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LOGATAK SUPPORT TO PACOM THEATER NUCLEAR FORCE PROGRAM [redacted]

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BDM Corporation
7915 Jones Branch Drive
McLean, Virginia 22102

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Technical Report

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

[redacted] This report describes a logistics and ground force movement simulation model which was developed by The BDM Corporation for the Defense Nuclear Agency. The model provides a quantitative means of estimating unit movements and delays resulting from attacks on the transportation network. Attack strategies that were tested and related in this report are relevant to a surprise attack against the Republic of Korea.

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PREFACE

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The BDM Corporation is pleased to submit this document which summarizes the results of work performed on Defense Nuclear Agency (DNA) Contract DNA 001-81-C-0032-P3. This report describes a logistics and ground forces movement simulation model developed for DNA and provides quantitative estimates of delays imposed on the movement of supplies and combat units through the use of various interdiction strategies. These interdiction options were applied to scenarios in the Northeast Asia area of concern to PACOM planners.

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LIST OF TABLES

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SECTION 1
[redacted] EXECUTIVE SUMMARY

1.1 [redacted] INTRODUCTION

[redacted] The BDM Corporation (BDM) was tasked by the Defense Nuclear Agency (DNA), in support of the US Pacific Command (PACOM) Theater Nuclear Force Program, to investigate potential interdiction options available to US planners in the event of an attack by the Democratic People's Republic of Korea (DPRK) against Republic of Korea (ROK) and US forces in South Korea. A critical feature of a potential future conflict would be the fluid nature of the battlefield and the relative value of many potential targets as the battle unfolds. This analysis was based, in part, on data generated by a computer simulation model called LOGATAK, which was used to examine possible US/ROK interdiction options in the context of a dynamic situation in which the value of target sets would vary depending upon the stage of enemy mobilization or the progress of the attack.

[redacted] In 1977 BDM developed the LOGATAK model for DNA's study of interdiction options against enemy logistics, support and combat units, and the transportation network on which they would move. Since that time, the model has been used as an analytic tool to examine US/NATO interdiction opportunities in North, Central and Southern Europe; this effort was the first application of LOGATAK to examine interdiction options in North East Asia.

1.2 [redacted] LOGATAK MODEL

[redacted] Since its inception, the LOGATAK model has been subjected to a number of enhancements and expansions of capabilities. During this study, a further modification was made to provide continued realistic portrayals of mobilization and interdiction simulations.

[redacted] Both the Chinese People's Liberation Army (PLA) and the North Korean People's Army (NKPA) are currently composed primarily of infantry divisions which have a limited number of motor vehicles assigned to each division. As a result, to simulate the movement of these units, it was necessary to add the feature of troops walking along roads/trails enroute to forward locations. The model was modified to allow the simulation of individuals walking along roadsides while vehicles travel down the roadway. Also during this effort the existing air and sea movement modules of the model were further enhanced for use with Northeast Asian scenarios.

1.3 [redacted] MODEL APPLICATION

[redacted] The use of the LOGATAK model as an analytic tool requires large amounts of data. In studying a potential conflict on the Korean Peninsula, much information has been generated relative to possible attacks by the NKPA. The drawback to much of this data is the static nature of the studies/analyses from which the data was derived. LOGATAK, using the same input data, provides the capability of examining enemy force mobilization and movement, and US/ROK interdiction options in a dynamic setting.

[redacted] To provide insights to potential interdiction options, a number of sensitivities were tested. These included:

(1) NKPA Six Corps Attack. Mobilization and movement of NKPA forces on foot versus mobilization and movement by vehicle. This scenario used the Defense Intelligence Agency (DIA) Pre-H-Hour Attack Scenario, late 1980s scenario, employing six of the eight NKPA's corps deployed in first echelon, as input and examined the differences in capabilities if the NKPA elected to deploy forward with units moving primarily on foot versus having the same units use available civilian motor transport (trucks and other motor vehicles).

(2) NKPA Four Corps Attack. Mobilization and movement of NKPA forces on foot versus their mobilization and movement by vehicle. Since the potential exists for a minimal warning ("standing start") attack by the NKPA, using only four of the available eight corps in first echelon, this variation was examined in the same context as the DIA assessed six corps attack.

(3) PRC Support to an NKPA Attack. Based on historical precedent and current military support agreements, it is possible that the People's Republic of China (PRC) might enter

into hostilities in support of the NKPA. The mobilization and movement of People's Liberation Army (PLA) combat forces and logistics support were examined as a part of this study.

[redacted] By analyzing computer generated data, a number of potential interdiction target sets were identified relative to the various scenarios studied. The focus of this analysis was on the NKPA/PLA lines of communication (LOCs) and geographic targets, such as transshipment points (TSPs), which would potentially be high payoff targets for US/ROK interdiction attacks with medium to long-range interdiction assets.

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SECTION 2
INTRODUCTION

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2.1 BACKGROUND AND INTRODUCTION

The LOGATAK simulation model has been used extensively to study potential interdiction strategies designed to delay, disrupt and destroy threat force combat units and logistics in a theater-wide military campaign. Most of the efforts undertaken by the Defense Nuclear Agency (DNA) using this model have focused on potential hostilities in Central Europe. Other previous analyses using LOGATAK include scenarios set in the Balkans and northeast Turkey. The established methodology and expertise gained from these applications of LOGATAK made it possible to undertake a study of interdiction options PACOM planners might consider to counter a North Korean or North Korean/Chinese invasion of the Republic of Korea (ROK).

Generally, the LOGATAK simulation requires inputs such as the transportation networks to be simulated, threat force and logistics data, and an overall scenario. Once this data is gathered and formated it is input to the model. Simulation runs offer the analyst data from which targeting options can be developed. Interdiction strategies can be tested using LOGATAK to produce insights for military planners, who can then determine the necessary weapons and allocation to effectively disrupt threat force rear area activities.

2.2 OBJECTIVE

The objective of this study was to simulate a North Korean and a North Korean/PRC invasion of the Republic of Korea, and to test various potential interdiction strategies in support of the PACOM Theater Nuclear Force Program.

[redacted]

2.3 TASKS

The following tasks were performed for this effort:

2.3.1 Task 1 - Establish Data Base Requirements

As stated in Section 2.1, LOGATAK input data requirements include information concerning the geographic area in which the scenario is set (i.e., terrain, transportation facilities, etc.), the capabilities of the transportation system, the type and number of units to be included, their requirements and capabilities for logistics support, and the overall threat force objective in the scenario.

These specific data base requirements were established for the scenarios considered in the analysis. Input requirements unique to conflict scenarios set in Northeast Asia and including North Korean and People's Republic of China combat forces were identified.

2.3.2 Task 2 - Data Collection

The LOGATAK simulation model is heavily input-dependent. Careful consideration was made of all available data to satisfy the requirements set in Task 1. A detailed transportation network was developed and coded for inclusion in the model. Effects of terrain were noted so proper adjustments could be made in the capabilities of the network to move forces and logistics to desired locations.

LOGATAK uses a "stylized" unit to represent actual combat forces during simulations. As a result, every Motorized Rifle Division (MRD) in LOGATAK is composed of the identical number of vehicles and equipment as any other MRD. While actual units sometimes vary slightly in size and composition, this stylization is dictated by the nature of the program and is generally considered sufficiently accurate for portraying combat forces for the purposes of identifying interdiction opportunities. North Korean and PRC unit organizational data was used to produce stylized North Korean People's Army (NKPA) and PRC People's Liberation Army (PLA) forces.

Scenario inputs identified the starting locations and intended destinations for the North Korean and PRC units. This information was coded and input to the model. Logistics expenditure rates for North Korean and PRC forces were also developed for input to the model.

[redacted]

Potential interdiction targets were identified, including targets such as rail and road bridges on the threat forces' routes of advance. Other interdiction points (e.g. mountain passes, tunnels, landslide areas in mountainous terrain) were also identified. These targets, together with the probable assembly areas that would be used by threat forces, comprise the initial target sets for developing interdiction strategies.

2.3.3 Task 3 - Model Expansion

To adequately reflect the potential use of air and sealift by the NKPA and PRC forces, the LOGATAK model's capability to simulate these modes of travel was expanded. Realistic but limited airlift and sealift modules were included to allow for the transport of combat units and supplies from the PRC to areas proximate to the DMZ.

Another area in which the capabilities of LOGATAK were expanded for this effort was in the addition of a movement feature to simulate dismounted troops marching along roads. Since the NKPA and PLA consist primarily of infantry divisions which have few trucks assigned for troop transport, the movement module in LOGATAK was adjusted to allow for people walking along the sides of a road/trail while vehicles utilized the main portion of the road/trail.

2.3.4 Task 4 - Model Operations

With the appropriate data input to LOGATAK, simulation runs were made. The first simulation was a baseline, unimpeded (i.e., no attacks) analysis of the mobilization and movement potential of threat force combat units from their garrison locations to forward assembly areas. The stockpiling and movement of their logistics support was also simulated during this "baseline" run. Limitations in the transportation system and natural barriers which would cause excessive use of particular sections of the system and could cause creation of "queues" were identified as potential targets.

Subsequent runs tested various interdiction targeting strategies, the results of which were compared with the baseline case to ascertain the effectiveness of alternative interdiction options.

[redacted]

[redacted]

2.3.5 Task 5 - Analysis and Results

The data generated as a result of Task 4 was analyzed and the most effective interdiction strategies were identified.

LOGATAK is designed to identify vulnerabilities that exist in the threat forces transportation network and logistics systems. It portrays the movement of troops and supplies in a dynamic fashion allowing for a realistic view of these activities and vulnerabilities in the system. These analyses generate interdiction targeting options, particularly from the perspective of striking different target sets at different times during a conflict. A variety of interdiction strategies were tested in this analysis to produce insights into the effectiveness of interdiction options, considering the dynamic nature of the simulation. These analyses showed what the best targets would be and what combinations of targets would need to be destroyed to achieve a specified level of delay/destruction of threat forces and supplies.

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SECTION 3
LOGATAK MODEL

[redacted]

3.1 PURPOSE AND USE

The LOGATAK simulation model was developed to simulate the logistics supply demand functions and the movement of ground combat units in a non-combat environment. It is also used to develop and measure the relative effectiveness of interdiction strategies. The model simulates the movement of ground force units and supplies over a multi-mode transportation network over time. This permits the analysis of traffic flow and the identification of overloads and bottlenecks in the transportation network. The model determines the optimum route for a unit from its starting location to the final destination, changing the routing as necessary to reduce congestion caused by overload or interdiction attacks.

The model is designed to accept a wide range of scenarios and transportation networks. It is sufficiently flexible that the user can analyze any geographical area by modifying the data base. The road/rail networks, locations of supply bases and assembly areas, and the types and numbers of units to be considered in a scenario within the area selected for study are specified. The logistics scenario includes the varying demand patterns for a variety of supply classes.

LOGATAK is run first with no interdiction to provide a basis for comparison with interdiction runs. Having analyzed the baseline, the user develops candidate interdiction strategies and repeats the run with an interdiction strategy injected into the model. As insights are gained into the ability of the network to recover from attack, improvements to the interdiction strategies are developed.

3.2 LOGATAK ANCESTRY

3.2.1 MAWLOGS

The LOGATAK simulation model was developed using the MAWLOGS (Models of the US Army Worldwide Logistics System). MAWLOGS is a highly modular set of computer programs that model a wide variety of logistics

[redacted]

related program activities. These programs are tied together by a series of routines using an automated assembler. The system consists of a module library, the module assembler program, an output postprocessor, and a high level language used to describe the logistics structure being modeled. The modules have been designed to provide varying levels of detail for the activities in question. For example, transportation of supplies can be represented as a simple travel time between the supply source and its destination, or it can be modeled to the level of individual vehicles traveling along an actual transportation network.

3.2.2 LOGATAK

The initial LOGATAK simulation model required considerable expansion of the MAWLOGS module library. These additions included the ability to attack logistics supply bases, to attack the transportation network, and to repair or rebuild the damaged or destroyed sections of the transportation network. These modifications provided the necessary capabilities for simulating interdictive attacks; however, some details were still lacking. For example, attack weapons' effectiveness, use of multiple attacks, attrition of forces, and engineering repair/rebuild assets were not modeled explicitly in the initial LOGATAK.

3.2.3 LOGATAK/Force Movement Option

The ability to simulate more realistically the peculiarities of combat forces in road march, the rapid bridge repair and construction capability of engineer units, and the availability of sufficient interdiction assets to perform the desired interdiction mission were some of the necessary additions to LOGATAK.

Analysis showed a need to improve the LOGATAK model in two areas: the transportation allocation/route selection algorithm and the inclusion of convoy/train lengths as delaying factors in movement. The addition of these modules maintained the MAWLOGS flexibility, and at the same time allowed for more detailed analyses than were previously possible.

3.3 GENERAL DESIGN CHARACTERISTICS

LOGATAK is a discrete-event stochastic simulation model consisting of supply demand generator nodes, intermediate stockage points, supply

[redacted]

source nodes, assembly areas, and a multimode transportation network which connects the nodes. The flow of logistics and forces on the transportation network is simulated over time. Overloads cause queue buildups and rerouting of units. Attacks on the transportation network cause similar effects such as additional delays in the arrival of men and materiel.

The basic measures of effectiveness of an interdiction strategy are the delays in the arrival of forces, the delays in the delivery of logistics, and the reduction in stockage of supplies at the intermediate supply points.

The user of the model determines the following: the transportation network covered by the scenario (using DAMSEL[1]); the number, composition, starting locations, departure times, and destination of all forces; and the supply base locations, stockage levels, and demand rates over time. The attacks are defined by target sets that group individual targets (bridges, road intersections, etc.) into geographical coordinates. These target sets can then be attacked in whole or in part. This permits a better assessment of the results of the use of interdiction assets in the actual battle.

The model is written in the FORTRAN language and operates on a Control Data Corporation CYBER 176, using many of the features of the General Activities Simulation Program (GASP) simulation language. The model uses complex logic to adapt a wide range of problems and interactions so that it can simulate a complex transportation and supply network. The model can be stopped at any point during the course of the simulation and can be restarted from that point. Reports are generated for the user at any time during the run, thereby allowing the analyst to evaluate the system over time.

3.4 ACTIVITIES SIMULATED

3.4.1 Logistics

3.4.1.1 Physical Characteristics. The logistics structure of LOGATAK remains essentially unchanged from earlier versions of the model. Supplies

1. DAMSEL is a Data Management Selection System which converts data from the data base to the LOGATAK format. It adds data, deletes data, updates existing data, and orders the data library.

[redacted]

are moved in truck loads and train loads. Only two classes of supplies (ammunition and POL) were included in this study. In terms of priority for movement, supplies always move <u>after</u> forces; POL moves <u>after</u> ammo.

Stockage levels were set at 30 days of supply for all units being supplied by the logistics base.

Demand generators located near the FLOT (Forward Line of Troops) request supplies from intermediate stockage points represented by aggregated corps supply bases. These supply bases attempt to maintain their initial stockage level by requesting logistics from sources in the rear. The demand rates are computed on the basis of daily expenditures at the FLOT.

3.4.1.2 <u>Operating Variables</u>. No communications delays were played. Structure (division-to-corps) was maintained, even when shortfalls developed. Nationalities were mixed, i.e., PRC supply bases resupplied PRC units as well as North Korean units.

Daily demand requirements were developed using standard commitment schedules and division demand rates for first echelon forces, second echelon forces and reserves. A one-time division POL refill was ordered upon arrival of the division at its final assembly area to compensate for the use of fuel during the road march.

Demand priorities were "first received, first filled." No special priority for any attack axis was considered.

3.4.2 Forces

3.4.2.1 <u>Physical Characteristics</u>. The movement of ground combat forces in LOGATAK has been improved to better reflect the way in which these elements are organized and operate. The model accepts an organizational structure for a parent unit that breaks the unit down into smaller subunits. The smallest unit represented in LOGATAK for this study is the battalion. The model allows the definition of up to eight types of battalions. These battalions can be grouped together to form as many as seven types of regiments. This structure allows the analyst to reflect the order of march in a major unit and helps determine the combat strength of the forces that arrive in their assembly areas. Battalion types are generalized to reduce the computer storage requirements. Three major battalion categories are considered, i.e., combat (tank, infantry, artillery, etc.), combat support (engineers, chemical, etc.), and logistics support (ammunition train, hospital, etc.). These are aggregated and/or broken down as necessary to construct the various parent units (divisions, brigades, etc.).

After being broken down into suitable units, movement priorities are assigned to each unit. These priorities allow the model to determine which unit takes travel precedence when a bottleneck in the system occurs. In this way, the model can maintain a degree of regimental integrity.

3.4.2.2 Operating Variables. Starting location (garrison) and destination (final division assembly area) are defined by the scenario. Movement priority was assigned to allow entire divisions to arrive together as quickly as possible. The closest divisions were typically given highest priority, unless readiness category took precedence. Movement initiation time was defined as the earliest time a unit could be expected to begin movement in a short warning scenario. Some units were delayed a few hours to allow higher priority units to pass.

The scenario definition can greatly affect the results. A more staggered mobilization, for example, would reduce network congestion, but might provide more time for effective interdiction.

3.4.3 Movement Of Units

3.4.3.1 Physical Characteristics. As a unit enters the transportation network, its route of travel is calculated considering all traffic, queues, and other obstructions that exist in the network at the time of entry and traffic that has already been allocated to portions of the network. The size of the unit and the throughput capacities of the links and nodes of the network are used to determine the fastest route of travel. After an attack, the time required to repair or rebuild the damaged or destroyed part of the network is also included. Only the first part of the path (route) is remembered by the unit. Once this part has been traversed, a new route calculation is performed so that any changes that have occurred in the network can be considered.

[redacted]

The user of the model has some decision parameters available which must be addressed. For example, it is necessary to specify maximum queue size and maximum length of time that a unit will stay in a queue before looking for another route. Also, vehicle and train spacing are other variables to be considered. Adjusting these parameters in different ways may cause many small queues or a few large queues to develop. Shorter (but more) waiting times cause longer model run times and more extensive use of the network.

Maneuver units are given the ability to repair sections of the network which have been destroyed. This differentiates them from logistics units which must depend on other units to maintain their lines of communications. For this reason, logistics units are given the lowest movement priority. Maneuver units go first to clear the way.

When a unit in transit encounters an obstacle it recalculates its route. If the minimum travel time requires the removal of the obstacle, repairs begin immediately. The model considers all alternatives, including obstacles on other routes that may already be under repair, before determining the best route. Thus, only the minimum number of repairs actually required are initiated.

3.4.3.2 Operating Variables. Air and sea movement were played. For both, port-to-port movement was simulated. The speed and lift capacity are inputs to the model. It is necessary to specify a maximum capacity that the system can lift simultaneously. When the system reaches the maximum, queues will start to form and LOGATAK decides on alternatives for the unit in the same manner that it handles other queues in the model.

Foot movement of infantry was simulated in this study. An infantry unit could walk alongside the roads unimpeded by vehicular traffic. The right-of-way and prioritization at road intersections was treated as in the past, i.e., one column could block another column, queue waiting times were calculated, and alternative routes were examined. The speed, which is an input value, was adjusted to reflect time for rest stops, sleep, etc.

[redacted]

3.4.4 Interdiction Attacks

When a simulated attack is initiated, the number and types of weapons (bombs, missiles, aircraft, squadrons, etc.) available, the target set (group of targets selected for attack), the type of attack, and the time of the attack are specified. Each attack weapon has an effectiveness probability which combines target acquisition errors, delivery errors, probability of malfunction, etc. Once the weapon has been deemed effective, the attack is initiated. The targets within the target set are prioritized by the user. These priorities may be adjusted by the model using options which have been selected by the user.

There are three general attack types supported by the LOGATAK model:

(1) Geographic Targets (network),

(2) Forces and logistics on the network, and

(3) Supply bases.

In this study, the attack of geographic targets and forces and logistics on the network were included. The nature and forward deployed location of a large number of North Korean supply bases excluded them as potential targets.

3.4.4.1 Transportation Network Attacks. The attacks on the transportation network represent some of the possibilities that would be available in an actual battle situation. The attack could involve the destruction of a part of the transportation network such as a bridge, a tunnel or a mountain pass. Also, mine fields can be laid in order to provide additional barriers or increase the rebuild times of existing barriers. Nuclear attacks also have the potential of causing increased rebuild times and hence longer delays.

In the case of direct attacks on vulnerable points in the transportation network, each target is assigned a probability of destruction. Thus, an attack may or may not result in the desired destruction. The model must consider the probabilities. The model also accommodates partial destruction by reducing the throughput of the link and although not completely destroyed, subsequent attacks have cumulative effects on the link.

[redacted]

Attacks may also be made against rebuilds in progress, thereby extending the time required to repair the damage.

The user may alter the priorities of attack on the links by lowering the priority on all unused links. This would result in attacks to occur first on the links in use. This option would require perfect intelligence, but it would also maximize the delay of the units affected by the attacks.

Another option allows the model to prioritize targets based on historical use of that part of the transportation network up to the point in time of the strike plan, the assumption being that routes used in the past will be used again.

3.4.4.2 Repair and Rebuild. When a section of the transportation network is damaged or destroyed, the analyst must provide repair or rebuild criteria. The model permits the link to be:

(1) Repaired automatically with the repairs beginning immediately after the attack;

(2) Left in a destroyed condition permanently; or,

(3) Repaired on demand in accordance with analyst specified criteria.

The rebuild rates, cargo handling capacities and rates of travel for a number of bridge types are included in the model to reflect the engineer assets available to the forces. It is assumed that the length of a bridge destroyed by the attack is equal to that in its description. Therefore, bridges over wide rivers will take longer to rebuild than those over streams or canals. A materiel availability delay capability is built into the model in order to simulate the difficulties associated with not having the proper materiel available to conduct the repair operation. Movement of engineer units, gathering of equipment and materiel, preparing approaches, etc., are all aggregated into one delay time. This delay can be increased or decreased at the option of the user. Thus, the time required for repairs may vary (faster or slower) during the course of the model run. For this study, this delay is assumed to be zero. When the decision to repair is made by the model, sufficient assets to complete the repair are

[redacted]

assumed to be available at the site. Increases in repair time cause later arrival times and more queuing on the network.

3.4.4.3 Attrition of Units. The units which are present within the area of the attack are attrited when an effective weapon is expended on them. The attrition rates can be defined for up to six weapon types against each battalion or supply convoy. The appropriate attrition rate is applied to the units attacked and they are thereby reduced in size. Since LOGATAK is a model used for estimating the impact of interdiction, it is considered that this representation of attrition is sufficient for planning purposes. More detailed weapons effects analysis is conducted, when desired, external to the model to provide data inputs. Appendix D is representative of the type of specific data developed for a more detailed understanding of interdiction simulations.

An attack on units may have the additional effect of creating obstacles (damaged vehicles) on the road or highway which would reduce the capacity of the network at that point until cleared. Damaged vehicles are cleared automatically at a point later in the model run.

Additional flexibility is provided in the model in that attrition may also be applied to either logistics or maneuver units separately, and these attacks can be restricted to queues at road intersections if desirable. The model aborts attacks on these units when the queues drop below a threshold specified by the user, thus preventing complete destruction of the unit. This restriction accommodates the difficulty of conventional weapons systems to identify functional vs. destroyed vehicles and the problem of locating small units on a large transportation network. This restriction is lifted for nuclear attacks.

3.5 INPUTS AND OUTPUTS

Figure 3-1 shows the basic inputs and outputs for the LOGATAK model.

3.5.1 Inputs

The LOGATAK simulation model was designed to be data independent. The same computer program can be used to model military operations in different parts of the world, at different levels of detail without changing the model in any way. Variations in climate, geography, and scenario are

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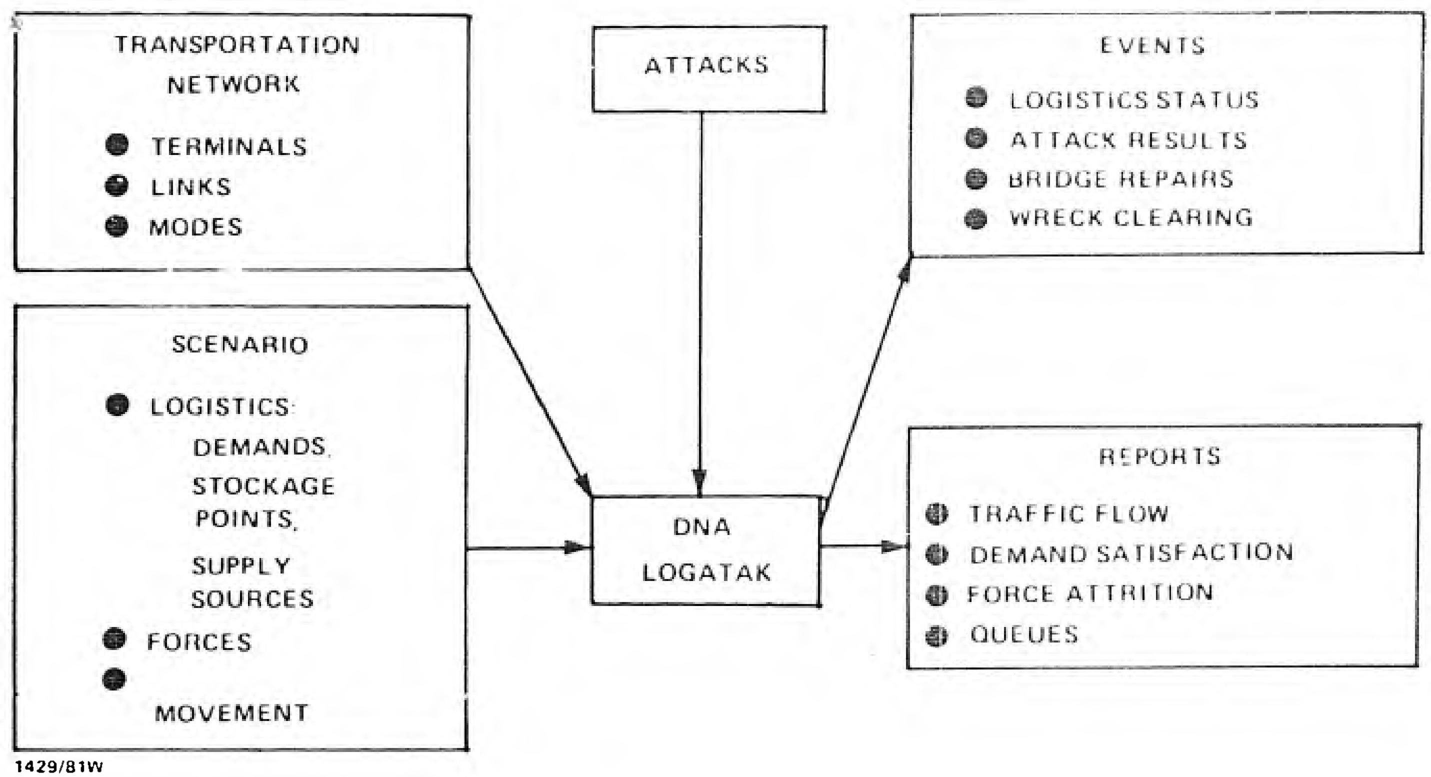

Figure 3-1. Inputs and outputs.

[redacted]

[redacted]

accomplished through the input data developed by military analysts for any specific case being studied. These data values are addressed below.

3.5.1.1 Transportation Network. The LOGATAK model uses a representation of the actual transportation network in the region of concern. Using 1:250,000 scale maps, analysts determine the density of the network that will be included. Modeling every road in a region is usually impractical. Thus, the analyst is responsible for evaluating the network, and including only as much as is necessary to facilitate analysis.

A typical network includes most of the rail lines in the region. Occasionally, a spur that is deemed unnecessary will be omitted.

Road routes are more difficult to assess. All limited access highway routes are included first. Primary roads are added to provide flexibility in route selection. Potential targets and choke points are identified at this point. Secondary and tertiary roads are added to provide bypasses around choke points and to insure that all targetable entities (e.g., all the bridges and ferry sites across a river) have been included. The final input incorporates scenario specific routes (garrison locations and assembly areas) as well as lateral movement routes and potential rail heads. At this point, the network is coded for input into LOGATAK. The principal data for the network is shown in Figure 3-2. The LOGATAK transportation network is defined by links and terminals. The terminals are the road intersections, cities, transloading points, etc. They are the decision points in the network. They have a capacity defined by the number of vehicles that can be within the terminal simultaneously. Delay factors are used to accommodate consolidation, loading, unloading and throughput of cargo. A set of statistical indicators are also used. These include average number of vehicles in the terminals, total vehicles moved through the terminals, and the average number of vehicles in arrival and departure queues.

The links in the transportation network serve to connect the terminals. They consist of railroads, highways and transshipment links. Each link is defined by its end points (terminal numbers). It has a length in kilometers, a rate of travel, and a set of statistical indicators such as

[redacted]

[redacted]

Highway

Type	Speed (KM/HR)*
Limited Access Highway	45
Principal	32
Secondary	24
Tertiary	18
Trail	12

Rail**

Single Track/Diesel	32
Single Track/Electric	40
Multi-Track/Diesel	40
Multi-Track/Electric	48

*Highway speeds reflect an average for a 24-hour period; this accommodates starting/stopping, breakdowns, etc.

**Rail speeds for single track segments are adjusted to accommodate for the management of two directional travel on single track lines. Speeds are average for 24-hour period.

Figure 3-2. Transportation network data base guidelines.

[redacted]

the average capacity of the link, and the average and total number of vehicles which can be moved over the link during a specific time period.

Each mode of transportation using the network is given a maximum size of shipment that can be carried. This size, in numbers of vehicles, is used to break the shipments down into manageable portions. The maximum queue size, wait time in the queue, and vehicle and train spacing are entered at this point.

Figure 3-3 summarizes the operating variables required to run the LOGATAK model.

Throughput delays are assigned to intersections based upon the population density around the intersection. This delay has been set to zero for most intersections, but increases to as much as one hour for major metropolitan areas. The delay accounts for turnpoints, civilian traffic, reduced rates of travel through cities, etc. Small increases in this factor, if applied throughout the network, have been shown to increase travel times substantially. Delaying the lead element of a column delays the entire column. LOGATAK compensates for this in part, by using additional routes for the column.

Loading/unloading delays are used to reflect the availability of trains and trucks. They have been set to zero for this study to support the assumption that sufficient rolling stock is available whenever and wherever it is needed. This represents the "best case" for North Korean and PRC forces.

Maximum queue size is a multiplier of the given physical capacity of a terminal or link. For this study, it has been set to two, allowing twice the number of vehicles to occupy the area around an intersection, or allowing two columns of vehicles to occupy a road at standard spacing (one on the right and one on the left) while waiting in a queue. Decreasing this factor reduces the size of queues but increases their number and duration. More routes are used by the model. An increase in queue size causes fewer, larger queues to develop. The value used reflects the most probable condition.

- Throughput Delays
- Transshipment Delays
- Queue Size Limitations
- Rerouting Time
- Traffic Management
- Weather/Road Conditions

Figure 3-3. LOGATAK operating variables.

Minimum waiting time prevents units from using alternate routes when minor delays are encountered enroute. The value of the rerouting time has been set to two hours. It was felt that a short halt would allow preventive maintenance to be done, troops to be fed, etc. and that after two hours, if the cause of the halt had not been eliminated, the unit commander would request further orders. Using a shorter value causes LOGATAK to do more route calculations, but changes the traffic pattern very little. Longer values cause undue delays. It must be remembered that should the cause of the queue be eliminated before the minimum time has expired, the unit will immediately resume forward movement.

Knowledge of traffic and network conditions is set to the best case for North Korean and PRC forces. All unit locations and the effects of interdiction are known to the route control module immediately. Each route calculation takes current conditions into account to provide optimum routing. Individual units request routes at least every 100 kms. Thus, a unit could march this distance toward a less than optimum path (due to interdiction) before altering its path. The actual average march distance between route calculations is approximately 45 kms.

Weather and road conditions are considered to be perfect. No road deterioration was modeled in this study.

In general, these operating variables drive the traffic patterns and travel times in the LOGATAK model. They have been set to realistic values as determined by military analysts. These factors seem to provide realistic network utilization, without causing excessively long model execution times.

3.5.1.2 Scenario Information. Scenario information inputs to the model include:

(1) Logistics, i.e., the demand generators, the intermediate stockage points, and the supply sources,

(2) The composition and movements of the combat forces, and

(3) The attack execution.

The demand generators request supplies and are the final destinations for these supplies. Each demand generator is given a demand interval, a priority, the number of demands for each type and quantity of material demanded, and a set of statistical indicators for due-ins, supply requests, and receipts.

Demand generators request supplies from intermediate stockage points representing corps supply bases (CSB). These CSBs have an initial balance on hand, a reorder point, and a stockage level. When the balance on hand falls below the reorder point, a demand is sent to a rear supply base for resupply up to the stockage level. In the LOGATAK model, the initial balance, reorder point and stockage level are identical. Statistics are collected on demands received, demands filled, and balance on hand.

As noted above, force composition, initial force movement rates, and destinations are inputs to the model. LOGATAK accepts division level organizations and breaks them down into battalion groups. Each battalion type is given a number of associated vehicles, a movement priority, and a set of attrition rates which might be expected from attacks by various weapon types. Up to eight generalized battalion types and six attrition rates may be included. These battalions are grouped into parent organizations (division, army, etc.) using a matrix which aggregates the battalions into regiments. This matrix establishes the movement order within the parent unit. As each unit enters the LOGATAK model, it is assigned a starting location, a destination, a departure time, a priority, and an identification number.

At the beginning of the model run, the analyst selects those parts of the transportation network considered to be viable targets. These may be grouped into any number of target sets to reflect alternate attack locations or distinguish between primary and secondary targets. The transportation network targets consist of links and terminals. Links are given special parameters for probabilities of destruction, length (for bridges), and type of rebuild activity. Terminals identify locations where units may form queues. These targets can be prioritized within the target set.

Attacks occur during the model run as requested by the user. These attacks can be placed against one or more target sets. The number of available weapons, the effectiveness probability of each weapon, the type of weapon, and the type of attack are all selective input variables.

Attacks may be executed against links, traffic, terminals, or queues alone or in a variety of combinations. Minefields and nuclear attacks can also be simulated through the reduction of network capacity for a period of time.

Bridges may be reprioritized during the run into "in use" vs. "not in use." This gives the analyst the ability to respond to current intelligence information.

The user can restrict the attrition of units to logistics traffic or maneuver forces if desired. Thus, the model allows the investigation of various attack strategies.

3.5.2 Outputs

3.5.2.1 Event Occurrences. The LOGATAK model has been expanded to include the printing of notifications of occurrences of some events that occur during the model run. These events include: the arrivals of logistics at final locations or intermediate storage points, attack effects, bridge repairs or rebuilds, and wreck clearing. All pertinent information is printed in as concise a form as possible. This permits the analyst to follow the scenario and observe the events as they occur.

3.5.2.2 Summary Reports. The analyst also has available, upon request, a variety of summary reports. The transportation network report indicates the traffic flow over each element of the network. The demand generator report prints the statistics on supply requests and arrivals, and on the duration of force movements. Statistics are also printed on the average inventory levels at intermediate stockage points and their ability to fill supply requests.

The LOGATAK model also reports on the attrition of force units, and existing queues in the transportation network. A reduced transportation report dealing only with targets is also available.

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SECTION 4

[redacted] UNILATERAL NORTH KOREAN ATTACK SCENARIO

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SECTION 5
[redacted] NORTH KOREAN ATTACK WITH PRC LOGISTICS/COMBAT FORCES SUPPORT SCENARIO

5.1 [redacted] OVERVIEW

[redacted] Although the DPRK has exhibited the characteristic of acting unilaterally on many occasions, it is logical to examine a scenario which includes support from the People's Republic of China (PRC). The PRC and the DPRK share a common border across which China could funnel a significant amount of logistics as well as combat units of the People's Liberation Army (PLA). Should the NKPA offensive be held back by US/ROK resistance for any significant amount of time, or should the PRC view the situation as a political opportunity to expand its influence in the Korean Peninsula, PRC intervention would be a possibility which can not be ignored.

[redacted] This section details the scenario and insights gained from conducting a detailed analysis of a DPRK attack against the ROK augmented by PRC support. Included are the order of battle, arrival rates of troops and logistics, and an analysis of potential interdiction target sets.

5.2 [redacted] SCENARIO DEVELOPMENT

[redacted] The first step in developing a realistic scenario which postulates PRC support was to ascertain a time frame in which the PLA would be committed. It was assumed that the PRC would not move troops or logistics to the DPRK prior to D-Day. Also, it was assumed that the PRC would delay any overt move, i.e., cross into North Korea, unless it was felt the NKPA could not defeat the ROK and US forces without assistance.

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APPENDIX A

[redacted] METHODOLOGY FOR POL CONSUMPTION RATES

[redacted] The movement of POL resupply to forward supply bases was required to reflect the additional military vehicle traffic (unit POL vehicles and civilian POL transport vehicles) that would exist on the North Korean transportation network for logistics support. An estimate of NKPA fuel expenditure during mobilization and while in combat had to be calculated. It was assumed that NKPA units would not be committed to battle until their fuel supply, diminished during mobilization, was restored. It would be tactically unsound to launch a major offensive operation with an initial fuel deficit.

[redacted] The North Korean Petroleum, Oil, and Lubricants (POL) consumption rates (Figure A-1) are based on information taken from the North Korean Military Forces Field Manual and the Warsaw Pact Logistics Guide. The vehicle refill data represents the amount of fuel required to fill the integral fuel tanks of tanks, self-propelled artillery, tracked APC's, prime movers and other tracked vehicles. For other vehicles it is the quantity of fuel required to travel 500 kilometers.

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A-2

Pages A-3 through B-6 were deleted.

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APPENDIX C

[redacted] GROUND ORDER OF BATTLE

[redacted] The following is a listing of those units whose movement from garrison locations to assembly areas was simulated using the LOGATAK model. Definitions of column headings are:

(1) UNIT - Name or number of unit and type.

 (a) INF DIV - Infantry Division,

 (b) INF Bde - Infantry Brigade,

 (c) TKD - Tank Division,

 (d) GTKD - Guards Tank Division,

 (e) TK Bde - Tank Brigade,

 (f) MRD - Motorized Rifle Division,

 (g) GMRD - Guards Motorized Rifle Division,

 (h) MRBde - Motorized Rifle Brigade,

 (i) ARMY HQ - Headquarters element,

 (j) CORPS - Headquarters element.

(2) GARRISON LOCATION - Starting location.

(3) ASSEMBLY AREA - The largest city in the vicinity of the division/army assembly area at which a unit's movement in LOGATAK ceased.

(4) TRAVEL TIME - Total time required until last element of the unit arrived at the assembly area.

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APPENDIX D

[redacted] WEAPON EFFECTIVENESS ANALYSIS

D.1 [redacted] GENERAL

[redacted] To fully assess the ability of the ROK's armed forces to successfully interdict the invading second echelon forces of the North Korean Army, a detailed analysis of the effectiveness of the weapon systems available to the ROK armed forces, both Korean systems and US systems, must be performed. The actual effectiveness of a specific weapon system against a target is a function of numerous variables. In consideration of air delivered weapon systems these variables encompass: the effects of aircraft delivery error, a function of the proficiency of the pilot and crew and the sophistication of the aircraft's delivery capabilities; weather conditions affecting the delivery profile executed; and existing enemy antiaircraft missile sites stationed within the terminal target area and enroute to the target area. Furthermore, to ensure adequate penetration of the aircraft into the target area, the combat radii of the aircraft, a function of the aircraft external stores payload and the aircraft's flight profile, must be assessed.

[redacted]

[redacted] Although the actual effects of these parameters is extremely dependent upon the specific target array and weapon system considered, careful utilization of the expectations of these parameters, throughout the analysis, would certainly provide a more realistic assessment of the given

[redacted]

weapon systems. This appendix is devoted to the development of the methodology utilized in the evaluation of the effectiveness of the weapon systems available to the South Korean Forces for use in interdiction activities against the North Korean armed forces.

D.2 [redacted] WEAPON SYSTEMS AVAILABLE

D.2.1 [redacted] Tactical Aircraft Available

[redacted]

D.2.2 [redacted] Conventional Weapons Available

[redacted] Table D-2 summarizes the conventional weapons assumed to be available to the ROK forces for use in interdiction operations. These weapons are presently available to the ROK armed forces.

[redacted] The Maverick missile can be carried by the A-6E, F-16, A-7E, and F-4. During daylight hours and clear weather, the Maverick missile is highly effective against armored targets. However, to ensure the missiles' homing devices are locked onto the target before launching, the target must

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D-4

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be of high contrast. This stipulation for launching could conceivably place the delivery aircraft within range of enemy antiaircraft systems. [redacted]

D.3 [redacted] EFFECTIVENESS OF CONVENTIONAL WEAPON SYSTEMS IN INTEGRATED OPERATIONS

[redacted] As previously stated, the effectiveness of a specific weapon system is highly contingent on numerous situationally dependent parameters. Clearly, the composition and characteristics of the target array considered for interdiction operations greatly influences the effectiveness of the weapon system. Thus, the critical step in assessing the effectiveness of

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the aforementioned weapon systems is the construction of realistic target arrays. Furthermore, in assessing the readiness of the aircraft in successfully accomplishing the interdiction mission, an evaluation of the operational combat radii of the aircraft must be performed. Upon completion of these tasks the effectiveness of the conventional weapon systems is addressed.

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D.3.2 [redacted] Tactical Aircraft Combat Radii

[redacted] Throughout the analysis it is assumed that all tactical aircraft will be launched for interdiction missions from the air bases in Taegu and Seoul. The HI-LO-HI ground support rules utilized in this evaluation are according to those found in reference 11. The calculations are based on information contained in reference 11. Drag and weight coefficients were applied to account for the variations in combat radii due to variations in aircraft payload. The following are sample results of the combat radii analysis:

Aircraft	Weapons Payload	Combat Radii (KM) Seoul	Taegu
A-7	4 AGM-65D	674	825
	6 MK82	668	814
	2 MK84	668	814
	6 CBU58	585	705

D.3.3 [redacted] Conventional Weapon Systems Effectiveness Analysis

[redacted] Throughout this analysis a sortie attrition rate of 5 percent, with 2.5 percent attrition on ingress, was assumed. The baseline data utilized in this study was based on the Air Force Tac Selector Model. To account for the 5 percent sortie attrition rate assumed, the sortie attrition rate generated by the model factored out of the expected kills per sortie value and the 2.5 percent sortie attrition factor was applied.

[redacted]

Furthermore, to account for the discrepancies in target density and composition between the target arrays designed for the Tac Selector model and the target arrays utilized in this study, when applicable, a scaling factor was applied to the expected kills per sortie value.

[redacted] To alleviate the effects of the aircraft delivery error characteristic of the specific aircraft of the weapon systems, a weighted average of the expected kills per sortie for each aircraft was calculated: The final result of this analysis is an expectation of the kills per sortie for each conventional weapon against each target array considered, aircraft independent, with the assumption of a 2.5 percent ingress sortie attrition. These results are exhibited in Tables D-4 and D-5.

D.4 [redacted] EFFECTIVENESS OF NUCLEAR WEAPON SYSTEMS IN INTERDICTION OPERATIONS

[redacted] The effectiveness of nuclear warheads for use in interdiction operations is a function of many parameters. For field launched systems these parameters include the range of the target from the launch location, the circular error probable (CEP) of the system, the yield of the warhead, and other employment constraints, such as the collateral damage preclusion distance of the warhead, should a city be located in the vicinity of the target. For air delivered warheads the effectiveness of the weapon system is a function of the aircraft delivery system accuracy. The aircraft delivery system accuracy is dependent upon the proficiency of the pilot and crew and the accuracy of the aircraft's delivery capabilities. Furthermore, the state of the weather influences the delivery profile employed in the interdiction attacks, thus affecting the CEP of the system. In addition, as for field launched warheads, the employment of an air delivered warhead is contingent upon the adherence to any collateral damage constraints.

(U) Although many of these parameters, such as pilot and crew proficiency, present problems characteristic of intractable solutions, a thorough investigation of the remaining parameters influencing the effectiveness of the warheads considered will result in a more realistic assessment of the effectiveness of the weapon systems in interdiction operations.

Pages D-10 and D-11 were deleted.

The following section provides an evaluation of the methodology utilized to compensate for the effects of the various parameters.

D.4.1 [redacted] Tactical Aircraft Circular Error Probable: Nuclear Payload

[redacted] To obtain an expected kills per sortie value independent of the aircraft delivering the warhead, the following methodology was utilized to find an average circular error probable (CEP) value. The CEP of an aircraft delivered warhead may be substantially influenced by the existing weather conditions. If the existing weather conditions surrounding the target area exhibit a ceiling of 1500 feet or more with a 3 mile visibility, a visual Low Altitude Drogue Delivery (LADD) profile can be successfully executed. However, if these weather conditions do not exist, a radar LADD profile is necessary to deliver the nuclear warhead. Hence, the accuracy of a tactical aircraft is contingent upon the weather and the sophistication of the radar system utilized.

[redacted] For this analysis, normal environmental conditions and average radar return characteristics were assumed. Figure D-1 exhibits the average time, per month, the weather conditions in Korea are not favorable to a visual LADD profile. Assuming an average of 12 hours of daylight per day, analysis of this data results in an estimate of 10.68 daylight hours per day in which a visual LADD profile is executable.

[redacted]

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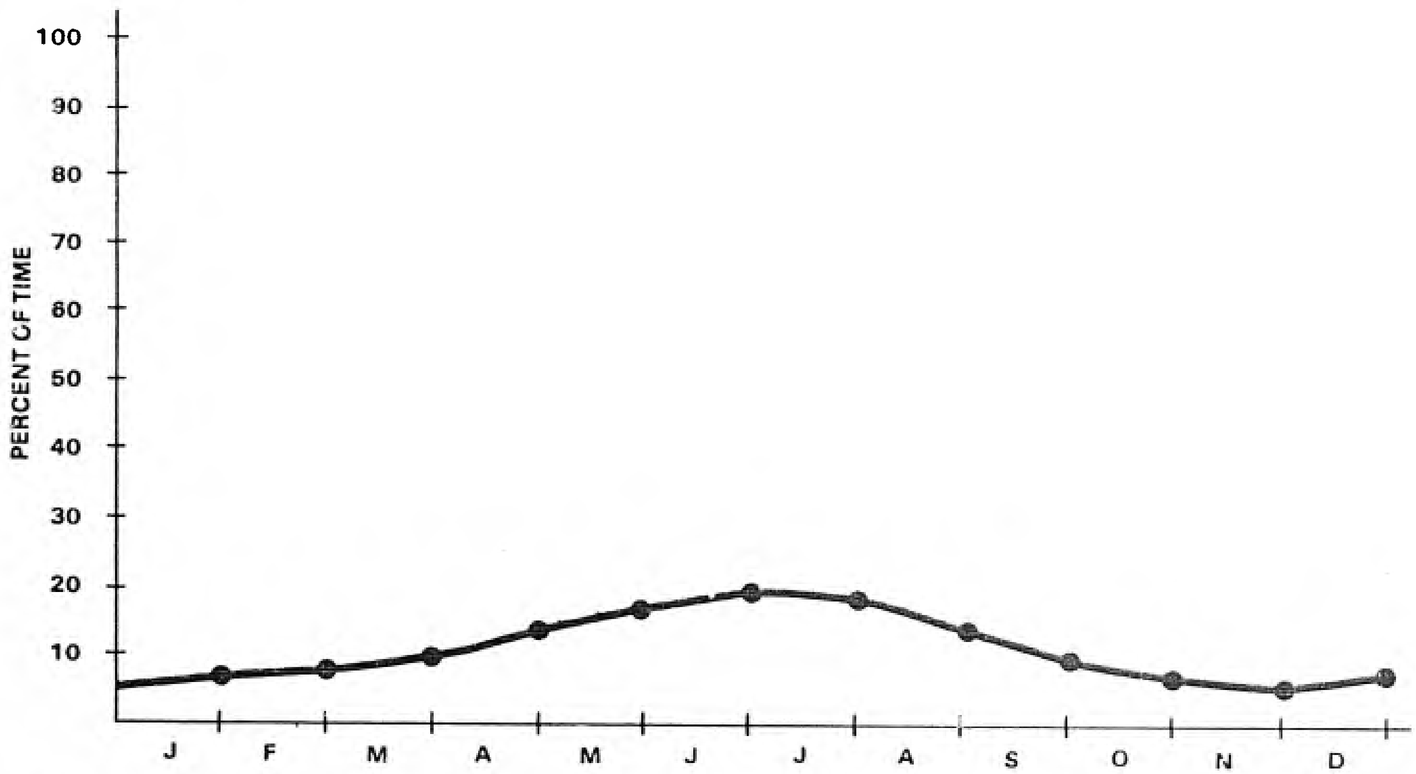

[redacted] SOURCE: TACTICAL DEFICIENCIES ANALYSIS (U), FINAL REPORT, BDM CORPORATION SEPTEMBER 30, 1981

[redacted]

[redacted] Figure D-1. Average time of ceiling below 1,500 ft. or visibility less than 3 miles.

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D.4.2 [redacted] A Probabilistic Approach to the Evaluation of the Effects of CEP on Weapon Effectiveness

[redacted] In assessing the effectiveness of nuclear warheads in interdiction operations, a great deal of attention should be given to the effects of the random variable CEP on warhead effectiveness. In conjunction with CEP, another error, target location error (TLE), should be analyzed. The combined effect of these two errors has a significant impact on the effectiveness of a weapon system. Thus, for this analysis, the following methodology was utilized to combine the two errors and analyze their effect as one error.

[redacted] In an effort to curtail the difficulty in assessing the error of the various sensor systems [redacted] in locating a target, a

[redacted]

[redacted]

TLE of 300 meters was incorporated into the analysis. However, to provide for the probabilistic nature of the TLE, this value of 300 meters was merged with the existing CEP to obtain an adjusted CEP value. This adjusted CEP is defined as:

$$CEP_{adj} = \sqrt{(CEP)^2 + (TLE)^2} \quad (U)$$

[redacted] Given the value of the adjusted CEP, the standard deviation of the combined errors, CEP and TLE, is given by:

$$\text{Sigma} = CEP_{adj}/1.1774 \qquad (U)$$

[redacted] Since TLE and CEP are independent random variables, the combined error possesses a bivariate normal distribution of two independent random variables with mean zero and common standard deviation sigma. Hence, the behavior of the adjusted error can be modeled in the following way. First, the offset angle of the warhead, theta, is uniformly distributed between zero and two PI radians. Furthermore, the offset distance R is based on the fact that 1/2 $(R/\text{sigma})^2$ possesses an exponential distribution. Hence, given a random number uniformly distributed between 0 and 1, and:

$$R = \text{sigma}\ (-2.0\ \text{lm}^{-1}\ (\text{rand}))^{1/2} \text{ and}$$
$$\text{theta} = 2\ (\text{PI})\ (\text{rand}).$$

[redacted] The conversion of the error from polar coordinates to cartesian coordinates, (x, y), follows from the fact that:

$$x = R\ (\cos\ (\text{theta}))$$
$$y = R\ (\sin\ (\text{theta})).$$

[redacted] Utilizing these tools, the actual point of detonation of a warhead can be calculated, in a probabilistic manner, providing a statistical base for the analysis of the effectiveness of nuclear warheads against the specific targets.

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D.4.3 [redacted] Nuclear Weapon Systems Effectiveness Analysis

[redacted] For the final analysis of the effectiveness of the nuclear warheads available [redacted] for use in interdiction operations, a computer model simulating the effects of the nuclear warheads against the various target arrays cited above was developed. This model incorporated the results of the previous two sections. When analyzing the effects of the nuclear weapons against the target arrays composed of tanks, APCs, and trucks, the damage criteria utilized was immediate transient incapacitation (3,000 rads) to the personnel operating the vehicles. Likewise, the damage criteria for the personnel in column formation was immediate transient incapacitation to personnel. Furthermore, a moderate damage criteria was utilized for the target arrays composed of self-propelled and towed artillery.

[redacted] A sample size of thirty runs provided the base data utilized for the study. From this data, the expectation, standard deviation, and 95 percent confidence interval for the number of target elements killed was calculated. Depending on the magnitude of the standard deviation and the width of the confidence interval of a specific warhead/target scenario, when necessity dictated, more samples were generated. The results of this analysis are exhibited in Tables D-6 through D-9.

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