures that any SP issues prior to receiving from any other SP in the group.
Note 2: These Army fwd SPs issue after the corps-level SPs and before more rearward SPs. Individual listings accomplish the same purpose as at corps level.	R-5916, 17, 18, 20, 19, 22, 21, 23, 27, 26, 25, 28.	
	R-5929, 30, 31, 33, 32, 34, 36, 35.	Note 3: These Army rear SPs continue the pattern.
Note 4: These communications zone SPs are the rearmost played, and the last to issue.	R-5937, 38, 39, 40, 41, 42.	

Fig. 48—Supply Point Order Card

Thus a player may provide for extraordinary resupply in anticipation of heavy combat. The maximum number of units and/or supply points that may be affected in any one day is 10 on each side. Increased resupply is contingent on availability of required supplies at the supporting supply point and adequate LOC capacity.

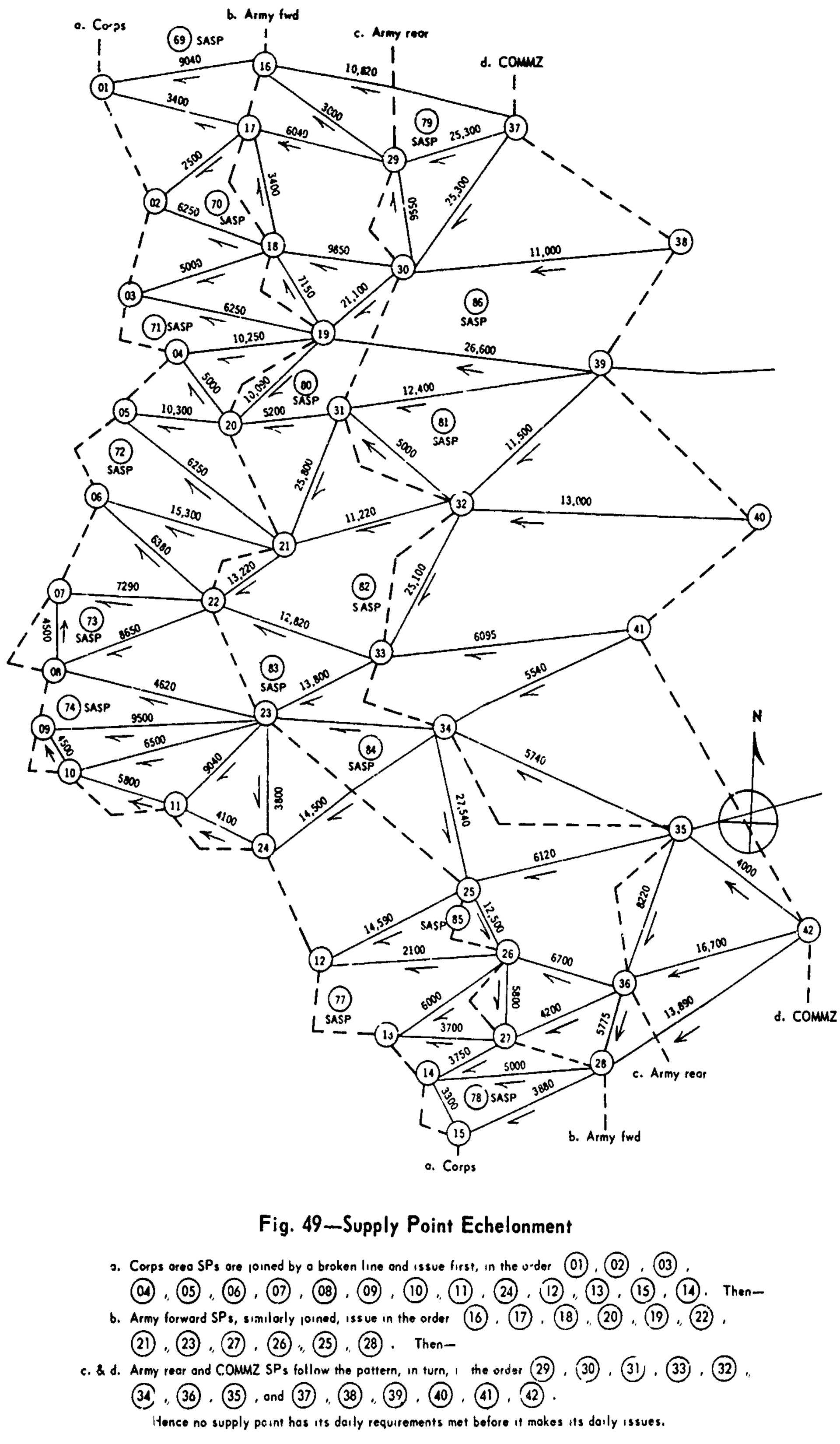


Fig. 49—Supply Point Echelonment

a. Corps area SPs are joined by a broken line and issue first, in the order 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 24, 12, 13, 15, 14. Then—

b. Army forward SPs, similarly joined, issue in the order 16, 17, 18, 20, 19, 22, 21, 23, 27, 26, 25, 28. Then—

c. & d. Army rear and COMMZ SPs follow the pattern, in turn, in the order 29, 30, 31, 33, 32, 34, 36, 35, and 37, 38, 39, 40, 41, 42.

Hence no supply point has its daily requirements met before it makes its daily issues.

RAC

GAME MR-2 RED √ ~~BLUE~~ DATE D + 4

	Unit desig					Class 1					Classes 2 and 4					Class 3					Class 5					Special				
Card Col.	1	2	3	4	5	20	21	22	23	24	28	29	30	31	32	36	37	38	39	40	44	45	46	47	48	52	53	54	55	56
Unit 1	R	3	9	4	6																		4	0	0					
2	R	3	9	4	8													3	0	0										
3																														
4																														
5																														
6																														
7																														
8																														
9																														
10																														

Fig. 50—Resupply Control Factors Input Sheet

Figure 50 has been filled in illustratively. The effect of the first entry would be to have unit R3946 supplied with 400 tons of class V regardless of the unit's "relative need." If receipt of 400 tons would make the unit's on-hand supply of class V exceed 110 percent of its present class V BL, the special issue would be reduced by the computer to keep on-hand supply at the maximum allowed.

The second entry would do the same for unit R3948 with regard to 300 tons of class III.

Airlift. To simulate establishment of an airlift, the format illustrated in Fig. 51 is filled in with the indicated input data and submitted.

An airlift usually supplements the surface resupply of the receiving unit. An additional airlift input LOC must be assigned to the receiving unit and an additional corresponding output LOC designated for the supporting supply point. Usually it is a new unused output LOC from a supply point other than the one providing surface support to the unit. The LOC designated must be one not already in use and can be from any conveniently located supply point that does not already have 10 customers. The receiving unit will normally receive as much of its requirements as LOCs and supply levels permit, by surface resupply. The remainder required and capable of being airlifted is then supplied by airlift to the extent provided for on the Airlift Data Sheet, Fig. 51.

Grid Nuclear. This input identifies a square in the game map grid in which capacities of all LOCs are reduced as a result of nuclear strikes and command, control, and communications disruptions.

Figure 52 illustrates the format employed to indicate a grid square (KV) and the percentage of reduction to be applied (25 percent).

Figure 53 shows a curve developed at RAC and a formula to enable hand assessment of the degree of reduction.

Assessments*

Broadly, the submodel assessment routines will do the following tasks:

(a) Quantify supply consumption and loss, thereby establishing resupply requirements.
(b) Develop and apply constraints on the capability to satisfy resupply requirements.
(c) Evaluate the adequacy† of the constrained resupply performance.

Consumption and Loss. Consumption in this context includes issues from supply points, whereas loss includes that supply attrition simulated by the submodel as being due to hostile action against both units and supply points.

Consumption for a supply point is simply the sum of its issues during the cycle. Unit consumption is assessed by class of supply through factoring the

*Assessments made by the recovery routine are discussed later in the text.
†The effect of inadequacies on unit IFP and CPP is assessed in the recovery routine discussed later in this text.

unit's present basic load (PBL) for each class by the pertinent BLCF reflecting unit posture. Given the unit's class I (rations) PBL = 15 tons, then 1 day's consumption for that unit = 15 × 0.33 (class I BLCF regardless of posture) = 5 tons, and the unit's classes II and IV consumption = (classes II and IV PBL) × (classes II and IV BLCF) × (posture factor reflecting the unit's activity).

GAME MR-2 RED √ ~~BLUE~~ DATE D + 5

PART I—Airlift Data

	Unit desig receiving unit	Airlift[a] input LOC	Unit desig lifting unit	No. sorties	Lift (tons/acft)	Classes[b]
Card Col.	1 2 3 4 5	22 23 24	28 29 30 31 32	38 39 40	46 47 48	52 53 54 55 56
					tenths	1 2/4 3 5
Unit 1	R 3 9 4 6	3 5 9	R 0 9 2 5	1 0	2 5	5
2						
3						
4						
5						
6						
7						
8						
9						

PART II—NOMODEL Changes

	Unit desig receiving unit	Input LOC 1	Input LOC 2[a]
Card Col.	1 2 3 4 5	22 23 24	28 29 30
Unit 1	R 3 9 4 6	1 2 3	3 5 9
2			
3			
4			
5			
6			
7			
8			
9			

[a]The airlift Input LOC to be assigned must be one from supplying depot that is not in use. The nomodel change entry to assign the airlift Input LOC to the receiving unit must be made in Part II.
[b]Fill in the number(s) only of classes to be lifted, not the quantity.

Fig. 51—Airlift Data Sheet

The BLCFs for each unit subtype, reflecting each posture appropriate for that subtype, are determined in pregame preparations for use in the computer processing of the Logistics Submodel.

Losses. The only materiel losses assessed against units by the submodel are those assumed to stem from unit casualties. They are assessed in tons.

For classes I, III, and V in SAM, combat-support, and logistics units the percentage lost is (casualties/prior strength) × LFD, where LFD is a damage factor determined in pregame preparations for use in the computer-processing phase of the submodel. The usual value for LFD is ¼, which may be altered as required.

RED __________ BLUE __________

GAME __________ GAME CYCLE __________ DATE __________

	Grid		% Reduction	
	1	2	23	24
Card Col. 1	K	V	2	5
2	M	U	1	0
3	X	P	0	5
4				
5				
6				
7				
8				

Fig. 52—Grid Nuclear Input Sheet

For classes I, III, and V in ground-combat units, instead of LFD a factor LFGND is used, which reflects unit postures, terrain, and unit success or failure. This factor is also a pregame development for use in the computer-processing phase of the submodel. Values for LFGND are in Table 20.

For classes II and IV losses of individual equipment in all units except air it is assumed that in 95 percent of conventional casualties there would be an unsalvageable loss of 10 lb (0.005 tons)/casualty. Thus tons of individual equipment lost = conventional casualties × 0.95 × 0.005.

For classes II and IV losses of organizational equipment in all units except air, it is assumed that 5 percent of conventional casualties will be at-

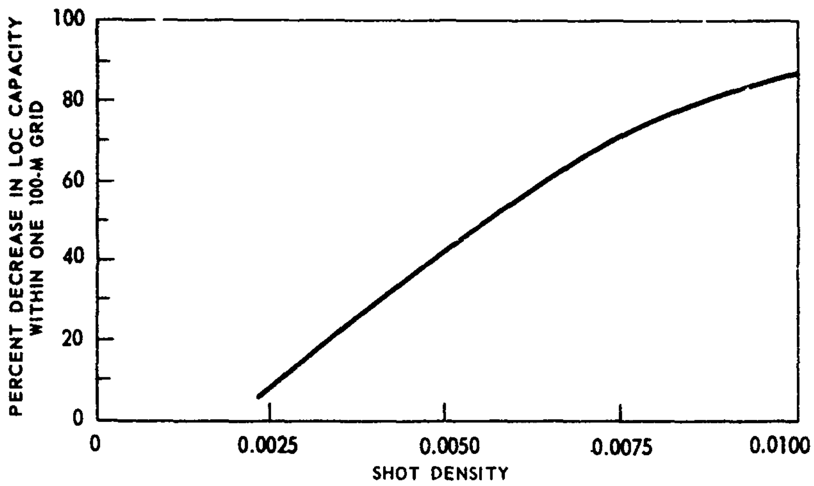


Fig. 53—Decrease in LOC Capacity Due to Nuclear Damage

Density shots per km^2 in any 100-km grid square =

$$\frac{\left(\frac{\text{shots} < 10\ \text{KT}}{2}\right) + (\text{shots } 10\text{–}25\ \text{KT}) + 2\,(\text{shots} > 25\ \text{KT})}{10{,}000}$$

thus if there were 20 5-KT, 20 20-KT, and 20 30-KT shots in grid square *KV*, the density for this purpose is $\frac{10 + 20 + 40}{10{,}000} = 0.007$ and percentage decrease is approximately 65 for all LOCs in grid square *KV*.

tended by a loss of some of this equipment. It is further assumed that in ground-combat units only the degree of loss will vary with unit postures, the terrain, and success or failure of unit operations. The tons of organizational equipment lost then equals

$$(\text{Casualties/prior strength}) \times 0.05 \times \text{on-hand tons of II and IV} \times F$$

where F is LFD for SAM, combat-support, and logistics units, or F is LFGND for ground-combat units.

Finally, total II and IV loss due to conventional casualties suffered is the sum of individual equipment lost plus organizational equipment lost.

For the assessment of losses in the Special Class of supply, subroutines are devised in accordance with those items that for each game's purposes are placed in this class for discrete treatment.

Loss of supplies and loss of storage capacity in supply points due to hostile air and ground action, including nuclear, are assessed in the appropriate submodels. The results then update the on-hand data in the Logistics Submodel and line 9 of the MSF, "PRESENT STORAGE CAPACITY."

TABLE 20

Loss Factors (LFGND) for Classes I, II and IV, III, and V

(Ground-combat units only)

Posture	Attacker		Defender			
	Won	Lost	Won	Lost		
				Terrain 1	Terrain 2	Terrain 3
Static	—[a]	—[a]	—[a]	—[a]	—[a]	—[a]
Withdrawal	¼	¼	½	1	2	3
Delay	¼	½	¼	½	1	2
Meeting engagement	¼	½	¼	½	1	1½
Hastily prepared positions	¼	½	¼	½	1	2
Prepared positions	¼	½	⅛	1	1½	2½
Fortified positions	¼	½	⅛	⅜	2	3

[a]In static situations the action consists only of combat-support fires by both sides in which there is no win-lose determination and terrain is immaterial. LFGND is ¼ for both sides in static situations.

If a supply point is overrun or abandoned, a hand assessment and a data change input are required. It is assumed that a tonnage equal to the supply point's LOC capacities could be evacuated before abandonment or capture and transferred to other friendly supply points. The remaining tonnage is then transferred to enemy custody with the usability factors, which reflect a RAC logistical judgment, shown in the accompanying tabulation.

Class	Percent usable by enemy
I	70
II and IV	20
III	80
V	15

Constraints on Resupply. The significant constraint on resupply to offset theater consumption and loss is nuclear damage to LOCs. Generally no overall supply shortages are simulated, and resupply suffers largely from constrained distribution.

Nuclear damage to LOCs is assessed by hand as mentioned in discussion of the cyclic input, "Grid Nuclear." The loss of LOC capacity to be assessed in any grid square is determined by the RAC-developed curve and formula in Fig. 53.

Other Degradations

Special Situations. Data changes submitted by the Logistics Controller may also be used for degradation of LOC capacities due to excessive LOC distances, inadequate communication facilities, or clogging of routes by refugees. They are used to provide reasonable assessments indicative of special situations in the game.

Adequacy of Resupply. The submodel assumes generally that unit IFP and unit CPP become sharply degraded when on-hand supplies of any class drop below two-thirds of the unit's BL. When that happens the submodel issues warning in the Logistics Report that the unit is low on supply (LOS) and identifies the class or classes that are low. This enables players to take remedial action, such as institution of an airlift.

The same warning is issued for supply points when stockage drops below two-thirds of authorized storage.

The degree of degradation for unit IFP and CPP is assessed and applied in the recovery routine, which is discussed later in this text.

Cycle Outputs

The Logistics Submodel printout records the results of logistics data processing for one cycle and constitutes a basis for processing in the next cycle. It consists of the following items, printed separately for RED and BLUE:

Input Capacity Loss Report
Logistics Report
Results of Airlifts
Summary of class III
Summary of class V
Logistics Summary
Replacements Report

Input Capacity Loss Report. This is a listing of units and supply points that have suffered input capacity loss due to nuclear damage to LOCs. Set opposite the unit designations are the amounts (in tons) of capacity loss by cause of loss. Other losses, such as that accomplished by saboteurs, can also be introduced by data changes.

Logistics Report. This is a supply status listing of each unit and supply point being gamed. It shows classes I, II and IV, III, and V consumption (issues) destroyed, required, and received by unit and supply point.

This report also indicates units and supply points that are LOS.

Results of Airlift. If airlift made available is excess to the supplied unit's need, the submodel uses only that amount necessary. The submodel then records (a) consuming unit, (b) lifting unit, and (c) tonnage lifted for classes I, II and IV, III, and V.

Summary of Class III. This is a summary of POL consumed, destroyed, required, and received by all the different subtypes of unit found within the broader categories of units.

Summary of Class V. This is the same for ammunition as the previous item is for POL.

Logistics Summary. This is a summation of classes of supply consumed, destroyed, required, received, and on hand in each of the six categories (air, SAM, etc) of units. It also indicates how many subtype units within each category are LOS by class of supply.

Replacements Report. This item is a listing of units indicating respective individual personnel receipts during the day gamed.

RECOVERY ROUTINE

Introduction

The recovery routine of the Logistics Submodel performs the final computer processing of game data in the game cycle, except for the data-processing phase of the Intelligence Submodel. The data processed are taken from the MSF and other submodels, reflecting the casualties and materiel attrition due to 1 day or one cycle of operations. The recovery routine then updates these data to reflect personnel and materiel replenishment in the cycle. Finally the routine recomputes unit IFP and CPP, based on the updated data, for use in the next cycle.

Description of the Routine

Pregame Preparations. Pregame preparations for the recovery routine consist of reviewing and adjusting routine instructions and reference data to ensure their responsiveness to game requirements. They are the prime responsibility of THEATERSPIEL programmers, in coordination with the client.

The details that must be considered in this phase are indicated in the "Assessments" paragraph.

Cycle Inputs. The routine operates on data available in the MSF or data tables. No player or controller inputs are prepared directly for the routine, either before the game or in the gaming cycle.

Assessments. For the units on the BLUE side, the routine computes the receipt of replacements during the day. The daily replacement rate is normally 2 percent of the units' authorized strengths, with a positive provision against the creation of overstrength. The units' starting strengths, minus casualties assessed in the operational submodels and plus the replacements computed by the recovery routine, are furnished to the MSF, line 9, for ground-combat, combat-support, and logistics units and line 18 for air and SAM units, as the units' present strengths for assessment purposes in the next cycle. Inasmuch as the RED side normally employs a unit replacement system, individual RED replacements are not usually computed.

For ground-combat units the base IFP, which fluctuates with unit strength, is recomputed at the end of each cycle. Authorized base IFP (line 18, MSF), degraded to reflect understrength, is improved to reflect replacements received. Because the preponderance of casualties is in the ground-combat units, the understrength penalty against combat effectiveness is doubled as indicated in the following recomputation formula:

$$\text{Base IFP} = \text{authorized base} \times \left[\frac{(\text{authorized strength}) - (2 \times \text{unit understrength*})}{\text{authorized strength}}\right]$$

When base IFP has been computed the submodel computes armor IFP and classes II and IV IFP. This is done by multiplying tons of armor and tons of II and IV supplies on hand by factors developed before the game, which represent IFP per ton. The sum of base IFP, armor IFP, and classes II and IV IFP is then determined. This sum is then further processed to produce the four posture IFPs that appear on lines 19 to 22 of the MSF.

Further processing reflects the adverse effects on combat effectiveness of insufficient on-hand POL or ammunition. The penalty is assessed because of POL shortage or because of ammunition shortage, according to which shortage is the greater.

The factor used, for either POL or ammunition, is taken from the curve developed at RAC and shown in Fig. 54.

Because the term OH in the Fig. 54 formula is a function of consumption rates, which vary according to unit postures, the formula is computed four times. It is computed with OH reflecting (a) the number of days of POL or ammunition on hand at retrograde posture consumption rates, (b) the defensive posture consumption rates, (c) attack/retrograde rate, and (d) attack consumption rate. The respective results of the four computations are then the four corresponding posture IFPs, printed on lines 19 to 22 of the MSF.

At the end of each cycle the recovery routine recomputes combat-support unit CPPs for assessment purposes in the following cycle.

The first recomputation reflects the unit's personnel strength at the end of the cycle. This takes into account casualties suffered and replacements received.

Next the CPP of combat-support units is modified to reflect any unit storage of POL or ammunition. This is accomplished in the way described previously for the similar degradation of IFP.

The CPP is finally modified to reflect any unit shortage of classes II and IV. In this step Prior Strength (line 10, MSF) is divided into the unit's classes II and IV BL† to determine classes II and IV BL per man (BLPM). Then Present Strength (line 9, MSF) is divided into on-hand classes II and IV (line 13, MSF) to determine on-hand classes II and IV per man (OHPM). If OHPM is less than BLPM,

*Understrength is that understrength remaining after the cycle's casualties have been assessed and the cycle's replacements have been received.

†BL = prior strength × BLF, determined before the game.

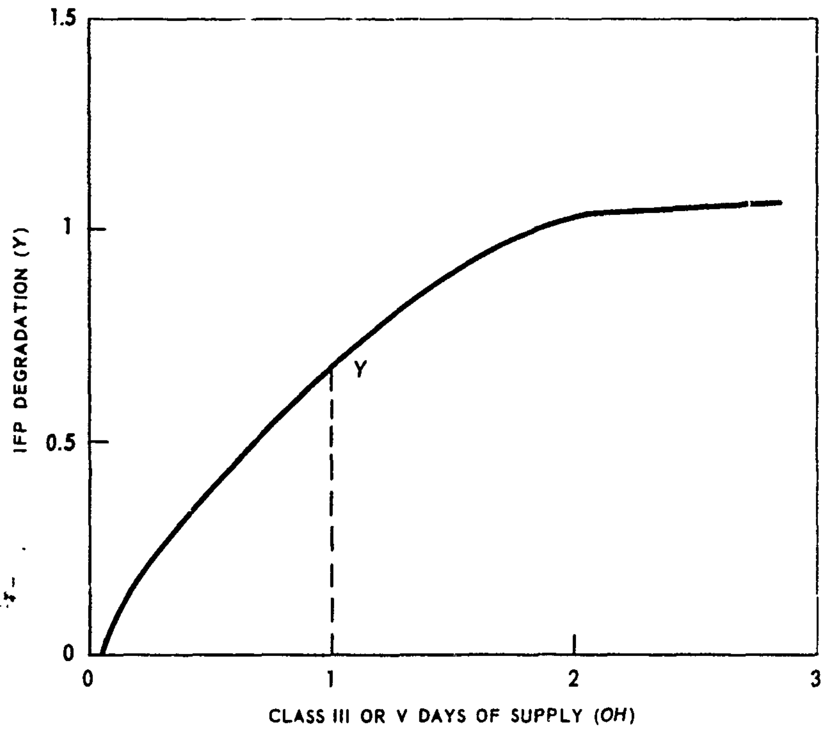


Fig. 54—IFP Degradation Due to Class III or Class V LOS

$$Y = \left(\frac{4.5\,OH\text{-}1}{8}\right)^{3/5} \quad \text{whenever } OH \leq 2 \ .$$

For example, if $OH = 1$ day's supply, then

$$Y = \left(\frac{(4.5 \times 1) - 1}{8}\right)^{3/5} = \left(\frac{3.5}{8}\right)^{3/5} = 0.609.$$

then CPP is modified by OHPM/BLPM and the result is printed out in the MSF as the CPP for use in the following cycle's casualty assessments.

Chapter 8

INTELLIGENCE SUBMODELS

INTRODUCTION

AGGREGATED AND DISCRETE SUBMODELS

Two intelligence submodels are available for theater-level war gaming, the Aggregated Submodel and the Discrete Submodel. Both are derived from similar principles but are employed separately, with a single submodel used in each game.

Both submodels are designed to simulate the employment of intelligence resources by opposing forces, generating combat intelligence. They define the environmental constraints (enemy, geography, weather) affecting the operations of intelligence resources. They indicate the type and amount of intelligence information received and the extent of attrition of intelligence resources. Data produced by the submodels provide gaming participants a measured estimate of enemy dispositions on a map overlay and a periodic intelligence report, or spot reports of important events that reflect a standard of intelligence based on military operations.

PURPOSE AND SCOPE

Intelligence Production. The purposes of the intelligence submodels are to establish a logical method for the production of intelligence data during simulated combat and to provide military gaming participants realistic intelligence for the conduct of gaming operations.

Submodel Capabilities. The Aggregated Submodel employs aggregated tables of detection probabilities to yield intelligence data capable of sustaining gaming operations. It is generally used with the THEATERSPIEL Model, particularly when there is a premium on time for the overall conduct of the game. Selection of the Aggregated Submodel for gaming is predicated on assumptions that (a) aggregated probability of detection factors are acceptable for the production of simulated intelligence and (b) intelligence data generated from play will not be used to analyze intelligence systems.

The Discrete Submodel employs individual sensors and unit detection in a more complex methodology for sustaining the game. It provides game intelligence through individual sensor acquisition of targets, and detections may be subjected to detailed analysis.

Simulation of the Intelligence Cycle. Both submodels are designed to simulate the four-step intelligence cycle: (1) planning the collection effort and orders, (2) collecting information, (3) processing collected information, and (4) disseminating and using the resulting intelligence.

THE AGGREGATED SUBMODEL

METHODOLOGY

Aggregated Submodel Concepts. The basic premise of this submodel is that the expected results of all intelligence sensors, air and ground, may be aggregated and provide target detection and identification probability factors adequate to sustain realistic game operations. Game intelligence is produced by the cyclical application of these probability factors to each unit being gamed.

Game intelligence is the outcome of the selection of units for detection, a more exact refinement of detections to note the quality of detection, the correlation of latest detections with prior detections to update results, the infusion or degradation factors to simulate losses in transmitting intelligence from sensor to user, and the preparation of intelligence maps and reports based principally on detections of forces' dispositions.

Target Characteristics and Status of Activity. The Aggregated Submodel recognizes that physical characteristics of targets (their strength, deployment, number of vehicles and weapons) and rate of movement or immobility (status of activity) contribute to their probability of detection. Probability factors are altered as targets move and function, and varied factors are assigned elements that are "active," "inactive," or making an "administrative move."

Target units are classified as to type, subtype, and nationality as described in Chap. 2. The physical characteristics of each category of unit are considered in establishing basic detection probability factors. As mentioned in Chap. 2, nationality may be utilized in the normal sense or, alternatively, to differentiate between units of a single subtype having different characteristics (see Table 21).

Units are active as they perform their primary role, e.g., fighting, firing, flying, radiating, constructing, and receiving and issuing supplies. In this status, concealment is considered a secondary aspect of the mission.

Inactive units are those whose primary mission is to avoid detection. They do not perform primary or other combat roles while in this status. Reserve forces and unopened supply and headquarters installations are typical examples of inactive units.

Administrative move applies to night movement by units. A similar daylight movement subjects an organization to detection as an active unit.

TABLE 21

Example of Subtype Nationality Designators for Combat-Support Units

Unit designator	Size and type of artillery group	Number of similar units	Subtypes	Nationality
R2801–R2803	3 battalions, 122-mm	3	1	1
R2904–R2931	5 battalions, 122-mm	28	1	2
R2732–R2741	2 battalions, 152-mm	10	2	1
R2842	3 battalions, 152-mm	1	2	2
R2943–R2944	4 battalions, 152-mm	2	2	3
R2845–R2854	2 battalions, 130-mm	10	3	1
R2955–R2957	3 battalions, 130-mm	3	3	2
R2858–R2867	3 RL battalions, 140-mm, 1 RL battalion, 240-mm	10	4	1
R2968–R2971	4 RL battalions, 240-mm, 1 RL battalion, 140-mm	4	4	2
R2872–R2881	4 battalions, FROG	10	5	1
R2982–R2985	5 battalions, FROG	4	5	2
R2686–R2689	3 brigades, SS-1	4	6	1
R2790–R2791	4 brigades, SS-1	2	6	2
R2892–R2894	2 battalions, SS-2	3	6	3
R2995–R2997	1 regiment, SSC-1	3	6	4

[a]In this table there are six OB subtype groupings under the combat-support units: the 122-mm, 152-mm, 130-mm, rocket launchers (RL), FROG (free rocket over ground), and combined SS-1 and SSC-1 unit groupings. The inclusion of nationality indicators (the third figure in the five-unit designator) is a further contribution to exactness. Variations in strength, number and type of weapons, and unit organization between similar types of unit are determined more precisely through the use of the combined subtype and nationality indicators.

Intelligence Zones. Game terrain maps are divided into zones of similar size on both sides of the FEBA, with zone boundaries paralleling the front line. An example of zoning is in Fig. 55.

Use of zonal target locations is based on the concept that unit detection probabilities are reduced as unit distances from the FEBA are increased. The Aggregated Submodel performs this by lowering detection probability factors as units fall into zones farther removed from the FEBA.

The depths of zones are generally influenced by troop deployment, aircraft operational ranges, and characteristics of intelligence sensors. In theater-level operations with the Aggregated Submodel, zonal depths are usually the depths of forces being played, with zone rear boundaries 40, 100, 300, and more than 300 km from the FEBA corresponding to depths of the divisions, corps, army, and the area to the rear of the army rear boundary.

Quality of Target Detections. Four levels of target detections, ranging from the particular to the indistinct, provide an ample cross-section of intelligence detections. They can be acquired through a two-step process of random

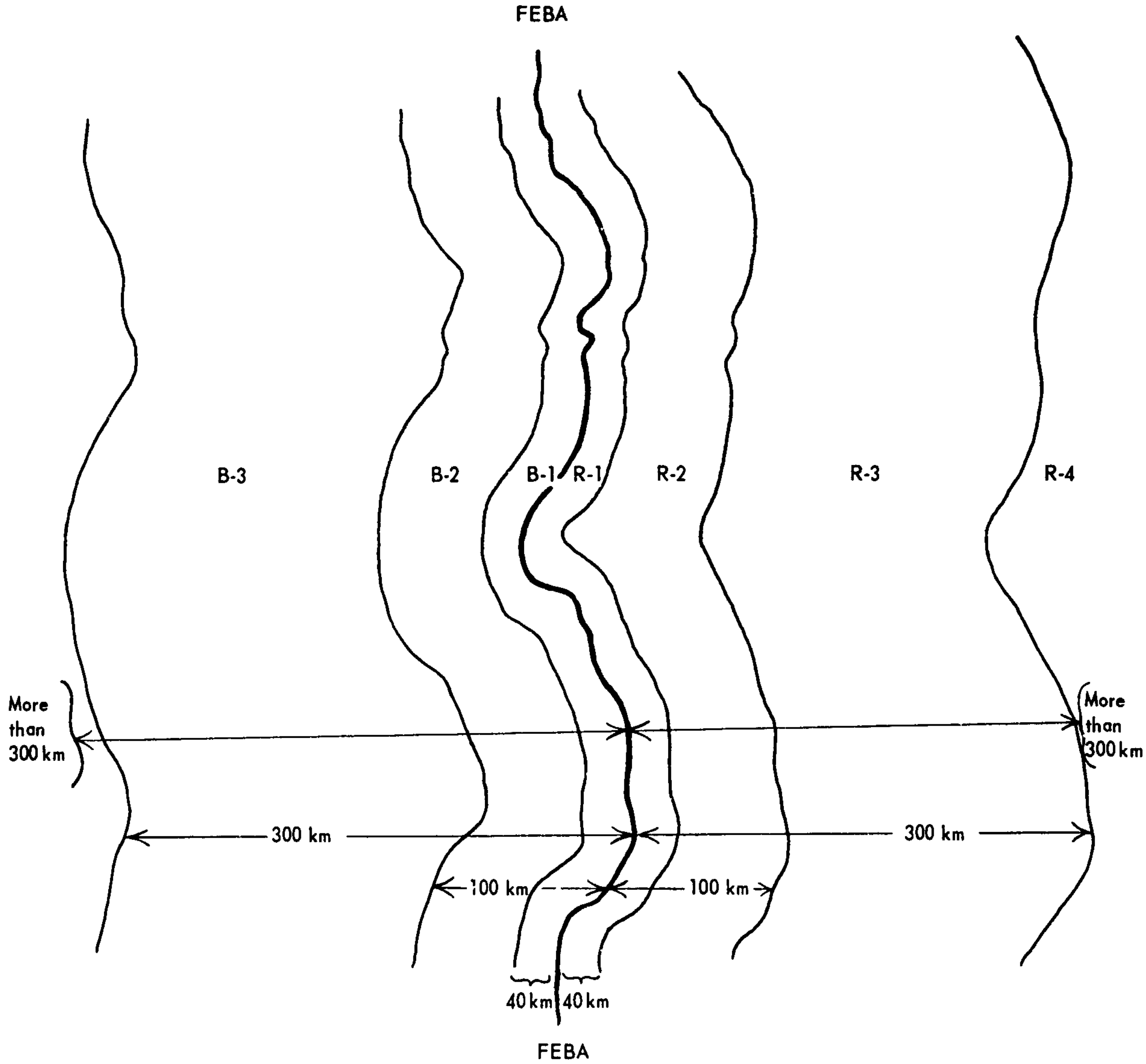


Fig. 55—Aggregated Submodel Intelligence Zones

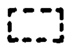
B = BLUE	R = RED
B-1 = BLUE Zone 1	R-1 = RED Zone 1
B-2 = BLUE Zone 2	R-2 = RED Zone 2

selection of detected units. This is accomplished by first applying random selection factors to units detected to establish whether the type of detection is "particular," "general," or "unknown." The same process is repeated (with different factors) to determine the unit size, expressed as "particular" or "unknown." The quality of detection is then graded on the scale indicated in Table 22.

From Table 22 it can be determined that TP (type particular) describes an actual unit arm or function, as air, SAM, infantry, armor; SP (size particular)

TABLE 22

Levels of Quality of Target Detections for Aggregated Submodel

Quality of detection	Unit type and size code	Target description	Derivation of detection from target description	Example of map symbol
1	TP-SP	Type particular, size particular	TP-SP Infantry division	
2	TG-SP	Type general, size particular	TG-SP Ground division	
3	TG-SU	Type general, size unknown	TG-SU Ground concentration	
4	TU-SU	Type unknown, size unknown	TU-SU Enemy concentration	

indicates a definite unit size, as company, battalion, regiment, division; TG (type general) is the general role of a unit, as ground or air; TU (type unknown) represents an unidentified type of unit and is designated as "enemy"; and SU (size unknown) is a unit of unidentified size, designated as "enemy concentration."

Weather. To simulate realistic weather conditions, recorded weather experience data (cloud condition, ceiling, precipitation, and visibility) for the geographic area of game play are utilized. Forecast and current weather conditions are incorporated in periodic weather reports during game play.

The submodel considers essentially only two aspects of weather as degrading the basic aggregated detection factors. These are visibility and operability of aerial platforms carrying sensors.

Attrition of Target Detection Means. Attrition of target detection means and resultant loss of effectiveness are considered to occur at the same rate as the loss of effectiveness in combat forces.

Time Delay in Processing and Disseminating Intelligence. Delays in processing and disseminating intelligence are simulated by incorporating a degradation factor in aggregated tabular probabilities governing the quality of detections.

Role of Intelligence Controller. The Intelligence Controller prepares game inputs, interprets outputs, posts intelligence maps, prepares periodic intelligence reports (PERINTREPTS), and provides decisions, within predetermined limits, concerning game intelligence activities. He is comparable with the staff intelligence officer for both player teams, representing, as necessary, each echelon of command within opposing forces.

DESCRIPTION OF SUBMODEL

Pregame Preparations

Preliminary. Before initial preparations for the game, game operators and their sponsoring agency must have a mutual understanding of goals to be achieved through intelligence play and intelligence factors to be used. Sponsors must be aware of the capabilities of the Aggregated Submodel. The Intelligence Controller must know the game purpose, scope, objectives, and basic assumptions and have available the rules to be followed, the constraints of any type, the troop order of battle (OB) and installation lists, operational situations, and data essential to measuring and factoring submodel inputs.

Specific preliminary tasks that must be performed include:

(a) Specification of the number and dimensions of the intelligence zones to be employed. The computer programs will accept as many as six zones of any predetermined depth. However, four zones, as illustrated in Fig. 55, are normally employed in games of division-level resolution.
(b) Determination of theater weather conditions that will be simulated during game play.
(c) Confirmation of OBs and unit type/subtype/nationality designators to be employed.
(d) Determination of the degree of control judgment authorized with respect to play of decoys,* spurious targets,† specific reconnaissance requests, and the play of agents or other unusual intelligence operations.

Data Tables. Based on data provided by the client or available within RAC, the following tables are prepared.

Basis detection probability table. This table contains the aggregated unit detection probabilities based on unit category, unit activity, and zone. Table 23 provides an example of a portion of this data array.

Visibility table. Degradation of detection is considered in terms of percentage loss to the basic detection probabilities under various conditions of

*Decoy target is a deception to attract sensor attention from existing units or installations. It is introduced by player's request to the Intelligence Controller.

†Spurious target is a false, nonexistent unit introduced into the submodel by the Intelligence Controller to simulate erroneous detections that occur in combat.

light. This decrease is reflected in degradation factors, which depend on the zonal locations and activity status of the unit. Table 24 provides an example of the relation of weather conditions, coded inputs to reflect these conditions, and degradation factors applied.

TABLE 23

Example of Basic Detection Probabilities

(In percent)

Activity	Zone	Subtype 1			Subtype 2			Subtype 3		
		Nationality 1	2	3	1	2	3	1	2	3
Active	1	50	45	50	45	45	50	60	50	60
	2	25	25	25	25	25	25	35	35	45
	3	15	10	10	10	10	10	25	30	35
	4	5	5	5	5	5	5	10	20	20
Inactive	1	20	20	20	20	20	30	35	30	35
	2	10	10	10	10	10	10	15	25	25
	3	5	5	5	5	5	5	10	15	15
	4	5	5	5	5	5	5	5	5	5
Administrative move	1	30	30	30	30	30	35	35	35	35
	2	10	15	15	15	15	20	30	30	35
	3	5	5	5	5	5	10	10	15	15
	4	5	5	5	5	5	5	10	10	10

Aerial platform operability table. These factors relate aircraft operability in zonal areas to existing weather conditions. Apart from visibility,

TABLE 24

Example of Visibility Factors

Weather conditions and weather	Code	Factors by zone: 1, Unit active	1, Unit inactive	2, Unit active	2, Unit inactive	3, Unit active	3, Unit inactive	4, Unit active	4, Unit inactive
Sunlight, 3 to 15 miles	S	1	1	1	1	1	1	1	1
Light precipitation in daylight, 1 to 3 miles	L	0.7	0.6	0.8	0.7	0.8	0.7	0.8	0.7
Clear night	C	0.6	0.5	0.7	0.6	0.7	0.6	0.7	0.6
Dense fog or heavy precipitation, less than 1 mile	F	0.5	0.4	0.6	0.5	0.6	0.5	0.6	0.5

helicopters (hels), light fixed-wing aircraft (FWA), and high-performance aircraft (HPA) will be ineffective at various levels of weather adversity. The inability of any one or any combination of these categories of aircraft to perform normal reconnaissance missions results in a degradation of the overall detection capability, as illustrated in Table 25.

TABLE 25

Example of Aerial Platform Operabilities Factors

Operability condition	Code	Factors by zone			
		1	2	3	4
All aircraft "go"	A1	1	1	1	1
HPA ineffective	A2	0.9	0.7	0.6	0.5
FWA ineffective	A3	0.8	0.6	0.5	0.3
All aircraft ineffective	A4	0.7	0.5	0.4	0.3

Decoy detection probability table. This table contains the percentage probability of detecting decoy targets by type and zone. An example is presented in Table 26.

TABLE 26

Example of Decoy Target Probability of Detection Factors

(In percent)

Type unit	Zone			
	1	2	3	4
Air	75	60	45	30
SAM	75	60	30	10
Combat support	50	25	10	5
Ground combat	80	65	30	10
Logistics	80	45	35	25
Supply point	30	25	15	15

Quality of detection table. This table is used, following determination of a detection, to establish the quality of the detection. Table 27 provides an example of this table.

The foregoing tables, when completed, are coded for insertion in the computer program.

Preparation of Initial Detection File. In order to provide intelligence for the initiation of game play the Intelligence Controller manually determines whether units have been detected. With these detections and with information from the forces' general and special situations, realistic intelligence reports are prepared for both forces.

TABLE 27

Example of Numbers for Random Selection of Unit Quality of Detection

Unit category	Random numbers			
	00–11	12–46	47–85	86–99
	Quality of detection			
	Type particular, size particular	Type general, size particular	Type general, size unknown	Type unknown, size unknown
	Description of detection			
Air	Fighter division	Air division	Air concentration	Enemy concentration
	Reconnaissance wing	Air wing	Air concentration	Enemy concentration
SAM	Hawk battalion	SAM battalion	SAM concentration	Enemy concentration
	SA-2 regiment	SAM regiment	SAM concentration	Enemy concentration
Combat support	Howitzer battalion, 122-mm gun	Combat-support battalion	Combat-support concentration	Enemy concentration
	Artillery battalion, 155-mm howitzer	Combat-support battalion	Combat-support concentration	Enemy concentration
Ground combat	RED mechanized rifle division (MRD)	Ground-combat division	Ground-combat concentration	Enemy concentration
	Armored division	Ground-combat division	Ground-combat concentration	Enemy concentration
Logistics and headquarters	Corps headquarters	Ground headquarters	Ground concentration	Enemy concentration
	Field army support command headquarters	Logistics headquarters	Logistics concentration	Enemy concentration
Supply point	Division supply point	Supply point	Supply concentration	Enemy concentration
	Corps SASP	SASP	Supply concentration	Enemy concentration

After initial manual detections have been produced they are placed on magnetic tape for subsequent use during the computer-processing phase of the submodel. Thereafter, intelligence detections are processed by the computer.

The action and coordination required of the Intelligence Controller to place day-before-D-day detections in the computer and make detections available to players preparing D-day orders are in Table 28. A detailed explanation of inputs and assessments mentioned in Intelligence Controller pregame action and coordination is in the sections "Cycle Inputs" and "Assessments."

TABLE 28

Pregame Actions and Coordination by Intelligence Controller for Aggregated Submodel

Action	Coordination	Purpose
Prepare intelligence zones, placing zone boundaries on Master Intelligence Map (Fig. 55)	Chief controller	For information
Prepare Intelligence OB Work Sheet (Fig. 56) and make entries	—	—
Post Master Intelligence Map; place Master Situation Overlay over map	Intelligence control group	Post Master Intelligence Map using unit locations on Ground Controller's map
Enter location, zone, and status of activity of units on OB Work Sheet	—	—
Subject each OB unit to random selection regarding detection probability according to zone and activity; where detection is obtained, make second random choice (with applicable factors) for quality of detection; post results on OB Work Sheet and place corresponding detection sticker (on Situation Overlay) over unit symbol on Master Intelligence Map	Intelligence assistants	One assistant calls unit from OB Work Sheet and records resulting detection for that unit; second assistant posts noted detection symbol on Situation Overlay, covering basic unit detected (on map) with detection symbol on overlay
Furnish data on Intelligence OB Work Sheet to programmer, using Intelligence Detection File "Nomodel Change Form Work Sheet" (Fig. 57)	Programmer	Assemble input data for computer
Arrange for printout of pre-D-day inputs; forward printouts (with enemy detections) and daily weather report to controller and players	Each controller group	Receive copy of D-day weather report
	BLUE and RED player groups	Receive D-day weather report and applicable (BLUE or RED) enemy situation overlay accompanied by detection printout
Prepare D-day intelligence inputs: (a) Zone Cards (Data) (Fig. 58); (b) Zone Define Cards (Fig. 59); and (c) Spurious, Decoy, or Special Features Cards (Fig. 60)	Programmer	Prepare Initializing Master Status and Intelligence Files input tape

With the completion of pregame preparations, the acquisition and dissemination of day-before-D-day detections, and the introduction of intelligence

Intelligence Order of Battle
Worksheet

Game [2] ___________

BLUE-RED[1]

Designation of Unit or Installation		Unit[5] Grid Location	Zone in[6] Which Unit is Situated	Status[7] of Unit Activity	Quality[8] of Unit Detection
T/O[3]	Printout[4]				

[1] Cross out inapplicable word.
[2] Enter abbreviated game designation.
[3] Group units by Table of Organization title, under category headings, as Air, SAM, Cbt Spt, Gnd Cbt, Log or Supply.
[4] List five-digit unit designators.
[5] List grid designator (as NB32, NA51).
[6] Number of zone in which unit is situated (1, 2, 3 or 4).
[7] Status of unit Activity (Active, Inactive, Administrative Move).
[8] Quality of unit detection (1, 2, 3 or 4).

Fig. 56—Order of Battle Work Sheet

Intelligence Detection File

NOMODEL CHANGES

BLUE – ~~RED~~[1]   Game[2] TR-2   Period[3] D + 1 AM

Unit Designator[4]

1	2	3	4	5	6
B	2	0	9	5	
B	2	0	6	8	
B	3	0	1	2	
B	2	6	6	5	
B	3	0	2	1	
B	3	0	3	0	
B	3	0	3	4	
B	2	6	1	5	

Unit Location[5]

8	9	10	11	12	13
M	A	6	2		
0					
M	A	1	4		
N	A	3	5		
M	A	1	9		
M	B	1	7		
M	C	1	3		
M	A	7	3		

Status of Unit Activity[6]

15	16	17	18	19	20
A	C	T	I	V	E
0					
A	C	T	I	V	E
I	N	A	C	T	I
A	C	T	I	V	E
A	C	T	I	V	E
A	C	T	I	V	E
A	C	T	I	V	E

Type Unit Detection[7]

22	23	24	25	26	27
S	P	T			
0					
I	N	F			
S	P	T			
G	N	D			
I	N	F			
I	N	F			
S	P	T			

Size Unit Detected[8]

29	30	31	32	33	34
B	N				
0					
D	I	V			
C	O	N	C		
D	I	V			
D	I	V			
D	I	V			
B	N				

Zone in Which Unit Is Located[9]

36	37	38	39	40	41
					2
					0
					1
					3
					1
					1
					1
					3

Quality of Detection[10]

43	44	45	46	47	48
					2
					0
					1
					3
					2
					1
					1
					2

Detection Serial Number[11]

50	51	52	53	54	55
					5
					0
					8
				1	1
				1	3
				1	4
				1	5
				1	9

[1] Cross out inapplicable word.
[2] Enter abbreviated game title.
[3] Enter period of play.
[4] Fill in five-digit unit designator (B2095) oriented on left column (1).
[5] Fill in two-letter two-numeral grid location of unit (MA62) or zero-out unit. Orient entry to left column (8).
[6] Status of unit activity (ACTIVE, INACTIVE, or zeroed out). Orient entry on left column (15).
[7] Enter specific unit detection (AIR, SAM, SPT, GND, LOG, SUP, MR, MECH, INF, ARM, ARTY, SA2, EN, NIKE, HAWK, TRP) orienting entry to left column (22).
[8] Enter specific size of unit detected (BN, REGT, DIV, WING, CONC, or zero out) oriented on left column (29).
[9] Fill in intelligence zone in which unit is located (1, 2, 3, 4, or zero out). Orient entry to right-hand column (41).
[10] Enter quality (level of resolution) of detection (1, 2, 3, 4, or zero out). Orient entry to right column (43).
[11] Enter serial number given unit detect on in printout, orienting number to right-hand column, or zero out.

Fig. 57—Nomodel Change Card Work Sheet

ZONE CARD (DATA)
WORK SHEET

Zone No. 1 BLUE – ~~RED~~[2] Game[3] TR-2 Period[4] D + 1 AM

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Card 1[5]						1																						
Card 2[6]	N	B	—	—	—	—	—	1																				
Card 3	N	C	—	—	—	—	—	0	1	1	0	0	1	1	0	0	1	1	1	0	1	1	1	1				
Card																												
Card																												

Sub-Grid and Designators

9	10	11	12
13	14	15	16
17	18	19	20
21	22	23	24

Above is an example of a geographic grid with 16 parts, each part being 2.5 km square. Squares are numbered to correspond to columnar headings on the Zone Card (Data). A corresponding template (of transparent material) is placed over each map grid to determine visually the zone in which 500-grid segments are located.

[1] Fill in Intelligence Zone number (1, 2, 3, or 4).
[2] Cross out inapplicable word.
[3] Fill in abbreviated game title.
[4] Fill in period of play.

[5] Card 1 is start of Zone input, indicated by placing zone number under Column 6. As Zone changes, indicate by starting new Card 1, with changed zone number in heading.

[6] Indicate grid designation in Columns 1 and 2 (as NB, ND, MA, etc.). Where all of grid is in Zone, indicate by placing 1 (Yes) in Column 8. Where part of grid is in Zone, indicate by placing 0 (No) in Column 8, and 1 (Yes) or 0 (No) where sub-grid is (or is not) in Zone. Start with Column 9, filling in through Column 24. (See example of sub-grid above.)

Fig. 58—Zone Card (Data) Work Sheet

ZONE DEFINE CARD WORK SHEET

BLUE – ~~RED~~[1] Game[2] TR-2 Period[3] D + 1 AM

Card[4]	Zone No.[5]		Zone Width[6]			Zone Depth[7]			Vis.[8]	Operability[9]	
	5	6	28	29	30	34	35	36	42	47	48
Card 1		1	3	0	0	0	4	0	S	A	1
Card 2		2	3	0	0	1	0	0	S	A	1
Card 3		3	3	0	0	3	0	0	S	A	1
Card 4		4	3	0	0	6	0	0	S	A	1

[1]Cross out inapplicable word.
[2]Enter abbreviated game title.
[3]Enter period of play.
[4]Enter Card Number (corresponding to Zone Number) with separate card for each zone.
[5]Enter Zone Number for each card, starting entry with right-hand column (Col. 6).
[6]Enter Zone Width in km, orienting figure on right-hand column.
[7]Enter Zone Depth (from FEBA to rear boundary of zone) in km, orienting figure in right-hand column.
[8]Enter weather condition (S—Sun; L—Light precipitation, C—Clear night; F—Dense fog or heavy precipitation).
[9]Enter operability indicator (A1, A2, A3, A4) according to effect of weather on aircraft operations and sensors. A1 indicates all aircraft and sensors fully capable; A2 indicates degradation to Army helicopter effectiveness; A3 notes degradation to all Army aircraft; and A4 indicates all aircraft are ineffective.

Fig. 59—Zone Define Card Work Sheet

RAC

SPURIOUS, DECOY, OR SPECIAL FEATURES CARD WORK SHEET

BLUE – ~~RED~~[1]   Game[2] TR-2   Period[3] D + 1 AM

Card No.[4]	Zone[5]		Location[6]				Type Unit[7]			Type Target[8]						Activity[9]					
	7	8	11	12	13	14	21	22	23	31	32	33	34	35	36	41	42	43	44	45	46
Card 1		2	M	A	6	2	G	N	D	S	P	U	R			A	C	T	I	V	E
Card 2		4	P	C	4	5	S	A	M	D	E	C	O	Y		A	C	T	I	V	E
Card 3		3	M	B	1	4	S	P	T	A	R	T	Y	B	N	A	C	T	I	V	E
Card 4		1	M	A	1	6	G	N	D	A	R	M	O	R		I	N	A	C	T	I
Card 5		2	P	D	1	3	L	O	G	B	R	I	D	G	E	I	N	A	C	T	I

[1]Cross out inapplicable word.
[2]Enter abbreviated game title.
[3]Enter period of play.
[4]In this column indicate Card No., in sequence.
[5]Enter Zone Number for each card, starting with right-hand column (8).
[6]Enter two-letter two-digit grid location (MA62) of target.
[7]Enter general category of unit or installation target (AIR, SAM, SPT, GND, LOG, SUP).
[8]Enter type target (SPUR or DECOY), or nomenclature of special features target, using no more than six letters. Start entry with left column (31).
[9]Enter status of target activity (ACTIVE or INACTIVE only, no Admin Mov) filling all columns from left.

Fig. 60—Spurious, Decoy, or Special Feature Card Work Sheet

inputs for D-day operations,* the Aggregated Submodel is prepared for the routine of daily gaming, which is discussed in the following paragraphs.

Cycle Inputs

Intelligence Controller Inputs. With the Aggregated Submodel activated and the game under way, the Intelligence Controller furnishes four basic inputs at the conclusion of each cycle of play to keep the submodel abreast of operations. The four inputs are submitted on work sheets, whose numbered columnar headings correspond to numbered headings on machine punch cards. The work sheets are forwarded to the programmer, who transfers data from them to machine punch cards. Information submitted on work sheets includes data for preparation of Zone Cards (Data); Zone Define Cards; Spurious, Decoy, or Special Feature Cards; and the Intelligence Detection File Nomodel Change Cards, which are described in greater detail in following paragraphs.

Zone Cards (Data). A correspondence between unit locations of the game map and intelligence zones is established for use by the computer program through input cards called Zone Cards (Data), which, using map grid letters (as NB, MA, GC) and a 16-square subgrid, introduce map segments 25 km square into the computer. Separate Zone Card (Data) Work Sheets are prepared for each intelligence zone, thus aligning segments of the map (through grid and subgrid designators) in proper locations in each intelligence zone. The preparation of the Zone Card (Data) Work Sheet is explained in Fig. 58.

Zone Define Card. The Zone Define Card conveys two distinct categories of information to the computer: (1) the dimensions, in kilometers, of each intelligence zone (width from flank to flank and depth from the FEBA to the rear boundary of each zone) and (2) notations that codify, for computer usage, the influence of weather on visibility capabilities of sensors and on the operation of aircraft. Controller use of the Zone Define Card Work Sheet is described in Fig. 59.

Spurious, Decoy, or Special Feature Card. The Aggregated Submodel is capable of assessing spurious targets,† decoy targets, or player requests for specific reconnaissance through use of Spurious, Decoy, or Special Feature Cards. These cards give the zone and location of targets introduced into play by the Intelligence Controller, the category of unit (as air, SAM, ground combat), the special feature introduced by the controller (spurious, decoy, or units designated for possible detection), and the status of target activity.

Information on the cards is processed by random selection for detection or nondetection, following all other units in each zone. Detections are noted at the third or fourth level of resolution to maintain the elements of uncertainty in intelligence detections.

Details of the preparation and use of Spurious, Decoy, or Special Feature Cards are in Fig. 60.

*Tables and factors required for computer processing must be made known to the programmer sufficiently in advance for them to be introduced in the program.

†Spurious targets are always shown as having been detected but are assessed in the submodel routine to determine whether their detection is at the third or fourth level of quality.

Nomodel Change Card. Daily inputs by the Intelligence Controller, influencing the Intelligence Detection Status File, are accomplished through the Nomodel Change Card. The purpose of the Nomodel Change Card is to update unit locations, to remove units no longer in the area of operations, and to make changes in unit activity, characteristics, and level of resolution. The Nomodel Change Card is described in Fig. 57.

Card Preparation for Each Cycle of Play. The use of all four types of input may be unnecessary for each cycle of play. When there is no change to the FEBA, redefinition of zone boundaries is unnecessary, and preparation of Zone Cards (Data) Work Sheets may be eliminated since cards from the previous cycle may be used. Slight changes in weather may result in no alteration to visibility and aircraft operability factors, making unnecessary the filing of Zone Define Card Work Sheets. Should there be no requirement, or a part requirement, for inclusion of spurious, decoy, or special feature targets, completion of all or part of the Spurious, Decoy, or Special Feature Work Sheets may be dispensed with. It is seldom that there are no changes in unit locations and status of activity during a cycle of play. Such changes necessitate the manual submission of Nomodel Change Card Work Sheets to reflect properly the location and status changes in the submodel before play of the next cycle.

Assessments

Controller and Computer Assessment Operations. Intelligence Controller actions and submodel routines for each cycle of play are outlined in the following paragraphs. References to targets, installations, and OB units apply equally to forces on each side of the FEBA.

Step 1. The selection of unit locations, by zone, is activated by the submodel routine, using Zone Data Card inputs that trigger the extraction of OB units from the Master Status File (MSF) and consolidate units in an Intelligence Target Storage Table according to their zonal location. This table serves as a check to eliminate the possibility of a unit being considered for detection in more than one zone and ensures that only one detection factor will be applied to each unit in its zonal location.

Step 2. Concurrently with step 1, the submodel routine stores an activity status and aggregated detection probability to be applied to each OB unit. Detection probabilities are stored in separate tables for each force (BLUE and RED) by zone and for each unit's status of activity.

Step 3. The computer routine next assesses inputs from the Zone Define Card. These inputs serve two purposes. They define the width and depth of intelligence zones. They reflect detection degradation factors, caused by the influence of weather on reconnaissance aircraft and the capabilities of both BLUE and RED reconnaissance aircraft to perform reconnaissance missions. These degradation factors modify probabilities of detection noted in step 2.

Step 4. The submodel routine, influenced by the introduction of tables in prior steps, subjects the Target Detection Status File to random selection within the computer to obtain unit and installation detections.

Step 5. Detections are subsequently subjected to a computer routine that calls in a table that determines, through random-number selection, the level of quality of each detection on a gradation of 1 (highest) to 4 (lowest). Resulting graded detections are stored in the Intelligence Detection Status File, which lists units, their location, status of activity, and quality of detection. In subsequent periods the repeated detection of units previously acquired, and with no lapse between detections, increases their quality one grade with each subsequent detection.

Step 6. The submodel routine then examines the Intelligence Target Storage Table (step 1) to pair units by size and type with detections made in the assessment process in step 5. Resulting detections are transferred to intelligence printouts.

Spurious, Decoy, and Special Reconnaissance Requests. During the assessment routine, spurious and decoy targets and specific reconnaissance requests are assessed in the submodel routine following the assessment of OB units. If decoy targets are detected they are reported at the third or fourth quality level of detection. Special reconnaissance requests receive individual handling by the Intelligence Controller. If special reconnaissance request target coordinates are detected at Quality Level 4, a negative report is made to players by the Intelligence Controller. Similar targets detected at Quality Level 3 cause the Intelligence Controller to examine the Master Intelligence Map within a radius of 10 to 20 km of the target coordinate. If other targets in the area were not detected in the computer routine, they are given a Quality Level 3 detection if within 10 km of the special reconnaissance request coordinate, or a Quality Level 4 if they were between 10 and 20 km. If other types of target in the special reconnaissance request area were detected in the computer routine, their quality of detection is raised one level. This information is furnished to players by an Intelligence Controller hand notation on the player printout.

Sequence of Intelligence Computer Run. Aggregated intelligence detections depend on the location of gamed units and installations in relation to the FEBA. Accordingly the Aggregated Submodel follows other submodel computer runs after the latest data on gamed elements (their status, characteristics, and location) are in the MSF.

Cycle Outputs

Intelligence Controller Action. The game output cycle starts with delivery of computer printouts and is continued with the preparation of Intelligence Situation Overlays and accompanying PERINTREPTS. It is concluded, for the Intelligence Controller, with updating player team Situation Overlays, distributing PERINTREPTS to respective player teams, and preparing required game reports.

Computer Printouts. Computer printouts furnish intelligence information to the Intelligence Controller and game players, in separate printouts, as follows:

(a) To each player team, through Intelligence Controller: enemy detections, listing detection designator, detection location, and level of resolution.

(b) To Intelligence Controller: enemy detections of both forces, by zone, listing detected unit serial number, unit location, level of resolution, and actual nomenclature of detected units.

(c) Results of Spurious, Decoy, and Specific Reconnaissance Requests in the form of detections.

(d) Detections for both forces by unit category (as air, SAM, ground combat, combat support) and delineated to show individual unit designation, quality of unit detection, zone of detection, and actual unit location.

(e) A Target Storage List containing unit designations, unit activity, new and old locations, strength, and quality of detection (type and size indicators).

Preparation of Intelligence Maps and Reports. Enemy situation overlays are prepared by the Intelligence Control Group as a Master Intelligence Overlay and by BLUE and RED player teams on their respective overlays, taking unit detections from the printout and duplicating them on respective Control and BLUE and RED overlays.

The Intelligence Controller's completed overlay is next coordinated with Ground and Logistics Controllers' after-battle Operations and Logistics Maps. Unit detections on the Intelligence Overlay are moved, as necessary, to coincide with Operations and Logistics after-battle unit locations on the Operations and Logistics Maps.

BLUE and RED segments of the Master Intelligence Overlay, incorporating after-battle detection locations, are next coordinated with respective player team Situation Overlays, on which detections are updated to correspond to those on the Intelligence Overlay.

Concurrently with map posting, a member of Intelligence Control Group has prepared PERINTREPTS for each player team, based on Ground Control's written or verbal summary of action, player orders, before- and after-battle maps, and the printout. Each PERINTREPT contains a brief summary of the enemy situation and enemy operations based on printout detections and Ground Control's summary; an estimate of enemy casualties obtained from printout casualties plus a percentage deception factor; an estimate of enemy equipment damaged and destroyed based on printout figures plus a percentage deception factor; a statement of enemy capabilities and vulnerabilities derived from unit status, location, and force objectives; and a weather forecast for the subsequent period. The PERINTREPT accompanies or precedes distribution of the Situation Overlay to player teams.

THE DISCRETE SUBMODEL

METHODOLOGY

Discrete Submodel Concepts. The Discrete Submodel uses a combination of aggregated and discrete means for obtaining intelligence information. The submodel first requires that all targets in the theater of operations be subjected to aggregated detection probabilities to simulate target acquisitions by ground sensors, as in the Aggregated Submodel. Then, in areas of the theater overflown by aerial sensors, targets are assessed individually to simulate discrete aerial inspection. Aerial reconnaissance, in areas overflown, is thus capable of corroborating or enhancing the quality of ground-acquired detections and may produce additional targets that were unobserved by ground sensors.

The resulting acquisition of simulated battlefield information, and subsequent production of intelligence, duplicates the four-step intelligence cycle to sustain gaming operations. Additionally, as a result of discrete methods of target acquisition, the Discrete Submodel generates data that are not produced by the Aggregated Submodel. Such data can be a gage of sensor effectiveness in the collection of intelligence information.

A discussion of submodel components that influence target detections is presented in sections that follow. The components are: target characteristics, intelligence zones, quality of target detections, and the effect of weather on detections, aircraft, and aerial sensors.

Target Characteristics and Status of Activity. Target acquisitions simulated by ground and aerial sensors are based on probabilities of detection of units and installations. Probabilities of detection consider target characteristics, type, size, activity, distance from the FEBA, weather conditions, time of daylight and darkness, and type of terrain on which targets are sited. The output from aerial sensors considers the probability of detection of enemy units in each intelligence zone, the number and type of aerial sensors employed, the proportion of area sensor coverage to the zonal area, the number of sensors lost in flight, and the extent of enemy opposition to aerial reconnaissance.

Intelligence Zones. To follow the concept that unit detection probabilities are reduced as unit distances from the FEBA are increased and to achieve more precise target locations than the Aggregated Submodel, geographic areas of the Discrete Submodel are divided into zones of similar size for each force (Fig. 61). Zone vertical boundaries parallel the FEBA. Horizontal boundaries extend on equidistant, parallel axes across BLUE and RED areas of operations and divide the area horizontally into four equal parts.

In theater-level operations, zone vertical boundaries are usually 40, 100, 300, and more than 300 km from the FEBA, corresponding to depths of the division, corps, army, and the area of operations behind the army rear boundary.

Quality of Target Detections. The Discrete Submodel uses six levels of target identification to describe quality of intelligence detections (Table 29). The highest three levels include type-particular and size-particular information on target acquisition and are grouped for map presentation. For preparation of the PERINTREPT, or other intelligence reports, these levels furnish target descriptions that range from a precise unit or installation designation to a less-detailed definition that is accurate enough to furnish a high level of quality of intelligence. The three lower levels of detection vary from the general to the indistinct.

Examples of the six qualities of detection from the highest (1) to the lowest (6) are:

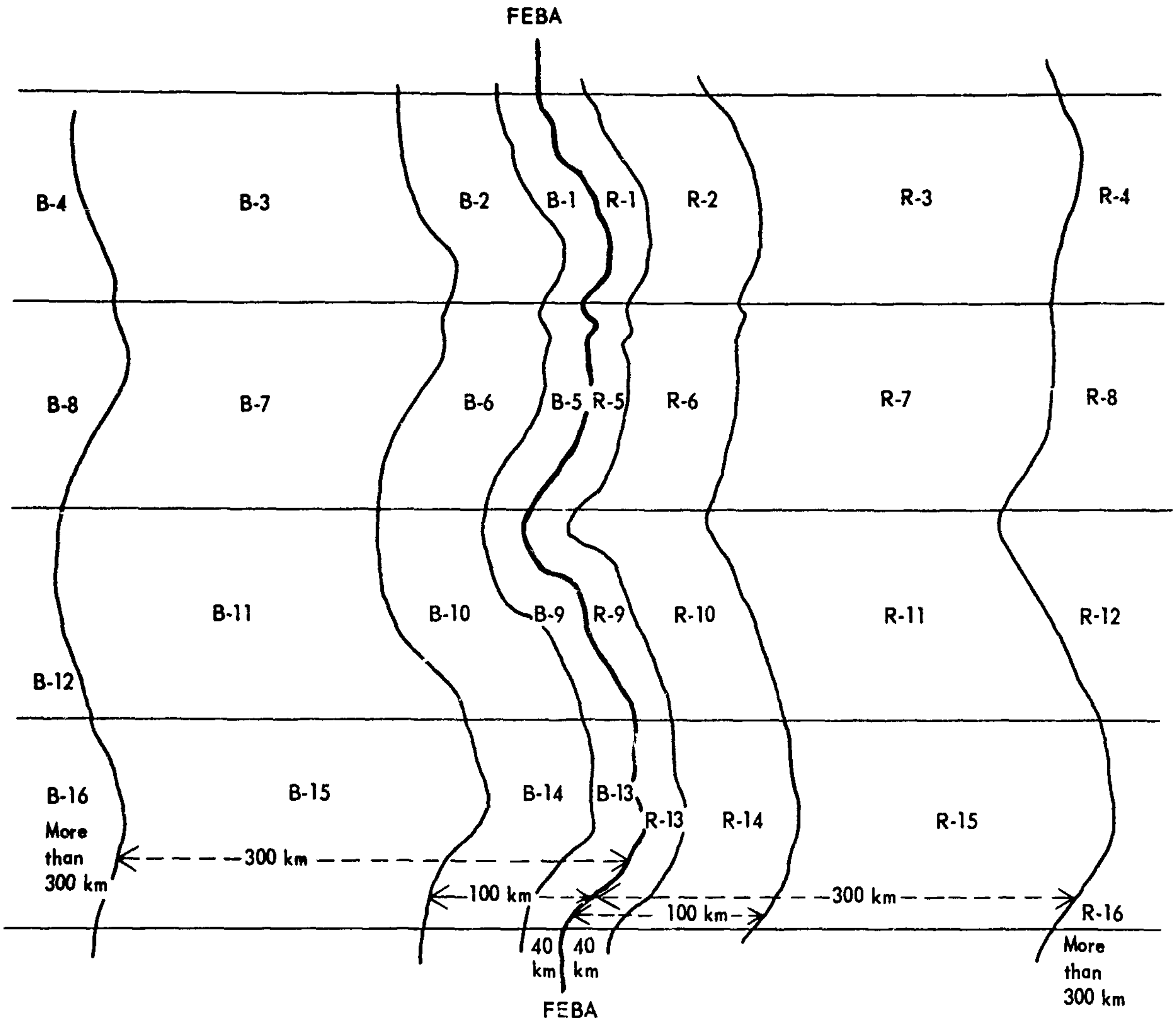


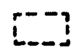
Fig. 61—Discrete Submodel Intelligence Zones

B = BLUE	R = RED
B-1 = BLUE Zone 1	R-1 = RED Zone 1
B-2 = BLUE Zone 2	R-2 = RED Zone 2

(1) Those detections gained by ground units in contact. Elements in contact gather specific information on enemy units' type, size, strength, and capability from close combat, close observation, patrols, prisoners of war, and electronic means of detection.

TABLE 29

Levels of Quality of Target Detections for Discrete Submodel

Level of quality	Unit type and size code	Target description	Derivation of detection from target description	Example of map symbol
1	TP–SP	Type particular, size particular	TP–SP 3d Inf Div	
2	TP–SP	Type particular, size particular	TP–SP Air division	[a]
3	TP–SP	Type particular, size particular	TP–SP Infantry division	
4	TP–SP	Type general, size particular	TG–SP Ground division	
5	TG–SU	Type general, size unknown	TG–SU Ground concentration	
6	TU–SU	Type unknown, size unknown	TU–SU Enemy concentration	

[a]RED air division.

(2) Detections acquired through aerial observation, photographs, and electronic sensors. These sensors provide specific detail on enemy elements, particularly those beyond the zone of contact. Examples of type elements detected are long-range combat support, reserves, supply points, depots, and airfields. Additionally aerial sensors may detect new targets or they may refine ground detections in Level 1 by providing more precise detail on ground-acquired targets.

(3) Acquisitions by ground or aerial sensors that produce a high-quality enemy unit detection (type particular and size particular) but do not include information in as great detail as Levels 1 and 2.

(4) Ground and aerial detections that identify units within a general category, as ground or air, and by a specific size, as battalion, regiment, division, squadron, or wing. These acquisitions are noted as type-general and size-particular detections.

(5) The level of quality in which sensors detect a general type of unit, as ground or air, and a unit of unknown size. This is described as a type-general and size-unknown detection.

(6) The lowest level of detection, in which enemy forces are noted but there is no indication of the size or type of unit. This acquisition is described as an "enemy concentration."

Effects of Weather. Weather-experience factors in the geographic area of game play, at the time of year in which play is simulated, are aggregated for game purposes. Aggregated weather components are subjected to selection by random processing from a scale of weather probabilities in the sequence of cloud conditions; wind; temperature; ceiling, within limits of cloud conditions; precipitation, as may be consistent with cloud conditions and modified by temperature; and visibility, as may be modified by cloud conditions and precipitation, with a single exception. Where sandstorms are present, their effect is substituted for cloud conditions in determining the extent of visibility.

Following the random selection of weather conditions, results are incorporated in periodic weather reports that reflect combinations of eight types of weather, viz, clear, high clouds, low clouds, night, rain, snow, sand, and fog. Cloud descriptions are separated into two categories, complete or partial cloud cover.

Weather conditions are coded for computer inputs as shown in Table 30.

TABLE 30

Weather Codes for Computer Inputs

Weather condition	Code	Weather condition	Code
Clear	C	Rain	R
High clouds	H	Snow	X
Low clouds	L	Sand	S
Night	N	Fog or smoke	F

The degradation of sensor capabilities caused by varying degrees of adverse weather is reflected in factors governing the assessment of targets for detection. These factors, and their employment, are exemplified in Tables 31 and 32.

Reconnaissance Aircraft. The Discrete Submodel simulates aerial reconnaissance with drones and three types of piloted aircraft. Piloted planes are HPA, light fixed-wing aircraft (LPA), FWA, and hels.

The HPA are jet planes with a rating of Mach 1 or higher. In gaming they can penetrate the enemy area to the limit of their range. The FWA are propeller planes of the Mohawk or equivalent type, which may penetrate the enemy zone up to 40 km beyond the FEBA. The LPA are light observation aircraft. Hels and LPA perform surveillance only from the friendly side of the FEBA. Drones, when used, are high-performance drones and can function to the limits of their effective radius of operation.

Although many aircraft can carry and operate several sensors, the Discrete Submodel assesses one sensor per aircraft per sortie.

Aircraft sortie rates per day are provided by the game sponsor or conform to approved rates in authorized publications.

Reconnaissance aircraft lost to enemy fires during flight, whether outgoing or incoming, are considered unable to transmit the result of their reconnaissance.

TABLE 31

Example of Weather Condition Reflected by Weather Code

Weather code	Weather condition	Effect of weather on assessment by sensor
C	Ceiling 20,000 ft or higher, no clouds	No degradation to sensor caused by weather
H	Ceiling 6000 to 20,000 ft	Sensor assessment for observation in complete or partial cloud cover[a]
L	Ceiling 500 to 6000 ft	Sensor assessment for observation in complete or partial cloud cover
N	Night	Elimination of visual observation
R	Rain	Degradation of sensors according to factor stored in submodel table
X	Snow	Degradation of sensors according to factor stored in submodel table
S	Sandstorm	Degradation of sensors according to factor stored in submodel table
F	Fog	Degradation of sensors according to factor stored in submodel table

[a]Complete cloud cover prevents observation by sensor unable to penetrate clouds and results in degradation of sensor effectiveness. Partial cloud cover permits sensor observation.

Aerial Sensors. There are five categories of aerial sensors. They represent visual, photographic, mechanical, electrical, and electronic means of target acquisition performed by aerial crews, aerial cameras, infrared sensors,

TABLE 32

Example of Degradation to Sensor-Aircraft Combination by Weather Code L with Partial Cloud Cover

Aerial sensor	Surveillance by type aircraft[a]				
	HPA	FWA	Hel	Drone	LPA
Infrared	1	1	0	1	0
Side-looking aerial radar	1	1	0	1	0
Large-scale photo	1	1	0	1	1
Medium-scale photo	1	1	0	1	1
Small-scale photo	1	1	0	1	1
Electronic intelligence	1	0	0	0	0
Visual reconnaissance	1	1	1	0	1
Armed vision	1	0	0	0	1

[a]"0" indicates no surveillance by sensor-aircraft, caused by adverse weather or aircraft inability to perform surveillance with sensor noted; "1" indicates sensor-aircraft can perform surveillance under weather condition noted.

side-looking aerial radar (SLAR) and electronic intelligence (ELINT). Piloted aircraft conduct two types of visual observation, according to aircraft missions, that are designated as "visual reconnaissance" (visual observation performed by an aircraft crew on a reconnaissance mission) or "armed vision" (visual observation accomplished by an aircraft crew while participating in a combat or transport mission behind enemy lines). A description of sensor characteristics, capabilities, and employment follows.

Photographic sensors. Aerial photography is simulated at altitudes ranging from 500 to 50,000 ft, permitting sensors to take aerial photos at optimum altitudes in good weather or at lower altitudes during adverse weather. The submodel simulates the production of small-, medium-, and large-scale photos.

To compute the area of ground coverage by aerial photos, the altitude of aircraft over the target, the focal length of the camera used, the amount of film carried, and, at night, the number of illumination devices available are processed by the submodel routine. Calculations to determine the extent of ground coverage by aerial photo sensors are shown in Fig. 62, and the computation is accomplished by the submodel.

Night photography is limited to large- and medium-scale coverage by one type of camera, the vertical camera. Daylight photography is accomplished by vertical and panoramic cameras that produce prints for small-, medium-, and large-scale area coverage.

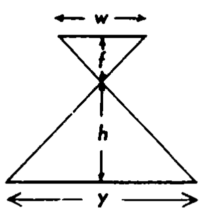
Infrared sensors. Thermal photo coverage by infrared sensors is simulated in the submodel. Infrared has a day or night capability although smoke, precipitation, clouds, haze, dust, or sandstorms may interfere with infrared missions. Such interference is simulated in the submodel. Calculations for infrared photography of areas of ground coverage are the same as those for aerial photographs.

SLAR. SLAR capabilities and limitations are simulated in the submodel. SLAR acquires both active and inactive targets. One of its principal uses is to locate potential targets initially for follow-up photographic missions. Intense precipitation, heavy cloud cover, vegetation, and electronic countermeasures reduce SLAR's effectiveness, although haze, partial clouds, fog, and smoke have no significant effect on its surveillance capability.

ELINT sensors. The operation of electronic sensors is simulated. Electronic sensors operate in all weather, day and night, and at all but lowest altitudes, where signals are masked by obstructions.

Visual observation. Two types of aerial visual observations are simulated. One type is conducted by aircraft crews who have a gamed assignment to achieve visual detections. Such missions are described as "visual reconnaissance," and observers on such missions have a capability of detecting targets 1.5 km on each side of their HPA, FWA, or hel.

Aerial missions other than reconnaissance are called "armed vision" sorties. The effect of armed vision surveillance is determined by averaging the depth of penetration of a flight of four aircraft as they fly close air support, bombing, or interdiction missions and using a width of coverage as 12 km. Results of armed vision detections acquired in this manner are degraded 96 percent, as reconnaissance is a secondary function of the mission.



f = focal length in inches

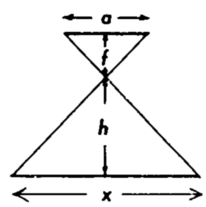
w = film width in inches

h = aircraft altitude in feet

y = width of ground coverage

$$y = \frac{hw}{f}$$

1a. To obtain the width of panoramic camera ground coverage.



f = focal length in inches

h = altitude in feet

x = length of ground cov^rage in feet

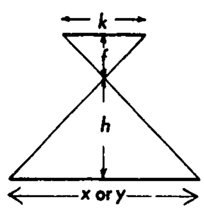
c = overlap constant

a = length of film in inches

n = number of exposures

$$x = n\frac{hac}{f}$$

1b. To compute the length of panoramic camera ground coverage.



f = focal length in inches

k = film size in inches (film is square)

h = aircraft altitude in feet

x = width of ground co ·age

y = length of ground :age

$$x \text{ or } y = \frac{hk}{f}$$

2. Calculations to determine the length and width of vertical camera ground coverage.*

*Night coverage calculations are the same, multiplied by a factor N to equal the number of cassettes used in contiguous exposures.

Fig. 62—Computations To Determine Aerial Camera Ground Area Coverage

Attrition of Reconnaissance Aircraft and Aerial Sensors. The effects of attrition of reconnaissance aircraft and failure of aerial and visual sensors are reflected in the Discrete Submodel routine.

Reconnaissance aircraft losses and incapacitation. Reconnaissance aircraft losses are based on enemy action such as air interception, SAM, and ground fires. Inability to perform missions results from aborts, inoperability, and malfunctioning of aircraft. The Air Controller develops kill probability factors for losses of HPA under varied conditions of weather, altitude, and capabilities of hostile air-defense systems. Similar tables are developed from the HPA tables by the Air Controller for kills of FWA, hels, and drones, using conversion factors authorized by the game sponsor. These tables and similar tables on incapacitation are incorporated in the Discrete Submodel and reduce detections by airborne sensors.

Losses of aircraft and their sensors, as developed by the Air Controller, result from (a) the number and capability of enemy interceptor units, (b) SAM density and potential diameter of coverage, and (c) ground fires and air-defense artillery (ADA). The flight altitude and performance characteristics of reconnaissance aircraft are also considered in assessing reconnaissance aircraft losses.

Aerial sensor inoperability and malfunctioning. The failure of mechanized sensors, caused by malfunctioning, is represented in the Discrete Submodel. Degradation of sensors is based on experience with specific items of equipment in use and, for new or proposed equipment, on an estimate of malfunctions based on equipment specifications. An example of inoperability and system malfunction factors, including aircraft and aerial sensors, is in Table 33.

TABLE 33

Aircraft Abort and Inoperability Factor and Sensor Malfunctioning Factor[a]

Aerial sensor	Type of aircraft				
	HPA	FWA	LPA	Hel	Drone
Infrared	0.35	0.36	0.35	—	0.29
Side-looking aerial radar	0.40	0.36	0.40	—	0.29
Large-scale photo	0.32	0.36	0.32	—	0.36
Medium-scale photo	0.32	0.32	0.32	—	0.36
Small-scale photo	0.32	0.32	0.32	—	0.36
Electronic intelligence	0.35	—	0.35	—	—
Visual reconnaissance	0.35	0.36	0.35	0.57	—

[a]These are aggregated factors for loss of aircraft and sensor operability, taking into consideration aircraft abort experience and maintenance down time and sensor inoperability experience.

The possibility that an aerial observer may fail to see or record or will misinterpret target indicators has been represented by a factor of 50 percent in recent theater-level games. This has been a sponsor-designated figure. It is based on partly completed intelligence studies and may be altered by further research.

Pregame Preparations

Procurement of Game Factors. The Game Director and staff and their sponsoring agency must have a mutual understanding of goals to be achieved through intelligence play. There must be a thorough understanding of the validity and parameters of factors used in game assessments. Sponsors must be aware of the capabilities and limitations of the Discrete Submodel. The Intelligence Controller must know the game purpose, scope, objectives, and basic assumptions and have available the rules to be followed, the constraints of any type, the troop OB and installation lists, operational situations, and data essential to measuring and factoring submodel inputs.

Background game data and guidelines must include (but are not limited to) the following:

(1) Intelligence zone dimensions.

(2) Factors for ground sensor target detections. These are similar to tables of factors in the Aggregated Submodel, as in Tables 23 to 25, with the exception that eight weather conditions, as in Table 30, are factored rather than four as in the Aggregated Submodel.

(3) Kill probability factors for three types of air-defense systems, i.e., interceptors, SAM, and ground fires (Table 34).

TABLE 34

Example of Kill Probability Factors for BLUE Interceptors, SAMs, and Ground Fires vs RED Reconnaissance HPA[a]

Type of BLUE air defense	P_k factor according to altitude of RED reconnaissance HPA	
	Low, <500 ft above terrain	High, >500 ft above terrain
Interceptor[b]		
Little or no radar close control	0.02	0.05
Low-density radar close control	0.04	0.10
High-density radar close control	0.05	0.15
SAM[c]		
Type 1 (e.g., Hawk)	0.12	0.12
Type 2 (e.g., Nike)	0.00	0.40
Type 3 (e.g., Chaparral)	0.06	0.00
Ground fire	0.01	0.00

[a]Data listed are illustrative only.

[b]Interceptor with radar diameter of coverage 25 km for low and 150 km for high incoming aircraft.

[c]SAM radar diameter of coverage:
Type 1: low, 15 km; high, 30 km
Type 2: low, 0; high, 150 km
Type 3: low, 30 km; high, 0.

(4) Conversion factors to be used to determine probability of kills of LPA, FWA, hels, and drones, in proportion to kills of HPA (Table 35).

(5) Capabilities of the various aerial sensors to determine the basis for calculating their operational limits in submodel routines. These must be provided by the game sponsor or derived from publications approved by the game sponsor.

TABLE 35

Example of Factors To Convert BLUE and RED Kill Probability Factors for HPA Reconnaissance to Kill Probability Factors for LPA, FWA, Hels, and Drones[a]

Type of aerial reconnaissance	Attacked by	Conversion factor according to altitude of reconnaissance aircraft[b]	
		Low	High
LPA[c]	Fighter	0.5	0.5
	SAM	0.1	0.2
	Ground fire	0.1	—
Hel[c]	Fighter	0.3	0.5
	SAM	0.1	0.2
	Ground fire	0.1	—
FWA	Fighter	1.2	1.2
	SAM	1.5	1.5
	Ground fire	1.2	—
Drone	Fighter	0.5	1.0
	SAM	2.0	2.0
	Ground fire	2.0	—

[a]Data listed are illustrative only.
[b]These factors, multiplied by the associated factors in Table 34, convert from HPA P_k's to LPA, hel, FWA, and drone P_k's.
[c]LPA and hels do not cross the FEBA.

(6) Specific weather data, including time of daylight and darkness and special effects weather may have on operations.

(7) Aircraft operability factors and sortie rates for the four types of reconnaissance aircraft. These must be determined by the game sponsor or derived from publications approved by the game sponsor.

(8) A basis for Intelligence Controller decisions with respect to the play of decoys, spurious targets, specific reconnaissance requests, and the play of agents and special intelligence operations.

Preparation of the Initial Detection File. Before the start of game play the Intelligence Controller hand assesses forces' prebattle dispositions for intelligence detections and, with forces' general and special situations as a guide, produces D-day−1 intelligence for both forces. This intelligence is furnished game players for use in the preparation of D-day orders. Data from the hand assessment are placed on magnetic tape for storage in the computer, and, thereafter, intelligence detections are processed by the computer.

The action and coordination required of the Intelligence Controller, to place day-before-D-day detections in the computer and make detections available to players preparing D-day orders, are in Table 36. A detailed explanation of inputs and assessments mentioned in "Pregame Actions and Coordination by the Intelligence Controller" is in sections "Cycle Inputs" and "Assessments."

TABLE 36

Pregame Actions and Coordination by Intelligence Controller for Discrete Submodel

Action	Coordination	Purpose
Develop intelligence subtype and nationality designators (Table 37)	Programmer	Include data in computer program
Post unit and installation dispositions on Master Intelligence Map; place overlay over map	Intelligence Control Group	Post Master Intelligence Map using unit locations on Ground Controller's map as a guide
Prepare Intelligence OB Work Sheet (Fig. 56) and make entries	Intelligence Control Group	Prepare OB Work Sheet
Subject each OB unit to random number selection regarding detection probability according to unit zonal location and status of activity; where detection is obtained, make second random selection using factors for quality of detection; post results on OB Work Sheet and place corresponding detection sticker (on Situation Overlay) over unit symbol on Master Intelligence Map	Intelligence assistants	One assistant calls unit from OB Work Sheet and records detection for that unit, other assistant posts noted detection symbol on Situation Overlay, covering basic unit detection (on map) with detection symbol on overlay
Furnish Intelligence OB Work Sheet to programmer and request printout	Programmer	Assemble input data for the computer
Forward enemy detection printout, pregame intelligence report, and D-day weather forecast to player teams; furnish weather report to controllers	Programmer	Prepare initializing Master Status and Intelligence Files input tape
Prepare D-day intelligence inputs: (a) Zone Input Card Work Sheet (Fig. 63) and (b) Mission Input Card Work Sheet (Fig. 64)	—	—

Intelligence subtype groupings in the Discrete Submodel are derived from the OB. For example, in Table 37 there are four OB subtype groupings under the type heading for combat-support units: the combined 122-mm gun/howitzer, 130-mm gun, and 152-mm gun/howitzer brigades in Subtype 1; mixed field artillery brigades in Subtype 2; FROG regiments in Subtype 3; and combined SS-1, SS-2, and SSCM units in Subtype 4.

The inclusion of nationality indicators (the third figure in the five-unit designator) is a further contribution to exactness. Variations in strength, number, and type of weapons between similar types of unit from different nations are assessed more precisely through the use of the nationality indicator.

Cycle Inputs

Intelligence Controller Inputs. The Intelligence Controller furnishes two basic inputs at the conclusion of each cycle of play to keep the submodel

Zone No.[1] 5 BLUE - ~~RED~~[2] Game[3] 1R-1 Period[4] D + 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Card 1[5]						5		2	0	0				4	0																	
Card 2[6]	N	B													1																	
Card 3	N	C													0	1	1	0	0	1	1	0	0	1	1	1	0	1	1	1	0	
Card 4																																
Card 5																																

[1] Fill in Intelligence Zone Number (from Master Intelligence Map).

[2] Cross out inapplicable word.

[3] Fill in abbreviated game title.

[4] Fill in period of play.

[5] Card 1 is start of zone input for conversion of map grid to the sub-model routine. Place zone number under Col. 6. Indicate change in zone by placing applicable zone number opposite Card 1, under Col. 6 of another work sheet. Use Cols. 7, 8, 9, and 10 to delineate zone width (flank to flank) in km. Orient figures on Col. 10. Use Cols. 11, 12, 13, 14, and 15 to indicate zone depth in km. Orient figures on Col. 15.

[6] Cards 2, 3, and subsequent cards indicate lettered map grid designators in Cols. 1 and 2 (NB, NC, ND). Where all of map grid is in zone, so indicate by placing 1 (Yes) in Col. 15. Where part of grid is in zone, indicate by placing zero (No) in Col. 15, as is done opposite Card 3, and 1 (Yes) where sub-grid is in zone, starting with Col. 16, or zero (No) where sub-grid is not in zone. Fill in through Col. 31 to indicate 16 sub-grid locations. The same sub-grid designators are used as in Fig. 58.

Fig. 63—Example of Zone Input Card Work Sheet

BLUE - RED[1]

Game[2] ____________ Period[3] ____________

Card No	1 2 3 4 5 6 7 8	9 10 11 12 13 14	15 16 17 18 19 20	21 22 23 24 25 26	27 28 29 30 31 32	33 34 35 36 37 38	39 40 41 42 43 44	45 46 47 48 49 50	51 52 53 54 55 56	57 58 59 60 61 62
	Zone No[4]	Weather[5]								
1	5	C								
	Aircraft	Flt. Alt[6]	IR[7]	SLAR[7]	LSP[7]	MSP[7]	SSP[7]	ELINT[7]	VIS[7]	ARMD VIS[7]
2	H P A	L		5						4 0
3	H E L	L							2 0	
4	F W A	L		1 0						
5	D R N	L			2					

Card No										
	Zone No.	Weather								
1	2	N O N E								
	Aircraft	Flt Alt	IR	SLAR	LSP	MSP	SSP	ELINT	VIS	ARMD VIS
2	H P A									
3	H E L									
4	F W A									
5	D R N									

[1]Cross out inapplicable force designator
[2]Enter abbreviated game title
[3]Enter period of game play
[4]Enter zone number, oriented to right side of box under Column 8
[5]Enter weather code (C, H, L, N, R, X, S, F) oriented to right side of box under Column 14. Where no reconnaissance aircraft are flying over zone enter none in the right end of the weather box, opposite Card 1
[6]In boxes opposite Cards 2, 3, 4, and 5 indicate under Flt Alt the altitude of aircraft during reconnaissance (L or H). The altitude at L is below 500 ft. Altitude at H is above 500 ft
[7]Under the eight sensors give the number of aircraft sensors of each type conducting surveillance. Orient figure to the right-hand column of each box used

Fig. 64—Example of Mission Input Card Work Sheet

abreast of operations. The inputs are recorded on Zone Input Card Work Sheets and Mission Input Card Work Sheets, whose numbered columnar headings correspond to numbered headings on machine punch cards. The work

TABLE 37

Example of Threshold Designators for Combat-Support Units

Unit designator	Size and type of unit	Number of similar units	Subtype	Nationality
R2701–R2706	Field artillery brigades, 122-mm gun/howitzer	6	1	1
R2807–R2814	Field artillery brigades, 130-mm gun	8	1	2
R2915–R2920	Field artillery brigades, 152-mm gun/howitzer	6	1	3
R2921–R2935	Field artillery brigades, mixed	15	2	1
R2936–R2945	FROG regiments	10	3	1
R2746–R2760	Guided missile brigades, SS-1	15	4	1
R2861–R2870	Guided missile battalions, SS-2	10	4	2
R2971–R2985	SSCM regiments	15	4	3

sheets are forwarded to the programmer, who transfers their data to machine punch cards. The work sheets are described in greater detail in the following paragraphs.

Zone Input Card Work Sheets. A correspondence between unit locations on the game map and intelligence zones (Fig. 61) is established for use by the computer program through Zone Input Cards. These cards use map grid letters (NB, MA, GC) and a 16-square subgrid, explained in Fig. 58, to introduce map segments 25 km square into the computer. A separate Zone Input Card Work Sheet is prepared for each of the numbered intelligence zones. Data on the cards convey three categories of information to the computer: (1) the location of each zone in alignment with its grid position on the map; (2) the dimensions, in kilometers, of each zone; and (3) a further alignment of segments of the map (through grid and subgrid designators) in 25-km squares within each intelligence zone. The preparation of the Zone Input Card Work Sheet is explained in Fig. 63.

Mission Input Card Work Sheets. Mission Input Cards provide the submodel with data that define force aerial reconnaissance missions. They simulate BLUE or RED force aerial sensors conducting reconnaissance in enemy territory. The cards define weather conditions in the area observed; the number, type, and flight altitude of aircraft; and their sensors over each zone. A separate Mission Input Card is prepared for reconnaissance flights over each intelligence zone, thus aligning the path of each aircraft and sensor over segments of the map. The preparation of the Mission Input Card Work Sheet is explained in Fig. 64.

Play of Spurious and Decoy Targets. To simulate the element of uncertainty in intelligence operations, the Discrete Submodel introduces spurious and decoy targets into the game. Spurious targets are produced by the submodel routine on an automatic basis, using factors approved by the game sponsor. The factors are carried in tables that are used to assess each type of unit (air, SAM, combat support, ground combat, logistics, and supply point or SASP) on a percentage basis by random selection. This selection chooses numbers and types of unit and their status of activity to be detected on a spurious basis. Types of unit selected, with their status of activity, are given a location by random selection. Resulting spurious detections are reproduced in the printout at level of quality 5 or 6.

Decoy targets are entered into play by the Intelligence Controller. Their number and usage are included in pregame instructions from the game sponsor. They are assessed in the submodel routine as individual units and, when detected, are reported at level of quality 5 or 6.

Sequence of Intelligence Computer Run. The Discrete Submodel is run in the computer following other submodels. In this sequence it can make assessments by taking into consideration the influence that preceding submodels have had on gamed elements, i.e., changes to unit status, characteristics, and location arising from prior routine assessments and noted in the MSF. The Discrete Submodel thus makes cyclic assessments for unit and installation detections, using the latest available information influencing probabilities of detection by ground and aerial sensors.

Assessments

Intelligence Controller and Computer Assessment Operations. Action taken by the Intelligence Controller at the start of each cycle of game play, to furnish required inputs for the Discrete Submodel, and the submodel assessment routines during each cycle of play are described in the following paragraphs. References to units, installations, and ground and aerial sensors apply equally to both BLUE and RED forces. Submodel assessment routines start their assessment of all units and installations with Zone 1 and complete the assessment of all zones of a force before repeating the process for the opposing force.

Controller inputs and computer routines are as follows:

(1) The Intelligence Controller prepares Zone Input Card Work Sheets (Fig. 63) that provide information for the establishment, location, and dimensions of intelligence zones within the submodel.

(2) The Intelligence Controller prepares Mission Input Card Work Sheets that introduce into the submodel data describing and defining force aerial reconnaissance missions (Fig. 64).

(3) The submodel assesses and stores ground intelligence detections of combat-support and ground-combat units and determines their level of quality of detections. Detections are determined by random selection of the detection probability of units in contact,* of units not in contact but less than 40 km from the FEBA, and of those more than 40 km from the FEBA. Probabilities of detection of units not in contact are shown in Table 38.

The computer generates a random number and compares it with the appropriate detection probability for the unit being processed. If the random

*Units in contact are assessed at 95 percent probability of detection at level of quality 1, 2, or 3 and 5 percent at level of quality 4 or 5.

number is equal to or greater than the probability, the unit is undetected. If the random number is less than the probability, the unit is detected. If the unit

TABLE 38

Probability of Ground Detection of Units Not in Combat

(In percent)

Distance from FEBA	Air	SAM	SSM	Combat support	Ground-combat division	Ground-combat regiment or brigade	Headquarters, corps or higher	Supply point and headquarters, lower than corps
40 km or more	25	16	5	5	5	5	8	5
<40 km	25	21	13	11	13	11	13	13

is detected a second random number is generated to determine the level of quality of the detection, from 1 (highest) to 6 (lowest). Each unit is subjected to the same process, and resulting detections are accumulated and stored in a detection file that lists units with their location, status of activity, and level of quality of detection.

(4) Following assessment of ground-combat and combat-support units, the submodel assesses and stores ground sensor detections of all other units (air, SAM, headquarters, logistics, and supply point) using the same process as in para 3. Resulting detections are stored in a table that lists each detection location, status of activity, and level of quality of detection.

(5) The submodel routine calculates and stores in-flight and over-target ground kill probabilities against reconnaissance aircraft for Zones 1, 5, 9, and 13 along the FEBA. In zones further from the FEBA it additionally calculates the kill probabilities by SAM and enemy air intercept.

The kill probabilities for each of these three air-defense systems are first calculated against HPA flying at low altitudes (under 500 ft). For each air-defense system in the zone, the computer divides the system's width of coverage by the zonal width to obtain the percentage of coverage by the air-defense system, then multiplies this by an aggregated systems kill probability factor to obtain the respective kill probabilities of the various air-defense systems against HPA at low altitude. The routine is repeated using the aggregated systems kill probabilities for over 500 ft to obtain the kill probabilities at high altitude. To establish the kill probabilities of each air-defense system against FWA, hels, and drones, conversion factors are applied to the HPA kill probabilities for that system (Tables 34 and 35). The resultant kill probabilities are stored for future recall to assess aircraft losses.

(6) The submodel routine degrades sensor-aircraft combinations introduced by the Mission Input Card (Fig. 64), using weather degradation factors as indicated by the weather code (Table 31) and the flight altitude designator in the Mission Input Card.

Three successive tables of factors are used. Multiplication by a factor in the first table determines whether weather conditions will permit aircraft to fly. The second table prescribes the over-target altitude for each sensor-aircraft and weather condition in zones overflown. The third governs the number of sorties per aircraft permitted by weather conditions. Sensor-aircraft combinations accepted as being capable of performance, after these degradation routines, are next subject to the following routine.

(7) The submodel routine calculates aborts, inoperability, and sensor malfunctions for each mission element. (A mission element is the number of sensor-aircraft participating in a single aerial reconnaissance mission.) Aircraft capable of performance (from para 6) are multiplied by a probability factor (Table 33) representing an aggregation of the three causes of sensor or aircraft incapacitation (abort, inoperability, and malfunction). This routine reduces the number of reconnaissance missions by simulating aborts, inoperability, and malfunctions within the submodel.

(8) Assessment is next made to determine losses to sensor-aircraft caused by in-flight and over-target kill probabilities, using factors produced in para 5. Assessments are made in the sequence: (a) in-flight kills from ground fire; (b) in-flight and over-target kills by SAM; (c) in-flight and over-target kills by aerial interceptors; (d) over-target kills from ground fire; (e) in-flight losses to SAMs on the return flight; and (f) in-flight losses to ground fire on the return flight. In the foregoing routine sensor-aircraft are assessed at either low or high altitudes.

This routine concludes assessments for losses to sensor-aircraft. Subsequent assessments are based on sensor-aircraft remaining after reduction in strength caused by loss assessment routines.

(9) This step determines the percentage of intelligence zone coverage by operable sensor-aircraft.

Ground coverage by a mission element is the product of the length and width of the ground strip observed by an individual sensor-aircraft, multiplied by the number of aircraft in the mission element. For a surveillance mission the percentage of area coverage is ground coverage divided by the area of the intelligence zone under observation. The result represents the percentage of aerial sensor coverage of a zone by each surveillance mission. Should the area of ground coverage derived be greater than the area of the zone, it is reduced to equal the area of the zone.

(10) The submodel routine next determines units detected by airborne sensors, considering the percentage of zonal coverage by airborne sensors, the status of targeted unit activity, weather conditions, and sensor capabilities. Targets are processed, simulating surveillance by each aerial mission, using random-number comparison from a table of detection probabilities. Resulting detections are stored for processing to determine the level of quality by the assessment routine in para 12.

(11) Units undetected by infrared, ELINT, and visual sensors are subjected to random selection to produce a group of types of unit and their status of activity for possible designation as spurious targets. The units themselves are not detected. Only their type and activity status are noted. The number of spurious targets selected is based on a predetermined percentage of all OB units previously authorized by the game sponsor.

Types of unit selected are given an unoccupied grid location by random selection and take on a type of identity, status of activity, and location. The resulting spurious targets are detected at level of quality 5 or 6 and are placed in the detection output file.

(12) The submodel routine determines the level of quality of unit detections obtained in para 10. Factors denoting unit size, type, and status of activity; the type of sensor making the detection; and weather conditions influencing the detection are considered in a process of random selection to obtain a level of quality for each target detected by aerial sensors. Resulting aerial detections and their level of quality are stored.

(13) Referring to detections obtained by ground means (paras 3 and 4) and by aerial means (para 12), the submodel compares ground and aerial detections and their respective levels of quality. Where a detection was acquired by both ground and aerial sensors, its highest level of quality is recorded. Detections by ground and aerial means and spurious and decoy targets from para 11 are consolidated and stored according to their level of quality. The submodel is then prepared to make intelligence detection printouts.

Cycle Outputs

Composite Printouts. Computer printouts furnish intelligence information to the Intelligence Controller and game players in separate printouts. Controller printouts include data on both BLUE and RED forces. Player printouts contain data logically available only to the respective forces.

Printouts are distributed with the following information:

(1) To the Intelligence Controller:

(a) A printout containing the number of reconnaissance aircraft sorties and losses in each zone, by type of aircraft (HPA, FWA, hel, and drone), from various causes (air, SAM, and ground fire).

(b) Unit and installation detections by zone, listing the serial number of each detection, unit type and size, location, and activity.

(c) A cumulative list of detections at the end of each period, listing units detected by their 5-digit designator, the grid location of each detection, and the level of quality of each detection.

(d) A summary of aircraft missions listing type of aircraft (HPA, FWA, hel, and drone) and the number and type of sensors (infrared, SLAR, large-scale photo, medium-scale photo, small-scale photo, ELINT, visual reconnaissance, and armed vision) used by observing aircraft.

(e) A summary of aircraft missions for all zones showing the four types of aircraft, the number of sorties flown, and the number of losses of aircraft to the types of enemy action encountered (aerial intercept, SAM, or ground fires).

(2) To each player team, through the Intelligence Controller: enemy detections, with the level of quality and the location of each detection.

Preparation of Intelligence Maps and Reports. Enemy situation overlays are prepared by the Intelligence Control Group on a Master Intelligence Overlay and by BLUE and RED player teams on their respective overlays taking unit detections from the printout and duplicating them on respective Control and BLUE and RED overlays.

The Intelligence Controller's completed overlay is next coordinated with Ground and Logistics Controllers' after-battle Operations and Logistics Maps. Unit detections on the Intelligence Overlay are moved, as necessary, to coincide with operations and logistics after-battle unit locations on the Operations and Logistics Maps.

BLUE and RED segments of the Master Intelligence Overlay, incorporating after-battle detection locations, are next coordinated with respective player team Situation Overlays, on which detections are updated to correspond to those on the Intelligence Overlay.

Concurrently with map posting, a member of the Intelligence Control Group has prepared PERINTREPTS for each player team, based on Ground Control's written or verbal summary of action, player orders, before- and after-battle maps, and the printout. Each PERINTREPT contains a brief summary of the enemy situation and enemy operations, based on printout detections and the Ground Controller's summary; an estimate of enemy casualties, which is printout casualties plus a percentage deception factor; and a statement of enemy capabilities and vulnerabilities, derived from reports on unit status of activity, location, and force objectives. A weather report for the next period of play and a weather forecast for the subsequent period are prepared and forwarded at the end of each period of play.

GLOSSARY

artillery target grouping. A grouping of opposing units in a static posture in which there will be artillery firing but no ground-combat activity during a specific period of game play.

basic load. Three days of supply for consumer units. The term can apply to the sum of all classes of supplies or to any one class of supply.

basic load consumption factor. The percentage of a unit's basic load that is expected to be consumed daily.

basic load factor. A one-man slice, in pounds, of a unit's basic load.

battle grouping. A grouping of opposing units in an active posture in which both combat and combat-support elements will be engaged during a specific period of game play.

casualty-producing potential. The potential of a combat-support unit to inflict losses of personnel and materiel under specified conditions of engagements. There are two types of casualty-producing potential: authorized and present.

casualty-producing potential (authorized). The expected number of casualties per day caused by a combat-support unit when it is at authorized strength and firing on an enemy defending in a meeting engagement.

casualty-producing potential (present). The expected number of casualties per day caused by a combat-support unit when its firepower capability has been adjusted by personnel and materiel losses and replacements and when it is firing on an enemy defending in a meeting engagement.

centroid effect. Refers to a point of aim at the center of mass (two or more targets) as opposed to the individual target.

Class Distribution Factor. The percentage of a supply point's total stockage by class of supply.

consumption rate. The daily consumption of any class of supply expressed in pounds per man.

force ratio. The ratio of the attacker's index of firepower potential to that of the defender, adjusted to a specific combat situation.

grid nuclear. A cyclic input for the Logistics and Recovery Submodel. It indicates grid squares in which a percentage of nuclear damage has been sustained by LOCs.

index of firepower potential. The relative firepower potential of ground-combat units under specified conditions of engagement.

input capacity. The daily tonnage of resupply that a consumer unit receives from its supporting supply point.

Input LOC. The LOC over which a consumer unit or a supply point receives its supplies. Simultaneously it is an Output LOC for the supporting supply point.

lethal area. The area within which some level of lethal effect is produced by an area fire weapon against personnel or materiel.

LOC capacity. Daily tonnage capacity of an LOC into a supply point.

loss factor. A factor used to indicate the effect of loss of supplies on operational effectiveness.

low on supply. A consumer unit with less than a predetermined percentage of its basic load or a supply point with less than a predetermined percentage of its authorized supplies on hand is considered to be low on supply.

low on supply factor. The smallest percentage of a unit's basic load or a supply point's authorized stockage that must be on hand in order to avoid a reduction of operational effectiveness.

nomodel change. A nomodel change is a controller-approved card input to the program that (a) effects a change to the previous information concerning a designated unit carried in the order of battle in the unit status file and (b) adds or deletes a unit from the order of battle.

threshold. A threshold is formed by grouping like units based on common characteristics. These units are then assigned threshold numbers to provide ready identification in the computer program.

REFERENCES

CITED REFERENCES

1. US Army Command and General Staff College, "War Gaming," ST 105-5-1, Nov 65, p 62.
2. Research Analysis Corporation, "TACSPIEL War Game Procedures and Rules of Play (U)," RAC-TP-111, Nov 63. SECRET
3. Dept of Army, "Staff Officers' Field Manual," FM 101-10-1, Jan 66.
4. US Army War College, "Analysis Seminar Control Manual (U)," 1 Feb 66. SECRET
5. Dept of Defense, Defense Intelligence Agency, "Physical Vulnerability Handbook (U)," PC-555/1-1, Aug 63. CONFIDENTIAL
6. John Dorsett, "Game Models for Tactical Air Operations in Theater War Games (U)," RAC-TP-52, Research Analysis Corporation, Dec 61. CONFIDENTIAL
7. Philip L. Alger, Mathematics for Science and Engineering, McGraw-Hill Book Co., New York, 1957, p 168.
8. Dept of Army, "Nuclear Weapons Employment (U)," FM 101-31-2, 1 Feb 63. SECRET
9. ——, "Fallout Prediction," TM 3-210, 22 May 62.
10. Research Analysis Corporation, "Theater Battle Model (U)," RAC-R-36, Vol I, Jan 68. SECRET—RESTRICTED DATA
11. US Army Combat Developments Command, Institute of Special Studies, "Final Report, Measuring Combat Effectiveness (U)," Vol I, "Firepower Potential Methodology (U)," Mar 67. CONFIDENTIAL
12. ——, ——, "War Game Directive, AAFSS-3 (U)," Vol II, 7 Jul 67. SECRET—SPECIAL HANDLING—NOFORN
13. ——, Advanced Tactics Project, "Measuring Combat Effectiveness (U)," Vol III, "Weapon and Unit Firepower Potentials (U)," Dec 64. SECRET—SPECIAL HANDLING—NOFORN
14. ——, "Area of Operation and Influence of Elements of the Field Army for the Period 1965–1970 (U)," Aug 64. SECRET
15. Dept of Army, "Dictionary of United States Army Terms," AR 320-5, Oct 67.
16. US Army Combat Developments Command, "Interim Report, Measuring Firepower Potential and Combat Effectiveness (U)," Mar 64. SECRET—SPECIAL HANDLING—NOFORN—COFRAM
17. Research Analysis Corporation, "Theater Battle Model (U)," RAC-R-36, App A, Vol II, "Development of Indexes of Combat Effectiveness (U)," 1968. SECRET
18. US Army War College, "Analytical War Games Control Manual (U)," Nov 61. SECRET

ADDITIONAL REFERENCES

Aviation Week & Space Technology, Forecast and Inventory Issue, 86 (10): (6 Mar 67).
Central Intelligence Agency, National Intelligence Survey series. SECRET, CONFIDENTIAL
Christiansen, James G., et al, "Information and Target Acquisition 1965–1967 (U)," ORO-T-392, Operations Research Office (now RAC), Oct 60. CONFIDENTIAL

Dept of Air Force

Air Battle Analysis Center, "Air Force Studies Handbook," Oct 65.
"Aircraft/Stores Compatibility Manual," TO 1-1-27, Oct 66.
"Airfields and Seaplane Stations of the World (U)," Vols 9, 11, 12a, 14, and 39, May 41. SECRET
Air Force Armament Laboratory, Energy Maneuverability, "USAF and USN Aircraft in Clean Configuration (U)," Dec 66. SECRET
Air Force Systems Command, "Technical Characteristics of Soviet Aerospace Systems (U)," OO-AF-SC FTD SAS 62, Jun 62. SECRET
"Air-to-Air P_k Computer Print (U)," SAG-S670634, 1967. SECRET
Director of Plans, "Conventional War Game Model, European Theater," 1962.
"Planning Factors, Peacetime and Wartime (U)," Vol I, Oct 61. SECRET
"Standard Aircraft Characteristics, Air Force Guide (U)," Vols I and II. SECRET
"Summary of Air Staff Analysis of a Systems Analysis of NATO and Warsaw Pact Air Forces (U)," Vols I and II, May 67. TOP SECRET
"Tactical Air-to-Ground Missiles, Program Objectives for 1969–70 (U)," Apr 64. SECRET
"USAF Wartime Requirements (U)," Vol I, 1 May 67. TOP SECRET

Dept of Army

"Army Aviation Organization and Equipment," FM 1-5, 26 May 66.
"Authorized Abbreviations and Brevity Codes," AR 320-50, Jun 64.
"Combat Intelligence," FM 30-5, 11 Jul 63.
"Combat Intelligence Field Army, 1965–1975 (U)," Pamphlet 381-1, 18 Sep 62. CONFIDENTIAL
Deputy Chief of Staff for Operations, "Conventional War Forces (U)," Vol V, "Air Power and Air Defense (U)," Jun 62. SECRET
——, "Conventional War Forces of Sino-Soviet Bloc, 1967 (U)," Jun 62. SECRET
"Divisional Aviation Battalion and Group," FM 1-15, 21 Apr 67.
"Division Armored and Air Cavalry Units," FM 17-36, 8 Oct 65.
"Field Artillery Tactics," FM 6-20-1, 1 Jul 65.
"Field Artillery Techniques," FM 6-20-2, 8 Jan 62.
"Field Service Regulations, Larger Units," FM 100-15, 12 Dec 63.
"Field Service Regulations, Operations," FM 100-5, 19 Feb 62.
"Infantry, Airborne and Mechanized Division Brigades," FM 7-30, 19 May 65.
"Infantry, Airborne Infantry and Mechanized Infantry Battalions," FM 7-20, 28 May 65.
"Meteorology for Army Aviation," TM 1-300, 10 Jun 63.
"Staff Officers' Field Manual, Nuclear Weapons Employment," FM 101-31-1, 1 Feb 63.
"The Airborne Division," FM 57-100, 9 Sep 59.
"The Division," FM 61-100, 25 Jun 65.
"USCONARC War Gaming Handbook (U)," 70-5, Sep 61. SECRET

Dept of Defense

Defense Intelligence Agency, "Organization and Logistical Data on Soviet Ground Forces (U)," Oct 64. SECRET
——, "Physical Vulnerability Handbook—Nonnuclear Weapons (U)," Aug 63. CONFIDENTIAL
——, "Sino-Soviet Bloc, Technical Characteristics and Performance Handbook (U)," 1964. SECRET
——, "Soviet Bloc Aircraft Planning Factors (U)," Dec 66. SECRET
——, "Soviet Doctrine and Planning Factors for Nuclear Operations (U)," Jan 64. SECRET
——, "The Sino-Soviet Bloc Aerospace Order of Battle (U)," PC 240/2-1 series SECRET
Weapons Systems Evaluation Group, "Estimated Losses of US Tactical Aircraft to Conventional Ground Fire (U)," Study 110, Vols I and II. TOP SECRET, CONFIDENTIAL

Dept of Navy, Naval Ordnance Test Station

"Analyses of Advanced US and USSR Air Defense Systems (U)," Vol I, TP 152, Dec 65. SECRET
"Sino-Soviet Attack Capabilities (U)." TP 3672, Feb 65. SECRET

Hantzes, Harry N., Stanford E. Hoffman, and Edward P. Kerlin, "Division Aerial Surveillance Capabilities, 1963–1975 (U)," RAC-T-414, Research Analysis Corporation, Jul 63. SECRET—SPECIAL HANDLING

Research Analysis Corporation, "Air Model in Pomex I," unpublished data, Oct 61.

Stanford Research Institute, "ANRAD-70, Effectiveness Study (U)," Research Memo, OED-RM-5205-1, May 65. SECRET

Taylor, John W. R. (ed), Jane's All the World's Aircraft, 1966–67, Netherwood Dalton & Co. Ltd., Huddersfield, England, no date.

US Army Combat Developments Command

Advanced Tactics Project, "Air Defense Weapons Characteristics (U)," May 64. SECRET
——, "War Game Handbook, No. A-1 (U)," no date. SECRET
——, "War Game Handbook, No. A-4 (U)," no date. SECRET
——, "War Game Handbook, No. A-7 (U)," 1 Sep 64. SECRET
——, "War Game Handbook, No. A-13 (U)," 27 Aug 64. SECRET
"Air Defense of the Field Army (U)," Vol I, 16 Mar 62. SECRET
"Army Requirements for Fire Support (U)," Apr 63. SECRET
"A Type Soviet Army Front, 1968–1972 (U)," Apr 65. SECRET
"Criteria for Nuclear Weapons Personnel Casualties (U)," CDOG Study 8, USACDCNG 62-8, Dec 63. SECRET—RESTRICTED DATA
"Doctrinal Guidance for Field Evaluation, Nuclear Warfare, Final Draft (U)," 2 Nov 65. CONFIDENTIAL
"Field Army Requirements for Air Reconnaissance and Aerial Surveillance (U)" May 63. SECRET
Institute of Special Studies, "War Game Directive AAFSS-3 (U)," Vol II, 7 Jul 67. SECRET—SPECIAL HANDLING—NOFORN
"RODAC-70 (U)," Vol I to V, 10 Nov 64. SECRET

US Army Materiel Command

"Air Defense Guided Missile System, Chaparral (U)," TIR 21.1.8.1, Jun 66. SECRET
"Air Defense Missile Battalion, Nike Hercules (U)," Dec 63. CONFIDENTIAL
"Air Defense System, Vulcan (U)," interim rept, TIR 27.2.2.2, May 66. SECRET
"Development of Air Defense Guided Missile System, Hawk (U)," TIR 21.1.4.1, Nov 65. SECRET
"Fire Control Acquisition Radar for Low Altitude Targets (U)," TR-64-27, Oct 64. SECRET

US Army War College, "War Games Control Course 4, 1961–1962 Curriculum (U)," Nov 61. SECRET

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13. ABSTRACT THEATERSPIEL is a two-sided, closed, computer-assisted, theater-level war game with resolution at division level. The THEATERSPIEL game model consists of the cyclical application of flexible sets of rules, procedures, mathematical expressions, empirical formulas, and military judgments to a specific set of data descriptive of the military units, weapons, and equipment being studied. The purpose of the model is to realistically simulate combat situations in specified environments, producing information that will approximate the results of actual conflict under the same conditions.

The THEATERSPIEL Model is presented in eight chapters. Chapter 1 contains a general description of the model and its submodels and describes the requirements for game preparation and game play.

Chapter 2 explains the computer-processing sequence and the basic element of the THEATERSPIEL Model, the Master Status File. It also discusses the "main link" of the computer program, which brings the "dependent" submodel links into the computer as required.

Chapters 3 to 8 contain descriptions of the computer-assisted submodels: Air, Nuclear, Combat Support, Ground Combat, Logistics and Recovery, and Intelligence. They describe the submodel operations, the sources of input data, the assessment routines, and the expected output data. The sequence of processing each submodel and their interrelations are described.

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