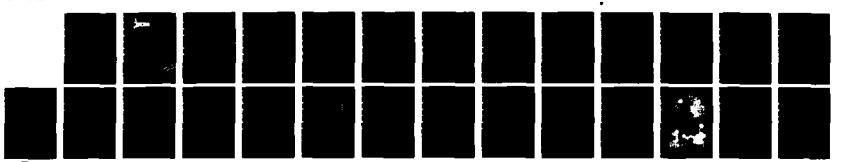
AD-A125 090 INTEGRATED NUCLEAR AND CONVENTIONAL THEATER WARFARE SIMULATION (INWARS) L.. (U) BDM CORP MCLEAN VA 24 JUL 78 BDM/W-78-402-TR-VOL-1 DAAG39-77-C-0174 1/1

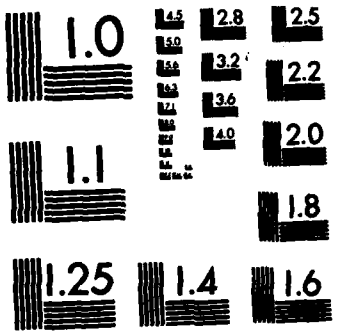
UNCLASSIFIED F/G 15/4 NL



END

FILMED

DTIC



THE BDM CORPORATION

7915 Jones Branch Drive
McLean, Virginia 22102
Phone (703) 821-5000

24 July 1978

BDM/W-78-402-TR

Contract DAAG39-77-C-0174

(DRAFT)

INTEGRATED NUCLEAR AND CONVENTIONAL THEATER WARFARE SIMULATION (INWARS) LEVEL III SPECIFICATIONS VOLUME I: INTRODUCTION

This document is submitted to Headquarters, Department of the Army, Office of the Deputy Chief of Staff for Operations and Plans, ATTN: Mr. P. E. Louer (DAMO-ZD) Washington, D.C. 20310

FOREWORD

This document is Volume I of five volumes presenting the Level III Specifications for the Integrated Nuclear and Conventional Theater Warfare Simulation (INWARS) under development for the U.S. Army by The BDM Corporation. This volume introduces the specifications, surveys the overall architecture of INWARS in terms of the force elements to be represented, and presents the INWARS representation of the environment.

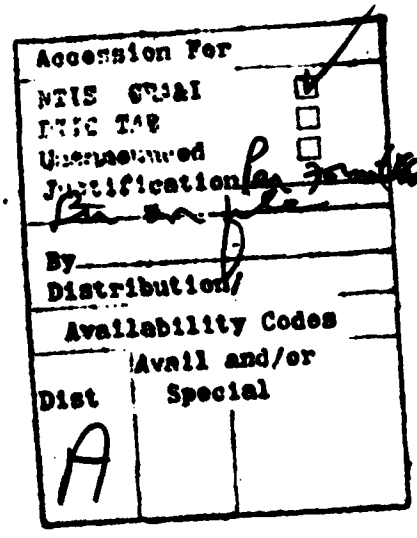


TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER I

INTRODUCTION

A. OVERVIEW

The "Level III" Specifications presented in this document represent the completion of the third stage in the top-down specification, design, and development of INWARS. Within the BDM system of software development, this marks the end of the Specification Phase by providing a relatively detailed statement of the substance of what will be treated in INWARS. The Level III Specifications are presented in terms of:

(1) what force elements and other entities will be explicitly treated in INWARS and how they will be represented,

(2) what activities these force elements will be capable of explicitly undertaking in INWARS, and how these acts and their performance will be represented, and

(3) what effects the performance of these activities may have considering the ongoing activities of other related force elements.

It should, however, be noted that what is really specified herein is "Basic INWARS": it will be recalled that the overall INWARS development program provides for the early development of a basic experimental version of INWARS--Basic INWARS-- followed by a period of formal experimentation and refinement. Thus, these specifications should be reviewed against the following two questions:

(1) Will a model with these specifications prove useful in meeting the INWARS objectives? and,

(2) Will a model with these specifications permit useful experimentation and refinement?

B. DEVELOPMENT OF THE LEVEL III SPECIFICATIONS

The Level III Specifications have been developed by extending the Level II Specifications to include the modeling representation of the

force elements, their activities, and the effects of those activities. In many cases, the Level II Specifications made "strawman suggestions" about such issues of representation. These suggestions have generally been adopted for INWARS (although sometimes with modifications based on comments received from SAG members).

Like the earlier phases of the INWARS design process, the principal consideration in developing the Level III Specifications has been to strike an acceptable balance between realism, set up and run time, and storage requirements. In essence, the approach taken can be characterized as an attempt to minimize set up and run time and storage requirements subject to the provision of a requisite level of realism.

The provision for requisite, consistent realism and detail has been guided by the fundamental focus of INWARS, namely, the high-level Command, Control, and Intelligence (C^2I) processes. As before, the guiding principle in assessing realism and detail has been that INWARS should reflect both the benefits accruing to appropriate decisions and the costs accruing to inappropriate decisions of C^2I elements from division up through theater. This implies that force elements controlled by C^2I elements--maneuver brigades/regiments, artillery battalions, the support elements, etc.--must be provided with a sufficiently large repertoire of distinct actions that they can properly implement the directives of the controlling C^2I elements. Another guiding principle has been that distinctive operational characteristics of different types of force elements be represented in sufficient depth that they can be employed in their fundamental roles by C^2I elements.

Also like earlier phases in the design process, balancing the need for realism against set-up, time, run time, storage requirements, and level-of-effort constraints has necessarily been largely a judgemental process throughout the development of the Level III Specifications. At the present stage in the development program, it is difficult to establish specific time and storage requirements beyond a judgement based on detail treated and complexity of the treatment. Consequently, tradeoffs at this stage have reduced to balancing the value of added realism obtainable

by increasing detail and complexity against the cost of that detail and complexity in terms of its potential increases in set-up time, run time, and storage requirements. However, in the physical combat process representations, it has been possible to better assess run time magnitudes by analogy to structurally similar treatments in other similar models (T COR and the Corps Level Electronic Warfare Model). Although this method has not been applicable to the Command, Control, and Intelligence (C^2I) area due to the absence of similar models, some sizing considerations have been made. Thus, set-up time, run-time, and storage requirements are becoming clearer.

C. ROLE OF THE LEVEL III SPECIFICATIONS

As indicated above, the Level III Specifications provide the framework within which the software to implement INWARS will be developed. Up to this point in the overall specification/design/development process, the emphasis has been on modeling issues: what is to be represented in INWARS and how it is to be represented. Accordingly, the concern has focused on what force elements to include, the activities they are to be able to undertake, and the effects of those activities. The Level III Specifications provide a statement of the design decisions regarding these issues (at least for Basic INWARS).

In subsequent stages of the development process, the emphasis will shift to software issues. In the transition from model design to software design (i.e., the next phase), concern will focus on organizing the various activities and processes specified for inclusion in INWARS into discrete "packages" or modules representing the occurrence of events. Design considerations will accordingly concern the types of events to include and their linkages (what events can schedule what other events). From that point on until Basic INWARS is ready for test and experimentation, concern will focus on the definition of appropriate data structures and algorithms to implement these "event occurrences". Many of these issues have been considered during the current and previous

design phases in order to provide a basis for assessing the feasibility of the modeling specifications. With the Army Study Advisory Group's approval of these Level III specifications, the modeling design of Basic INWARS will be considered "frozen". Substantive changes in modeling or representations will be difficult and may require extensive effort once software development is initiated.

D. PRESENTATION OF THE LEVEL III SPECIFICATIONS

Since the Level III Specifications are an extension of the Level II Specifications, they are presented as such. In particular, the various representations and processes have been integrated directly into the Level II Specifications wherever possible. This approach was taken in order to provide a complete statement of the modeling approach and to eliminate the need for continual reference back to the Level II Specifications. Of course, in some functional areas (such as ground combat), the extensions are extensive; in other areas, where suggested representations were provided, it has been possible to preserve much of the original Level II Specifications.

In terms of organization, the Level III Specifications have been broken up into five short volumes. Volume I presents the architecture of the model as well as the specifications of the INWARS environmental representation. Volume II is concerned with ground combat modeling (maneuver, fire support, and related issues). Volume III discusses the air combat modeling. Volume IV presents the combat support modeling including combat service support, information collection (or perception), and communication. Finally, Volume V discusses the modeling of the high-level command, control, and intelligence processes.

CHAPTER II
ARCHITECTURE: A SURVEY OF INWARS FORCE STRUCTURE

A. INTRODUCTION

This chapter provides an overview of the INWARS Level III specifications by surveying the particular types of force elements to be included. The survey presents the form of each type of force element, synopsizes what it can do (and what can be done to it) in the model, and indicates its relationship to other force elements. Additionally, references to more detailed discussion over the sequel are provided. Section B surveys the players in INWARS, i.e., the explicit "thinkers" which dynamically control the evolution of the situation in the model. Section C surveys the entities in INWARS, i.e., the force elements which react to both the situation and the directives of players. Finally, Section D presents the command relationships between players and entities.

B. INWARS PLAYERS: C^2I ELEMENTS

The C^2I elements to be included in INWARS are: (1) Theater Headquarters, (2) Army Group/Front Headquarters, (3) Allied Tactical Air Force/ Tactical Air Army (ATAF/TAA) Headquarters, (4) Corps/Army Headquarters, and (5) Division Headquarters. These headquarters--the C^2I elements--are portrayed in Figure II-1. Also exhibited in the picture are the command and coordination linkages among these C^2I elements. (Subordinate entities will be presented in Section C below.)

This particular structure of C^2I elements reflects a design decision to restrict the number of explicit decisionmakers to the essential ground and air command headquarters. Thus, for example, Corps Artillery will not be treated as a player in INWARS. This decision will require that the C^2I elements modeled make certain decisions on behalf of their subordinate entities. For example, since Corps Artillery will not be

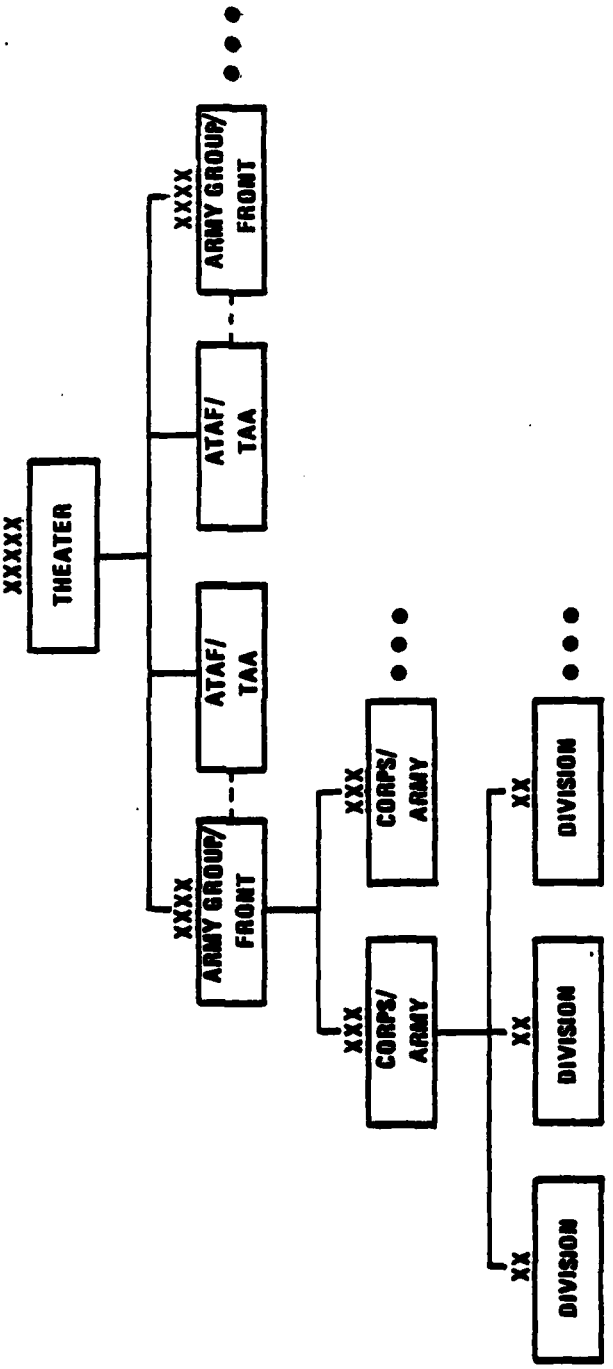


Figure II-1. INWARS C^2I Elements

treated as a player in INWARS, decisions regarding its allocation and operation will necessarily be handled by its parent Corps C^2I element.

C^2I elements will be spatially located in terms of the INWARS hexagonal coordinate system, and will be capable of explicit movement. C^2I elements will also be susceptible to engagement by enemy fire support elements (artillery, missile, and tactical air, using conventional nuclear or chemical weapons) and attack by enemy ground units. They will possess a defensive capability against air and ground attack commensurate with their command level.

C^2I elements will develop and control the operations of their subordinates (both subordinate C^2I elements and other force elements discussed below). The user will input a theater level operations plan specifying broad strategic objectives including relative priorities, a general mission (attack or defend), and an allocation of forces. This overall operations plan provides the context within which the Theater C^2I elements develop operations involving their subordinate Army Groups/Fronts and other subordinates. The directives implementing these operations will, in turn, provide the context for Army Group/Front development of operations involving their subordinate Corps/Armies. This process continues down the chain of command hierarchy to Division level. Once developed, operations are implemented. Execution and control is accomplished by C^2I elements, and is essentially treated as a process of recognizing and responding to such contingencies as "force imbalance", "nuclear/chemical attack", "targeting opportunity", and "penetration".

The processes by which C^2I elements develop, execute, and control operations will be represented in different ways at different levels of command. In part, this is due to the different responsibilities and concerns of these various levels of command. However, there will be a basic difference between the modeling of Division C^2I processes and Echelons Above Division (EAD) C^2I processes. For example, the treatment of EAD C^2I element will include a complex information structure representing their "understanding of the situation" they face; appropriate

processes will also be included to represent the mental activities by which EAD C^2I elements develop and maintain their understanding of the situation as well as use it in making operational decisions. (EAD C^2I modeling is described in Volume V.) By contrast, division level C^2I elements will be provided with a much simpler "memory" and correspondingly simpler, more "mechanical" planning and control processes. These are discussed in Volume II.

The reason for this fundamental difference in approach is principally one of storage conservation: saving space in the representation of divisions can lead to significant overall reductions in storage requirements due to the large number of divisions to be treated in INWARS. Simplifying the divisional C^2I processes is also in consonance with the emphasis on high-level C^2I processes and the concerns of the SAG regarding the amount of detail to be included in INWARS.

C. INWARS FORCE ENTITIES: REACTIVE ELEMENTS

1. Overview

The entities or force elements that respond to C^2I direction and control in INWARS include maneuver units, fire support units, air operations elements, intelligence elements, and combat service support elements (see Figure II-2). As entities, these force elements will not be capable of complex C^2I activities. Nonetheless, they will be able to react to the situations that confront them as well as to directives from the controlling C^2I elements. In effect, it is the entities which ultimately implement the directives of C^2I elements.

Before describing the individual types of INWARS entities in more detail, one basic feature of their representation must be highlighted. All the entities will, as described below, be associated with a C^2I element. Certain entities, such as maneuver units, will be explicitly located and will be able to move as directed by their parent C^2I element; these entities can be characterized as individual entities. Certain other entities will not be individually located. Rather, they will be

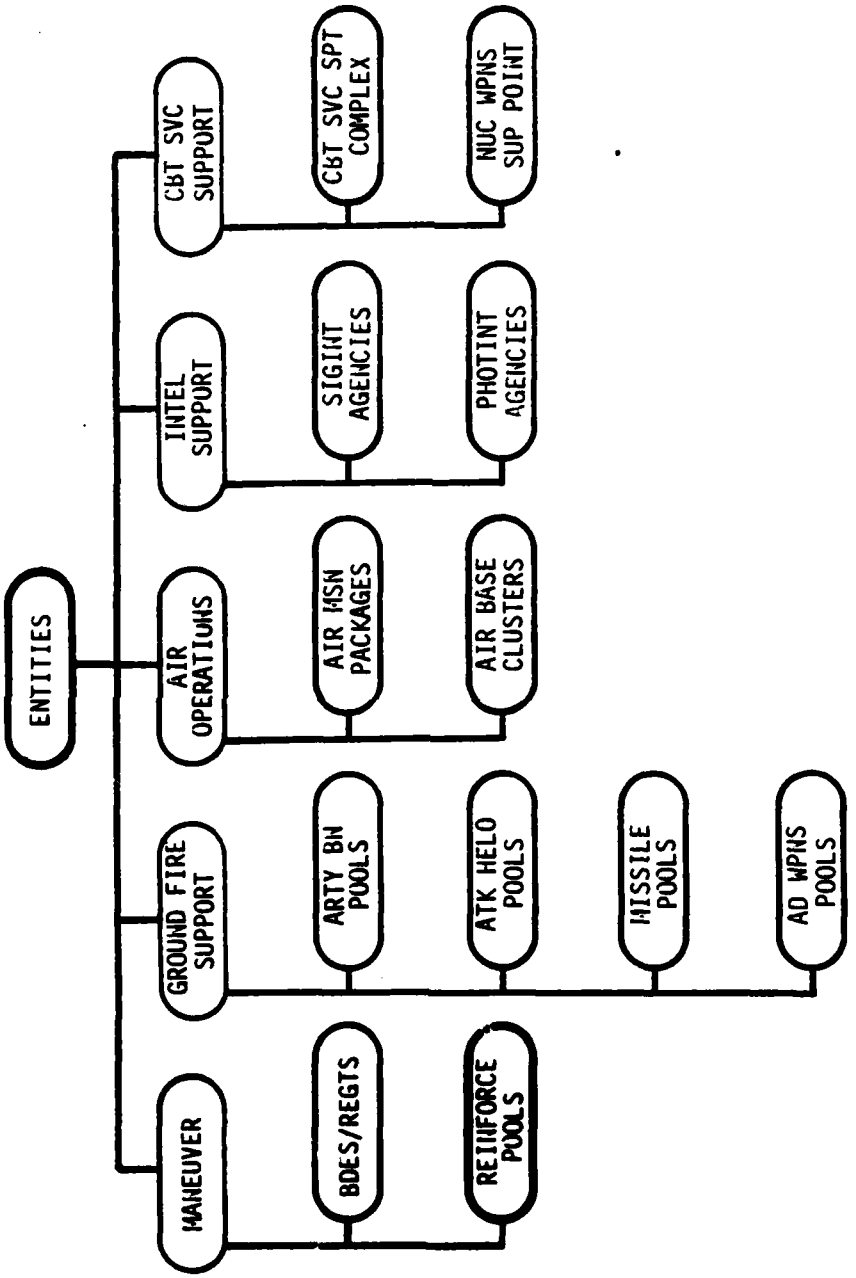


Figure II-2. INWARS Entities

implicitly located in the general area of their parent C^2I element, and will thus only move when the parent moves. This form of positioning will be used for such entities as missiles, airbases, and service support elements. In contrast to the individual entities, these elements can be characterized as pool or cluster entities, and are usually identified as such, i.e., "Missile Pool", or "Airbase Cluster."

2. Ground Maneuver Entities

The basic maneuver entity in INWARS will be the Brigade or Regiment. These are the entities which will actually engage in ground combat. They will be the chief components in the execution of the Division C^2I element's combat directives. As such, they will have the capability to move, engage in combat, disengage from combat when appropriate to their mission, change their nuclear or chemical readiness posture when directed by the C^2I element at Division, and deploy as directed. In so doing, they will be subject to attack by the opposing side's ground maneuver entities, artillery, air, and missiles. Brigade/regiments can be commanded individually or in reinforcement pools; the latter form of command is associated with echelons above Division. Volume II describes ground combat modeling in more detail.

3. Fire Support Entities

A number of fire support entities will be represented in INWARS. They represent the assets available to ground C^2I elements for allocation to subordinates in response to (or anticipation of) ground combat. These entities represent the artillery assets, missile resources, attack helicopters, and the air defense systems. With the exception of the air defense systems, these assets will be used by the C^2I elements which control them to influence the tactical situation where they are required. To this end, these systems will be capable of attacking opposing entities and of being attacked. They are discussed in more detail in Volume II. Air defense weapons will be used to attack enemy aircraft engaging the various targets in their area of responsibility.

4. Air Operations Entities

Air operations will involve a number of entities associated with the major air players--the ATAF/TAAs. These entities represent the physical aspects of air operations: airbases, flights of aircraft, and area air defense systems.

Forward Air Base clusters will be subject to attack by enemy air and missile systems, and will thus sustain attrition of aircraft on base as well as a degradation of capabilities. Rear Air Base clusters will not be subject to such attack.

Aircraft will be utilized in mission-oriented groupings termed Air Mission Packages (AMPs). AMPs will be composed from available aircraft located at and launched from Air Base Clusters to accomplish specific missions. Once launched, the AMP will enter an air battle during which it may sustain attrition. Survivors will then go on to their assigned target and carry out designated missions where they will be subject to attrition from point air defense capabilities associated with their targets. Air combat operations are discussed in Volume III.

5. Intelligence Support Entities

Intelligence support entities represent information collection and intelligence production capabilities associated with particular C^2I elements (Theater, ATAF/TAA, and Corps/Army level). They will be located relative to the supported C^2I element and will move with it. Two types of intelligence support entities will be distinguished on the basis of the form of their collections, namely airborne imagery (PHOTINT) entities and signals intelligence (SIGINT) entities. Collection assets associated with these elements will be limited in number thus requiring allocation and direction by the supported C^2I element. PHOTINT entities will be able to "look at" regions (up to a certain depth into enemy territory) as directed by the supported C^2I element. Resulting information about enemy force element composition, disposition, and status will be disseminated back to that C^2I element. SIGINT entities will be able to intercept enemy communications in particular regions as directed by the supported C^2I element. Resulting information about enemy force element

composition, disposition, status, and operations will be disseminated to that C^2I element. These intelligence collection entities are discussed in Vol IV, Chapter III.

6. Combat Service Support Entities

The combat service support entities include the supply, repair, and casualty treatment functions to be represented in INWARS. There are two basic types of entities: the Combat Service Support Complex (CS^2C) and the Nuclear Supply Point Cluster.

Each CS^2C will support a particular C^2I element. These complexes stock and distribute resources to the subordinates of the supported C^2I elements. These resources will include conventional supplies, (ammunition and POL), major end item replacements, and personnel replacements. The guidelines for allocating these resources will be provided in the form of desired issue rates by the associated C^2I element. The CS^2C will issue, receive, and stock these resources.

In addition to the supply function they perform at the various levels, CS^2Cs will perform the repair and maintenance functions as well as the hospitalization functions. They can be attacked by the opposing side's air and missile assets. The functions of the CS^2C are discussed further in Chapter II of Volume IV.

D. COMMAND RELATIONSHIPS AMONG PLAYERS AND ENTITIES

The command relationships among players were exhibited in Figure II-1 above. In addition to subordinate C^2I elements, a given C^2I element may also command various types of entities. From a modeling point of view, enabling a C^2I element to command a given type of entity requires the model to endow the C^2I element with the processes and logic to employ that entity and dynamically guide its operations. But providing a C^2I element with these processes and logic is costly in terms of model development time as well as set up, run time, and storage requirements. This design consideration is reflected in the following discussion.

The command relationships which will be possible in INWARS are portrayed in matrix form in Figure II-3. A dot in a particular cell indicates that the C^2I element in the cell's row will have the capability to command the entity at the top of the cell's column; that is, the C^2I element will be provided with decision processes appropriate to utilize the element. This command relationship matrix establishes the framework within which particular command organizations can be specified in INWARS. Thus, for example, it will not be possible for an ATAF/TAA HQ to control maneuver brigades or missile pools. However, organizations need not exercise all possible command relationships indicated in the matrix. For example, a particular Division need not control a missile pool. This will enable asymmetries between and within NATO and Warsaw Pact forces structures to be properly reflected in the model; likewise, it facilitates the examination of alternative force organizations.

As indicated in the Level II Specifications, developing this command relationship matrix has entailed some compromises. A case in point is the absence of Division level SIGINT elements. Although "real" Divisions may have a SIGINT capability, INWARS divisions will not be able to command an explicit SIGINT element. Accordingly, Division level SIGINT will necessarily be treated as an implicit capability in INWARS. It is felt that the loss of detail resulting from this treatment is justified by the reduction in complexity (and hence, in set up, run time and storage requirements).

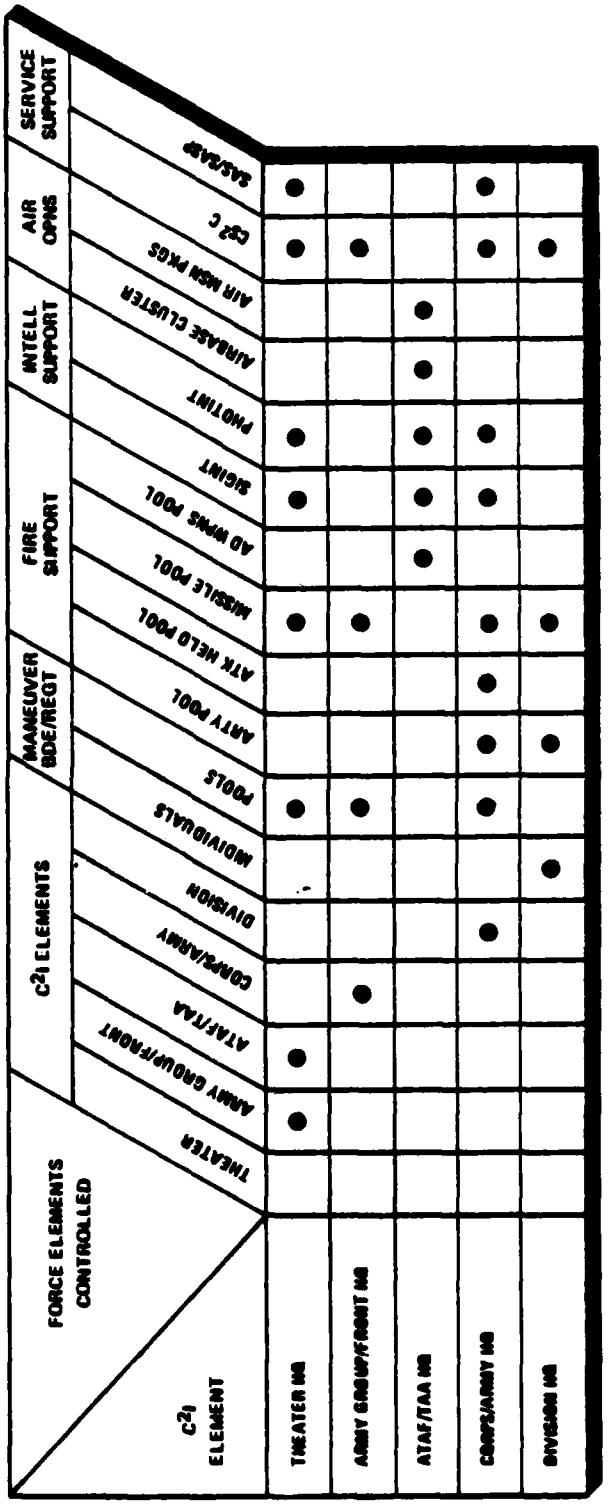


Figure II-3. Command Relationships Possible in INWARS

CHAPTER III
COMBAT INTERACTIONS/COMMUNICATIONS (CIC): ENVIRONMENTAL ASPECTS

A. INTRODUCTION

Given the high level decision orientation of INWARS and the aggregate nature of the force interactions, there will be little need for a detailed treatment of specific environmental features. Only the broad aspects of environment of concern to the commanders need be treated; moreover, an aggregated treatment of the features and their impact on operations will suffice. Due to the concern for adequate and realistic decision process representation in INWARS, certain significant variations in the environment need to be included in the model, namely day/night and weather. The design objective has been to provide an aggregated treatment of those environmental aspects that have a significant impact on high level operations.

The aspects of the environment that will be reflected in INWARS are of six types: terrain, barriers, weather, day/night, and population density. The means of implementing these effects involves the use of a hexagonal grid coordinate system already implemented in other modeling efforts. Before discussing how the environmental effects will be treated, the hexagonal grid system will be discussed.

B. HEXAGONAL GRID COORDINATE SYSTEM

A hexagonal grid system will be the principal means of partitioning the total "playing area" for the simulation. This system permits the aggregation of the "playing area" into hexagonal regions which can be nested by "levels" (Figure III-1). The lowest level that is used defines the maximum spatial resolution that is possible. Aggregation to higher levels facilitates the representation of multiple levels of detail as a function of the hex sizes and permits the use of an efficient

INTERNAL "COORDINATE SYSTEM" BASED ON NESTED HEXAGONAL REGIONS

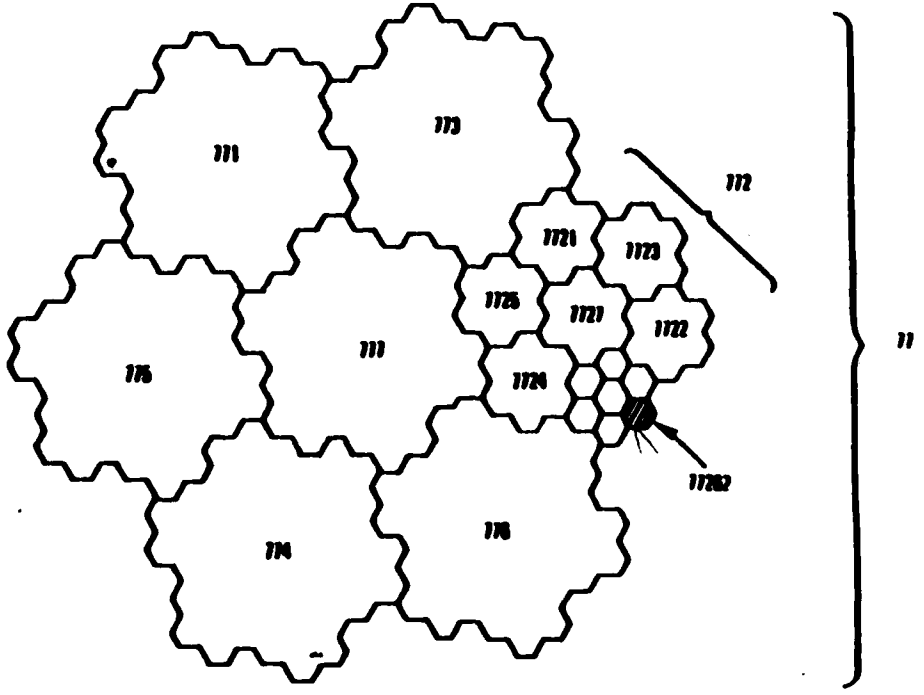


Figure III-1. Hexagonal Grid System

computational system for calculating both distance and direction of movement. (A more detailed treatment of the hex computation mathematics and theory is contained in Krecker, D. K. and Lattimore, P. J., An Integrated Coordinate System for Combat Modeling, BDM/W-78-297-TR, 19 May 1978.)

Figure III-2 shows the hex sizes that will be used in INWARS. As indicated in the figure, hexes smaller than level 6 (9.45 km) will not be utilized in INWARS. Brigade/regimental size force elements will be located in one or more level 6 cells, 9.45 kilometers in diameter. One of these cells roughly equates to a brigade deployed in a defense with two battalions up and one back. In such a case, each forward battalion would be covering approximately 4.8 kilometers of frontage. In a Red breakthrough operation, two regiments occupying the same size hex would be attacking on 1.8 kilometers of frontage.

The hexagonal coordinate system provides an efficient method for locating force elements and determining how they may interact. The hex coordinate system also provides the means to represent environmental aspects. In essence, the coordinate system constitutes an "address system" for the storage of environmental information about particular hexes. This use of the hex system in INWARS is discussed below.

C. TERRAIN DESCRIPTION

The terrain will be divided into five types, all of which have some influence on the movement and attrition of the ground combat units. These terrain types will be associated with the hex cooordinate system at the appropriate level of detail. Specifically, terrain will be stored in 9.45 km hexes (although regions of similar terrain could be inputted at the 25 km or larger level). The five types of terrain will be as follows:

(1) Type A - flat-to-gently rolling with a minimum of timber - excellent tank country.

LEVEL		CELL DIAMETER = d	CELL AREA = $\frac{d^2 3}{2}$
13		8575.km	63,700,000 Km^2
12		3240.	9,100,000
11		1225.	1,300,000
10		463.	185,600
9		175.	26,500
8		66.1	3,790
7		25.	541
6		9.45	77.3
5	NOT USED IN INWARS	3.57	11.05
4		1.35	1.578
3		510 meter	225,000.$meter^2$
2		193	32,200
1		72.9	4,600

Figure III-2. Levels of The Hex Coordinate System

(2) Type B - marginal for tanks and wheeled vehicles due to topography, soil, and vegetation.

(3) Type C - tanks and wheeled vehicles must remain on roads due to topography, soil, and vegetation density.

(4) Type D - major built up areas. Advance of lead units through a built up area can be extremely time consuming if it is defended.

(5) Type E - prohibited areas, usually water.

There will be two mobility factors associated with each type terrain, one for road movement and the other for cross country movement. These will be numbers between 0 and 1 which will be used to modify the movement rate. Figure III-1 illustrates how this representation might be applied in the Fulda Gap area. Terrain type will also impact on attrition processes as described in Volume II, Chapter VI.

D. BARRIERS

Barriers, as contrasted to terrain, tend to be more linear in nature and can occupy hex sides or entire hexes. In addition, barriers have a more significant military value to a commander than most terrain. For these reasons, they have been classified separately. In INWARS, only barriers representing major obstacles will be treated. There will be one natural barrier type and provision for types of manmade barriers. Major rivers will be the only natural barriers in INWARS. An example of a major man made barrier might be a mine field requiring a significant level of effort to construct.

The barriers that will be simulated in INWARS will be categorized as active and passive. Active barriers such as minefields or significant contaminated areas will have an inherent capability to inflict damage on the enemy as well as reduce his rate of movement. Passive barriers such as rivers will only reduce the enemy's rate of movement. Both active and passive barriers will enhance a defender's capability to some degree.

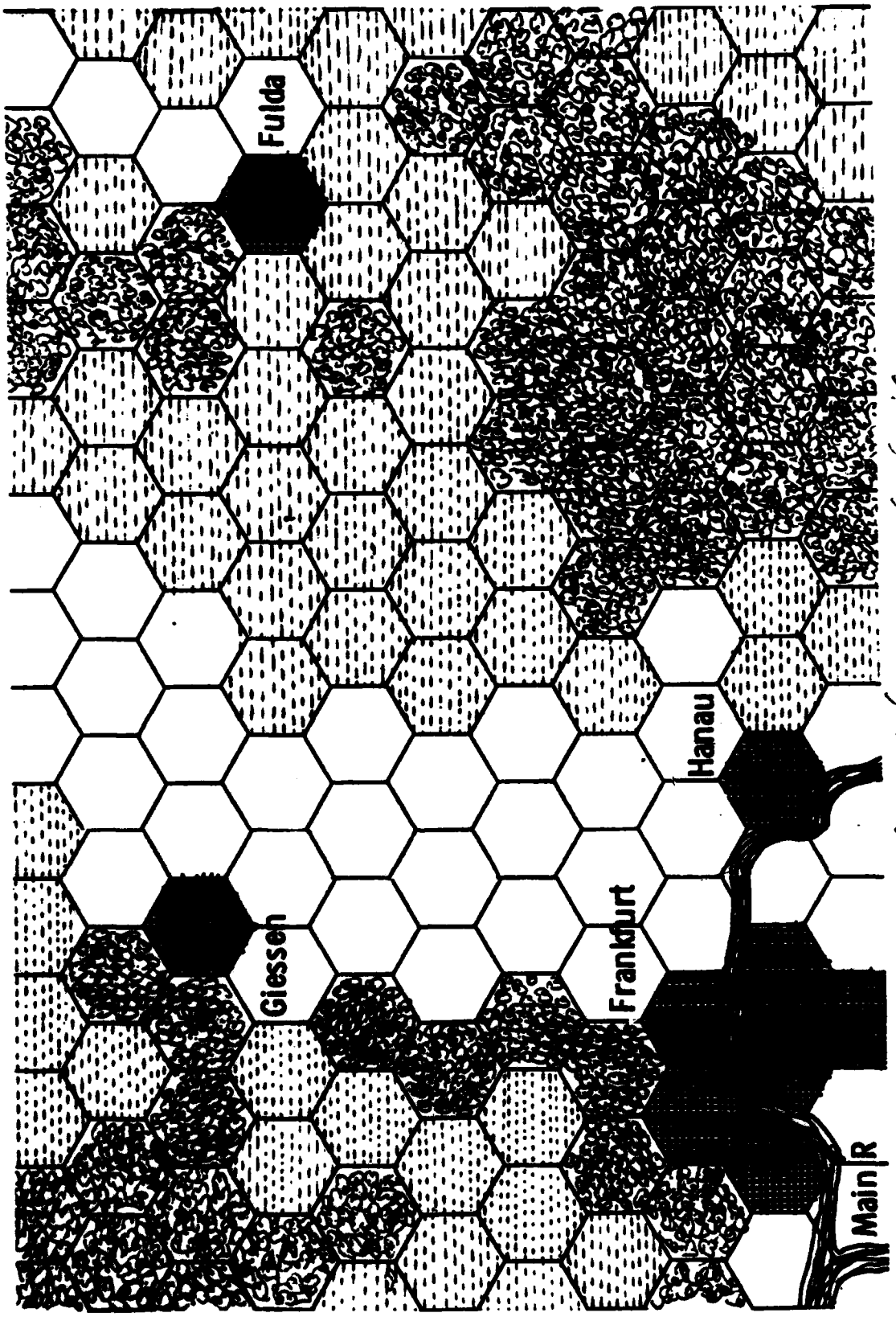


Figure III-3. Illustration of Terrain Type

E. POPULATION DENSITY DESCRIPTIONS

Population density will be represented in INWARS using the same hex scheme as terrain. There will be four classes of population density, all of which may (depending on user inputs) influence the use of nuclear weapons. These will be used in estimating collateral damage and weapon yields. The exact population densities will be determined by the user.

(1) Type A - farm land, forests, etc. -- less than x population per hectare

(2) Type B - small villages or towns -- less than y population, but more than x per hectare

(3) Type C - medium to medium - large cities having an industrial base and including bridges and civilian airfields - less than z population, but more than y per hectare

(4) Type D - very large cities or areas in which the detonation of a nuclear weapon would have grave military and/or political implications.

As in the terrain characterization, the population density indicators will be associated with appropriate level hexes (though no smaller than level 6 which are 9.45 Km in width.)

F. WEATHER AND DAY/NIGHT

Weather will be a user input. It will consist of a sequence of "forecasts" which will cover the entire length of the simulation run. Weather can be played at the discretion of the user. There will be a number of discrete weather states which will influence the physical processes. The physical effects of weather will be represented in terms of its effect on visibility and trafficability. Visibility effects will have an impact on air operations and intensity of ground operation. Trafficability effects will have an impact on the movement rate of ground forces.

Day will be defined in terms of the hours of daylight per 24 hour period. Night will be simulated in a number of ways. The mobility of units will be reduced, aircraft will not be permitted to fly unless they are capable of night operations, and unit capability will be reduced to account for the effect of limited visibility on targeting.

END

FILMED

3-83

DTIC