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NATO Conventional Defense: Force Augmentation with European Reservists

Roy F. Phillips

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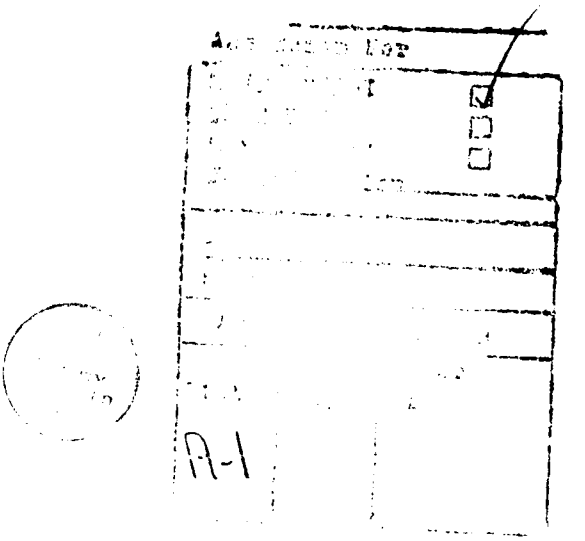

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PREFACE

This Note documents research conducted under a larger project that was jointly sponsored by the Army and the Air Force through RAND's Arroyo Center and Project AIR FORCE. The larger project, entitled "Enhancing NATO's Conventional Defense," identified a range of high-leverage initiatives for improving NATO's conventional defense capabilities. These initiatives were assessed in terms of their military effectiveness, economic practicality, political acceptance, and their effect on deterrence. The reserve option was one of the initiatives studied under this larger RAND project. The analysis in this study was completed in October 1988.

This Note should be of interest to political and military analysts involved with Central European defense issues.

SUMMARY

NATO maintains a triad of conventional, non-strategic nuclear, and strategic nuclear forces for two purposes. First, NATO aims at deterring a potential aggressor from an attack by creating a perception that the costs of such an attack would outweigh any potential benefits gained. Second, should deterrence fail, NATO aims at using those forces, deliberately escalating if necessary up the triad from conventional to non-strategic nuclear and then to strategic nuclear forces, to defeat the enemy. NATO's conventional defense would begin forward near the border with Warsaw Pact states. A successful forward defense would either slow the enemy's advance such that he would have to escalate the conflict to achieve his goals (or call off the attack); or provide NATO with a reasonable amount of time to deliberate the use of non-strategic nuclear weapons (or to negotiate peace).

According to General Bernard Rogers, former Supreme Allied Commander Europe, NATO currently lacks a capability to conduct a successful forward defense. He has stated, "If attacked conventionally today, NATO would be forced fairly quickly to decide whether it should escalate to the non-strategic nuclear level . . . or to accept defeat."[1]

There are several ways by which NATO could enhance a capability for successful forward defense. One such way, summarily entitled the *reserve option*, would create additional NATO forces from the pool of un- or under-utilized European reservists. To assess the feasibility of the reserve option, this study addresses one technical and two policy questions: first, what factors are important to reserve unit effectiveness; second, how many and what type of reserve of units would be required to provide NATO with a capability for successful forward defense; third, what would be the manpower and budgetary costs of acquiring that security? **The analysis shows that approximately 12**

[1]General Bernard Rogers, "NATO's Conventional Defense Improvement Initiative: A New Approach to an Old Challenge," *NATO's Sixteen Nations*, Vol. 31, No. 4, July 1986, p. 18.

division equivalents of reserve forces, costing $50 billion over 15 years (representing a 1.7 percent increase in the defense expenditures of those nations contributing to NATO's Central European defense), could mount the necessary defense.

RESERVE UNIT EFFECTIVENESS

Reserve unit effectiveness is a function of combat strength and mission, proficiency, and availability. *Combat strength* can be estimated based upon a unit's weapon systems and described in terms of division equivalents (DEs). Different types of units have different combat strengths and missions. For example, an armored brigade has roughly three times the combat strength of an infantry or artillery brigade. Further, its range of mission (precisely coordinated offensive and defensive) tasks are more complex.

Proficiency is a function of mission difficulty and training. The more difficult the mission the longer it will take the unit to train up to an adequate level of proficiency. Reserve units from different nations, with different (more or less rigorous) active-duty and reserve training programs, will require different amounts of refresher training to reach an adequate level of proficiency.

Availability is a function of the time it takes a unit to mobilize, train up to an adequate level of proficiency, and deploy to a defensive position or staging area. Reserve option units would be available between 5 and 26 days after being ordered to mobilize. In this time range, they would be effective (timely) in medium- to long-term mobilization scenarios (e.g., 10 days or more). In very short-term mobilization scenarios (e.g., 5 days or less), they would be less effective.

RESERVE OPTION REQUIREMENTS

Reserve option requirements are driven by the goal of a successful forward defense. A successful forward defense is defined in this study as one that would hold a Warsaw Pact attack to an average penetration of less than 45 kilometers. This study utilizes dynamic analysis, in a

combat simulation, to derive reserve option requirements. Specifically, attack and defense scenarios are developed to simulate a war in Central Europe. The attack and defense scenarios are based upon 1985 to 1987 databases of available Warsaw Pact and NATO forces. The databases represent the current and near-term future disposition of forces. The scenario and databases were developed for this study and are included in the text. In the base case scenario, the Warsaw Pact and NATO mobilize their forces for 25 and 10 days, respectively, prior to D-Day. In the simulation of the base case, Warsaw Pact units penetrate NATO territory an average of 194 kilometers over the course of a 30 day war. Simulation results suggest that 12 DEs of reserve option units would be required for a successful forward defense.

RESERVE OPTION MANPOWER AND BUDGETARY COSTS

The manpower requirements for a 12 DE reserve option would increase NATO's active force strength by 20,000 men and increase by one to two years the average length of time a serviceman would remain obliged to perform reserve service. An increase in active force strength of 20,000 would represent a significant political challenge given the demographic changes now affecting NATO nations. Nonetheless, the figure is small relative to current NATO manpower commitments. The increase in the average length of reserve service, currently between three and five years, would be well within statutory limits (generally at least to age 35 for NATO's conscript-based armed forces).

The budgetary costs for the reserve option appear modest. A 12 DE reserve option would increase NATO defense budgets by $3.3 billion annually.[2] For nations contributing to the defense of Central Europe, this would represent a 1.7 percent increase in defense expenditures.

[2]The labor cost component of this and succeeding estimates was derived from market wages paid to American servicemen. While more reflective of the societal cost of military labor, this estimate may overestimate the monetary cost that would be borne by implementation of the reserve option in the conscription-based military service systems in Europe.

CONCLUSIONS

The reserve option could provide NATO with a robust forward defense capability at a cost of $50 billion (spread over 15 years). Another way to assess the reserve option is to compare its capabilities with those that could be acquired with similar expenditure elsewhere. A recent study by the Congressional Budget Office assessed three alternatives costing between $40 and $50 billion (spread over 20 years).[3] **The least expensive alternative, at a cost of $41.2 billion, would purchase one U.S.-based heavy division with a companion POMCUS[4] set in Europe. The addition of a single division, however, would not come close to providing NATO with the capability to mount a successful forward defense.**

In summary, the reserve option warrants serious consideration as NATO discusses alternatives for improving its conventional capabilities.

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[3]Congressional Budget Office, *U.S. Ground Forces and the Conventional Balance in Europe*, Washington D.C., June 1988.

[4]POMCUS is the acronym for Prepositioned Materiel Configured in Unit Sets.

ACKNOWLEDGMENTS

The original version of this study was accepted as a dissertation in October 1988 in partial fulfillment of the requirements of the doctoral degree in policy analysis at the RAND Graduate School. The faculty committee that supervised and approved the dissertation consisted of James H. Bigelow (Chairman), Charles T. Kelley, and James A. Thomson. I thank each of them for their time, patience, and encouragement.

This study was conducted under the auspices of a larger RAND project entitled "Enhancing NATO's Conventional Defense." The research herein benefitted greatly from my interactions, during this project, with Richard J. Hillestad and Bruce Don (project leaders), Gary Massey (cost analysis), Sinclair Coleman (modeling), and Milton G. Weiner and Robert Howe (force employment). Philip J. Romero provided an excellent technical review of an earlier draft of this Note.

An accredited doctoral program is fraught with hurdles that sometimes appear too daunting to leap. Always there are persons who provide encouragement, support, and criticism which is recognized as constructive only after the process is complete. To James Bigelow, James Dertouzos, Gay-Rose Soque, my parents, and especially Charles Wolf, I extend my hearty thanks.

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TABLES

GLOSSARY

ACM	Army Cost Model
AD-70	Allied Defense Plan 1970
AFCENT	Allied Forces Central Europe
AFPCH	Army Force Planning Handbook
AMDF	Army Master Data File
ARC	Annual Recurring Costs
AWAC	Airborne Early Warning and Control
CATWTS	Category Weights
CBO	Congressional Budget Office
CFA	Covering Force Area
CGF	Group of Soviet Forces Czechoslovakia
CPX	Command Post Exercise
D-Day	Day of Attack
DE	Division Equivalent
FOFA	Follow-On Forces Attack
FPP	Force Planning Process
FTX	Field Training Exercise
GDP	General Defense Position
GSFG	Group of Soviet Forces Germany
IFV	Infantry Fighting Vehicle
IMF	International Monetary Fund
INF	Intermediate-Range Nuclear Forces
LTDP	Long Term Defense Plan
MASTER	Mass and Space/Time Evaluation Routine
MBA	Main Battle Area
MBFR	Mutual and Balanced Force Reductions
MD	Military District
MLRS	Multiple Launch Rocket System
MPA	Military Personnel Army
NATO	North Atlantic Treaty Organization
NGF	Group of Soviet Forces Poland

NRC	Non-Recurring Costs
OMA	Operations and Maintenance
PCS	Permanent Change of Station
POMCUS	Pre-Positioned Materiel Configured in Unit Sets
RA	Rear Area
SACEUR	Supreme Allied Commander Europe
SHAPE	Supreme Headquarters Allied Powers Europe
TO&E	Table of Organization and Equipment
TSI	Tactial Support Increment
TOTEM	Theater of Operations Tactical Evaluation Model
VTAADS	Vertical Total Army Authorization Document System
WAS	Wartime Authorized Strength
WEI/WUV	Weapons Effectiveness Index/Weighted Unit Value
WP	Warsaw Pact
WTVD	Western Theater of Military Operations

I. INTRODUCTION

A greater utilization of European reservists is a possible remedy to NATO's conventional deficiencies.[1] Proponents favoring their use argue that (1) there exists a large pool of un- or under-utilized reservists (which conscription continually replenishes); (2) this pool, with proper planning and organization, could quickly be mobilized into combat units; and (3) relative to other options, European reservists offer a low cost counter to Warsaw Pact (WP) conventional strength. Opponents argue that the costs of a greater utilization of reservists are not low because reserve units are not very effective. The purpose of this study is to clarify the salient issues surrounding the reserve option, for policymakers who must make decisions about where to allocate scarce defense resources in the years ahead.

PROBLEM DESCRIPTION

NATO's security problem results in part from an imbalance of conventional forces between the WP and NATO in Central Europe. This imbalance is generally described in terms of the forces available to each side under different scenarios (static comparisons) and in terms of estimates of war outcomes (dynamic analyses) if those forces engage in conflict. Static comparisons and dynamic analyses will differ depending upon (among other things):

- Scenarios
- Data sources
- Assumptions about weapon effectiveness
- Assumptions about the adjudication of conflict

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[1]See Andrew Hamilton, "Redressing the Conventional Balance: NATO's Reserve Manpower," *International Security*, Vol. 10, No. 1, Summer 1985, pp. 111-136.

Many different sources provide balance comparisons or net assessments of the force balance in Europe. Some of the more often quoted sources include the following:

> NATO, *Force Comparisons*, 1984: ... some 61 [WP] divisions in the German Democratic Republic, Czechoslovakia, Poland and the Northern and Western Military Districts of the Soviet Union could launch operations [against Central Europe] within a few days of mobilization. In the best situation, assuming simultaneous mobilization and deployment forward within the region, NATO could count on the equivalent of nearly 43 divisions, which would have to hold out until additional United States and Canadian forces arrive by sea. In the meantime, the Warsaw Pact forces could quickly expand to a full 104 divisions, plus a portion of 16 Strategic Reserve Divisions from the [Soviet Union's] three Central Military Districts. (p. 19)

> IISS, *The Military Balance*, 1986-1987: ... the conventional military balance is still such to make general military aggression a highly risky undertaking for either side. Though possession of the initiative in war will always permit an aggressor to achieve a local advantage in numbers (perhaps sufficient to allow him to believe that he might achieve limited tactical success in some areas), there would still appear to be insufficient overall strength on either side to guarantee victory. ... One can conclude [however] that there is still sufficient danger in the trend to require remedies by the Western Alliance. (p. 225)

> U.S. DoD, *Soviet Military Power*, 1988: NATO remains at a severe disadvantage on the ground. ...While Pact leaders may not feel this superiority is sufficient to give them a high degree of confidence of victory, given their doctrine of preemption under crisis conditions, their advantages may prove to be sufficient in the event of war. (pp. 110, 117)

Common themes (often implicit) among most assessments are that the WP has a conventional advantage in Europe and that remedies are needed.

THE RANGE OF ALTERNATIVES AND THE RESERVES OPTION[2]

There are several means by which NATO can improve its conventional capabilities.[3] These alternative means can be grouped arbitrarily into three interrelated categories:

- Force structure
- Technology
- Strategy and tactics

Force structure refers to the men and equipment that make up NATO armed forces. In 1952, NATO decisionmakers called for 96 divisions to meet the threat from the East.[4] Political and budgetary constraints prevented NATO from ever reaching this goal (and the WP has had an advantage in conventional forces since its inception). Instead of fielding a commensurate conventional force, NATO has primarily relied on strategic and theater nuclear weapons to deter a conventional attack by the Soviet Union.

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[2]NATO coordinates its collective defense efforts through one of two means: either through NATO's formal Force Planning Process (FPP) or through special initiatives. The FPP functions on a biannual schedule. In odd years NATO military authorities describe and evaluate the threat posed by the WP. NATO ministers use this and other inputs to produce a Guidance to assist in developing force proposals. In even years, military authorities use the Guidance to develop specific proposals which are later modified by the ministers (accounting for political considerations) and developed into Force Goals. Special initiatives supplement (some would say bypass altogether) the NATO FPP. Special initiatives (e.g., AD-70, LTDP and the AWACs purchase) highlight priorities and, through high-level political involvement, pressure the membership to expressly pursue these priorities. See James C. Wendt and Nanette Brown, *Improving the Force Planning Process: Lessons from Past Efforts*, The RAND Corporation, R-3383-USDP, June 1986.

[3]Alternatively, the imbalance could be redressed by a WP decision to draw down its forces (either unilaterally or through an arms control agreement).

[4]Steven L. Canby, *Short and Long War Responses: Restructuring, Border Defense and Reserve Mobilization for Armored Warfare*, Technology Service Corporation, Silver Spring Maryland, March 1978, p. 3.

Technology refers to the efficiency of weapon systems. In the 1950s and early 1960s nuclear weapons were an effective counter to Soviet conventional strength. In the late 1960s and into the 1970s, the Soviet Union built its strategic and theater nuclear arsenals to rough equality with the United States. With nuclear parity, the deterrence-of-conventional-war aspect of nuclear weapons declined relative to the WP. A less credible nuclear deterrent increased the importance of conventional forces; yet NATO's conventional strength (in terms of manpower and the number of committed units) has declined. To compensate for an inadequate force structure, NATO has relied on technologically superior conventional weaponry. Technology, as it is used here, refers to the efficiency of *conventional* weapon systems. Examples of superior technology include fire control systems that allow tanks to accurately fire while moving; or "smart" munitions that, after launch, can home in on enemy vehicles and destroy them without additional human interaction. While technology can, within limits, compensate for numerical inferiority, most authorities assert that NATO's technology lead has shrunk and continues to shrink.

NATO's general *strategy*, i.e., forward defense with flexible response, has remained constant since 1967. NATO's specific *tactics*, i.e., the way in which NATO plans to fight the enemy, evolve and are openly discussed.[5] Terms and phrases often heard in current discussions of strategy and tactics include:

- Follow On Forces Attack (FOFA), Deep Attack
- Fight Outnumbered and Win, Southern Strategy
- Barrier Defense, Attrition Net, Territorial Defense

Different tactics are suggested as more cost-effective means for carrying out NATO's general strategy. They often incorporate advances in technology (e.g., FOFA) or possible changes in force structure (e.g., Territorial Defense).

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[5]For references that survey the range of strategies and tactics see: General Bernard Rogers, "NATO Strategy: Time to Change?" *The Alliance Papers*, No. 9, The Atlantic Council, October 1985; Phillip A.

Of the three categories of potential force improvements, force structure change, which relies on adding units to NATO's side until opposing forces are more closely balanced, is a conceptually simple solution to NATO's problem.[6] Such a change, however, has generally been dismissed as politically unworkable because its budgetary cost or manpower requirements have been perceived as too great. Because of this, most discussions have centered on improving NATO's capabilities through technology or tactics. Several studies[7] have suggested, however, that, relative to technology or tactical types of alternatives, a greater utilization of reservists is both a robust alternative and relatively inexpensive.[8]

TIMELINESS OF A RESERVES OPTION ASSESSMENT

An assessment of the reserve option is particularly timely at this juncture for several reasons. First, the signing of the INF treaty, since it removes a step in the nuclear escalation ladder, weakens deterrence. It moves NATO more toward the conventional defense end of

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Karber, "In Defense of Forward Defense," *Armed Forces Journal*, May 1984; Robert Levine et al., *A Survey of NATO Defense Concepts*, The RAND Corporation, N-1871-AF, June 1982; Samuel P. Huntington, "Conventional Deterrence and Conventional Retaliation in Europe," *International Security*, Winter 1983/84, and Canby, *Short and Long War Responses*.

[6]The reserve option can have both technology and strategy/tactics components. With respect to technology, reserve option units might be outfitted with technologically advanced weapons systems (e.g., MLRS or some type of indirect or direct fire precision guided anti-tank system). With respect to strategy and tactics, reserve option units might allow defense options currently impossible due to a force structure barely large enough to adequately cover the front (e.g., additional units could make possible the creation of sizable operational reserve forces, not only to guard against WP breakthroughs but also to take advantage of WP weaknesses through offense).

[7]Hamilton, *Redressing the Conventional Balance*; Robert Komer, "Is Conventional Defense of Europe Feasible?" *Naval War College Review*, Sept.-Oct. 1982, Vol. 35, No. 5, pp. 80-91; Steven L. Canby, "Military Reform and the Art of War," *International Security Review*, Vol. VII, No. 3, Fall 1982, pp. 245-268.

[8]Robustness refers to the ability to exceed minimum acceptable performance under a wide range of conditions, such as worse-than-expected enemy behavior (e.g., when weapons work only half as well as expected).

the defense/deterrence spectrum. As conventional forces become more important to NATO's defense, then the reserve option must be evaluated (in terms of cost and effectiveness) relative to other means for providing requisite conventional defense capability.

Second, the INF treaty portends the possibility of a conventional arms control agreement. The Soviet Union supports a new forum that would expand upon the now defunct MBFR talks. The new forum would expand the area covered to include the entire area between the Atlantic Ocean and the Ural Mountains. These negotiations could result in active force reductions and could enhance European security.[9] The Soviets would still enjoy its inherent advantages (centralized decisionmaking and a secure land line of communication) if it decided to mobilize and reintroduce forces into Central Europe. Additional European reserve units could hedge against this advantage.

Third, many U.S. politicians believe the United States bears too large a share of NATO's defense burden. If U.S. political pressures led to a unilateral decision to reduce the U.S. troops' presence in Europe, European reserves could provide a replacement. Alternatively, additional European reserve units might countervail American perceptions that Europeans are not shouldering their fair share of the burden and provide a strong case for maintaining current American troop levels.

Finally, economic and demographic constraints may preclude holding active force strengths at their current levels. Defense budgets, already stagnant in real terms, are likely to decline in coming years as social programs compete for a limited amount of government resources. Additionally, adverse demographic trends will increase the real cost of military manpower. If active forces are downsized, then reserve forces are one means of compensation. Alternatively, if active force strengths can be maintained, then additional reserve units provide NATO with a stronger mobilized force.

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[9]Force reductions might not enhance security, however, if they are not largely asymmetrical. See James A. Thomson and Nanette C. Gantz, *Conventional Arms Control Revisited: Objectives in the New Phase,* The RAND Corporation, N-2697-AF, December 1987.

ANALYTIC FRAMEWORK

This reserve option study is an outgrowth of a larger RAND study that was designed to assess NATO's conventional defense requirements in the 1990s. This larger, two-year study surveyed the range of possible NATO force improvements and used theater-level combat simulation and cost analysis to evaluate them. During its course, the conventional defense study utilized the five basic elements of policy analysis--objectives, alternatives, impacts, criteria and model(s).[10] A brief review of the phases of the conventional defense study illustrates the process of policy analysis and the general methodology used in the reserve option study.

The first phase of the conventional defense study began with the identification of the problem and the statement of *objectives*. The objective was to develop and assess different strategies that would allow NATO to defend forward. Strategies were designed to satisfy certain *criteria*, which included:

- Military requirements
- Deterrence requirements
- Political, economic, and demographic constraints
- Arms control

A starting list of *alternatives* was developed through a literature survey and a general corporate knowledge of the subject. The list of alternatives was screened and the criteria were refined through an iterative process that included interviews with high-level political and military specialists and a discussion with a subgroup of the same at a RAND-sponsored conference.

The second phase of the study involved extensive modification of existing RAND *models* (including combat simulation and cost accounting models) and the development of databases to depict WP and NATO air and ground forces in the early 1990s. A *base case* scenario was developed using the databases and models.

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[10]See Edward S. Quade, *Analysis for Public Decisions*, American Elsevier Publishing Company, New York, 1975, pp. 46-48.

The final phase of the study involved running the alternative cases through the models to discern *impacts*. Cases were run under different sets of scenario assumptions. Two classes of alternatives were identified as most promising. The first involved the creation of additional operational reserves, fighting behind improved barrier defenses. The second involved the procurement of "smart" munitions.

During the course of the conventional defense study the reserve option was identified as a promising alternative. The analysis in this study follows the framework of the larger conventional defense study.

The major components of this study include the development of a base case and reserve option alternatives. Alternatives considered include creating heavy units (mobile armor or mechanized infantry), light units (infantry and anti-tank), and artillery units from the currently un- or under-utilized pool of European reservists. In analyzing the alternatives, several key policy variables are adjusted to derive specific impacts. The policy variables used in this study and the areas in which they have a specific impact are listed in Table 1.1.

Table 1.1

POLICY VARIABLES AND IMPACTS

Policy Variables	Effectiveness	Budgetary Costs	Societal/ Political Impacts
Unit quantity	x	x	x
Unit type	x	x	
Unit quality	x	x	
Mobilization time			
Deployment time			
Proficiency level			
Unit supplier (country)	x		x

Figure 1.1 provides a conceptual depiction of the process by which the reserve option is evaluated in this study. First, specific conventional defense requirements are specified through the development

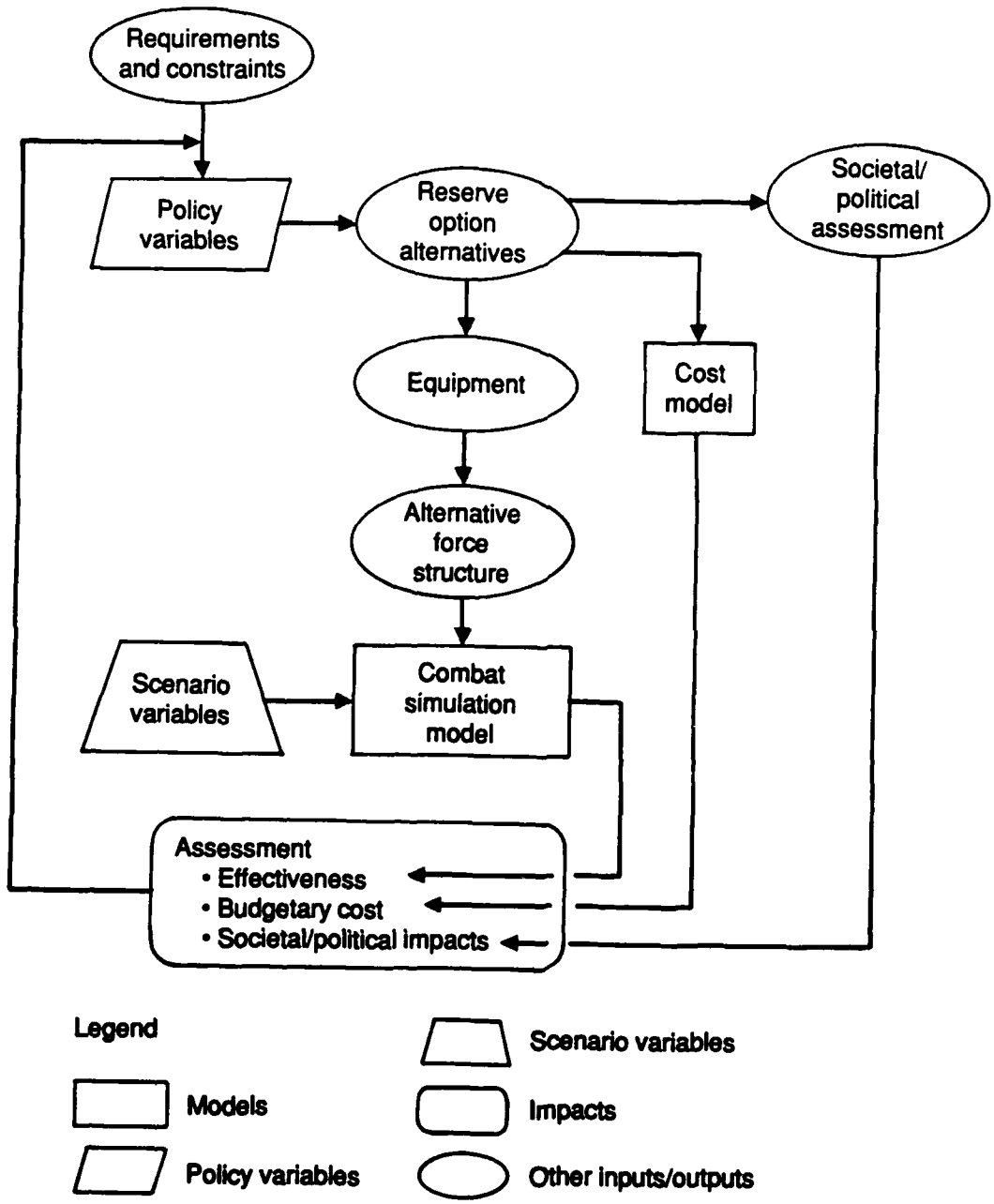

Fig. 1.1—Methodology

of a base case. Next, reserve option alternatives are described. These alternatives have effectiveness, cost and societal/political implications. Effectiveness is evaluated using a combat simulation model (the same model used, to specify our requirements) which pits WP combat units against NATO combat units. Costs are evaluated using a cost model that includes both equipment and manpower components. Societal/Political impacts are evaluated based upon the distribution of financial and manpower burdens among NATO countries.

ORGANIZATION OF THIS STUDY

Section II, "The Base Case," uses both static and dynamic analysis to describe the current situation in NATO and forms the basis by which we evaluate the effectiveness of the reserve option. Static comparisons, like photographs, provide pictures of the threat at a point in time. Dynamic analyses, like movies, play out the situation through time. Both methods are used to describe the threat facing NATO in Central Europe.

Section III, "Reserve Unit Characteristics and Study Alternatives," provides an explicit description of reserve option units and how they could be used. The reserve option involves the creation of additional combat units. Units are described in terms of their combat strengths and how they would be used on the battlefield.

Section IV, "Reserve Unit Requirements," uses the base case developed in Section II as a starting point for assessing the effectiveness of different reserve options. It describes how the simulation model, by setting an objective (e.g., hold the WP to a maximum penetration), can be used to ascertain requirements. The reserve option is simulated by adding "division equivalents" to NATO's force structure to derive reserve unit requirements.

Section V, "Reserve Option Costs," estimates the manpower and equipment costs for the different reserve units described in Section IV. Costs are delineated by procurement (non-recurring) and operating (annual recurring) costs.

Section VI, "Societal/Political Impacts and Conclusions," summarizes the analyses of study and ties them together in a manner meaningful to a policymaker. Conclusions, in terms of policy choices necessary to implement the reserve option, and the impacts of such decisions, are highlighted.

II. THE BASE CASE

Much analysis and speculation has been devoted to NATO defense, the most pressing issues being the size of the threat and our ability to meet the threat. Static and dynamic analyses are the methods most often used to address these issues. This section first uses static comparisons to describe the threat faced by NATO in Central Europe. The exercise involves counting the number of units NATO and the WP could mobilize and deploy to wartime positions, normalizing for comparable combat capabilities, and then comparing the totals. Second, dynamic analysis is used to describe how the war might "play out," using a simulation model to capture the "rules" of modern warfare.

STATIC COMPARISONS

All WP/NATO balance assessments begin with a static count of the combat units (and the men and equipment comprised by them) that military strategists expect to engage in hostilities.[1] Which units are counted depends upon which units are or could be made available to support various attack and defense scenarios. Table 2.1 lists additive groupings of units that the WP could conceivably use if it were to attack across NATO's Central Front. Likewise, Table 2.2 lists additive groupings of units that NATO could conceivably use in its defense. These groupings are based upon the readiness and location of the combat units, and the political/military propensities of the nations involved.

Actual Units versus DEs

Although combat units can generically be described by their type, e.g., armored or infantry, and size, e.g., brigade or division, very few combat units are exactly alike in their organization and equipment

[1]Such counts are often colloquially referred to as "bean counts."

Table 2.1

WP COMBAT UNITS

Owner/Loc	Category 1	2	3	Armor Units	Mech Units	Inf Units	Cumulative Divisions	DEs	DEs
Standing							35	26.21	
SU/EG	x			10	9	1			15.31
SU/CZ	x			2	3				4.02
EG/EG	x			2	4				4.24
CZ/CZ	x			1	3				2.64
Reinforce-1							50	36.43	
SU/PO	x			2					1.80
CZ/CZ		x		2	1				2.24
PO/PO	x			5	3	2			5.98
PO/PO		x							0.20
Reinforce-2							62	43.17	
SU/SU-Bal	x			1		2.33			1.10
SU/SU-Bal		x			1				0.62
SU/SU-Bel	x			2		0.33			1.68
SU/SU-Bel		x			2				1.24
SU/SU-Car	x			1		0.33			0.86
SU/SU-Car		x			2				1.24
Reinforce-3							126	84.91	
CZ/CZ			x	2	1				1.93
PO/PO			x		5				2.75
SU/SU-Bal			x	2	5				4.36
SU/SU-Bel			x	8	2				7.00
SU/SU-Car			x	3	6				5.67
SU/SU-Mos	x			1		1			0.94
SU/SU-Mos		x			1				0.62
SU/SU-Mos			x	1	5				3.63
SU/SU-Vol		x			1				0.83
SU/SU-Vol			x		3				1.74
SU/SU-Url		x			1				0.62
SU/SU-Url			x	1	3				2.47
SU/SU-Kiv	x			1					0.82
SU/SU-Kiv		x			2				1.66
SU/SU-Kiv			x	6	4				6.70

NOTE: The data in this table are gleaned from IISS, *The Military Balance, 1986-87*, London, 1986. IISS defines Warsaw Pact categories as follows: Category 1: full strength on 24-hour notice, equipment complete; Category 2: 50 to 75 percent strength, complete with fighting

Table 2.1 (continued)

vehicles, full manning planned to take three days; Category 3: cadre (roughly 20 percent strength), combat equipment possibly complete (older models), planned to be fully manned in roughly eight to nine weeks. Infantry units include airborne and air assault. DE scores include 8 artillery divisions (6 Soviet -- 2 and 2/3 Category 1 in EG, 1/3 Category 1 in CZ, 1 Category 2 in SU-Vol, and 1 Category 2 in SU-Kiv; 1 Czech -- Category 2 in CZ; and 1 Polish -- Category 2 in PO).

Key:
DE - Division equivalent
SU - Soviet Union
EG - East Germany
CZ - Czechoslovakia
PO - Poland
SU-Bal - Baltic Military District in the Soviet Union
SU-Bel - Belorussian Military District in the Soviet Union
SU-Car - Carpathian Military District in the Soviet Union
SU-Mos - Moscow Military District in the Soviet Union
SU-Vol - Volga Military District in the Soviet Union
SU-Url - Ural Military District in the Soviet Union
SU-Kiv - Kiev Military District in the Soviet Union

Table 2.2

NATO COMBAT UNITS

Owner/Loc	Category Act	Category Res	Armor Units	Mech Units	Inf Units	Cumulative Divisions	DEs	DEs
Standing						22	15.11	
GE/GE[a]	x		6.67	4	2			7.13
US/GE[b]	x		3	2.33				5.72
UK/GE[c]	x		2.67					1.68
NE/GE[d]	x			0.33				0.16
BE/GE[e]	x		0.33	0.33				0.22
CA/GE	x			0.33				0.20
Reinforce-1						33.33	19.29	
GE/GE[f]		x	1.33	2				0.96
FR/GE[g]	x		3					0.96
UK/UK[h]	x		0.33		1			0.66
NE/NE[i]	x			1.67				1.02
BE/BE[j]	x			0.67	0.33			0.25
DN/DN		x		1				0.33
Reinforce-2						50.00	26.08	
US/US[k]	x		2.67	1.67	2			4.21
FR/FR[l]	x		2		6			1.68
UK/UK[m]		x			0.33			0.15
NE/NE[n]		x		1	0.33			0.57
BE/BE[o]		x		0.67				0.18
Reinforce-3						60.00	31.38	
US/US[p]	x	x		4	2			4.28
FR/FR[q]	x		4					1.02

NOTE: The data in this table are gleaned from Isby and Kamps, *Armies of NATO's Central Front*, 1985, and IISS, *The Military Balance, 1986-87*. Infantry units include airborne and air assault. DE scores include separate artillery assets for NATO's 8 Corps sectors (I, II, and III German, V and VII United States, I British, I Dutch, and I Belgian). The units counted in each grouping are as follows:

Standing Forces

[a] GE armor consists of six divisions and two 50-series Home Defense Brigades (HDBs). GE infantry consists of a mountain division and three airborne brigades.

[b] US V Corps consists of the 3rd Armored Division, the 11th ACR (listed as 0.33 armor), and the 8th Mechanized Division. US VII Corps consists of the 1st Armored Division, the 2nd ACR (listed as 0.33 armor),

Table 2.2 (continued)

and the 3rd Mechanized Division. US Operational Reserve consists of one brigade each from the 2nd Armored Division and the 1st Mechanized Division.

[c] UK BAOR consists of the 1st and 4th Armored Divisions and two brigades from the 3rd Armored Division.

[d] NE forces consist of one brigade from the 4th Mechanized Division.

[e] BE forces consist of the two brigades of the 16th Division.

Level One Reinforcements

[f] GE armor consists of four 50-series HDBs. GE mechanized consists of six 60-series HDBs.

[g] FR forces consist of the three divisions in II Corps.

[h] UK forces consist of the 2nd Infantry Division and roundout for the 3rd Armored Division.

[i] NE forces consist of the 1st Mechanized Division and roundout for the 4th Mechanized Division.

[j] BE forces consist of the two brigades of the 1st Mechanized Division and the 1st Para-Commando Regiment (listed as 0.33 infantry).

Level Two Reinforcements

[k] US POMCUS units consist of roundout for the 2nd Armored and 1st Mechanized Divisions, the 3rd ACR (listed as 0.33 armor), the 4th Mechanized Division, and the 1st Cavalry Division (listed as 1.0 armor). Also included here are the 194th and 197th Armored Brigades and the 82nd Airborne and 101st Air Assault Divisions (listed as infantry).

[l] FR forces consist of the FAR and III Corps.

[m] UK infantry consists of the 5th Airborne Brigade.

[n] NE forces consist of the 5th Mechanized Division and the 101st Infantry Brigade.

[o] BE forces consist of the 10th and 12th Brigades.

Level Three Reinforcements

[p] US forces consist of the 7th and 25th Light Infantry Divisions (counted as infantry), the 5th and 24th Mechanized Divisions, and miscellaneous units from the Army, Army Reserve and National Guard.

[q] FR forces consist of the four divisions in I Corps.

Key:
DE - Division equivalent
GE - West Germany
US - United States
UK - United Kingdom
NE - Netherlands
BE - Belgium
CA - Canada
FR - France
DN - Denmark

holdings. To account for the differences between units, it is useful to measure combat strength in terms of a common metric. One such metric is based upon a Weapon Effectiveness Index (WEI). All the weapons in a combat unit are assigned a lethality score based upon the index. The sum of the scores represents the combat strength of the unit. One unit is then used as the standard (division equivalent) against which the rest are compared. The last column in Tables 2.1 and 2.2 lists the division equivalent (DE) scores for the additive groupings of NATO and WP units. A detailed description of the methodology used to generate these division equivalent scores, as well as its application to NATO and WP units, is provided in Appendix A.

Availability Scenarios and Force Ratio Comparisons

The balance of forces is a function of which units are mobilized, ready, and in place at a particular moment in time. Any number of availability scenarios could be described and quantified. The paragraphs below describe the four availability scenarios that were used as the basis for the additive groupings of WP forces in Table 2.1 and the four availability scenarios that were used as the basis for the additive groupings of NATO forces in Table 2.2. Table 2.3 depicts the overall balance of forces, in division equivalents, based upon the availability scenario chosen. In all but one of the 16 cases, the WP has an advantage. In the 15 cases where the WP has an advantage, it ranges from a low of 1.01 to 1.00 (a WP Standing Attack versus a NATO Level 2 Reinforced Defense) to a high of 5.62 to 1.00 (a WP Level 3 Reinforced Attack versus a NATO Standing Defense).

WP Mobilization Scenarios[2]

Because we are not privy to the WP's military contingency plans, it is difficult to estimate which WP forces would be committed to an invasion

[2]Mobilization scenarios for WP and NATO forces are based upon decisions about which forces should be included. The scenarios in Tables 2.1 and 2.2 range from very short mobilization time (Standing) to very long mobilization time (Level Three Reinforced). They are consistent with those that appear in the public realm. See John J. Mearsheimer, "Why the Soviets Can't Win Quickly in Central Europe," *International Security*, Vol. 7, No. 1, Summer 1982; Barry R. Posen, "Measuring the European Conventional Balance: Coping with Complexity in Threat Assessment," *International Security*, Vol. 9, No. 3, Winter

Table 2.3

WP:NATO FORCE RATIO IN NATO CENTRAL REGION
UNDER DIFFERENT AVAILABILITY SCENARIOS
(in Division Equivalents)

Time Frame (days of mobilization)			1-3	7-15	15-30	>30
Time Frame (days)	NATO DEs	WP DEs	26.21 Stand	36.43 R-1	43.17 R-2	84.91 R-3
1-3	15.11	Stand	1.73	2.41	2.86	5.62
2-7	19.29	R-1	1.36	1.89	2.24	4.40
2-15	26.08	R-2	1.01	1.40	1.66	3.26
15-30	31.38	R-3	0.84	1.16	1.38	2.71

NOTE: Time frames are notional (see text). Some of the pairs of availability scenarios are highly unlikely. For example, pairings in the upper right quadrant would indicate extraordinary WP deception or NATO indecision. Pairs in the lower left quadrant would indicate a NATO decision to mobilize first. Definitions are as follows:

Stand: Standing Forces Attack (WP) or Defense (NATO)
R-1: Level One Reinforced Attack (WP) or Defense (NATO)
R-2: Level Two Reinforced Attack (WP) or Defense (NATO)
R-3: Level Three Reinforced Attack (WP) or Defense (NATO)

of Central Europe. The additive groupings of forces in Table 2.1 are based upon the geographic proximity of WP units to the Central Front and the peacetime readiness of those forces. East Germany, Czechoslovakia, Poland, and Soviet Military Districts (MDs) are illustrative of proximity.[3] East European national boundaries and Soviet MDs are

1984-85; and William P. Mako, *U.S. Ground Forces and the Defense of Central Europe*, 1983.

[3]Soviet armed forces are organized in four groups of forces in Eastern Europe (in East Germany, Czechoslovakia, Poland, and Hungary) and in 16 military districts in the Soviet Union.

delineated in Figure 2.1. WP unit category levels are defined in Table 2.1.

The assumptions underlying Table 2.1 are that all forces in the Soviet Union's Western Theater of Military Operations (WTVD) would be committed to an attack on Central Europe and that they would be reinforced by units from the Soviet Central Reserve and from the Kiev MD.[4] The specific groupings commit forces as follows: A *Standing Forces Attack* would commit all WP Category 1 units in East Germany and Czechoslovakia.[5] A *Level-One Reinforced Attack* would add WP Category 1 and 2 units in Poland and Category 2 units in Czechoslovakia to the standing forces attack.[6] A *Level-Two Reinforced Attack* would add Category 1 and 2 Soviet units based in the Baltic, Belorussian, and Carpathian Military Districts' to the Level-One Attack. A *Level-Three Reinforced Attack* would add Category Three units from Czechoslovakia and Poland and all units from the Soviet Union's Central Reserve (the Moscow, Volga, and Ural Military Districts) and all units from the Kiev Military District.

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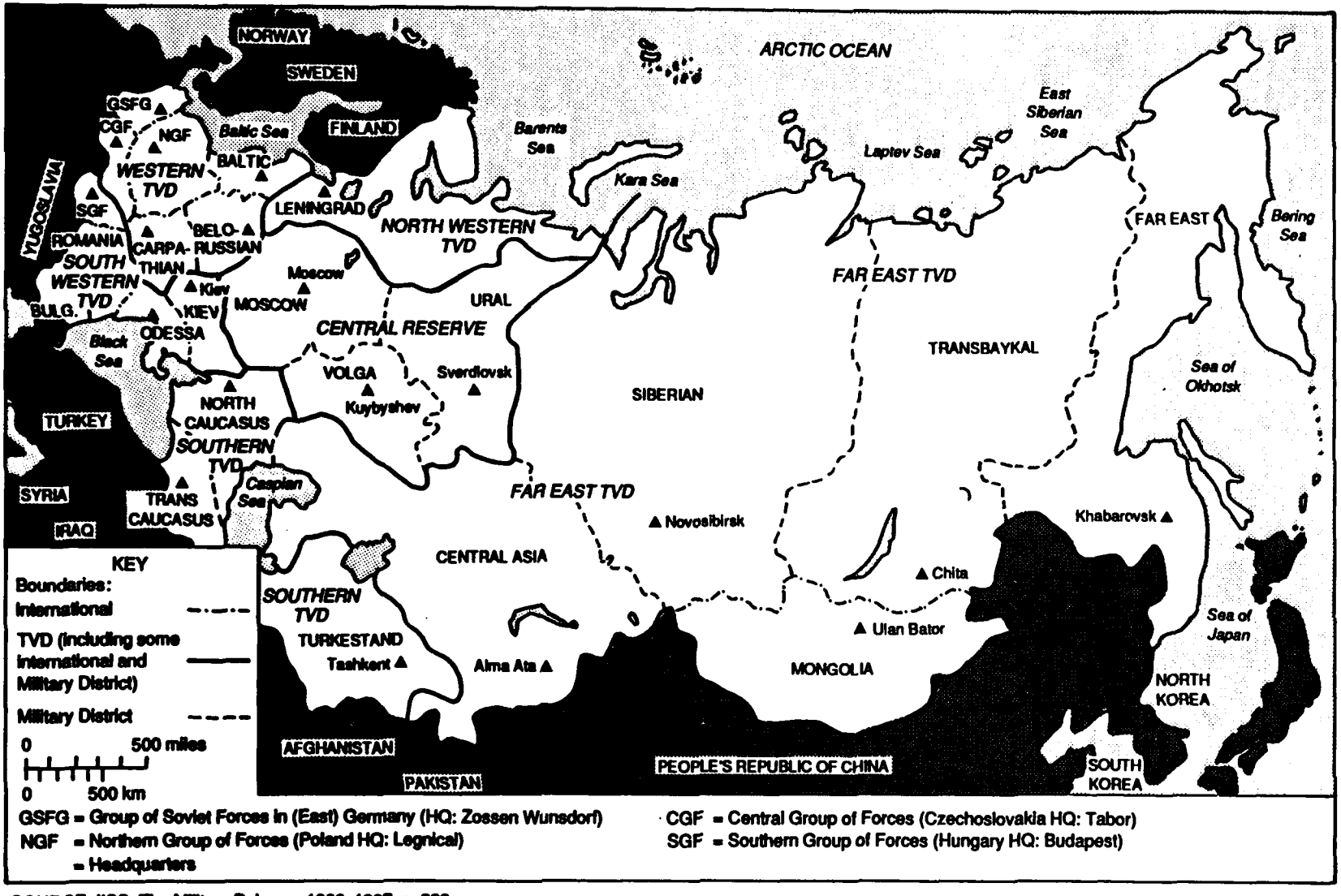
[4]A TVD "is both a level of command and a geographic area within which Soviet armed forces would function in wartime." The WTVD commands all forces in East Germany, Czechoslovakia, Poland, and the Soviet Baltic, Belorussian, and Carpathian MDs. Its geographic area of responsibility includes NATO's Central Region plus Denmark. See U.S. Army, *FM 100-2-3, The Soviet Army: Troops, Organization and Equipment*, 1984, pp. 1-3. The selection of which units would reinforce the WTVD is somewhat arbitrary. Committing all Central Reserve and Kiev MD forces to the WTVD would likely be contingent upon a favorable political/military situation in other TVDs.

[5]Soviet forces in East Germany and Czechoslovakia are organized into two groups: the Group of Soviet Forces in Germany (GSFG) and the Central Group of Forces in Czechoslovakia (CGF). All Soviet forces in Eastern Europe are Category 1.

[6]Soviet forces in Poland are organized into the Northern Group of Forces Poland (NGF).



SOURCE: IISS, The Military Balance, 1986–1987, p. 229.

Fig. 2.1—WP national boundaries and Soviet MDs

NATO Mobilization Scenarios

NATO has a detailed set of plans that transition its forces from peacetime to wartime footings. The process begins with a SACEUR declaration of Military Vigilance (a request for nations to mobilize their forces) and continues through several stages of alert (Simple, Reinforced, and then General) where forces are first chopped to SACEUR and then ordered to their defense positions.[7] While NATO's specific defensive plans are classified, the additive groupings of forces in Table 2.2 are based upon the geographic proximity of NATO units to the Central Front, the peacetime readiness (active or reserve) of those forces, and (with respect to the French) an accounting for political considerations.[8]

The assumptions underlying Table 2.2 are that all forces in the Central Front nations (plus Denmark) would be committed to a defense of Central Europe and that they would be reinforced by American units from the United States.[9] The specific groupings commit forces as follows: A *Standing Forces Defense* would include all active units in West Germany except the French. A *Level-One Reinforced Defense* would add (1) active

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[7]The stages of mobilization are based on the author's discussions with NATO officials.

[8]France withdrew from NATO's military command structure in 1967. Nonetheless it continues to maintain forces in West Germany and adheres to an alliance pledge of military assistance if NATO is attacked. In this study we assume a forthright commitment of all French forces, but one that delays commitment until after an actual attack. In general, all NATO members are assumed reliable. That is, everyone shows up (eventually) and everyone fights.

[9]Early arriving U.S.-based units would utilize prepositioned equipment (POMCUS) already in the theater. The United States has a limited ability (most notably its small fleet of SL-7 transport ships) to move additional units to the theater. In this study it is optimistically assumed that, in addition to POMCUS, the United States would be able to bring four light and the equivalent of four heavy divisions into the theater over a period of 30 to 40 days. See P. M. Dadant et al., *A Comparison of Methods for Improving U.S. Capability to Project Ground Forces to Southwest Asia in the 1990's*, The RAND Corporation, November 1984, and Congressional Budget Office, *U.S. Airlift Forces: Enhancement Alternatives for NATO and Non-NATO Contingencies*, April 1979.

units committed to NATO that are peacetime-garrisoned in the Netherlands, Belgium, and Great Britain; (2) French II Corps (peacetime; garrisoned in Germany); and (3) Germany's cadre-strength Home Defense Brigades. A *Level-Two Reinforced Defense* would add (1) U.S. POMCUS units; (2) France's III Corps and Rapid Action Force; and (3) cadre-strength Dutch, Belgian, and British units committed to NATO. A *Level-Three Reinforced Defense* would add France's I Corps and, from the United States, four light divisions, two mechanized divisions, and six mechanized brigades.

Interpreting Static Comparisons

The advantages of static comparisons are that they are relatively easy to compile and assimilate. Theater force ratio comparisons (attacker to defender) are generally used as a metric to predict the outcome of a war in Europe (and thus as a justification for greater or lesser amounts of defense spending). A common rule of thumb is that an attacker could be relatively confident of success with an overall force ratio of 3:1 or better.[18] Some authorities have suggested that much lower force ratios might be enough for the WP to defeat NATO. For example, former Secretary of Defense Harold Brown (in 1982) suggested that an overall theater force ratio of 2:1 might be enough for the WP to capture large amounts of NATO territory. Former Secretary of Defense James Schlesinger (in 1977) suggested that this ratio might be as low as 1.5:1. Analysts from the Congressional Budget Office (in 1980) have suggested that a successful defense of NATO would probably be likely if theater force ratios were held below 1.4:1.

The disadvantage of static comparisons is that they do not capture the dynamics of warfare. In actual warfare, combat units mobilize and move into localized positions for attack and defense. Their movement and combat capabilities are affected by terrain conditions. Static,

[18]For a critique of the 3:1 rule, see Joshua M. Epstein, "Dynamic Analysis and the Conventional Balance in Europe," *International Security*, Vol. 12, No. 4, Spring 1988, pp. 155-158. The force ratio examples from Brown, Schlesinger, and the CBO are cited in William P. Mako, *U.S. Ground Forces and the Defense of Central Europe*, 1983, p. 38 (notes 24-26).

theater-level force ratios do not capture the unit movements, localized engagements, or the impact of terrain.[11]

DYNAMIC ANALYSIS

Dynamic analysis brings a greater dimension (as well as a greater level of complexity) to the realm of threat assessment. A dynamic assessment allows the analyst to "play" the war. In doing so, the analyst can capture important time and space aspects associated with the initial disposition and the movement of units, and the additive attrition effects associated with unit engagements.

Categories of Dynamic Analysis

Dynamic analyses of theater warfare generically fall into one of three categories: manual games, computer games, and simulations. *Manual games* pit human players (usually a blue team versus a red team) against one another. The players order forces to deploy and engage the enemy over time. A control team provides the scenario, performs time-keeping functions (stopping the clock to accept player inputs), and, based upon a set of rules agreed to at the start of the game, tracks force movements and attrition. *Computer games* have many variants, but the basic characteristic is that a computer is used to perform the arithmetic involved in keeping track of forces, their movements, and attrition. Computer game variations range from human teams pitted against one another (with the computer assuming most or all of the control team functions), to games in which only one side (either blue or red) or the control team (usually inputting a scenario variation) accepts human inputs. Finally, *simulations* play the forces of both sides (red and blue) against each other without human interaction. The forces and the scenario are input by the analyst at the start of the simulation. The movement, engagement of forces, and the adjudication of battles are then undertaken on the basis of the rule sets and algorithms in the simulation program.

[11]While static analysis does not capture wartime dynamics a dynamic analysis does not necessarily capture "truth" about war. A dynamic analysis does, however, force the analyst to make explicit his more important assumptions about wartime processes, such as attrition and advance rates.

Games and computer games are useful for the development of rule sets and assumptions that can then be used in simulations in place of human players. Once structured, simulations have advantages over games which include fast run times, low manpower requirements, transparency, reproducibility, and the capability to more easily perform sensitivity tests (i.e., tests which show how model outputs change when selected changes are made to scenario inputs or model assumptions).[12] In this study a simulation model is used to assess the effectiveness of reserve force options. The following paragraphs describe a base case mobilization (attacker and defender) scenario, and show representative output from a run of the simulation model with this scenario. The simulation model used in this study is described in Appendix B.

The Base Case

On mobilization, NATO forces will deploy to defensive positions along the eastern border of West Germany. Figure 2.2 depicts AFCENT's eight corps sectors and the Danish area of responsibility in the north of West Germany.[13] Each of these areas of responsibility may be considered an axis along which WP and NATO forces attack and defend. These axes provide a useful framework for constructing attack and defense scenarios.

In NATO force structure analysis it is common to build scenarios with NATO's mobilization commencing several days or weeks after the WP. This lag represents the defensive and non-provocative nature of the NATO alliance. A long mobilization scenario might pit a WP force that has mobilized for 25 days against a NATO force that has mobilized for only

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[12]Simulations often are criticized because they are not particularly transparent. Transparency refers to the ease with which the user can discern the model's cause and effect relationships (changing an input causes a change in output). Reproducibility refers to the consistency of the simulation's results (the same inputs should produce the same outputs). Reproducibility and patience will generally make the most opaque simulation models transparent.

[13]AFCENT is the acronym for Allied Forces Central Europe.

Fig. 2.2—NATO Corps areas of responsibility

10 days. This commonly analyzed mobilization scenario is called a 25/10 case to recognize the respective WP/NATO mobilization periods before the outbreak of hostilities. This scenario is used as our base case.[14]

Knowing how much time each side has to mobilize allows the analyst to build analytic war plans for attacking and defending forces. Analytic war plans apportion attacking and defending forces in terms of time and space, i.e., when and where they will enter a side's available force structure (in the simulation). The following paragraphs, tables, and graphs describe this study's base case analytic war plan for the WP's attack and NATO's defense. The results of running this base case are then presented.

The Base Case Attack Scenario[15]

The initial attack utilizes WP Category 1 and 2 units peacetime garrisoned in East Germany, Czechoslovakia, and Poland. In the first five days of the war, with 36.43 DEs (from Table 2.1, standing forces plus level one reinforcements), the WP develops three main axes of attack; in NorthAG against the Dutch and Belgian Corps' sectors, and in CentAG against the II German Corps sector. Other axes are covered with enough strength to pin down the defense. In the following ten days, the

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[14]In the course of this study other mobilization scenarios were analyzed as candidates for the base case. Shorter scenarios (e.g., a 10/5 or a 7/3) were rejected as analytically less threatening to NATO. Other scenarios were rejected as less plausible (e.g., a very short mobilization scenario on the order of 4/1, or scenarios in which NATO mobilization closely mirrored WP mobilization). Within the realm of "more likely" scenarios, a 25/10 scenario represents something of a "worst case" for NATO.

[15]Several references provided useful information for the initial development of the base case attack and defense scenarios. Among these were William P. Mako, *U.S. Ground Forces and the Defense of Central Europe*, 1983, pp. 40-55 and Appendix B; David C. Isby and Charles Kamps Jr., *Armies of NATO's Central Front*, 1985, pp. 19-23; and Col. Daniel Gans, "'Fight Outnumbered and Win' ... Against What Odds?, Part I," *Military Review*, December 1980, pp. 31-46. The author is also indebted to RAND Corporation analysts Dr. Milton Weiner and Col. Robert Howe (Ret.) for their abundant war gaming tutelage and critique. The specific attack and defense scenarios described in this study are the author's, however, and are based on the assumptions in the text.

initial attacking force is joined by Category 3 units from Czechoslovakia and Poland (4.68 DEs), all units from the Soviet Union's Baltic, Belorussian, Carpathian, and Kiev Military Districts (39.95 DEs), and part (3.45 DEs) of the Soviet Union's Strategic Reserve, for a total attacking force of 73.83 DEs.[16] In the last half of the war (the simulation is set to run for 30 days) additional units (4.31 DEs) from the Soviet Union's Strategic Reserve join the attacking force. By the end of the simulation, 77.14 DEs have been committed to the attack. Table 2.4 lists the actual units that play in the base case WP attack and the day and the area in which they enter the WP's force structure.

The Base Case Defense Scenario[17]

The initial defense utilizes AFCENT forces that would be available to SACEUR in the early stages of mobilization. Forces are sent either to Corps areas of responsibility or to operational reserve. At the beginning of the war, NATO fields 23.44 DEs (from Table 2.2, standing forces plus level one and two reinforcements, less French forces). Of these divisions, approximately four fill the covering force area, six fill the operational reserve (mostly US III Corps POMCUS units), and the remainder fill the main battle area. In the second stage of the war (Days 6 through 15 of the simulation), France's II Corps, the FAR and III Corps (2.64 DEs), and two U.S. mechanized and four U.S. light divisions (2.56 DEs) are added to NATO's operational reserve for a total defending force of 28.64 DEs. In the last stage of the war (Days 16 through 30), France's I Corps (1.02 DEs) and six U.S. mechanized brigades (2.0 DEs) join NATO's operational reserve to bring NATO's total committed strength to 31.66 DEs. Table 2.5 lists the actual units that

[16]The Soviet Union's Strategic Reserve consists of those units from the Moscow, Volga, and Ural Military Districts. In the base case, six units from the Moscow Military District join the WP's force structure between Days 6 and 15 of the simulation. Remaining units from the Moscow Military District and all units from the Volga Military District are added to the WP's force structure between Day 16 and 30.

[17]The specific attack and defense scenarios described in this study are the author's and are based on the assumptions in the text. See also the note to The Base Case Attack Scenario.

Table 2.4

WP ATTACK (Base Case)

Day	Axis One[a]	Axis Two[b]	Axis Three[c]	Axis Four[d]	Axis Five[e]	Axis Six[f]	Axis Seven[g]	Axis Eight[h]	Axis Nine[i]
1	PO 1xArm-1 PO 1xMec-1 PO 2xAir-1	PO 3xArm-1 PO 1xMec-1 EG 1xArm-1 EG 2xMec-1	SU 2xArm-1 SU 2xMec-1 SU 1/3xAty-1	SU 2xArm-1 SU 1xMec-1 SU 1xAir-1 SU 1/3xAty-1	SU 2xArm-1 SU 2xMec-1 SU 1/3xAty-1 SU 1xMec-1	SU 2xArm-1 SU 1xMec-1 SU 1/3xAty-1	EG 1xArm-1 EG 2xMec-1 SU 1xArm-1	SU 1xArm-1 SU 1xMec-1 SU 2/3xAty-1 CZ 2xMec-1	SU 2xMec-1 SU 1/3xAty-1 CZ 1xArm-1 CZ 1xMec-1
3 0 0	PO 1xArm-1 PO 1xMec-1 PO 1xAty-2	SU 2xArm-1 SU 1/3xAty-1			SU 2xArm-1 SU 2xMec-1 SU 1/3xAty-1			SU 1xArm-1 2xMec-2 SU 1/3xAir-1	CZ 2xArm-2 CZ 1xMec-2 CZ 1xAty-2
5		SU-Bal 7/3xAir-1 SU-Bal 1xArm-1 SU-Bal 1xMec-2			SU-Bel 2xArm-1 SU-Bel 1/3xAir-1 SU-Bel 2xMec-2				SU-Kiv 1xArm-1 SU-Kiv 2xMec-2 SU-Kiv 2xAty-2
7	PO 2xMec-3	PO 3xMec-3			SU-Bel 1xArm-3	SU-Car 1xMec-3	SU-Car 1xMec-3	SU-Car 1xMec-3	CZ 2xArm-3
9		SU-Bal 1xArm-3 SU-Bal 2xMec-3			SU-Bel 2xArm-3 SU-Bel 1xMec-3	SU-Car 1xArm-3	SU-Car 1xArm-3	SU-Car 1xArm-3	SU-Kiv 2xArm-3 SU-Kiv 1xMec-3
11		SU-Bal 1xArm-3 SU-Bal 2xMec-3			SU-Bel 3xArm-3 SU-Bel 1xMec-3	SU-Car 1xMec-3	SU-Car 1xMec-3	SU-Car 1xMec-3	SU-Kiv 2xArm-3 SU-Kiv 1xMec-3
13		SU-Bal 1xMec-3			SU-Bel 2xArm-3				SU-Kiv 2xArm-3

WP THEATER REINFORCEMENT

Days 6-15	Days 16-30
SU-Mos 1xArm-1	SU-Mos 3xMec-3
SU-Mos 1xAir-1	SU-Vol 1xMec-2
SU-Mos 1xMec-2	SU-Vol 1xAty-2
SU-Mos 1xArm-3	SU-Vol 3xMec-3
SU-Mos 2xMec-3	

NOTES: Entries are listed by owner, quantity, type, and category. The first entry under Axis One would read one Polish Category 1 armored division. All units are in division strengths. For key see Table 2.1.

[a]Days 1 and 3—Polish Pomeranian Army.

[b]Day 1—Polish Silesian Army and East German V Military District Forces; Day 3—Soviet NGF.

[c]Day 1—Soviet 2nd Guards Tank Army.

[d]Day 1—Soviet 1st Guards Tank Army.

[e]Day 1—Soviet 3rd Shock Army and Soviet 8th Guards Army(–); Day 3—Soviet 20th Guards Army.

[f]Day 1—Soviet 8th Guards Army(+).

[g]Day 1—East German III Military District Forces and Soviet XXVII Corps(–).

[h]Day 1—Soviet XXVIII Corps(+) and Czechoslovakian 1st Army(–).

[i]Day 1—Soviet CGF and Czechoslovakian 1st Army(+); Day 3—Czechoslovakian 4th Army.

Table 2.5

NATO DEFENSE (Base Case)

DN *Axis One*	NE *Axis Two*	I GE *Axis Three*	UK *Axis Four*	BE *Axis Five*	III GE *Axis Six*	V US *Axis Seven*	VII US *Axis Eight*	II GE *Axis Nine*
GE 6th_MecD	NE 4th_MecD	GE 1st_ArmD	UK 1st_ArmD	BE 17th_ArmB	GE 5th_ArmD	US 11th_ACR	US 2nd_ACR	GE 10th_ArmD
DN Div	NE CorArty	GE 3rd_ArmD	UK 4th_ArmD	BE 4th_MecB	GE 12th_ArmD	US 3rd_ArmD	US 1st_ArmD	GE 4th_MecD
	NE 1st_MecD	GE 11th_MecD	UK 3rd_ArmD	BE 1st_MecB	GE 2nd_MecD	US 8th_MecD	US 3rd_MecD	GE 1st_MtnD
	NE 5th_MecD	GE 27th_AirB	UK CorArty	BE 7th_MecB	GE 26th_AirB	US CorArty1	US CorArty2	GE 25th_AirB
	NE 101st_InfB	GE CorArty	UK 2nd_InfD	BE CorArty	GE CorArty			GE CorArty
			UK 5th_AbnB	BE ParaRgt				
				BE 10th_MecB				
				BE 12th_MtrB				

NATO OPERATIONAL RESERVE

Days 1-5	Days 6-15	Days 16-30
GE 7th_ArmD	US 24th_MecD	FR I Corps
GE 6xHDBs (51-56)	US 5th_MecD	US 218th_MecB
GE 6xHDBs (61-66)	US 82nd_AirD	US 30th_MecB
CA 4th_BdeGp	US 101st_AirAD	US (AR) 157th_MecB
US 2nd_ArmD	US 25th_LtD	US (NG) 35th_MecB
US 1st_MecD	US 7th_LtD	US (NG) 40th_MecB
US 3rd_ACR	FR II Corps	US (NG) 49th_MecB
US 4th_MecD	FR FAR	US (NG) 50th_MecB
US 1st_CavD	FR III Corps	
US 194th_ArmB		
US 197th_ArmB		

NOTES: Entries are listed by owner, unit designation number, type, and size. The first entry under Axis One would read German 6th mechanized division. Units are listed in division "D" or brigade "B" strengths. For key see Table 2.2.

play in the base case NATO defense and the day and the area in which they enter NATO's force structure. Figure 2.3 compares the disposition of attacking and defending forces at the start of the simulation.

Results of the Base Case Simulation[18]

Figures 2.4 through 2.8 display the results of running the base case scenario through the simulation model. The simulation represents thirty days of war. Figures 2.4 and 2.5 display the average penetration of WP forces over time. Figure 2.4 displays the average penetration by axis (in five day intervals) and Figure 2.5 displays average penetration for the theater as a whole. We observe, by day 30 of the simulation, that the WP has penetrated an average of 194 kilometers, with maximum penetration occurring in II German Corps sector (228 kilometers).[19] Figure 2.5 also provides a reference line to show when average penetration equals 45 kilometers. In the base case, the WP breaches the reference line on day 12.

Figures 2.6 and 2.7 display the attrition of WP and NATO forces over time. In Figure 2.6 we observe that by day 30 the WP has committed 72 DEs to the battle and lost 39 DEs. In Figure 2.7 we observe that NATO has committed 31 DEs and lost 18 DEs. Figure 2.8 displays the theater force ratio over time. By day 30 of the war, the ratio of surviving forces (approximately 32 DEs for the WP and 13 DEs for NATO) is 2.32.

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[18]The simulation plays only the eight corps sectors of AFCENT; the Danish Axis (Axis One in Tables 2.4 and 2.5) is not included. Thus, simulation results do not reflect the total number of divisions, described above, attacking and defending in Central Europe.

[19]One of the reasons for the depth of penetration among some axes is the existence of a flank variable, set in this study to 60 kilometers. When forces along an axis fall back, forces in adjacent axes will fall back to avoid excessive flank exposure. The model does not permit defending forces to attack into the flank of an attacker's penetration. Likewise, there is no requirement that the attacker hold local reserves to blunt such counterattacks.

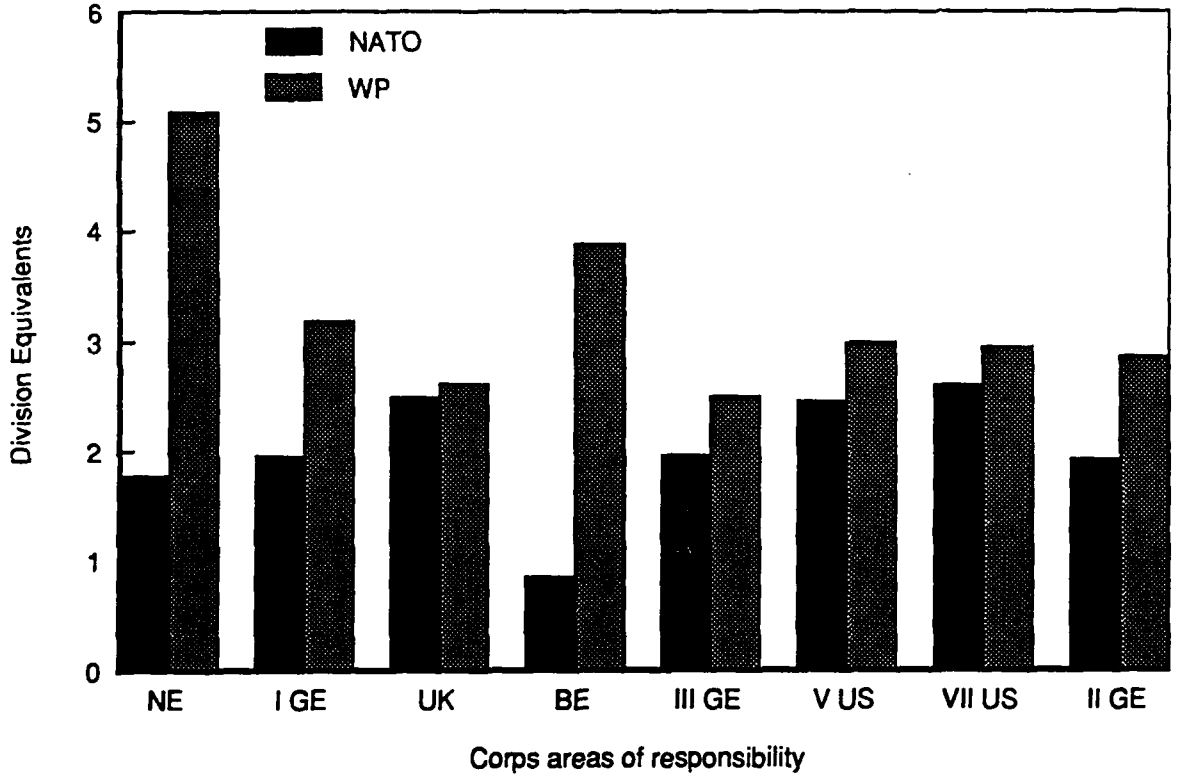

Fig. 2.3–Initial disposition of attacking and defending forces

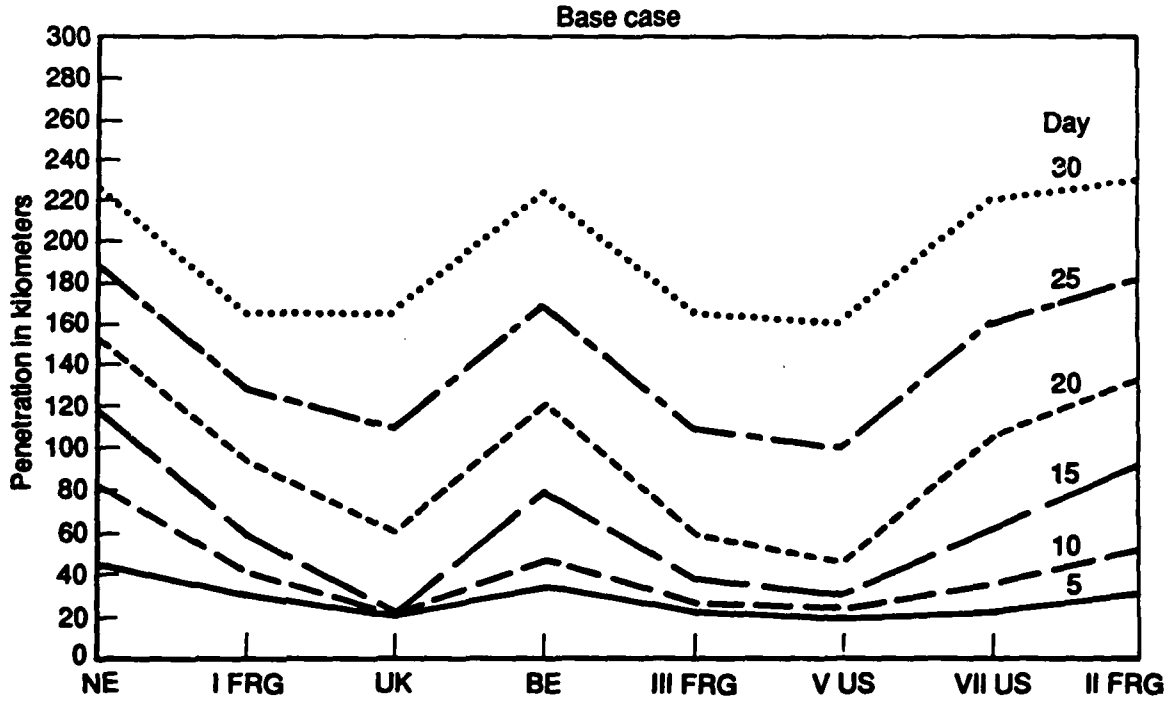

Fig. 2.4—Penetration (by axis)

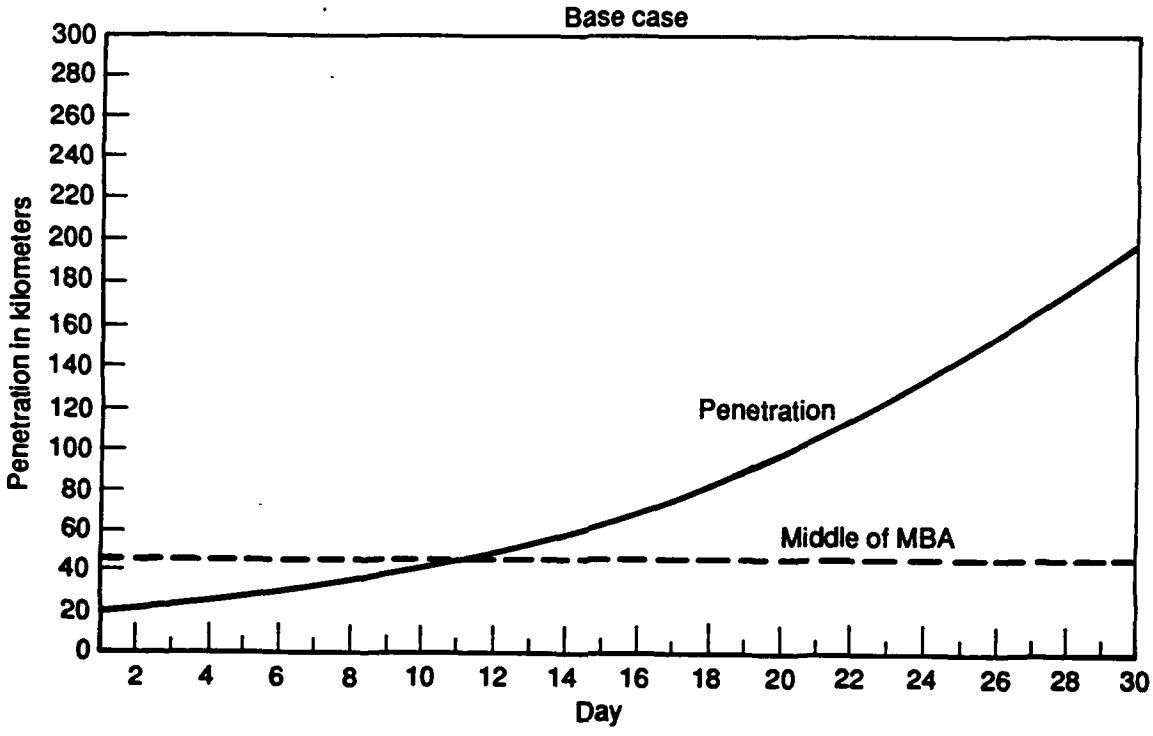

Fig. 2.5—Penetration (average)

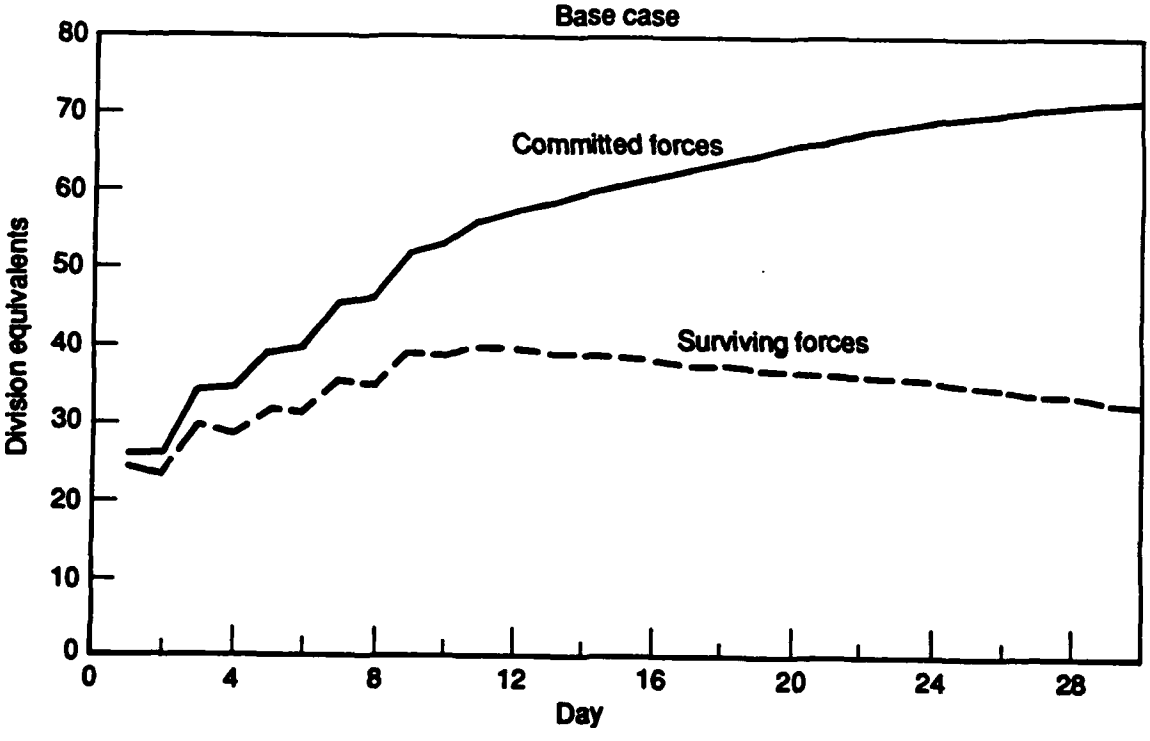

Fig. 2.6—Red attrition

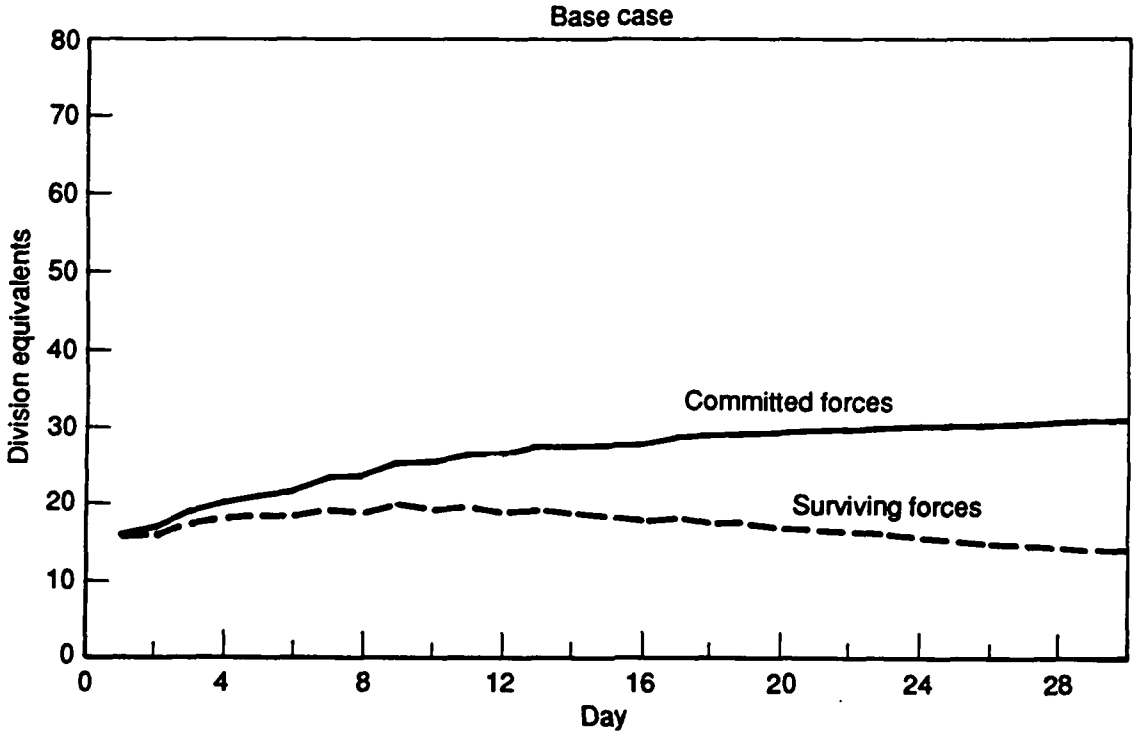

Fig. 2.7—Blue attrition

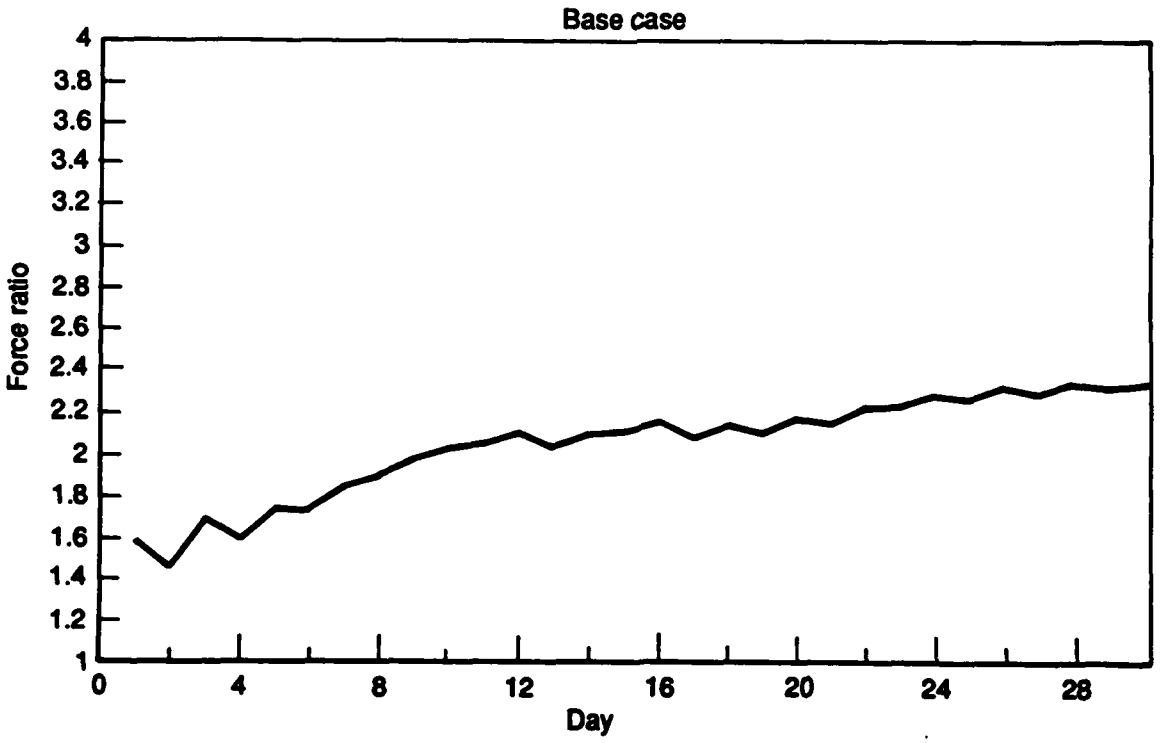

Fig. 2.8—Theater force ratio

Finally, Figures 2.9 and 2.10 display the location of forces over the course of the simulation (in five day intervals). In Figure 2.9 we observe the WP's initial concentration of its forces against the Dutch, Belgian, and German II Corps sectors. Model algorithms order WP forces that enter theater reserve to reinforce success. We observe most reinforcement to occur in the same axes where the initial attack is focused. In Figure 2.10 we observe that NATO initially has forces spread fairly evenly across the front. Model algorithms order NATO forces that enter theater reserve to shore up weak axes (i.e., to reinforce failure). As the WP builds up forces against the Dutch, Belgian, German II, and (later) the US VII Corps sectors, NATO responds by reinforcing them.[20]

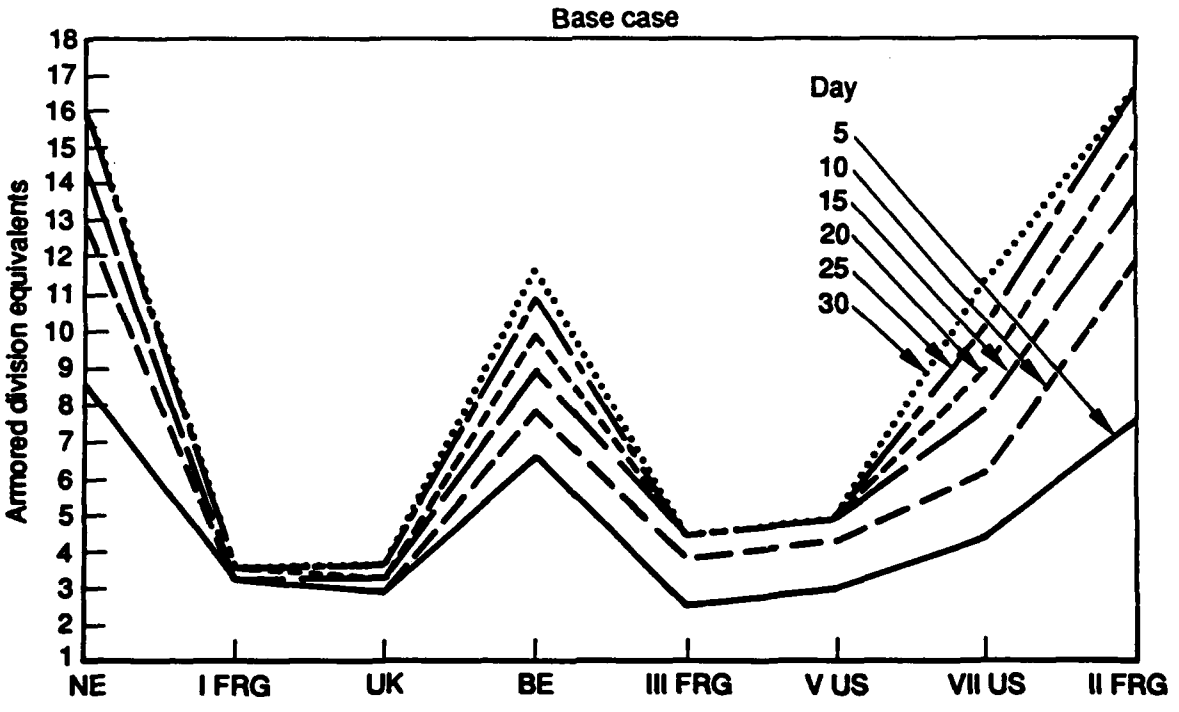

Fig. 2.9—Committed red forces

[20]Not all reinforcements are allocated by the model's rules. Some forces are scripted in to arrive on a specific axis on a specific day. See Table 2.4.

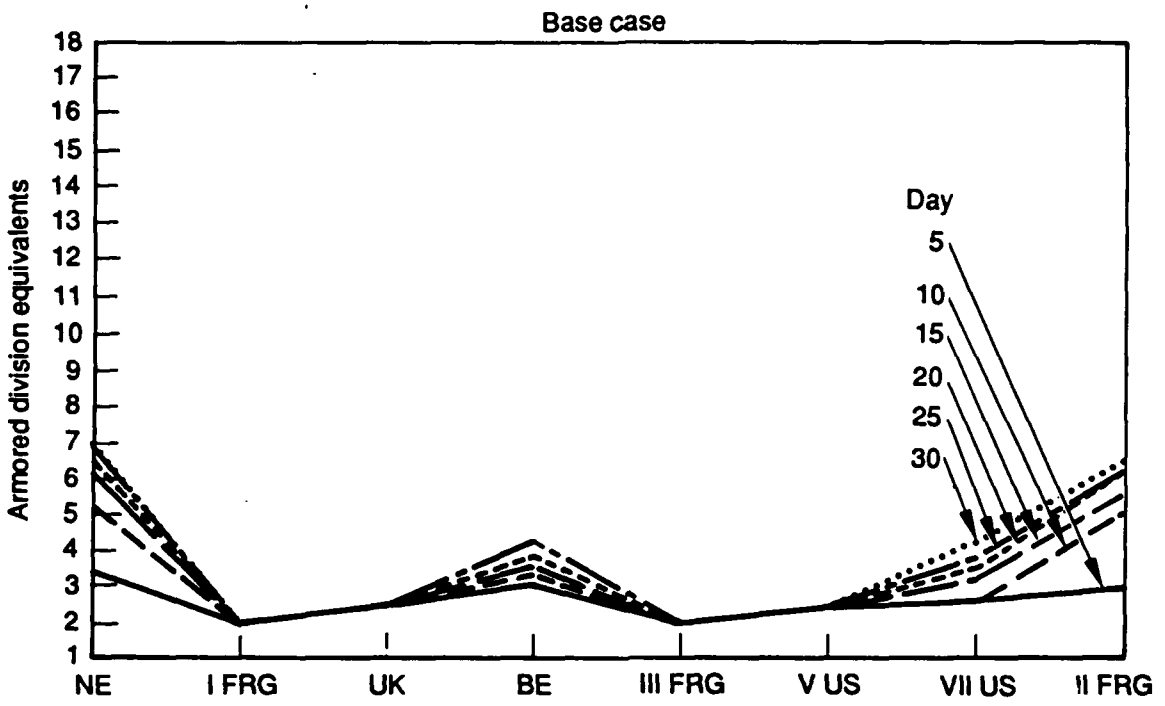

Fig. 2.10—Committed blue forces

Interpreting the Base Case -- NATO's Problem

Recall from the discussion of static comparisons above, the rule of thumb that suggests a defender can defeat an attacker if the ratio of attacking to defending forces is kept below 3 to 1. The rule is less appropriate in a theater-level analysis. In a theater-level campaign the attacker can mass his forces, at different points along the front, to achieve large local force disparities. This is the crux of NATO's problem. With a theater force advantage that, over the course of our simulation, ranges from 1.45:1 to 2.3:1, the WP is able to mass forces along certain major attack axes, while pinning down NATO forces elsewhere along the front. NATO lacks sufficient force to both cover the length of the Central Front and maintain a large enough operational reserve to contain major thrusts.[21] Reserve force units could correct this problem. Section III describes the ways reserve force units, if they were available, could be used. Section IV then describes reserve force requirements.

[21]Alternatively one could argue that NATO's ability to react (i.e., detect major axes of attack (intelligence) and apportion its forces appropriately (mobility), were insufficient. If NATO forces could move forces instantaneously then all local force ratios would be equal to the theater force ratio.

III. RESERVE UNIT CHARACTERISTICS AND STUDY ALTERNATIVES

Reserve units, like active units, can be organized different ways for different purposes.[1] These different organizations and purposes affect the ultimate cost and effectiveness of the unit. In this study, a reserve unit is defined as having a peacetime manning level equal to 5 percent of its mobilized (wartime) strength.[2] Three factors, discussed below, are especially important to the cost of the unit and to the contribution it can make to NATO's defense. These factors are:

- Unit type, strength, and mission
- Unit proficiency
- Unit availability

The purpose of this section is to familiarize the reader with these factors. The information in this section is used in the evaluation of the reserve option in succeeding sections.

RESERVE UNIT TYPE, STRENGTH, AND MISSION

The reserve option creates combat units.[3] Combat units directly

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[1]The term "reserve unit" may be misleading in that very few reserve units are composed of only reservists; most have active cadres. The cadre maintains the unit's equipment, organizes its refresher training, and would assume most leadership activities in war. Cadre sizes vary considerably and generally include active servicemen who have peacetime assignments away from the reserve unit. Some observers prefer to use the term *mobilizable units*, recognizing that while these types of units have active components, they would not be able to perform their wartime tasks until they had fully mobilized.

[2]Although the 5 percent figure is somewhat arbitrary, it is chosen based upon discussions with U.S. Army personnel. A cadre of 5 percent is considered a minimum level for adequate peacetime administration and equipment maintenance of a brigade-sized unit.

[3]Reserve units (like active units), when built into larger fighting entities, require both combat and support elements. Combat elements, e.g., infantry, armor, and artillery units, deliver fire. Support elements, e.g., engineer, supply, and maintenance units, enhance or help to sustain the efficiency with which combat units deliver fire. In this study, we build combat units with a requisite level of support to

influence the outcome of the battle. This influence occurs by defending against, or attacking the enemy. Unit strength can be estimated by the weapon systems in that unit -- their sizes, rates of fire, accuracy, mobility, and armored protection. The weapon systems in a unit are a product of the unit type. Several types of these units are listed in Table 3.1. Also listed in the table, for each type of unit, are quantities of their more lethal weapon systems and aggregate strengths in terms of division equivalents (DEs).

The DE scores in Table 3.1 were estimated using the Weapon Effectiveness Index/Weighted Unit Value (WEI/WUV) methodology (see Appendix A). The WEI/WUV methodology uses an index of lethality scores (the WEI) to produce a unit lethality score (the WUV). The WEI provides lethality scores for the different types of weapons. The WUV is a summation of all the weapons in a combat unit multiplied by their WEI scores. For ease of comparison, one unit is then used as a standard DE against which all other units are compared. The standard used in Table 3.1 is a U.S. armored division.

The WEI is based upon professional military judgments about the effectiveness of different types of weapons systems fighting in a particular geographic/military context. The geographic/military context in Central Europe is generally suitable for tank warfare and forces there have thousands of tanks. The weighting scheme reflects this context. Thus, among similarly sized units, heavy units score higher.

Combat unit missions are assigned, generally, based upon unit characteristics. The units from Table 3.1 are characterized as heavy combat (armored and mechanized), light combat (infantry, motorized infantry, airborne), or artillery. *Heavy combat units* are the NATO standard. They are configured for combined arms operations at brigade

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represent the organizational nature of larger fighting organizations (see Section V).

The U.S. Army classifies units as either combat, combat support, or combat service support. Combat units and combat service support units correspond, respectively, to our definition of combat and support units. The second classification, combat support, includes artillery, air defense, engineer, and signal units. In accordance with the definition used here, artillery and air defense units are combat; engineer and signal units are support. See U.S. Army, FM 101-5-1, *Operational Terms and Graphics*, 1980, pp. 1-26.

Table 3.1

UNIT TYPES AND STRENGTHS

Type	Description	Tanks	IFVs APCs & MICVs	Howitzers	Long Anti-Tank	Short Anti-Tank	DEs[a]
Heavy	Armored brigade[b]	116	152	31	16	56	0.33
Light	Infantry brigade[c]			18	108	72	0.13
Arty	Artillery brigade[d]			72			0.11

[a] Division equivalent standard equals one U.S. armored division.

[b] Equipment totals equal 1/3 of corresponding U.S. armored or mechanized division totals. M2/M3 Bradley IFVs are equipped with TOW but are counted only in the IFV totals.

[c] Infantry brigade is non-standard; equipped with extra anti-tank weapons.

[d] The artillery brigade does not exist in NATO armies. The brigade totals here are equal to three times the battalion totals.

or higher levels of organization. They are capable of both defensive and offensive operations in most types of terrain. With rapid mobility, armor, and firepower, these units are particularly suited for battle in open terrain where speed, armored protection, and heavy caliber weapons are important for successful combat. Heavy units can take the battle to the enemy and regain lost territory. Their missions include holding a defensive position, blocking an enemy thrust, and counterattack.

NATO's *light combat units* directly or indirectly support heavy unit operations. These units are assigned to areas where they have a natural terrain advantage, e.g., built-up and forested areas.[4] Their missions

[4]Such favorable terrain is abundant in Germany. Thirty percent of Germany is densely forested, while villages and towns cover a significant portion of the rest.

are defensive, i.e., to delay, harass and attrite enemy forces. In forested areas, the tactics employed by light units would be to strike the forward elements of the advancing enemy and then fade back to the cover of the woods. The enemy, encountering light units defending built-up areas, must choose to directly assault a prepared position or to bypass. If he chooses a direct assault, he risks heavy losses. If he chooses to bypass, his forces become more concentrated and more vulnerable to effective counterattack. In both instances, light combat units are not decisive; they contribute to the armored battle. They do this in five ways:

1) "screen the front (sidesteping main thrusts);
2) relieve armored forces for concentration into operational reserves;
3) strip out the precursing reconnaissance and break down the synergism of the attacking combined arms teams;
4) channelize the attack into narrow thrust vectors; and
5) set up and mask the tank counterattack into the deep flank of the enemy thrust vector."[5]

Artillery units, in this Note, are the third type of unit that brings fire on the enemy. Artillery units support both heavy and light units by:

- Suppressing enemy artillery with counter-battery fire
- Supporting defensive operations with concentrated fire to break up an attack
- Providing covering fire to mask a defensive withdrawal
- Supporting offensive operations with saturation fire to "soften" the enemy's position

[5]Steven L. Canby, *NATO Defense: What Can Be Done?* Paper presented at a RAND Conference, March 3-5, 1986, pp. 9-10. Dr. Canby further observes that these tactics force "the enemy into open terrain while masking the assembly and movement of friendly armor. With new technology, [these tactics] can also inflict serious losses on bypassing armor. If the enemy attacks into the towns, tank losses will be heavy and much time lost. It the enemy attacks into forests, armor units risk being stripped of their recce and infantry and therefore the synergism of the combined arms team."

RESERVE UNIT PROFICIENCY

Proficiency is the ability of an Army unit to perform its wartime mission. The most important factor in creating unit proficiency is training--the *initial training* received during the course of a serviceman's active service obligation, and *refresher training* received during the course of a serviceman's reserve service obligation. Training produces not only mission skills, but also a unity of spirit and action known as unit cohesion.[6]

Figure 3.1 illustrates the effect of training on unit proficiency.[7] In the figure the vertical axis represents a unit's proficiency in the performance of a particular mission. The horizontal axis represents time and is separated into two periods: active-duty service and reserve-duty service. Proficiency peaks at the end of any training period. In the figure a peak occurs at the end of the active-duty service period and at the the end of each refresher training period.

Effectiveness of training may be regarded as a function of quality, duration, and intensity. Quality refers to the type of training activity (such as individual skills, school, command post exercises (CPXs), and field training exercises (FTXs)). Activities that more closely resemble wartime missions are higher quality training. Duration refers to elapsed time. A longer training period allows for learning more skills or a higher entrenchment of existing skills. Intensity refers to the number of different mission tasks practiced, the number of times a particular task is practiced per unit time, and the difficulty of those tasks.

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[6]Cohesion is relatively intangible but is clearly evident when a unit functions as a team rather than as the sum of the skills of its individual members. Cohesion results from the bonds and trust that develop among and between a unit's officers and enlisted men.

[7]See Ragnhild Sohlberg, *Defense Manpower Policy Analysis: NATO Ground Forces*, The RAND Corporation, P-6532, June 1980, pp. 79-81.

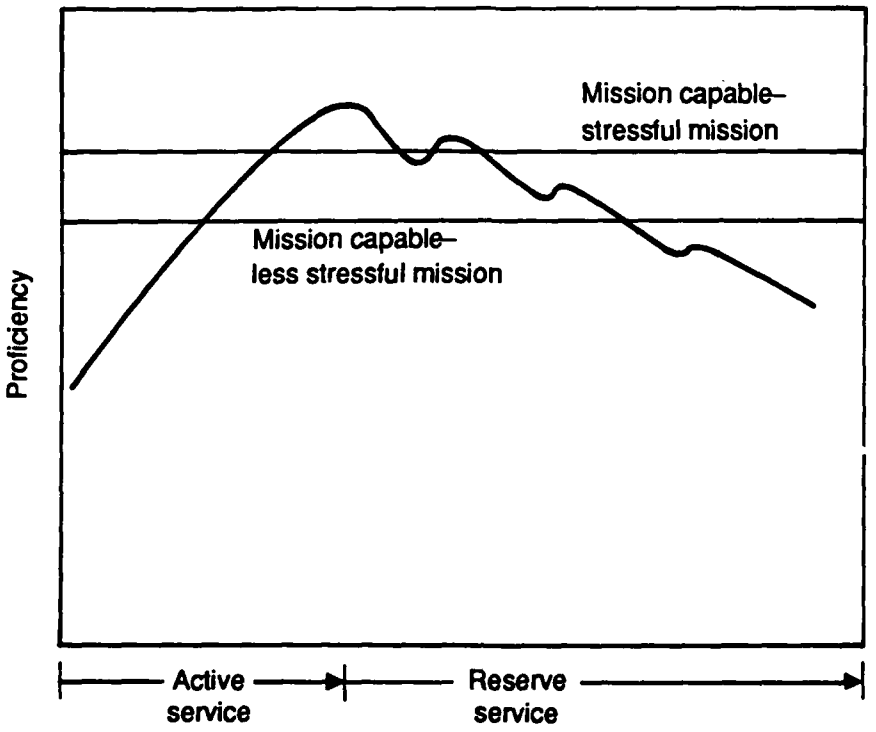

Fig. 3.1—Unit proficiency

Units are mission-capable (proficient in the tasks that must be performed to fulfill a mission) when they reach a certain skill level. This skill level is represented by horizontal line segments in Figure 3.1. Reserve units are generally withheld from combat until they have reached a threshold level of proficiency. In this study, we assume that reserve option units are withheld until they have reached an adequate level of proficiency.[8] While many factors affect how long it takes for a unit to reach this threshold, we estimate this time based upon the initial training received and mission difficulty.[9]

[8]This assumption partially obscures the fact that under certain conditions (for example, in a short mobilization scenario where NATO might need reserve units to prevent a catastrophic break in a thin defensive line) a military commander might be forced to commit inadequately trained units to battle.

[9]A more complete analysis would assess a range of per-unit time changes in reserve unit effectiveness (for different units performing different, and more or less stressful, missions) and a range of per-

Initial training refers to the basic service training program in each nation. The effectiveness of the basic training program is a function of both the quality of training (types of training, e.g., FTXs) and the amount of training. A longer training program allows for learning more skills (and a greater entrenchment of those skills) and more practice of learned skills. If we assume that instructors will seek to maximize the efficiency of their training programs, then a longer training program is more effective than a shorter training program.[10] Of the conscript-based armies in AFCENT, West Germany has the longest period (18 months) of compulsory service.[11] The Netherlands follows with a compulsory service period of 14 to 16 months (depending on whether service is performed in the Netherlands or in Germany), followed by Belgium with a service period of 10 to 12 months (depending on whether service is performed in Belgium or in Germany). We can rank the quality of the initial training received by servicemen in each of these countries as A, B, and C, respectively.

Mission difficulty refers to the number of tasks, difficulty of those tasks, and number of individuals (unit size) involved in carrying out the tasks associated with a particular mission. Different types of units perform different types of missions with varying levels of difficulty. In the European environment heavy units have the most demanding tasks; light units less demanding tasks; and artillery units even less demanding tasks. Heavy units must be able to operate (movement to, engagement with, and movement away from the enemy) in a coordinated fashion and they must be capable of both defensive and offensive operations. These units are generally organized at relatively large-sized (e.g., brigade) levels. Reserve option light units also

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unit commitment times. The point estimates used here (in Tables 3.2 and 3.3) represent *average* estimates based on professional military opinion.

[10]Training programs whose activities more closely resemble wartime operations (e.g., large-scale FTXs) are more effective than those that do not (e.g., individual skills training). Commanders often complain about inadequate funds and training space to conduct full-scale training activities. Such complaints are not confined to particular nations.

[11]German compulsory service will change from 15 months to 18 months beginning in 1989.

directly engage the enemy. Their tasks are perceived as less demanding than heavy units in that their operations are strictly defensive and they can be effectively organized at smaller (e.g., battalion and company) levels. Artillery units, having the least demanding tasks of the three reserve option units, are located behind engaged troops, operate fewer types of equipment, and can be organized at smaller levels. While they support both offensive and defensive operations, they do not directly engage the enemy. We can rank the level of difficulty of missions performed by these three types of units as 1, 2, and 3, respectively.

NATO military authorities expect cadre-type reserve units to be mission-proficient in 1 to 25 days.[12] Table 3.2 suggests wartime refresher training requirements (i.e., the time it would take for a particular unit to reach an acceptable proficiency level) based upon the level of mission difficulty, and the effectiveness of the initial training program.[13]

Table 3.2

RESERVE UNIT REFRESHER TRAINING REQUIREMENT
(in days)

	Initial Training Program		GE A	NE B	BE C
Mission Difficulty	Hvy	1	7	14	21
	Lt	2	4	8	12
	Arty	3	1	2	3

[12]These figures are *a posteriori* derived from estimates of when military authorities expect units to be available, taking into account the time it takes for them to mobilize and deploy. See "Reserve Unit Availability," below.

[13]The estimates in Table 3.2 are reasonable values within the 1-to-25-day range. They suggest that Dutch and Belgian units require, respectively, two and three times as long as German units to reach mission proficiency.

In developing Table 3.2 we ignore certain other factors which affect proficiency.[14] Other factors include:

- Peacetime refresher training[15]
- Length of time since active service
- Cadre size
- Membership over time
- Peacetime occupation
- Personnel qualities (e.g., morale, leadership, and intelligence)

These other factors are described below. For each a rationale is provided for why they are not explicitly addressed (with respect to their effect on proficiency) in this study.

Peacetime refresher training refers to the reserve training program in each nation. The effectiveness of the reserve training program is a function of the quality of training and the amount of training. The amount of training for a reservist includes not only the number of days spent in training but the frequency with which that training is received. If we assume that commanders maximize the effectiveness of their training programs, then the effectiveness of a particular training program is a function of the amount of refresher training received. NATO reservists generally follow the SHAPE training standard for cadre-type reserve units, which suggests that one-third of the unit be brought to wartime authorized strength (WAS) and receive two weeks of training

[14]The reader is encouraged to adjust the assessment of reserve unit effectiveness (and requirements) up or down where his views of the importance of these variables differs from the author's. It would be possible to incorporate an analysis of these other factors, in the framework of this study, through the use of sensitivity tests.

[15]Refresher training may be considered one of two distinct types, either peacetime or wartime. Wartime refresher training (the refresher training requirement in Table 3.2) emphasizes (by necessity) preparing the unit for actual combat as quickly as possible. Peacetime refresher training is more concerned with preparing the unit for effective mobilization.

annually (on average, then, each reservist receives 4-2/3 days of training each year).[16] Since European reservists generally follow this reserve training pattern,[17] we assume that this factor does not affect proficiency estimation across nations.

Time since active service refers to the overall length of time that has passed since members of a reserve combat unit performed their basic service obligation. The trend line for reserve unit proficiency is downward sloping. Some nations need five or six years of reserve unit cohorts to fill all of their mobilization assignments. Most reserve assignments are to support-type functions; most combat unit reserve assignments are filled with servicemen recently released from active service. We assume that combat units are filled with the most recently released reservists and, as such, their skills have not degraded significantly.

Cadre size refers to the number of servicemen who staff the unit in peacetime. Cadre size affects proficiency in that a larger (and better trained) active cadre should yield a more proficient mobilized unit. This observation can be extended to smaller reserve units being attached to larger active units. For example, in organizing a larger unit, reserve units could be associated with active units having greater experience, resulting in a mobilized unit with a higher proficiency level than that of the smaller reserve unit. Such paring could mitigate

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[16]Training standards are based upon the author's discussions with personnel in the Logistics and Manpower Division, SHAPE Headquarters, July 1986.

[17]Belgian reservists are obligated to perform 66 days of refresher training over a period of seven years (an annual average of 9.4 days). The actual amount of refresher training received is less. German reserve officers undergo about 12 days of refresher training every other year. They are joined by the unit's remaining servicemen for the latter half (6 days) of the period (an annual average of 6 and 3 days, respectively). Dutch reserve officers receive between one and four weeks of training every three years (an annual average of between 2.3 and 9.3 days). Dutch conscript reservists receive little peacetime refresher training. What additional training they do receive is limited mostly to familiarization with new equipment. See Robert R. Rumph, *Comparative Evaluation of Selected NATO and European Non-NATO Reserve Component Ground Force Structures*, National Defense University, Washington D.C., September 1984.

[18]For example, Belgium, which maintains a force that is only 33 percent conscript, would be more capable of such a practice than the Netherlands, which maintains a force that is 46 percent conscript.

some of the consequences of a shorter conscript period.[18] We assume that each reserve option unit has a well-trained cadre of active soldiers equal to 5 percent of the unit's wartime authorized strength.

Membership over time affects unit proficiency as the ties and bonds that develop among unit members affect unit cohesion. If unit membership is not maintained, then the personal bonds, which assist the unit operating as a team, are weakened. Most countries, especially conscript-based nations, recognize this phenomenon and try to hold cohort groups together (often at lower, e.g., company, levels of organization) in their transition from active to reserve status. We assume that membership is maintained over time.

Peacetime occupation and general *personnel qualities* can affect a unit's proficiency. For example, where civilian occupations are similar to wartime tasks, reserve unit proficiency will degrade more slowly and reservists will "train-up" more quickly. Personnel qualities, e.g., morale, motivation, intelligence, and leadership, all contribute to unit proficiency. Deficiencies in training can often be countered by these "intangibles." We assume that these factors affect unit proficiency similarly across nations.

RESERVE UNIT AVAILABILITY

SHAPE categorizes combat units according to when they would be available for combat. Availability levels are 1 through 5 and range from 48 hours to more than 30 days. Cadre-type reserve units are categorized as level 3 or 4 in terms of availability. Units with a level 3 rating are expected to be available in as little as 5 days; those with a level 4 rating are expected to be available in not more than 30 days.[19] We use these 5- and 30-day factors to bound estimates of reserve unit availability.

Availability refers to the time that elapses, after a mobilization decision, before a unit is ready and geographically located to join combat. The events that occur in making a reserve unit available are:

[19]Availability levels are based upon the author's discussions with personnel in the Logistics and Manpower Division, SHAPE Headquarters, July 1986.

- Mobilization
- Refresher training
- Deployment

These events do not necessarily occur in strict sequence. For example, a unit may deploy to a staging area prior to reaching a mission-capable status. The deployment may be ordered as a political signal or because training facilities are better in the staging area than they are in the mobilization area. Mobilization and deployment activities are described below. Refresher training, and its relationship to unit proficiency, were described in the previous section. At the end of this section, these three events are used to produce a reserve unit availability table.

Mobilization includes the following events:

- Notification
- Movement to processing centers
- Processing
- Breakout and servicing of unit equipment
- Issuing of equipment and munitions
- Formation of individuals and units into larger combat organizations

NATO countries have efficient mobilization systems. Some large-sized units are credited with a capability for quick mobilization. For example, Dutch authorities claim that RIM units, organizing up to the division level, will mobilize in two days. Smaller sized units, e.g., at the company and the battalion level, may be able to mobilize more quickly still. In this study, we assume that reserve units can mobilize in three days.

Deployment moves the unit from the place it mobilizes to a defensive position (or a staging area from which it can be ordered into a defensive position in a timely manner). NATO countries have relatively efficient deployment capabilities (redundant road and train

networks). The travel distances are relatively short: the widths of the Netherlands and Belgium are about 100 kilometers; the width of Germany from either the Dutch or Belgian border to the border with East Germany is between 200 and 300 kilometers. Assuming a unit can travel roughly 10 kilometers per hour for ten hours each day, and that staging areas are roughly 100 to 150 kilometers behind the inter-German border, then deployment would take not more than a day for units that mobilize in Germany, and not more than two days for those that mobilize in the Netherlands and Belgium.

Table 3.3 combines the mobilization and deployment assumptions above with Table 3.2 (Reserve Training Requirement) to estimate reserve unit availability.

Table 3.3

RESERVE UNIT AVAILABILITY
(In days)

	Initial Training Program		GE	NE	BE
			A	B	C
Mission Difficulty	Hvy	1	11	19	26
	Lt	2	8	13	17
	Arty	3	5	7	8

STUDY ALTERNATIVES

The discussion to this point suggests the option that will be examined in this study. The option involves building three types of reserve combat units: heavy, light and artillery. The units are built with support elements so that they will be capable of sustained (and effective) battlefield operations. In this section, two types of estimates have been produced to enable an evaluation of the theater-level contribution these units make to NATO's defense. The first is an estimate of unit strength based upon the unit's weapon systems. This estimate is reflected in the DE scores listed in Table 3.1. The second is an estimate of unit availability and is reflected in Table 3.3. The effectiveness of these alternatives is evaluated in the next section.

IV. RESERVE OPTION REQUIREMENTS

To derive reserve option requirements, we first begin by specifying an objective. In this study, we define the objective as a defeat of the WP's attack. Defeat can be defined, somewhat arbitrarily, as holding the WP penetration to some maximum amount within a certain time frame. To choose the specific objective, we look at the way NATO intends to fight. On mobilization, NATO's defense area will be organized into three parts: the covering force area (CFA), which lies adjacent to the inter-German border and has a width of roughly 20 kilometers; the main battle area (MBA), which lies next to the CFA and has a width of roughly 50 kilometers; and the rear area (RA), which lies next to the MBA.[1] NATO's principal defense positions lie in the MBA. NATO would lose many of its defense advantages should the WP break through this area in several places across the front. We therefore set an objective that holds a WP penetration, on average, to half the distance through the MBA (45 kilometers from the inter-German border).[2]

Having specified an objective, we use the simulation model to derive requirements. Figure 4.1 displays the results of adding DEs to NATO's force structure on D+1 in the 25/10 base case. Additional forces are added to NATO's operational reserve. The model then sends them to axes where NATO's strength is lowest relative to WP strength. Eleven DEs are required to hold WP penetration to an average of 45 kilometers over the course of a 30-day simulation.[3] Also, the figure displays

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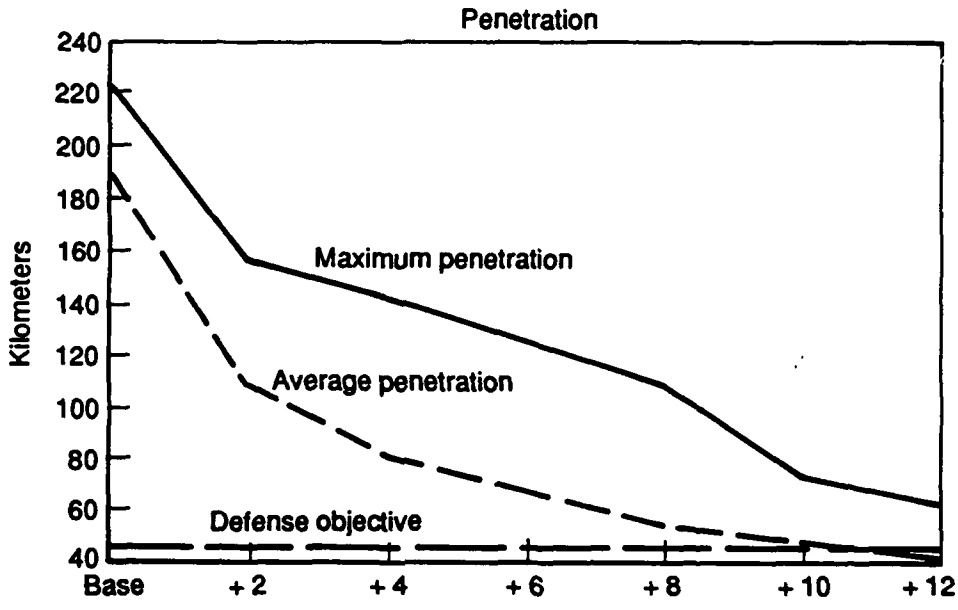
[1]See U.S. Army, *FM 100-5, Operations*, May 1986, pp. 129-151; and U.S. Army, *RB 101-999, Staff Officers' Handbook*, 1983, pp. 3-21 through 3-36.

[2]This objective is consistent with a "stalwart conventional defense capability," defined as "a balance in which NATO forces would prevent a substantial Warsaw Pact advance into West German territory under a range of assumptions and scenarios." See Thomson and Gantz, p. 4. In this study, robustness was captured through *a fortiori* analysis as explained in the next footnote.

[3]Obviously, the 11-DE result is sensitive to different factors including mobilization time and the schedule (time and space) of force arrivals. These sensitivities were addressed during the course of this study through the analysis of different scenarios. The results



	Base	+2	+4	+6	+8	+10	+12
Territory lost ($km^2 \times 1000$)	115,215	67,395	51,016	43,116	35,068	30,715	26,255
Day defense objective penetrated	12	17	19	22	25	29	--
Force ratio on day 30	2.32	1.82	1.65	1.49	1.33	1.23	1.16

Fig. 4.1—Add reserve DEs on D+1

roughly diminishing returns to force additions, i.e., while the first two DEs reduce average WP penetration by 80 kilometers, the second two reduce it by only 30 kilometers; and additional DEs reduce average WP penetration by lesser amounts.

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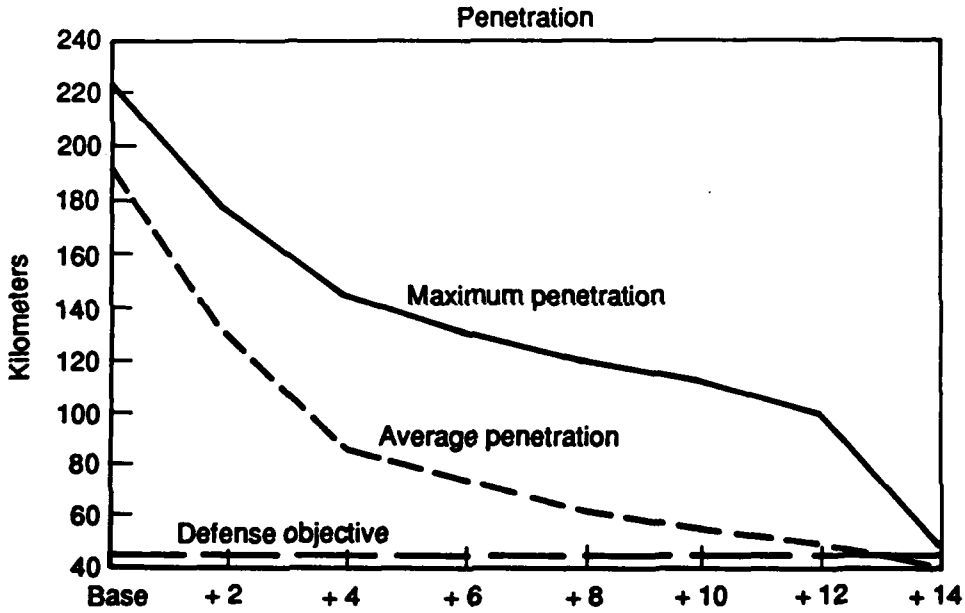
described in this section represent requirements for a NATO "worst case" scenario. See the description of the base case in "Dynamic Analysis" (in Section II, above).

Figure 4.2 displays the results of adding DEs to NATO's force structure on a somewhat staggered basis. In this case, additional forces are added on D+1, D+9, and D+16, with half added on D+1 and the remainder added, in equal portions, on D+9 and D+16. The results are similar to those in the previous figure, except that now two more DEs are required to reach the 45-kilometer objective.



	Base	+ 2	+ 4	+ 6	+ 8	+ 10	+ 12	+ 14
Territory lost ($km^2 \times 1000$)	115,215	79,067	53,452	47,015	39,351	36,168	31,567	24,978
Day defense objective penetrated	12	15	18	20	21	24	27	–
Force ratio on day 30	2.32	1.88	1.62	1.50	1.34	1.24	1.13	1.1

Fig. 4.2—Add reserve DEs on D+1, D+9, and D+16

Figures 4.1 and 4.2 depict the addition of reserve armored units according to the schedule of availability in Table 3.3. Specifically, Figure 4.1 displays the results of adding German armored units, which would be available 11 days after mobilization was ordered (D+1 in the 25/10 base case). Figure 4.2 displays the results of adding German, Dutch, and Belgian armored units 11, 19, and 26 days after mobilization was ordered in a 2:1:1 sharing arrangement. Comparing the two cases shows that more timely forces result in a more favorable outcome for NATO. In both cases, there are diminishing returns to force additions.

The addition of DEs depicted in Figures 4.1 and 4.2 track easily with additions of armored units. Armored units are mobile and robust fighting units. They can be ordered to axes where they are most needed and can engage the enemy in a variety of terrains and defensive postures. The addition of DEs can, to some extent, be reconciled with the addition of infantry and artillery units. Additional infantry could be ordered to areas where they would enjoy terrain conditions favorable to their employment. In doing so, armored units would be able to fall back into the operational reserve from where they could be ordered to positions where they would be most useful. Additional artillery could be used to strengthen units all across the front. Stronger units, in that they equalized local force ratios, would permit some to fall back into the operational reserve where they could be ordered to weak axes. According to the schedule of availability in Table 3.3, German, Dutch, and Belgian infantry units would be available, in the 25/10 case, on D-2, D+3, and D+7, respectively. Artillery units from each nation would all be available before the war started. Results of running these cases are similar to those depicted in Figure 4.1.[4]

Table 4.1 displays the unit totals necessary to fill DE requirements.

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[4]MASTER does not differentiate between types of units (it views units only in terms of their DE scores). Different cases, reflecting different types of units, were assessed through their different availabilities.

Table 4.1

UNIT REQUIREMENTS
(in Brigades)

Unit Type: DEs per Brigade:	Armor .33	Infantry .13	Artillery .11
DE Increment			
2	6	15	18
4	12	31	36
6	18	46	55
8	24	62	73
10	30	77	91
12	36	92	109
14	42	108	127

Pure strategies, for example the procurement of only one type of unit, do not provide robust solutions (i.e., consistent over a wide range of scenarios and assumptions) to NATO's conventional deficiencies. For example, if NATO had less mobilization time before the outbreak of war, then a reserve option strategy that focused on the procurement of armored units, would be less effective than one which partly procured more timely infantry or artillery units. Alternatively, a strategy that focused only on the procurement of artillery or infantry units would leave NATO with fewer forces capable of waging offensive defense. A mixed strategy, one that acquired all three types of units, would provide NATO with a robust defensive capability.[5]

[5]The analysis in this study uses a mixed strategy. That is, each DE is filled with a one-third DE of armor, a one-third DE of infantry, and a one-third DE of artillery.

V. RESERVE OPTION COSTS

European combat unit cost data are not readily available. European combat units, however, are configured similarly to American units, i.e., divisions are built around a three-brigade structure and have associated support elements. We use U.S. data to estimate costs of European reserve option units. Unit costs have manpower, equipment, and operating components. In this section, first we estimate manpower costs and then combine manpower costs with equipment and operating costs to derive cost estimates for whole reserve option units.

MANPOWER COSTS

The simplest measure of manpower costs is budget expenditure, i.e., wages paid to servicemen. If the labor market operates freely, then budget costs represent the economic value or the opportunity cost of that labor. A reserve option unit is structured so that 5 percent of its strength is filled by an active cadre of volunteers, i.e., servicemen who freely choose military service, at the prevailing military wage rate, over civilian occupations. The remaining 95 percent of a reserve option unit is filled with individuals (reservists) who are statutorily obligated to perform occasional active service. These reservists are obligated rather than induced to serve; consequently, it is possible that their wages (budget cost) may not reflect the true cost of their labor. In this study, we assume that reservists performing active-duty service are paid wages corresponding to the civilian wage rate and that this expenditure reflects the true economic cost of that labor.[1]

[1]The economic cost of military labor, narrowly defined, is the opportunity cost to the civilian economy. Opportunity cost to the civilian economy is measured by the monetary benefits the serviceman would receive if he, instead, entered the civilian economy. This is the cost definition used in this section. The economic cost of military labor, broadly defined, includes not only the loss to the civilian economy, but also the loss of the individual's freedom of choice if he is partly coerced, through statutory obligation (rather than wholly induced through wages and benefits) to service. This latter definition of economic cost, sometimes referred to as social cost, is measured by

We use wage rates for American servicemen to estimate the manpower costs for reserve option units.[2] This requires several steps. First, to approximate current European labor costs, we adjust American military labor costs based upon per capita income between the United States and Europe. Second, to estimate future labor costs, we account for the effect of demographic changes. Finally, we estimate total reserve option manpower costs based upon unit manpower requirements.

U.S. Manpower Costs as a Proxy for European Manpower

To estimate European military labor costs from American military labor costs, we build a conversion factor based upon a per capita income index and exchange rates. Table 5.1 calculates the relevant conversion factors. Also in Table 5.1 are average American labor costs for military officers and enlistees. Labor costs include basic pay, Social Security, subsistence, quarters, and special and incentive pay.[3] The last column in Table 5.1 estimates European military labor costs, based upon American wage levels and the conversion factors.

Demographics and Enlistment Elasticities

The availability of European manpower (in terms of the number of age 18 males) peaked in the early 1980s. Manpower availability has

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civilian wages plus a monetized valuation of the constraint on choice. See, for instance, Richard L. Cooper, *Military Manpower and the All-Volunteer Force*, The RAND Corporation, R-1450-ARPA, September 1977, especially pp. 66-74.

[2]There are two reasons for using American wage rates. First, the data are readily available. Second, and more important, is the fact that American servicemen, unlike most of their European counterparts, are paid a market wage. As discussed in the previous paragraph. The market wage reflects the real cost of military labor. The notional reserve option labor costs derived here are more reflective of the costs to society than are the actual wages paid to European conscripts.

[3]See John F. Schank et al., *Unit Cost Analysis: Annual Recurring Operating and Support Cost Methodology*, The RAND Corporation, R-3210-RA, March 1986, pp. 81-82. Schank estimates U.S. labor costs in 1983. The costs in Table 5.1 are in 1987 dollars. The conversion factor used is 1.128 (from U.S. Department of Defense Deflators, January 1987).

Table 5.1

CONVERSION FACTORS AND LABOR COST ESTIMATES

	GDP[a,b]	Population[a,c]	Per Capita GDP	Exchange Rate[a]	Per Capita $ GDP	Conversion Factor[d]	Enlisted Wages[e]	Officer Wages[e]
US	$4,194.5	241.60	$17,361	1.0000	$17,361	1.00	$25,040	$40,929
Germany	1,937 DM	61.05	31,728 DM	1.7267	$18,375	1.06	$26,543	$43,385
Netherlands	429.57 G	14.56	29,503 G	1.9330	$15,263	0.88	$22,036	$36,018
Belgium	5,148 BF	9.91	519,475 BF	36.0530	$14,409	0.83	$20,784	$33,971

[a]Figures are from *International Financial Statistics*, IMF, July 1988.
[b]1986 GDP in local currency × million ($ = U.S. dollars, DM = German marks, G = Dutch gilders, BF = Belgian francs).
[c]Population in millions.
[d]Per capita $ GDP/U.S. per capita $ GDP.
[e]Labor costs in 1983 (1987 dollars).

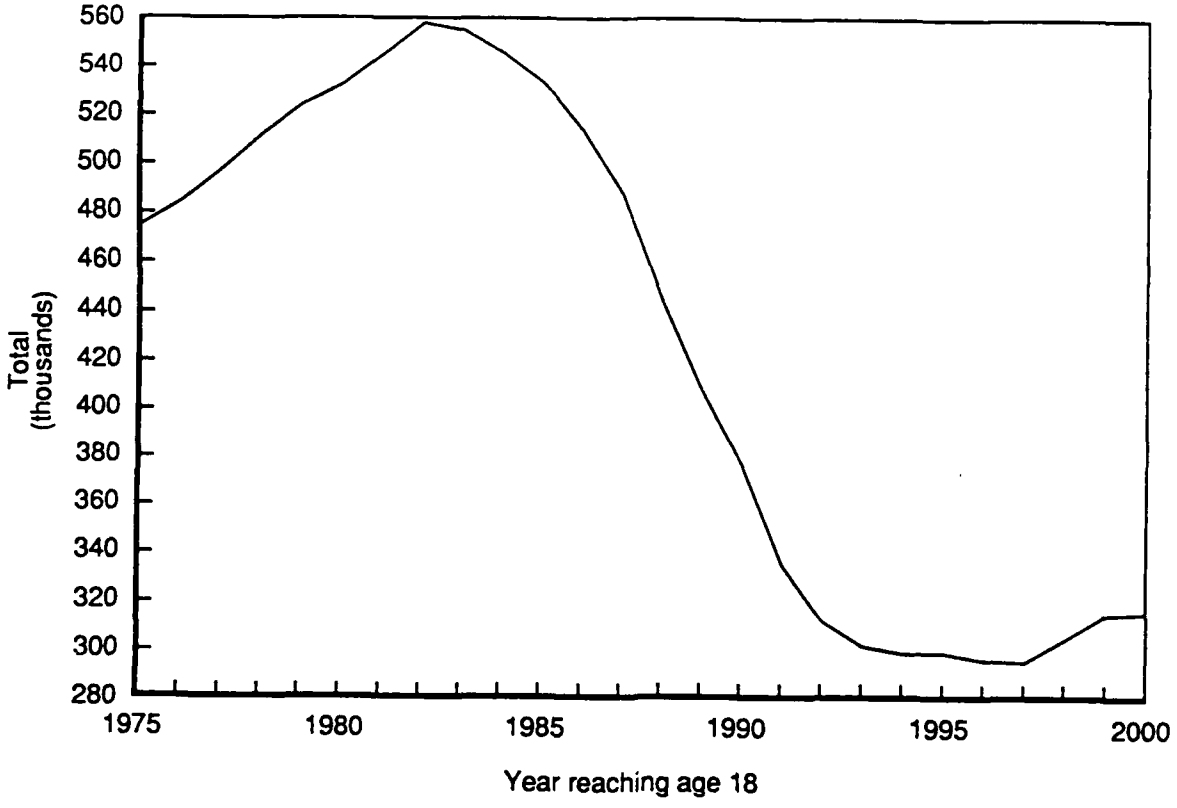

Fig. 5.1—German manpower availability age 18 males

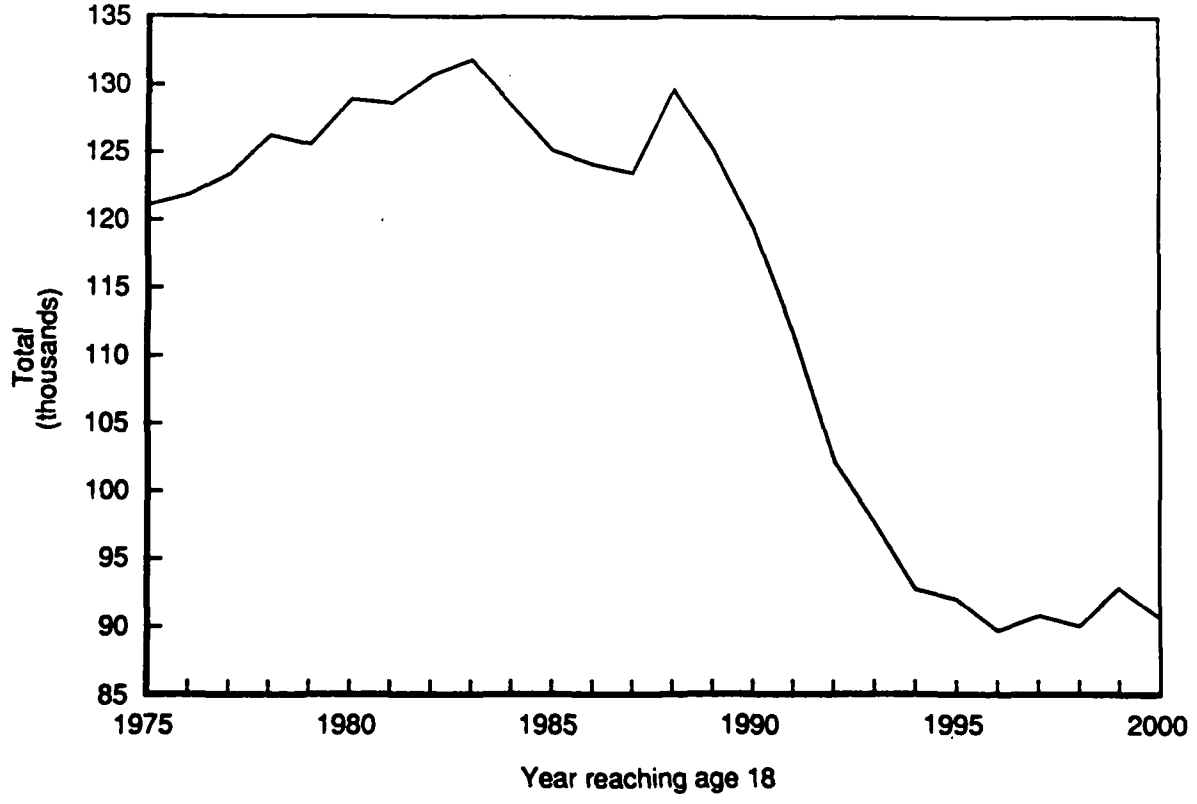

Fig. 5.2—Dutch manpower availability age 18 males

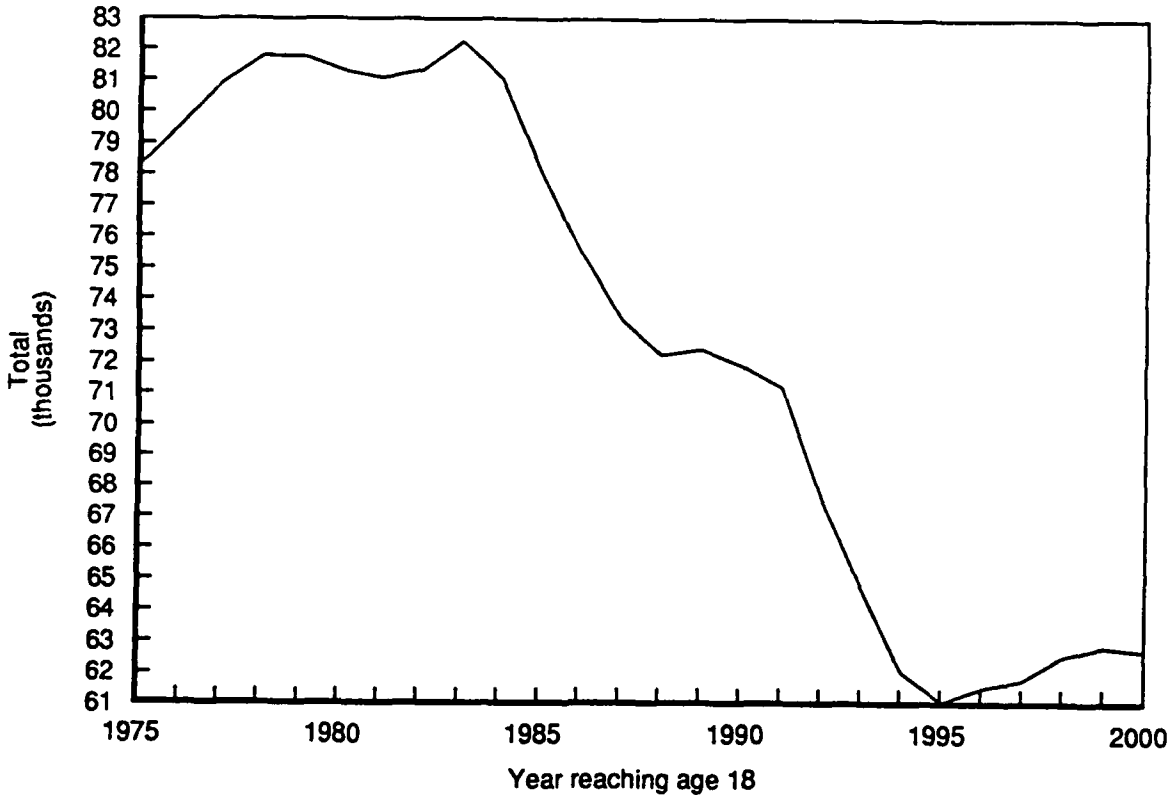

Fig. 5.3--Belgian manpower availability age 18 males

declined since this period and will continue to decline through the early 1990s. Figures 5.1, 5.2 and 5.3 depict these changes.[4] Percentage reductions, from 1983 to 2000, will be 43.1 percent, 31.2 percent and 23.8 percent, respectively, for Germany, the Netherlands, and Belgium. These demographic changes will increase the economic cost of military labor. That is, as the pool of available manpower shrinks, wages will have to rise to maintain similarly sized force structures.

[4]These graphs were generated based upon data in the *Demographic Yearbook*, published by the United Nations, and additional information provided to the author by the United Nations (Department of International Economic and Social Affairs, Statistical Office).

In making reserve option cost projections, we can estimate the effect of cohort size on wages. Future wages can be estimated based upon historical population and wage data. Specifically, mean wages can be related to cohort size through regression analysis. Wage elasticities, i.e., the percentage change in wages that results from a percentage change in cohort size, can be derived using this technique. In turn, these elasticities can be used to estimate future wage rates based upon projected demographic changes. A recent RAND Corporation study estimated wage elasticities with respect to cohort size.[5] The study found that, historically, a 1 percent change in cohort size caused wages to change by -0.323 percent.[6] Table 5.2 uses this wage elasticity, the labor cost estimates in Table 5.1, and demographic data to estimate future labor costs for European military labor. For the period 1983 to 2000, the projected cohort effect on German, Dutch, and Belgian wages is 13.92 percent, 10.08 percent, and 7.69 percent, respectively.

Unit Manpower Cost Estimates

Reserve option manpower costs are based upon the manpower requirements of a specific alternative. Table 5.3 lists manpower requirements for different types of units.[7] Requirements are separated into combat and support elements, and active (5 percent) and reserve (95 percent) components.

Table 5.4 estimates manpower costs for a German M-1 armored brigade for the years 1983 to 2000. Costs are listed by active and reserve and enlisted and officer components and reflect the cohort effect described above. Table 5.5 estimates manpower costs for different types of units from different countries in 1995.

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[5]Hong W. Tan and Michael P. Ward, *Forecasting the Wages of Young Men: The Effects of Cohort Size*, The RAND Corporation, R-3115-A, May 1985. See, especially, pp. 17-19.

[6]This wage elasticity is an average of the initial effects for annual earnings across the four school levels (Table 5, p. 18) in Tan and Ward.

[7]Enlisted personnel, in Table 5.3, include non-commissioned officers.

Table 5.2

PROJECTED MILITARY LABOR COSTS (COHORT EFFECT), 1983-2000
(Costs are in 1987 Dollars)

	German Enlisted	German Officer	Dutch Enlisted	Dutch Officer	Belgian Enlisted	Belgian Officer
1983	$26,543	$43,385	$22,036	$36,018	$20,784	$33,971
1984	$26,687	$43,620	$22,222	$36,323	$20,882	$34,132
1985	$26,883	$43,941	$22,395	$36,606	$21,129	$34,535
1986	$27,179	$44,426	$22,449	$36,693	$21,337	$34,876
1987	$27,592	$45,100	$22,482	$36,747	$21,513	$35,163
1988	$28,273	$46,213	$22,156	$36,215	$21,606	$35,315
1989	$28,826	$47,117	$22,390	$36,598	$21,590	$35,290
1990	$29,313	$47,912	$22,708	$37,117	$21,633	$35,360
1991	$29,944	$48,945	$23,127	$37,803	$21,689	$35,451
1992	$30,301	$49,528	$23,642	$38,643	$21,984	$35,934
1993	$30,456	$49,781	$23,883	$39,038	$22,215	$36,312
1994	$30,502	$49,857	$24,146	$39,468	$22,433	$36,668
1995	$30,496	$49,847	$24,185	$39,531	$22,514	$36,799
1996	$30,544	$49,925	$24,310	$39,735	$22,478	$36,741
1997	$30,555	$49,943	$24,250	$39,637	$22,458	$36,708
1998	$30,408	$49,703	$24,293	$39,707	$22,393	$36,602
1999	$30,253	$49,450	$24,141	$39,460	$22,369	$36,563
2000	$30,241	$49,430	$24,259	$39,652	$22,381	$36,582

UNIT COSTS

To estimate costs of U.S. Army units and to better understand U.S. Army organization, The RAND Corporation developed the Army Unit Cost Model (ACM).[8] Table 5.6 provides representative output from the model. The unit being costed is an armored brigade consisting of two M-1 armored battalions and one M-2 mechanized infantry battalion.

The ACM estimates a unit's non-recurring costs (NRC) and annual recurring costs (ARC) for the combat and support elements of the unit.[9] Non-recurring costs are the unit's initial investment or procurement costs; these have direct and indirect cost components. NRC direct cost include the following:

[8]See Appendix B for a description of the ACM.

[9]Support requirements are estimated based upon the size and composition of the basic combat unit.

Table 5.3

UNIT MANPOWER REQUIREMENTS

	M-1 Brigade	Infantry Brigade	Artillery Brigade
Combat personnel			
Officer	316	337	111
Enlisted	3959	4286	1710
Total	4275	4623	1821
Support personnel			
Officer	353	382	150
Enlisted	2107	2279	897
Total	2460	2661	1047
Total personnel			
Officer	669	719	261
Enlisted	6066	6565	2607
Total	6735	7284	2868
RESERVE OPTION MANPOWER REQUIREMENTS			
Active (5%)	337	364	143
Officer	33	36	13
Enlisted	304	328	130
Reserve (95%)	6398	6920	2725
Officer	636	683	248
Enlisted	5762	6237	2477

NOTE: Personnel totals were estimated using the Army Unit Cost Model described in Appendix B.

- Equipment -- includes all of the line items in the Table of Organization and Equipment (TO&E) of a combat unit.
- Spares and Repair Parts -- provide the initial base- and depot-level stocks of repair parts and equipment for the unit. These items, including test equipment and major repair parts (costing, on average, several thousand dollars and more), open the repair pipeline for the unit.
- OMA (Operations and Maintenance, Army) -- provide the initial stock of minor equipment items and consumables for the unit. Items included here are nuts, bolts, coveralls, and wrenches.

Table 5.4

ANNUAL LABOR COSTS (COHORT EFFECT)
GERMAN RESERVE OPTION M-1 BRIGADE
(1987, $ millions)

	Active Enlisted	Active Officer	Reserve Enlisted	Reserve Officer	Total
1983	8.05	1.45	2.94	0.53	12.97
1984	8.09	1.46	2.96	0.53	13.04
1985	8.15	1.47	2.98	0.54	13.14
1986	8.24	1.49	3.01	0.54	13.28
1987	8.37	1.51	3.06	0.55	13.49
1988	8.58	1.55	3.13	0.56	13.82
1989	8.74	1.58	3.19	0.58	14.09
1990	8.89	1.60	3.25	0.59	14.33
1991	9.08	1.64	3.32	0.60	14.64
1992	9.19	1.66	3.36	0.61	14.81
1993	9.24	1.67	3.38	0.61	14.89
1994	9.25	1.67	3.38	0.61	14.91
1995	9.25	1.67	3.38	0.61	14.91
1996	9.26	1.67	3.38	0.61	14.93
1997	9.27	1.67	3.39	0.61	14.93
1998	9.22	1.66	3.37	0.61	14.86
1999	9.18	1.65	3.35	0.60	14.79
2000	9.17	1.65	3.35	0.60	14.78

Table 5.5

LABOR COSTS FOR RESERVE OPTION UNITS IN 1995
(1987, $ millions)

	M-1 Brigade	Infantry Brigade	Artillery Brigade
Germany	14.91	16.91	6.32
Netherlands	11.82	12.78	5.01
Belgium	11.00	11.90	4.66

- MPA (Military Personnel Army) PCS (Permanent Change of Station) -- represents cost associated with the initial movement of men to station.

NRC indirect costs are those costs associated with the initial training of unit personnel.

Table 5.6

COST OF AN ACTIVE U.S. ARMORED BRIGADE [a]
(1987, $1,000s)

	Combat	Support	Total
NON-RECURRING	774,995	168,525	943,520
Total direct	712,784	132,510	845,294
Major equipment	556,764	47,902	604,666
Spares and repair parts	98,325	8,048	106,373
OMA (supplies etc.)	29,316	59,304	88,620
MPA (PCS travel) [b]	28,380	17,255	45,635
Total indirect	62,210	36,025	98,235
Ammo (MOS training) [b]	1,625	935	2,560
OMA (trng and trans) [b]	19,699	11,337	31,036
MPA (MOS training) [b]	40,877	23,753	64,630
ANNUAL RECURRING	207,167	105,723	312,890
Total direct	156,561	80,794	237,355
Equipment [c]	24,865	6,757	31,622
OMA (supplies etc.) [c]	16,937	2,564	19,501
MPA (pay and PCS travel) [d]	114,759	71,473	186,232
Total indirect	50,606	24,929	75,535
Ammo (MOS training) [c]	363	209	572
OMA (trng and trans) [c]	37,434	16,639	54,073
MPA (MOS training) [c]	12,809	8,081	20,890

[a] Costs do not include munitions.
[b] Deleted in reserve option estimates.
[c] Adjusted downward (12.5% of figure) in reserve option estimates.
[d] Pay (wages) calculated separately (from Section V), and PCS travel deleted in reserve option estimates.

Annual recurring costs are the annual costs of operating the unit. Like NRCs they have direct and indirect cost components. ARC direct costs include the replacement of equipment and the replenishment of spare parts; replenishment of consumables; and personnel pay and the costs associated with personnel rotation (PCS travel). ARC indirect costs include those costs associated with the annual training of unit personnel.

Support estimates the costs associated with providing the combat unit with combat service support. Support cost components are proportionately based upon the size and the composition of the combat unit. The combined costs, for both the support and combat components of an active M-1 brigade, total roughly $1 billion for the initial unit procurement (NRC), and $1/3 billion annually thereafter (ARC).[18]

Assumptions for Estimating the Budgetary Costs of European Reserve Units

We use ACM output to estimate the costs of European reserve option units. With respect to NRC we assume that the reserve unit will have the same TO&E as an active unit. We therefore keep all direct costs associated with the initial procurement of the unit, i.e., major equipment, spares and repair parts and OMA (supplies). We drop, however, direct costs associated with the initial movement of personnel to station because European reservists are not permanently stationed with the unit. We also drop all indirect (training) costs because reservists have already received their initial training (during their active-duty service).

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[18]The reader is cautioned against making direct cost comparisons with other studies. An active DE in this study represents three active brigades, not an actual division. Three active brigades, from Table 5.6, have an NRC equal to $3 billion and an ARC equal to $1 billion. An actual division would cost more because of its additional combat and support assets. A recent CBO study estimated the equipment procurement and the annual operating costs for a heavy division at $3.6 billion and $1.8 billion, respectively. See Congressional Budget Office, *U.S. Ground Forces and the Conventional Balance in Europe*, Washington D.C., June 1988, pp. xviii, 53, and 88.

With respect to ARC we make adjustments downward. ARC for operating, training and supporting an American reserve unit, are one-fourth that of an active unit.[11] An American reserve unit's active cadre is sized at 10 percent of the unit's mobilized strength and its reservists train an average of 38 days per year.[12] Reserve option units are sized with active cadres equal to 5 percent of their mobilized strengths and its reservists train roughly 6 days each year. (These figures are half and 12.5 percent, respectively, of those for American reserve units.) We assume that the ARC for operating, training and supporting a European reserve unit equal, with one exception, 12.5 percent of those of an American active unit (or 50 percent that of an American reserve unit). The exception is with respect to ARC for pay and PCS travel (direct MPA). Most of these costs, for an active unit, are for travel and relocation (PCS travel). Since travel and relocation costs for European reservists are minimal (relative to the costs associated with moving American troops in and out of Europe) we drop the ACM's active unit MPA and estimate wage costs separately. We use the labor cost calculations in Table 5.5 for our wage costs. Table 5.7 provides detailed NRC and ARC estimates for a German reserve option armored brigade (labor costs are for 1995).

Budgetary Cost Estimates for Reserve Option Alternatives

Table 5.8 presents summary NRC and ARC estimates for reserve option armor, infantry, and artillery units. ARC are for German units (the most costly) in 1995 (which includes most of the cohort effect).[13] The table combines these estimates with reserve option requirements (Table 4.1) to estimate costs for incremental reserve option alternatives.

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[11]See John F. Schank et al., *Unit Cost Analysis: Annual Recurring Operating and Support Methodology*, The RAND Corporation, R-3210-RA, March 1986 (especially pp. 28-32).

[12]An American Army National Guard serviceman trains one weekend a month plus 14 days.

[13]ARC estimates for Dutch armor, infantry, and artillery units, in 1995, are 28, 26, and 10 million dollars, respectively. ARC estimates for Belgian armor, infantry, and artillery units, in 1995, are 27, 25, and $9 million, respectively.

Table 5.7

COST ESTIMATES FOR GERMAN RESERVE OPTION M-1 BRIGADE
(1987, $1,000s)

	Combat	Support	Total
NON-RECURRING	684,405	115,254	799,659
Total direct	684,405	115,254	799,659
Major equipment	556,764	47,902	604,666
Spares and repair parts	98,325	8,048	106,373
OMA (supplies etc.)	29,316	59,304	88,620
Total indirect	0	0	0
ANNUAL RECURRING	20,869	9,869	30,738
Total direct	14,453	6,753	21,296
Equipment	3,108	845	3,953
OMA (supplies etc.)	2,117	321	2,438
MPA (wages only)	9,318	5,588	14,906
Total indirect	6,326	3,116	9,442
Ammo (MOS training)	45	26	72
OMA (trng and trans)	4,679	2,080	6,759
MPA (MOS training)	1,601	1,010	2,611

Table 5.8

COST ESTIMATES FOR EUROPEAN RESERVE OPTION ALTERNATIVES
(1987, $ millions)

DE Increment	Brigade Requirement	NRC per Brigade	ARC per Brigade	NRC	ARC
		ARMOR			
2	6	800	31	4,800	186
4	12	800	31	9,600	372
6	18	800	31	14,400	558
8	24	800	31	19,200	744
10	30	800	31	24,000	930
12	36	800	31	28,800	1,116
14	42	800	31	33,600	1,302
		INFANTRY			
2	15	348	29	5,220	435
4	31	348	29	10,788	899
6	46	348	29	16,008	1,334
8	62	348	29	21,576	1,789
10	77	348	29	26,796	2,233
12	92	348	29	32,016	2,668
14	108	348	29	37,584	3,132
		ARTILLERY			
2	18	126	11	2,268	198
4	36	126	11	4,536	396
6	55	126	11	6,930	605
8	73	126	11	9,198	803
10	91	126	11	11,466	1,001
12	109	126	11	13,734	1,199
14	127	126	11	16,002	1,397

VI. SOCIETAL/POLITICAL IMPACTS AND CONCLUSIONS

An additional 12 DEs of reserve option units could provide NATO with a robust conventional defense capability. These units would have societal and political impacts resulting from manpower and budgetary requirements. Table 6.1 describes the specific requirements of a 12-DE reserve option. The last column, an average of the first three, is used in the following discussion.

MANPOWER IMPACTS

The reserve option would be filled with manpower from European nations. Table 6.2 suggests measures of how the burden would affect individual nations. For example, if Germany, the Netherlands, and Belgium were to share the burden in a 2:1:1 arrangement, then the

Table 6.1

MANPOWER AND BUDGETARY REQUIREMENTS FOR 12 DES

	Armor	Infantry	Artillery	Mix of Units [a]
Servicemen				
Active	12,132	33,488	15,587	20,402
Reserve	230,328	636,640	297,025	387,998
Costs (in millions)				
Non-recurring	$28,800	$32,016	$13,734	$24,850
Annual recurring	$ 1,116	$ 2,668	$ 1,199	$ 1,661
15-year life cycle [b]	$45,540	$72,036	$31,719	$49,765

[a] Equal allocation to armor, infantry, and artillery.
[b] Life cycle costs represent the undiscounted costs of procuring and operating 12 DEs of a type (or mix) of unit for 15 years.

Table 6.2

MANPOWER IMPACTS OF 12 DES

	Germany	Netherlands	Belgium
Current			
Active force [a]	488,400	108,100	90,800
Reserve force [a]	770,000	174,400	145,000
Annual accessions [b]	170,000	45,000	45,000
Reserve period (in years)	4.53	3.88	3.22
Reserve option			
Active force	498,602	113,200	95,900
Reserve force	963,998	271,400	242,000
Reserve period (in years)	5.67	6.04	5.38
Change in			
Active force	10,202	5,100	5,100
(in % terms)	(2%)	(5%)	(6%)
Reserve force	193,998	97,000	97,000
Reserve period (in years)	1.14	2.16	2.16

[a] Source: IISS, *The Military Balance, 1987-88*.

[b] German estimates derived from Minister of Defense, *White Paper 1985: The Situation and the Development of the Federal Armed Forces*, The Federal Republic of Germany, 1985. Dutch and Belgian estimates based on discussions with military attaches in the Dutch and Belgian embassies in Washington D.C.

reserve option would increase the active manpower strengths of their respective armed forces by 2 percent, 5 percent, and 6 percent.[1] Such increases, in light of future manpower constraints, would represent significant political challenges.[2] A 2:1:1 arrangement would also increase the average length of time a serviceman would remain obliged to reserve service (and subject to annual call-ups). For Germany, the

[1]Alternative allocation rules were considered (e.g., rules that would allocate the additional burden based upon GNP or the pool of available manpower). The 2:1:1 allocation rule was selected as politically salable due to its simplicity.

[2]Current German plans will actually reduce, by 5 percent, the active strength of the Federal Republic's armed forces by the mid-1990s.

Netherlands, and Belgium the average reserve service obligation would increase on the order of one to two years. Such changes, however, would be well within statutory limits.

BUDGETARY IMPACTS

Table 6.3 provides GDP and defense budget data for nations contributing to the defense of Central Europe. If we assume that one-third of the U.S. defense budget is devoted to the defense of Central Europe, then NATO spends a total $194 billion for that defense.[3] The 12-DE reserve option would cost $50 billion over a 15-year period. This

Table 6.3

GDP AND DEFENSE BUDGET DATA

Country	1986 GDP ($ bn)	1986 Defense Budget ($ bn)	1986 Budget as a % of GDP	1987 Defense Budget ($ bn)
Belgium	115	2.87	2.50	3.29
Canada	374	7.18	1.92	7.77
Denmark	79	1.70	2.15	1.84
France	695	24.23	3.49	29.26
Germany	895	23.11	2.58	27.91
Netherlands	171	5.61	3.27	6.66
United Kingdom	556	27.58	4.96	30.50
United States	4169	280.50	6.73	282.90
Total	$7,054	$372.78		$390.13
Europe		$ 85.10		$ 99.46
One-third of U.S. Defense Budget				$ 94.30
Budget for Central Europe Defense				$193.76

SOURCE: IISS, *The Military Balance, 1987-88*.

[3]The assumption that one-third of the U.S. defense budget is devoted to the defense of Central Europe is notional but may be considered conservative. As a percentage of the defense budget, estimates of the U.S. commitment to European defense (which includes Central Europe) range between 52 percent and 61 percent. See Alice C. Maroni and John J. Ulrich, "The U.S. Commitment to Europe's Defense: A

figure translates into an average annual expenditure of $3.3 billion per year, or a 1.7 percent increase in NATO's budget for Central Europe defense.

CONCLUSIONS

This study has shown that a 12-DE reserve option could provide NATO with a robust conventional defense. The option would require an increase in the active strength of NATO's force structure of 20,000 men, an increase in reserve service periods of between one and two years, and an annual budgetary increase of $3.3 billion. These figures are modest when compared with current manpower contributions and budgetary expenditure.

Another way to assess the reserve option is to compare its capabilities against those that could be acquired with similar expenditure elsewhere. A recent CBO study assessed three alternatives costing between $40 and $50 billion.[4] The least expensive alternative, at a cost of $41.2 billion, would purchase one U.S.-based heavy division with a companion POMCUS set in Europe. The reserve option compares favorably in that it would procure much greater capabilities for a small additional cost. The second alternative, at a cost of $48.4 billion, would purchase equipment to enhance the close combat capability of U.S. forces. The CBO assessment suggests that this alternative would have about the same effect as the heavy division alternative. The third alternative, at a cost of $49.7 billion, would acquire weapons to implement a follow-on forces attack (FOFA) strategy. The CBO assessment suggests that this alternative would be the equivalent of adding five armored divisions to NATO. Assessed in this way, it would provide roughly half the capabilities of the reserve option. The CBO study observes, however, that that the FOFA alternative is based on

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Review of Cost Issues and Estimates," *The Congressional Research Service*, Report No. 85-211 F, Washington D.C., November 7, 1985.

[4]Congressional Budget Office, *U.S. Ground Forces and the Conventional Balance in Europe*, Washington D.C., June 1988. Costs in the CBO study costs are spread over 20 years. Costs in this study are spread over 15 years.

technologies that are in development, making a complete assessment impossible at this time. While comparisons across studies are implicitly troublesome, this cursory assessment suggests that the reserve option is probably more cost-effective and less risky than other alternatives currently being considered.

Beyond the scope of this study are suggestions which might make the reserve option more attractive. One such suggestion would be for European nations to reallocate resources from existing programs (for example from within their navies and air forces) to ground forces. The idea, recurrently pursued in NATO under such rubrics as force structure rationalization, specialization, or standardization, would have to overcome resistance from nations wishing to maintain a full range of military capabilities or to protect domestic industry.

Another suggestion that would make the reserve option more attractive would be to reduce the costs of the reserve option itself. Equipment costs make up about half of the costs for the reserve option. One possible way to reduce equipment costs would be to utilize existing stocks of equipment. Nations maintain war reserve stocks (WRS) to replace equipment destroyed in war. While it would probably be inadvisable to use large amounts of existing WRSs to create additional reserve fighting units, portions of the stocks might be usable without degrading the performance of existing units.[5] Another possible way to reduce equipment costs would be to purchase less expensive equipment. The equipment costs in this study are based on front-line U.S. unit inventories. Older equipment (perhaps already in military inventories but slated for replacement) might provide adequate capabilities at lower costs.

A final suggestion for making the reserve option more attractive would be to change the active/reserves manpower mix of NATO armed forces, i.e., thin active units to create additional reserve units. Thinning active units too much would pose readiness risks for NATO in very short warning scenarios. A reserve option that was based on a

[5]The methodology used in this study does not test this possibility (the simulations run only 30 days and attrited equipment is not replaced with WRS).

thinning of current forces might be manageable given its small active cadre requirements.

Each of the possibilities described above could reduce the overall burden of the reserve option. Each would have its own ramifications for NATO's conventional defense capability and would face varying amounts of political support and opposition. Further study could assess their feasibilities. The reserve option by itself, however, is a promising alternative for improving NATO's conventional capabilities.

Appendix A

DE SCORES FOR WP AND NATO UNITS

Static indicators are often used to describe the balance of forces in Central Europe. A division equivalent (DE) is one such indicator.[1] It describes combat units (usually divisions) in terms of their effectiveness, relative to a standard unit (usually a U.S. armored division). DEs can be used to generate "snapshots" of the balance of forces under different mobilization scenarios, or as inputs to a combat simulation.

A DE (which represents the combat strength of a unit) is a function of a unit's inventory of weapons, a weapons effectiveness index (WEI), and category weights (CATWTs). The WEI is an index of lethality scores for different types of weapons. CATWTs adjust WEI scores to account for the relative effectiveness of different categories of weapons and for whether a unit is performing an offensive or defensive mission. In general terms, these relationships are described in the following formulas:

$$WUV_x = \Sigma \left((Weapon_i) \times (WEI_{ij}) \times CATWT_{ijk}\right)$$

where i = type of weapon (e.g. TOW, Dragon, M60 or M1 Tank),
j = category into which a weapon of type i is placed (e.g. Anti-tank or Tank), and
k = mission type (offensive or defensive)

$$DE_x = WUV_x \div WUV_y$$

where x = unit
y = standard unit

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[1] An excellent discussion of the different methods used for assessing the balance of military forces can be found in the appendix to *Assessing the NATO/Warsaw Pact Military Balance*, by James Blaker and Andrew Hamilton, Congressional Budget Office, December 1977.

The remainder of this appendix reproduces in tabular format the DE calculations for the WP and NATO units in this study. The tables are organized in four sections:

	Tables
1. WEI factors for WP and NATO equipment[2]	A.1-A.2
2. Summary DE scores for WP and NATO units	A.3-A.4
3. DE calculations for WP units[3]	A.5-A.8
4. DE calculations for NATO units[4]	A.9-A.35

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[2]WEI factors are based on those appearing in William Mako, *U.S. Ground Forces and the Defense of Central Europe*, 1983, pp. 114-125. For those weapon systems that do not appear in Mako, the author estimated a WEI score by comparing weapon system characteristics. See Christopher F. Foss, editor, *Jane's Weapon Systems, 1986-87*, Jane's Publishing Company, London, 1986, and Ronald T. Pretty, editor, *Jane's Armor and Artillery, 1986-87*, Jane's Publishing Company, London, 1986.

[3]Equipment lists for Soviet units were taken from *FM 100-2-3, The Soviet Army, Troops, Organization and Equipment*, 1984, by the U.S. Army.

[4]Equipment lists for NATO units were taken from David C. Isby and Charles Kamps Jr., *Armies of NATO's Central Front*, 1985.

Table A.1

WEI FACTORS FOR WP EQUIPMENT

Weapon	WEI	Offensive Category Weight	Adjusted WEI
TANKS			
T-64/72/80	1.10	64	70.40
ANTI-TANK WEAPONS			
ATGM Launcher Vehicle (BRDM-2)*	0.89	27	24.03
APC with AT (AICV, BMP/BMP-1)*	0.89	27	24.03
ATGM Manpack*	0.50	27	13.50
AT Gun (100-125mm)*	0.52	27	14.04
ATGL, RPG-16	0.40	27	10.80
SP Assault Gun/85mm	0.30	27	8.10
Recoilless Gun/73mm*	0.21	27	5.67
ARMORED RECONNAISSANCE VEHICLES			
BMP, BRDM, BTR, M1976	0.75	36	27.00
ARMORED PERSONNEL CARRIERS			
BTR-50/60/70, M1974	1.00	13	13.00
ARTILLERY			
Rocket Launcher/122mm (BM-21)	0.54	72	38.88
SP Howitzer/152mm (2S3)	0.46	72	33.12
SP Howitzer/122mm (2S1)	0.44	72	31.68
Field Gun/130mm (M-46)	0.42	72	30.24
Howitzer/122mm (D-30)*	0.40	72	28.80
MORTARS			
Mortar/120mm (M1943)*	1.01	37	37.37

NOTE: * indicates WEI based on Mako; otherwise author's estimate.

Table A.2

WEI FACTORS FOR NATO EQUIPMENT

Weapon	WEI	Defensive Category Weight	Adjusted WEI
TANKS			
M1A1 Abrams (120mm)	1.25	55	68.75
Leopard 2 (120mm)	1.20	55	66.00
Challenger	1.20	55	66.00
M1 Abrams (105mm)	1.15	55	63.25
Chieftain	1.14	55	62.70
Leopard 1 (105mm)*	1.06	55	58.30
M60/A2/3	1.05	55	57.75
M60/A1*	1.00	55	55.00
AMX-30	0.93	55	51.15
ANTI-TANK WEAPONS			
M901 TOW Vehicle	1.10	46	50.60
JPzR/TOW*	1.10	46	50.60
M2/M3 Bradley	1.00	46	46.00
M113 TOW Vehicle	1.00	46	46.00
FV-438/Swingfire	0.90	46	41.40
TOW	0.70	46	32.20
VAB/Hot	0.70	46	32.20
Milan*	0.65	46	29.90
Dragon	0.64	46	29.44
JPzR/90mm*	0.53	46	24.38
Carl Gustav/84mm	0.50	46	23.00
LRAC/89mm	0.45	46	20.70
ARMORED RECONNAISSANCE VEHICLES			
Scimitar, Scorpion/76mm	0.95	36	34.20
Scimitar, Scorpion, Fox/30mm	0.88	36	31.68
EBR, AML/90mm	0.70	36	25.20
Luchs/20mm	0.70	36	25.20
ARMORED PERSONNEL CARRIERS			
Marder/20mm*	1.25	6	7.50
YPR-765/25mm	1.25	6	7.50
AMX-10P/20mm	1.23	6	7.38
M113/.50 cal.	1.00	6	6.00
VAB	0.85	6	5.10
FV-432, MCV-80, FV-106, Spartan, Saracen, Ferret, Lynx	0.78	6	4.68

Table A.2 (continued)

Weapon	WEI	Defensive Category Weight	Adjusted WEI
ARTILLERY			
SP Howitzer/203mm AdvMun*	1.15	85	97.75
SP Howitzer/155mm AdvMun*	1.00	85	85.00
MLRS/227mm	0.80	85	68.00
SP Howitzer/203mm (8")	0.70	85	59.50
SP Howitzer/155mm*	0.62	85	52.70
Howitzer/155mm	0.55	85	46.75
LARS/110mm*	0.47	85	39.95
SP Howitzer/105mm	0.40	85	34.00
Howitzer/105mm	0.35	85	29.75
MORTARS			
SP Mortar/120mm*	1.13	47	53.11
SP Mortar/107mm	1.00	47	47.00
Mortar/120mm	0.90	47	42.30
Mortar/81mm	0.70	47	32.90
Mortar/60mm	0.60	47	28.20
Mortar/51mm	0.50	47	23.50

NOTE: * indicates WEI based on Mako; otherwise author's estimate.

Table A.3

DE SCORES FOR WP UNITS

	Category		
	1	2	3
GSFG, NGF, CGF			
Soviet Armor	0.86		
Soviet Mechanized	0.69		
Soviet Airborne and Infantry	0.12		
Soviet Artillery	0.23		
IN THE SOVIET UNION			
Soviet Armor	0.82	0.78	0.73
Soviet Mechanized	0.65	0.62	0.58
Soviet Airborne and Infantry	0.12	0.11	0.11
Soviet Artillery	0.22	0.21	0.20
IN EAST GERMANY			
East German Armor	0.82		
East German Mechanized	0.65		
IN POLAND AND CZECHOSLOVAKIA			
Polish and Czech Armor	0.78	0.73	0.69
Polish and Czech Mechanized	0.62	0.58	0.55
Polish and Czech Air. and Infantry	0.11	0.11	0.10
Polish and Czech Artillery	0.21	0.20	0.19

Assumptions:

1. GSFG, NGF and CGF divisions 100% strength.
2. Soviet divisions in the Soviet Union:
   - o Category 1: 95% of GSFG divisions' strength
   - o Category 2: 90% of GSFG divisions' strength
   - o Category 3: 85% of GSFG divisions' strength
3. East German divisions: 95% of GSFG divisions strength.
4. Polish and Czech divisions:
   - o Category 1: 90% of GSFG divisions' strength
   - o Category 2: 85% of GSFG divisions' strength
   - o Category 3: 80% of GSFG divisions' strength

Table A.4

DE SCORES FOR NATO UNITS

	WUV	DE
UNIT		
U.S. Armored Division	58,129	1.00
U.S. Mechanized Division	58,346	1.00
U.S. Light Infantry Division	7,967	0.14
U.S. Armored Cavalry Regiment	17,179	0.30
West German Armored Division	35,142	0.60
West German Mechanized Division	33,157	0.57
West German Mountain Division	25,318	0.44
West German Airborne Brigade	8,053	0.14
West German 50-Series Home Defense Brigade	7,265	0.12
West German 60-Series Home Defense Brigade	4,906	0.08
British Armored Division	36,294	0.62
British Infantry Division	25,357	0.44
Belgian Armored Brigade	7,531	0.13
Belgian Mechanized Brigade	5,024	0.09
Belgian Paracommando Regiment	1,307	0.02
Dutch Armored Brigade	10,491	0.18
Dutch Mechanized Brigade	9,058	0.16
Canadian Brigade Group	11,380	0.20
French Armored Division	18,535	0.32
French Infantry Division	11,697	0.20
French Alpine Division	5,689	0.10
French Airborne Division	22,224	0.38
French Marine Division	9,968	0.17
French Light Armor (12th and 14th) Division	11,807	0.20
French Light Armor (6th) Division	10,850	0.19
French Airmobile Division	4,521	0.08
NOTIONAL UNIT		
U.S. Armored Brigade [a]		0.33
U.S. Mechanized Brigade [a]		0.33
U.S. Cavalry Division [b]		0.89
U.S. Seperate Infantry Brigade [c]		0.13
British Armored Brigade [a]		0.21
British Airborne Brigade [d]		0.15
Dutch 101 Infantry Brigade [e]		0.08

Table A.4 (continued)

	WUV	DE
CORPS ARTILLERY		
U.S. V Corps	8,568	0.15
U.S. VII Corps	17,553	0.30
German I Corps	2,856	0.05
German II Corps	2,856	0.05
German III Corps	2,856	0.05
British I Corps	2,142	0.04
Belgian I Corps	2,846	0.05
Dutch I Corps	11,506	0.20

Assumptions:
[a] One-third strength of associated division.
[b] Three times ACR.
[c] Configured with 180 Anti-Tank (108 TOW, 72 Dragon), 18 Artillery (18 105mm Howitzer), and 42 Mortar (15 81mm, 27 60mm).
[d] One-third strength of British infantry division.
[e] One-sixth strength of Dutch mechanized division.

Table A.5

SOVIET ARMORED (TANK) DIVISION

Quantity	Weapon	WEI	Offensive Category Weight	Value
11470	PERSONNEL			
	TANKS			
328	T-64/72/80	1.10	64	23,091
	ANTI-TANK WEAPONS			
9	ATGM Launcher Vehicle	0.89	27	216
240	APC with AT	0.89	27	5,767
469	ATGL,RPG-16	0.40	27	5,065
	ARMORED RECONNAISSANCE VEHICLES			
346	BMP, BRDM, BTR, M1976	0.75	36	9,342
	ARMORED PERSONNEL CARRIERS			
63	BTR-50/60/70, M1974	1.00	13	819
	ARTILLERY			
18	Rocket Launcher/122mm	0.54	72	700
18	SP Howitzer/152mm	0.46	72	596
72	SP Howitzer/122mm	0.44	72	2,281
36	Howitzer/122mm	0.40	72	1,037
	MORTARS			
36	Mortar/120mm	1.01	37	1,345
	Weighted Unit Value			50,260

SOURCE: FM 100-2-3, esp. pp. 4-107 and 4-108.

NOTES: Equipment summary does not include unit helicopter and air defense assets. Helicopters: 6 Mi-2/Hoplite, 6 Mi-8/Hip, and 6 Mi-24/Hind. Air defense: SA-6/Gainful SAM, 16 SA-9/Gaskin SAM, and 93 SA-7/Grail SA.

Table A.6

SOVIET MECHANIZED (MOTORIZED RIFLE) DIVISION

Quantity	Weapon	WEI	Offensive Category Weight	Value
12695	PERSONNEL			
	TANKS			
220	T-64/72/80	1.10	64	15,488
	ANTI-TANK WEAPONS			
36	ATGM Launcher Vehicle	0.89	27	865
132	APC with AT	0.89	27	3,172
24	ATGM Manpack	0.50	27	324
12	AT Gun (100-125mm)	0.52	27	168
598	ATGL, RPG-16	0.40	27	6,458
12	Recoilless Gun/73mm	0.21	27	68
	ARMORED RECONNAISSANCE VEHICLES			
122	BMP, BRDM, BTR, M1976	0.75	36	3,294
	ARMORED PERSONNEL CARRIERS			
271	BTR-50/60/70, M1974	1.00	13	3,523
	ARTILLERY			
18	Rocket Launcher/122mm	0.54	72	700
18	SP Howitzer/152mm	0.46	72	596
36	SP Howitzer/122mm	0.44	72	1,140
72	Howitzer/122mm	0.40	72	2,074
	MORTARS			
54	Mortar/120mm	1.01	37	2,018
	Weighted Unit Value			**39,889**

SOURCE: FM 100-2-3, esp. pp. 4-34 and 4-35.

NOTES: Equipment summary does not include unit helicopter and air defense assets. Helicopters: 6 Mi-2/Hoplite, 6 Mi-8/Hip, and 6 Mi-24/Hind. Air defense: 20 SA-6/Gainful SAM, 16 SA-9/Gaskin SAM, and 120 SA-7/Grail S.

Table A.7

SOVIET AIRBORNE DIVISION

Quantity	Weapon	WEI	Offensive Category Weight	Value
6500	PERSONNEL			
	ANTI-TANK WEAPONS			
27	ATGM Launcher Vehicle	0.89	27	649
421	ATGL, RPG-16	0.40	27	4,547
31	SP Assault Gun/85mm	0.30	27	251
	ARTILLERY			
6	Rocket Launcher/122mm	0.54	72	233
30	Howitzer/122mm	0.40	72	864
	MORTARS			
18	Mortar/120mm	1.01	37	673
	Weighted Unit Value			7,217

SOURCE: FM 100-2-3, esp. p. 4-140.

NOTES: Equipment summary does not include unit helicopter and air defense assets. Air defense: 183 SA-7/Grail SAM.

Table A.8

SOVIET ARTILLERY DIVISION

Quantity	Weapon	WEI	Offensive Category Weight	Value
	ANTI-TANK WEAPONS			
36	ATGM Launcher Vehicle (BRDM-2)	0.89	27	865
48	AT Gun (100-125mm)	0.52	27	674
	ARTILLERY			
72	Rocket Launcher/122mm (BM-21)	0.54	72	2,799
126	SP Howitzer/152mm (2S3)	0.46	72	4,173
168	Field Gun/130mm (M-46)	0.42	72	5,080
	Weighted Unit Value			13,592

SOURCE: FM 100-2-3, esp. p. 4-126.

Table A.9

U.S. ARMORED DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
16295	PERSONNEL			
	TANKS			
348	M1A1 Abrams (120mm)	1.25	55	23,925
	ANTI-TANK WEAPONS			
48	M901 TOW Vehicle	1.10	46	2,429
327	M2/M3 Bradley	1.00	46	15,042
168	Dragon	0.64	46	4,946
	ARMORED PERSONNEL CARRIERS			
130	M113/.50 cal.	1.00	6	780
	ARTILLERY			
12	SP Howitzer/203mm AdvMun	1.15	85	1,173
72	SP Howitzer/155mm AdvMun	1.00	85	6,120
9	MLRS/227mm	0.80	85	612
	MORTARS			
66	SP Mortar/107mm	1.00	47	3,102
	Weighted Unit Value			58,129

SOURCES: Isby and Kamps, especially p. 365. Mako, especially pp. 114-115.

NOTES: Equipment summary does not include unit helicopter and air defense assets. Helicopters: 50 AH-64, 64 OH-58, 27 UH-60, and 12 EH-60. Air defense: 60 Stinger SAM. WEI scores for U.S. self-propelled howitzers are higher than those for howitzers from other nations due to use of advanced munitions (see Mako, p. 114).

Table A.10

U.S. MECHANIZED DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
16597	PERSONNEL			
	TANKS			
290	M1A1 Abrams (120mm)	1.25	55	19,938
	ANTI-TANK WEAPONS			
60	M901 TOW Vehicle	1.10	46	3,036
381	M2/M3 Bradley	1.00	46	17,526
204	Dragon	0.64	46	6,006
	ARMORED PERSONNEL CARRIERS			
139	M113/.50 cal.	1.00	6	834
	ARTILLERY			
12	SP Howitzer/203mm AdvMun	1.15	85	1,173
72	SP Howitzer/155mm AdvMun	1.00	85	6,120
9	MLRS/227mm	0.80	85	612
	MORTARS			
66	SP Mortar/107mm	1.00	47	3,102
	Weighted Unit Value			58,346

SOURCES: Isby and Kamps, especially p. 365. Mako, especially pp. 114-115.

NOTES: Equipment summary does not include unit helicopter and air defense assets. Helicopters: 50 AH-64, 64 OH-58, 27 UH-60, and 12 EH-60. Air defense: 60 Stinger SAM. WEI scores for U.S. self-propelled howitzers are higher than those for howitzers from other nations due to use of advanced munitions (see Mako, p. 114).

Table A.11

U.S. LIGHT INFANTRY DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
10768	PERSONNEL			
	ANTI-TANK WEAPONS			
36	TOW	0.70	46	1,159
72	Dragon	0.64	46	2,120
	ARTILLERY			
8	Howitzer/155mm	0.55	85	374
54	Howitzer/105mm	0.35	85	1,607
	MORTARS			
36	Mortar/81mm	0.70	47	1,184
54	Mortar/60mm	0.60	47	1,523
	Weighted Unit Value			7,967

SOURCES: Isby and Kamps, especially p. 371. Mako, especially pp. 114-115.

NOTES: Equipment summary does not include unit helicopter and air defense assets. Helicopters: 29 AH-1, 31 OH-58, and 36 UH-60. Air defense: 18 Vulcan, and 3 Stinger SAM. The LID also has 306 HMMWV.

Table A.12

U.S. ARMORED CAVALRY REGIMENT

Quantity	Weapon	WEI	Defensive Category Weight	Value
5000	PERSONNEL			
	TANKS			
129	M1A1 Abrams (120mm)	1.25	55	8,869
	ANTI-TANK WEAPONS			
111	M2/M3 Bradley	1.00	46	5,106
	ARMORED PERSONNEL CARRIERS			
53	M113/.50 cal.	1.00	6	318
	ARTILLERY			
24	SP Howitzer/155mm AdvMun	1.00	85	2,040
	MORTARS			
18	SP Mortar/107mm	1.00	47	846
	Weighted Unit Value			17,179

SOURCES: Isby and Kamps, especially p. 363. Mako, especially pp. 114-115.

NOTES: Equipment summary does not include unit helicopter and air defense assets. Helicopters: 26 AH-64, 32 OH-58, and 25 UH-60. Air defense: 28 Stinger SAM. WEI scores for U.S. self-propelled howitzers are higher than those for howitzers from other nations due to use of advanced munitions (see Mako, p. 114).

Table A.13

WEST GERMAN ARMORED DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
20000	PERSONNEL			
	TANKS			
305	Leopard 2 (120mm)	1.20	55	20,130
	ANTI-TANK WEAPONS			
36	JPzR/TOW	1.10	46	1,822
180	Milan	0.65	46	5,382
	ARMORED RECONNAISSANCE VEHICLES			
31	Luchs/20mm	0.70	36	781
	ARMORED PERSONNEL CARRIERS			
180	Marder/20mm	1.25	6	1,350
	ARTILLERY			
0	SP Howitzer/203mm	0.70	85	357
54	SP Howitzer/155mm	0.62	85	2,846
12	Howitzer/155mm	0.55	85	561
16	LARS/110mm	0.47	85	639
	MORTARS			
24	SP Mortar/120mm	1.13	47	1,275
	Weighted Unit Value			35,142

SOURCES: Isby and Kamps, especially pp. 188 and 192. Mako, especially pp. 117-118.

NOTES: Equipment summary does not include unit helicopter and air defense assets. Helicopters: 9 Allouette. Air defense: 36 Gepard 35mm, and 46 Rh202 20mm. West German Armored (Panzer) divisions have two armored brigades and one mechanized brigade.

Table A.14

WEST GERMAN MECHANIZED DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
20000	PERSONNEL			
	TANKS			
249	Leopard 2 (120mm)	1.20	55	16,434
	ANTI-TANK WEAPONS			
36	JPzR/TOW	1.10	46	1,822
216	Milan	0.65	46	6,458
	ARMORED RECONNAISSANCE VEHICLES			
31	Luchs/20mm	0.70	36	781
	ARMORED PERSONNEL CARRIERS			
222	Marder/20mm	1.25	6	1,665
	ARTILLERY			
6	SP Howitzer/203mm	0.70	85	357
54	SP Howitzer/155mm	0.62	85	2,846
12	Howitzer/155mm	0.55	85	561
16	LARS/110mm	0.47	85	639
	MORTARS			
30	SP Mortar/120mm	1.13	47	1,593
	Weighted Unit Value			33,157

SOURCES: Isby and Kamps, especially pp. 188 and 192. Mako, especially pp. 117-118.

NOTES: Equipment summary does not include unit helicopter and air defense assets. Helicopters: 9 Allouette. Air defense: 36 Gepard 25mm, and 46 Rh202 20mm. West German Mechanized (Panzergrenadier) divisions have two armored brigades and one mechanized brigade.

Table A.15

WEST GERMAN MOUNTAIN DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
	PERSONNEL = 18,000 - 21,000			
	TANKS			
195	Leopard 2 (120mm)	1.20	55	12,870
	ANTI-TANK WEAPONS			
156	Milan	0.65	46	4,664
17	JPzR/90mm	0.53	46	414
	ARMORED RECONNAISSANCE VEHICLES			
31	Luchs/20mm	0.70	36	781
	ARMORED PERSONNEL CARRIERS			
134	Marder/20mm	1.25	6	1,005
	ARTILLERY			
6	SP Howitzer/203mm	0.70	85	357
36	SP Howitzer/155mm	0.62	85	1,897
12	Howitzer/155mm	0.55	85	561
16	LARS/110mm	0.47	85	639
18	Howitzer/105mm	0.35	85	536
	MORTARS			
30	SP Mortar/120mm	1.13	47	1,593
	Weighted Unit Value			25,318

SOURCES: Isby and Kamps, especially pp. 187-188, 192 and 197. Mako, especially pp. 117-118.

NOTES: Equipment summary does not include unit helicopter and air defense assets. Helicopters: 9 Allouette. Air defense: 36 Gepard 35mm, and 46 Rh202 20mm. The West German Mountain division has one armored brigade, one mechanized brigade and one mountain brigade.

Table A.16

WEST GERMAN AIRBORNE BRIGADE
(Division = 3 Brigades)

Quantity	Weapon	WEI	Defensive Category Weight	Value
3500	PERSONNEL			
	ANTI-TANK WEAPONS			
96	TOW	0.70	46	3,091
132	Milan	0.65	46	3,947
	MORTARS			
24	Mortar/120mm	0.90	47	1,015
	Weighted Unit Value			8,053

SOURCES: Isby and Kamps, especially pp. 185-186. Mako, especially pp. 117-118.

NOTES: Equipment summary does not include unit air defense assets: 18 Rh202 20mm. While West Germany's airborne brigades are organized into a division, they would operate as separate brigades in war (see Isby and Kamps, p. 197).

Table A.17

WEST GERMAN 50-SERIES HOME DEFENSE BRIGADE

Quantity	Weapon	WEI	Defensive Category Weight	Value
4000	PERSONNEL			
	TANKS			
82	Leopard 1 (105mm)	1.06	55	4,781
	ANTI-TANK WEAPONS			
24	Milan	0.65	46	718
14	JPzR/90mm	0.53	46	341
	ARMORED PERSONNEL CARRIERS			
60	VAB	0.85	6	306
	ARTILLERY			
18	SP Howitzer/105mm	0.40	85	612
	MORTARS			
12	Mortar/120mm	0.90	47	508
	Weighted Unit Value			7,265

SOURCES: Isby and Kamps, especially pp. 197-198 and 230. Mako, especially pp. 117-118.

Table A.18

WEST GERMAN 60-SERIES HOME DEFENSE BRIGADE

Quantity	Weapon	WEI	Defensive Category Weight	Value
4000	PERSONNEL			
	TANKS			
41	M60/A2/3	1.05	55	2,368
	ANTI-TANK WEAPONS			
24	Milan	0.65	46	718
14	JPzR/90mm	0.53	46	341
	ARMORED PERSONNEL CARRIERS			
60	M113/.50 cal.	1.00	6	360
	ARTILLERY			
18	SP Howitzer/105mm	0.40	85	612
	MORTARS			
12	Mortar/120mm	0.90	47	508
	Weighted Unit Value			4,906

SOURCES: Isby and Kamps, especially pp. 197-198 and 230. Mako, especially pp. 117-118.

Table A.19

BRITISH ARMORED DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
16300	PERSONNEL			
	TANKS			
285	Challenger	1.20	55	18,810
	ANTI-TANK WEAPONS			
45	FV-438/Swingfire	0.90	46	1,863
120	Milan	0.65	46	3,588
135	Carl Gustav/84mm	0.50	46	3,105
	ARMORED RECONNAISSANCE VEHICLES			
40	Scimitar, Scorpion/76mm	0.95	36	1,368
25	Scimitar, Scorpion, Fox/30mm	0.88	36	792
	ARMORED PERSONNEL CARRIERS			
450	FV-432, MCV-80, FV-106, Spartan, Saracen, Ferret, Lynx	0.78	6	2,106
	ARTILLERY			
48	SP Howitzer/155mm	0.62	85	2,530
24	SP Howitzer/105mm	0.40	85	816
	MORTARS			
40	Mortar/81mm	0.70	47	1,316
	Weighted Unit Value			**36,294**

SOURCES: Isby and Kamps, especially pp. 243-251. Mako, especially p. 119. IISS, p. 8 (for personnel strength).

NOTES: Equipment summary does not include unit helicopter and air defense assets. Helicopters: 18 Lynx, and 18 Gazelle. Air defense: 36 Javelin.

Table A.20

BRITISH INFANTRY DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
16300	PERSONNEL			
	ANTI-TANK WEAPONS			
126	Milan	0.65	46	3,767
324	Carl Gustav/84mm	0.50	46	7,452
	ARMORED RECONNAISSANCE VEHICLES			
184	Scimitar, Scorpion, Fox/30mm	0.88	36	5,829
	ARMORED PERSONNEL CARRIERS			
108	FV-432, MCV-80, FV-106, Spartan, Saracen, Ferret, Lynx	0.78	6	505
	ARTILLERY			
18	SP Howitzer/155mm	0.62	85	949
36	SP Howitzer/105mm	0.40	85	1,224
	MORTARS			
94	Mortar/81mm	0.70	47	3,093
108	Mortar/51mm	0.50	47	2,538
	Weighted Unit Value			25,357

SOURCES: Isby and Kamps, especially pp. 243-251. Mako, especially p. 119.

NOTES: Equipment summary does not include unit helicopters: 6 Gazelle. Personnel strength is assumed the same as an armored division.

Table A.21

BELGIAN ARMORED BRIGADE

Quantity	Weapon	WEI	Defensive Category Weight	Value
	PERSONNEL			
	TANKS			
86	Leopard 1 (105mm)	1.06	55	5,014
	ANTI-TANK WEAPONS			
20	Milan	0.65	46	598
12	JPzR/90mm	0.53	46	293
	ARMORED RECONNAISSANCE VEHICLES			
3	Scimitar, Scorpion/76mm	0.95	36	103
4	Scimitar, Scorpion, Fox/30mm	0.88	36	127
	ARMORED PERSONNEL CARRIERS			
70	M113/.50 cal.	1.00	6	420
	ARTILLERY			
9	SP Howitzer/155mm	0.62	85	474
9	SP Howitzer/105mm	0.40	85	306
	MORTARS			
6	Mortar/81mm	0.70	47	197
	Weighted Unit Value			7,531

SOURCES: Isby and Kamps, especially pp. 68-69. Mako, especially pp. 114-120.

NOTES: Equipment summary does not include air defense assets: 12 Rh202 20mm.

Table A.22

BELGIAN MECHANIZED BRIGADE

Quantity	Weapon	WEI	Defensive Category Weight	Value
	PERSONNEL			
	TANKS			
43	Leopard 1 (105mm)	1.06	55	2,507
	ANTI-TANK WEAPONS			
20	Milan	0.65	46	598
12	JPzR/90mm	0.53	46	293
	ARMORED RECONNAISSANCE VEHICLES			
3	Scimitar, Scorpion/76mm	0.95	36	103
4	Scimitar, Scorpion, Fox/30mm	0.88	36	127
	ARMORED PERSONNEL CARRIERS			
70	M113/.50 cal.	1.00	6	420
	ARTILLERY			
9	SP Howitzer/155mm	0.62	85	474
9	SP Howitzer/105mm	0.40	85	306
	MORTARS			
6	Mortar/81mm	0.70	47	197
	Weighted Unit Value			5,024

SOURCES: Isby and Kamps, especially pp. 68-69. Mako, especially pp. 114-120.

NOTES: Equipment summary does not include unit air defense assets: 12 Rh202 20mm.

Table A.23

BELGIAN PARACOMMANDO REGIMENT

Quantity	Weapon	WEI	Defensive Category Weight	Value
	PERSONNEL			
	ANTI-TANK WEAPONS			
12	Milan	0.65	46	359
	ARMORED RECONNAISSANCE VEHICLES			
6	Scimitar, Scorpion/76mm	0.95	36	205
15	Scimitar, Scorpion, Fox/30mm	0.88	36	475
	ARTILLERY			
9	Howitzer/105mm	0.35	85	268
	Weighted Unit Value			1,307

SOURCES: Isby and Kamps, especially p. 69. Mako, especially pp. 114-120.

Table A.24

DUTCH ARMORED BRIGADE

Quantity	Weapon	WEI	Defensive Category Weight	Value
4070	PERSONNEL			
	TANKS			
59	Leopard 2 (120mm)	1.20	55	3,894
56	Leopard 1 (105mm)	1.06	55	3,265
	ANTI-TANK WEAPONS			
18	TOW	0.70	46	580
27	Carl Gustav/84mm	0.50	46	621
	ARMORED PERSONNEL CARRIERS			
94	YPR-765/25mm	1.25	6	705
	ARTILLERY			
18	SP Howitzer/155mm	0.62	85	949
	MORTARS			
9	SP Mortar/120mm	1.13	47	478
	Weighted Unit Value			10,491

SOURCES: Isby and Kamps, especially pp. 327-330. Mako, especially pp. 114-120.

Table A.25

DUTCH MECHANIZED BRIGADE

Quantity	Weapon	WEI	Defensive Category Weight	Value
4070	PERSONNEL			
	TANKS			
30	Leopard 2 (120mm)	1.20	55	1,980
28	Leopard 1 (105mm)	1.06	55	1,632
	ANTI-TANK WEAPONS			
36	TOW	0.70	46	1,159
54	Carl Gustav/84mm	0.50	46	1,242
	ARMORED PERSONNEL CARRIERS			
152	YPR-765/25mm	1.25	6	1,140
	ARTILLERY			
18	SP Howitzer/155mm	0.62	85	949
	MORTARS			
18	SP Mortar/120mm	1.13	47	956
	Weighted Unit Value			9,058

SOURCES: Isby and Kamps, especially pp. 327-330. Mako, especially pp. 114-120.

NOTES: A Dutch mechanized division has two mechanized brigades and one armored brigade. Personnel strength is assumed to equal that for an armored brigade.

Table A.26

CANADIAN BRIGADE GROUP

Quantity	Weapon	WEI	Defensive Category Weight	Value
5000	PERSONNEL			
	TANKS			
57	Leopard 1 (105mm)	1.06	55	3,323
	ANTI-TANK WEAPONS			
36	TOW	0.70	46	1,159
133	Carl Gustav/84mm	0.50	46	3,059
	ARMORED PERSONNEL CARRIERS			
191	M113/.50 cal.	1.00	6	1,146
36	Spartan, Saracen, Ferret, Lynx	0.78	6	168
	ARTILLERY			
24	SP Howitzer/155mm	0.62	85	1,265
	MORTARS			
16	Mortar/81mm	0.70	47	526
26	Mortar/60mm	0.60	47	733
	Weighted Unit Value			11,380

SOURCES: Isby and Kamps, especially pp. 84-86. Mako, especially pp. 114-120.

NOTES: Equipment summary does not include unit helicopter and air defense assets. Helicopters: 11 OH-58A. Air defense: 15 Blowpipe.

Table A.27

FRENCH ARMORED DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
9000	PERSONNEL			
	TANKS			
122	AMX-30	0.93	55	6,240
	ANTI-TANK WEAPONS			
12	VAB/Hot	0.70	46	386
48	Milan	0.65	46	1,435
165	LRAC/89mm	0.45	46	3,416
	ARMORED PERSONNEL CARRIERS			
312	AMX-10P/20mm	1.23	6	2,303
280	VAB	0.85	6	1,428
	ARTILLERY			
40	SP Howitzer/155mm	0.62	85	2,108
	MORTARS			
18	SP Mortar/120mm	1.13	47	956
8	Mortar/81mm	0.70	47	263
	Weighted Unit Value			18,535

SOURCES: Isby and Kamps, especially pp. 118-125. Mako, especially p. 120.

Table A.28

FRENCH INFANTRY DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
6900	PERSONNEL			
	ANTI-TANK WEAPONS			
12	VAB/Hot	0.70	46	386
96	Milan	0.65	46	2,870
165	LRAC/89mm	0.45	46	3,416
	ARMORED RECONNAISSANCE VEHICLES			
36	EBR, AML/90mm	0.70	36	907
	ARMORED PERSONNEL CARRIERS			
400	VAB	0.85	6	2,040
	ARTILLERY			
24	Howitzer/155mm	0.55	85	1,122
	MORTARS			
18	SP Mortar/120mm	1.13	47	956
	Weighted Unit Value			11,697

SOURCES: Isby and Kamps, especially pp. 118-125. Mako, especially p. 120.

Table A.29

FRENCH ALPINE DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
8800	PERSONNEL			
	ANTI-TANK WEAPONS			
36	Milan	0.65	46	1,076
46	LRAC/89mm	0.45	46	952
	ARMORED RECONNAISSANCE VEHICLES			
32	EBR, AML/90mm	0.70	36	806
	ARTILLERY			
24	Howitzer/105mm	0.35	85	714
	MORTARS			
18	SP Mortar/120mm	1.13	47	956
36	Mortar/81mm	0.70	47	1,184
	Weighted Unit Value			5,689

SOURCES: Isby and Kamps, especially pp. 118-125. Mako, especially p. 120.

Table A.30

FRENCH AIRBORNE DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
16500	PERSONNEL			
	ANTI-TANK WEAPONS			
154	Milan	0.65	46	4,605
535	LRAC/89mm	0.45	46	11,075
	ARMORED RECONNAISSANCE VEHICLES			
62	EBR, AML/90mm	0.70	36	1,562
	ARTILLERY			
18	Howitzer/105mm	0.35	85	536
	MORTARS			
54	SP Mortar/120mm	1.13	47	2,868
48	Mortar/81mm	0.70	47	1,579
	Weighted Unit Value			22,224

SOURCES: Isby and Kamps, especially pp. 118-125. Mako, especially p. 120.

Table A.31

FRENCH MARINE DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
7600	PERSONNEL			
	ANTI-TANK WEAPONS			
48	Milan	0.65	46	1,435
230	LRAC/89mm	0.45	46	4,761
	ARMORED RECONNAISSANCE VEHICLES			
60	EBR, AML/90mm	0.70	36	1,512
	ARTILLERY			
12	Howitzer/105mm	0.35	85	357
	MORTARS			
16	SP Mortar/120mm	1.13	47	850
32	Mortar/81mm	0.70	47	1,053
	Weighted Unit Value			9,968

SOURCES: Isby and Kamps, especially pp. 118-125. Mako, especially p. 120.

Table A.32

FRENCH LIGHT ARMOR (12TH AND 14TH) DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
5000	PERSONNEL			
	TANKS			
54	AMX-30	0.93	55	2762
	ANTI-TANK WEAPONS			
48	Milan	0.65	46	1435
110	LRAC/89mm	0.45	46	2277
	ARMORED RECONNAISSANCE VEHICLES			
59	EBR, AML/90mm	0.70	36	1487
	ARMORED PERSONNEL CARRIERS			
340	VAB	0.85	6	1734
	ARTILLERY			
18	SP Howitzer/155mm	0.62	85	949
	MORTARS			
12	SP Mortar/120mm	1.13	47	637
16	Mortar/81mm	0.70	47	526
	Weighted Unit Value			11,807

SOURCES: Isby and Kamps, especially pp. 118-125. Mako, especially p. 120.

Table A.33

FRENCH LIGHT ARMOR (6TH) DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
7400	PERSONNEL			
	ANTI-TANK WEAPONS			
24	VAB/Hot	0.70	46	773
48	Milan	0.65	46	1,435
110	LRAC/89mm	0.45	46	2,277
	ARMORED RECONNAISSANCE VEHICLES			
72	EBR, AML/90mm	0.70	36	1,814
	ARMORED PERSONNEL CARRIERS			
72	AMX-10P/20mm	1.23	6	531
340	VAB	0.85	6	1,734
	ARTILLERY			
24	Howitzer/155mm	0.55	85	1,122
	MORTARS			
12	SP Mortar/120mm	1.13	47	637
16	Mortar/81mm	0.70	47	526
	Weighted Unit Value			10,850

SOURCES: Isby and Kamps, especially pp. 118-125. Mako, especially p. 120.

Table A.34

FRENCH AIRMOBILE DIVISION

Quantity	Weapon	WEI	Defensive Category Weight	Value
6400	PERSONNEL			
	ANTI-TANK WEAPONS			
48	Milan	0.65	46	1,435
60	LRAC/89mm	0.45	46	1,242
	ARMORED PERSONNEL CARRIERS			
185	VAB	0.85	6	944
	MORTARS			
12	SP Mortar/120mm	1.13	47	637
8	Mortar/81mm	0.70	47	263
	Weighted Unit Value			4,521

SOURCES: Isby and Kamps, especially pp. 118-125. Mako, especially p. 120.

Table A.35

CORPS AUGMENTATION (ARTILLERY)

Quantity	Weapon	WEI	Defensive Category Weight	Value
	US V CORPS ARTILLERY [a]			
48	SP Howitzer/203mm AdvMun	1.15	85	4,692
24	SP Howitzer/155mm AdvMun	1	85	2,040
27	MLRS/227mm	0.8	85	1,836
	US VII CORPS ARTILLERY [b]			
94	SP Howitzer/203mm AdvMun	1.15	85	9,189
48	SP Howitzer/155mm AdvMun	1	85	4,080
63	MLRS/227mm	0.8	85	4,284
	GERMAN I, II, and III CORPS ARTILLERY [c]			
48	SP Howitzer/203mm (8")	0.7	85	2,856
	UK CORPS ARTILLERY [d]			
36	SP Howitzer/203mm (8")	0.7	85	2,142
	BELGIAN CORPS ARTILLERY [e]			
54	SP Howitzer/155mm	0.62	85	2,846
	DUTCH CORPS ARTILLERY [f]			
18	SP Howitzer/203mm (8")	0.7	85	1,071
198	SP Howitzer/155mm	0.62	85	10,435

NOTES: Equipment summaries do not include Lance and Pershing missile firing batteries.

[a] One Bn with 24 sp 155mm, four Bns each with 9 MLRS and 12 sp 203mm howitzers.

[b] Two Bns each with 24 sp 155mm, seven Bns each with 9 MLRS and 12 sp 203mm howitzers.

[c] Two sp 203mm howitzers per Corps.

[d] One Bn with 18 sp 203mm. One Bn with 24 sp 175mm howitzers (counted as sp 203mm howitzers).

[e] Three Bns each with sp 155mm howitzers.

[f] One Bn with 18 sp 203mm howitzers. Seven Bns each with 18 sp 155mm howitzers. Four Bns each with 18 203mm howitzers (counted as sp 155mm howitzers).

Appendix B

THE MASTER SIMULATION MODEL

MASTER (Mass and Space/Time Evaluation Routine) is a theater level, deterministic, combat simulation model. MASTER was developed at The RAND Corporation for rapid evaluation of different defense concepts or force allocation strategies.[1] Several versions of MASTER currently exist; the one used in this study can be run on an IBM personal computer. Run time, on an 8088-based machine with 640 kilobytes of memory, is less than one minute; summary tables and graphs can be produced (using a post-processor) in about ten minutes.

MASTER is built on a grid overlay of Central Europe. The grid is derived from horizontal axes and vertical zones. Forces (brigade- and division-sized units) engage along the axes which correspond to NATO's Central Front corps sectors of responsibility, and in zones which correspond to NATO's defensive posture (delineated by the covering force area, main battle area, and rear area). Combat is represented in terms of the ratio of engaged forces in each corps area. Each cell in the grid has a terrain setting that affects the movement of forces. Terrain settings are based upon a terrain analysis of Central Europe.

MASTER has a number of variable parameters to guide the allocation and movement of forces and the adjudication of battle. A representative list of these parameters includes the following[2]:

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[1]MASTER, when it was initially developed in the early 1970s, was the successor to a larger combat simulation model called TOTEM (Theater Operations Tactical Evaluation Model). MASTER is the predecessor of CAMPAIGN (Combat Analysis Model for Policy Analysis), which was developed in the RAND Strategy Assessment Center.

[2]Parameter settings were calibrated against CAMPAIGN. CAMPAIGN was the model used in the conventional defense study described in Section II.

- Minimum force ratio to attack
- Maximum density of forces in each corps axis
- Maximum flank exposure before withdrawal ordered
- Axis widths and zone depths
- Movement as a function of force ratio, terrain, and defense posture
- Attrition as a function of force ratio and defense posture
- Attrition as a function of air attack[1]

Movement and attrition are the principal model outputs used to compare cases. The movement and attrition curves used in this study are displayed in Figs. B.1-B.5.

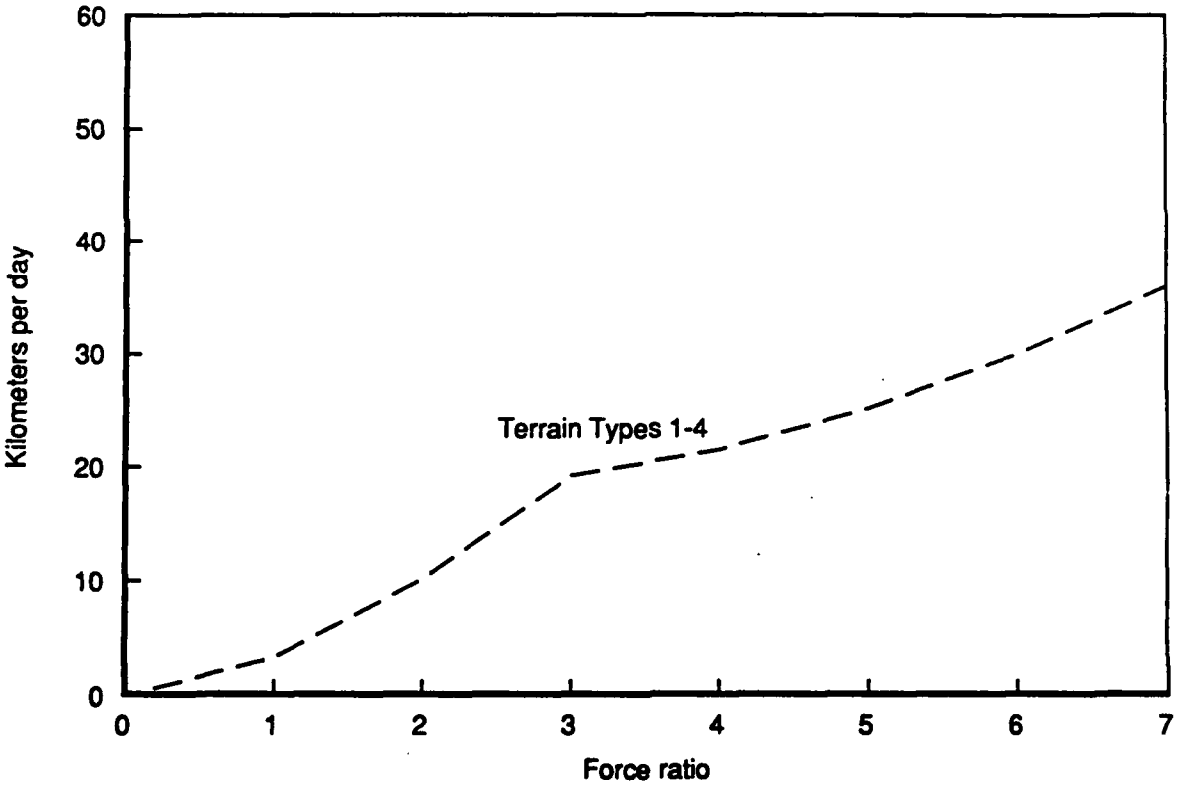

Fig. B.1—Movement: covering force area

[1]Attrition from air attack is based upon the number of sorties flown by different types of aircraft and estimates of the lethality of each aircraft type. Since the focus of this study is on the contribution of reserve force ground units, a generic air war was used across all cases.

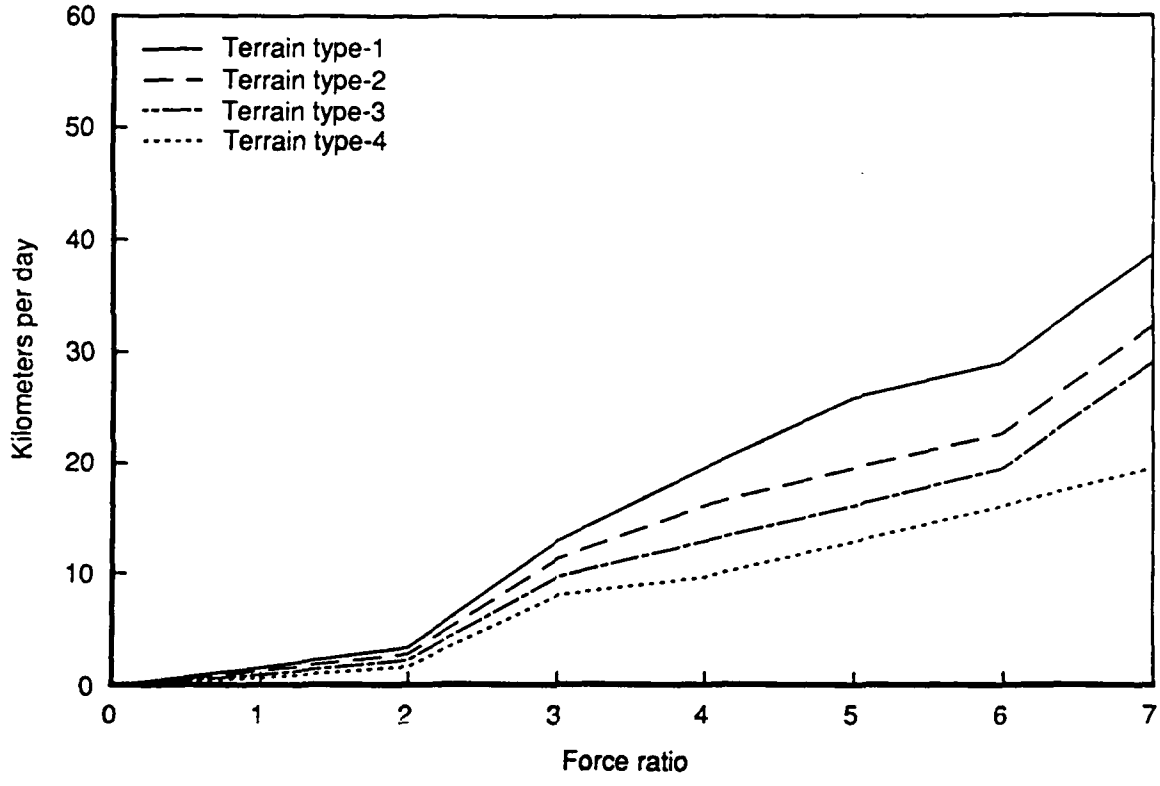

Fig. B.2–Movement: main battle area

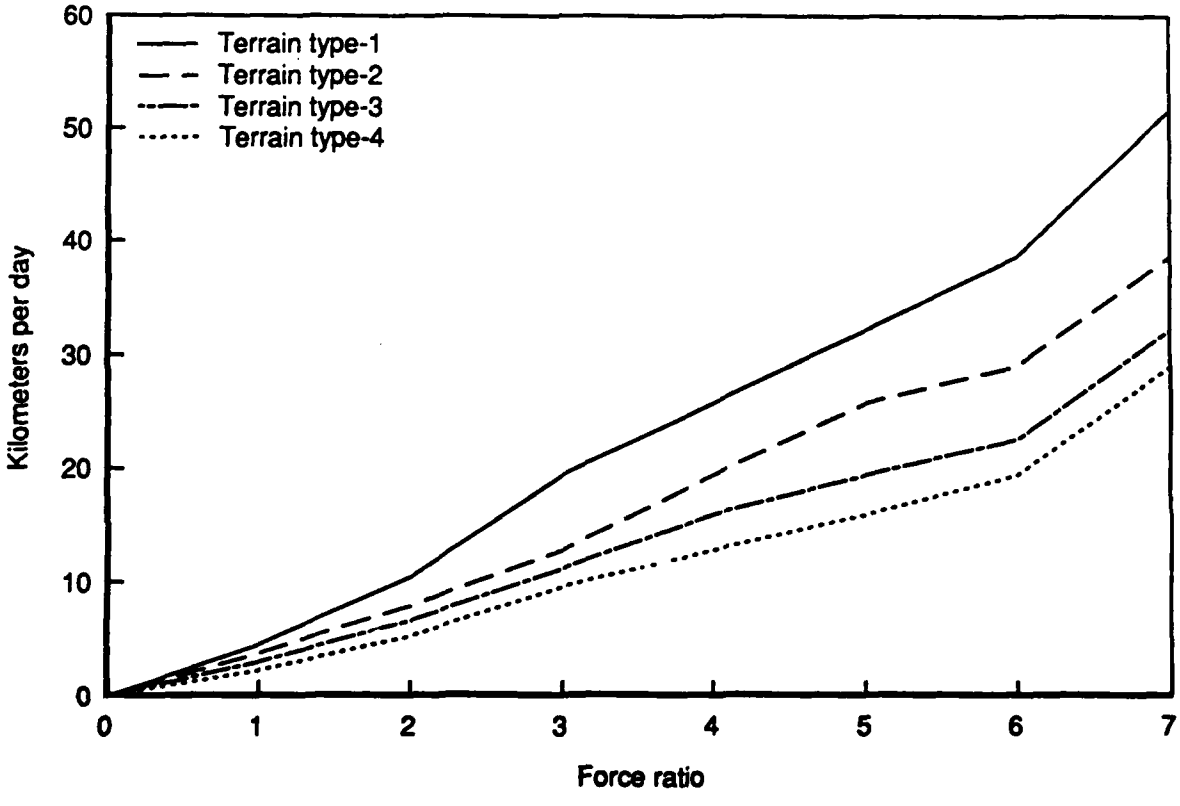

Fig. B.3–Movement: rear area

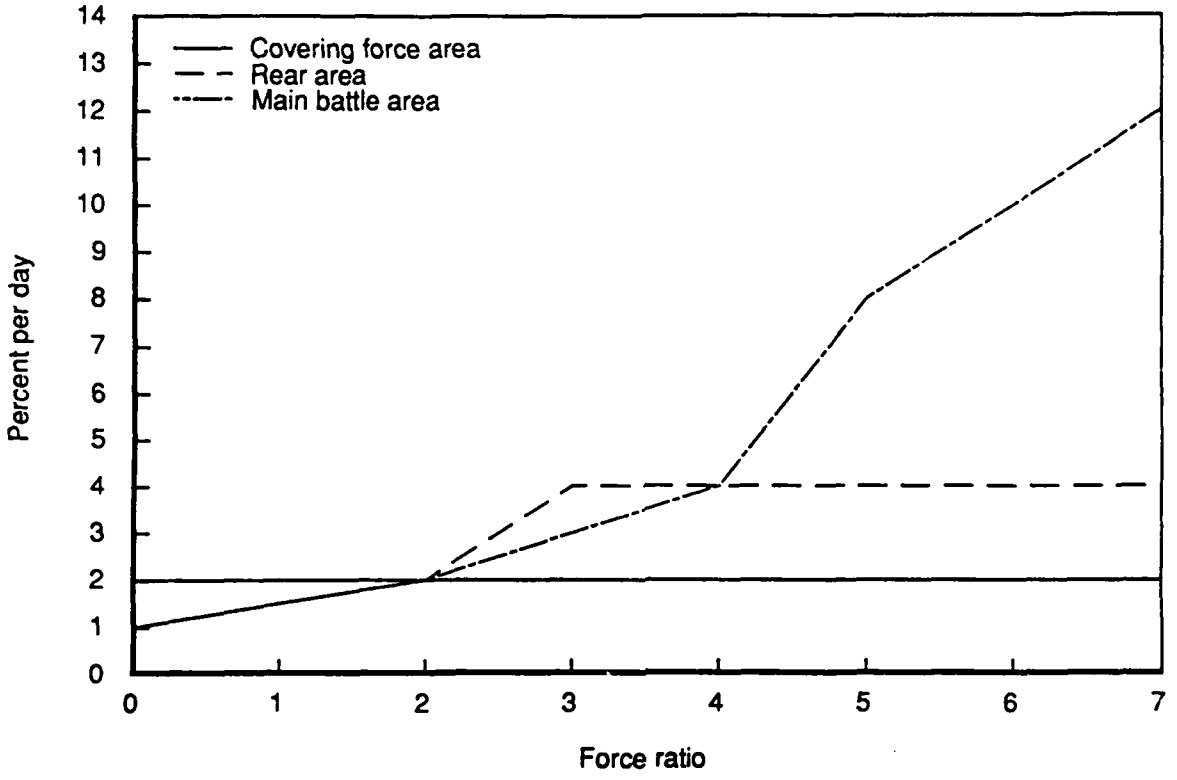

Fig. B.4—Attrition: defending force (NATO)

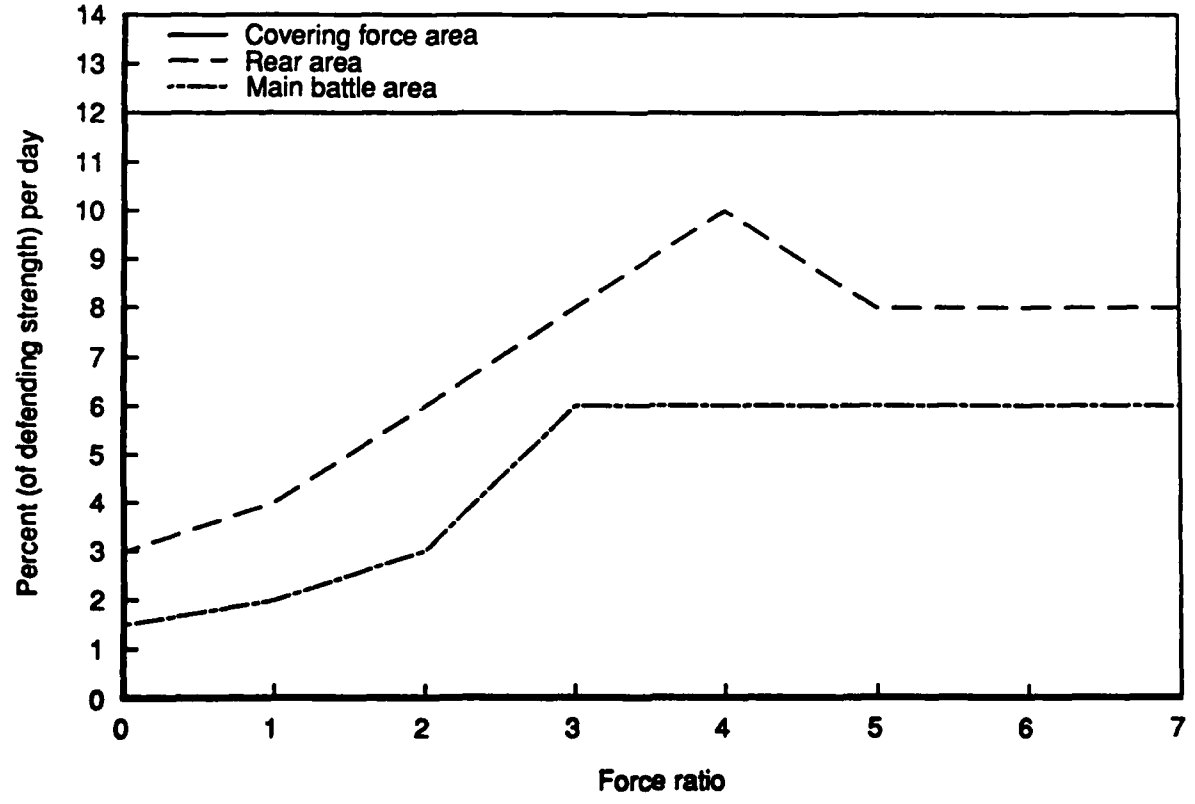

Fig. B.5—Attrition: attacking force (WP)

Appendix C

ARMY UNIT COST MODEL

RAND's Army Unit Cost Model (ACM) provides several pieces of information for combat units:

- Table of Organization and Equipment (TO&E)
- Non-Recurring Cost (NRC) estimates
- Annual Recurring Cost (ARC) estimates
- Tactical Support Increment (TSI) estimates

TO&Es describe combat units by equipment quantities (by line item number) and personnel totals. TO&Es for different units were constructed using TO&Es from the Vertical Total Army Authorization Document System (VTAADS) as a guide. The VTAADS is the Army's master list of unit TO&Es (authorized equipment and personnel). It is part of the Army's Force Accounting System and is used in the development of the M-Force (the Army's programmed force). All units in the Army are in the VTAADS and many are very similar. Representative units were chosen for the ACM.

NRC estimates are based upon the representative unit TO&Es matched against the Army Master Data File (AMDF). The AMDF is the Army's current price list for equipment and spare parts. ARC estimates are based upon cost factors published in the Army's OMA and MPA Cost Handbook.

The TSI estimates (equipment and personnel) support requirements for a combat unit TO&E. TSI estimates are based upon the Army division force equivalent framework. The framework decomposes a division into three parts: a division increment, a non-division combat increment, and a tactical support increment (TSI). The division increment is composed mostly of the organic combat and combat support units making up a division. The non-division combat increment is composed of independent (corps level) combat and combat support elements that would be attached

to a division in wartime. The tactical support increment is composed of combat service support units. Figure C.1 provides a representative description of the different components of a division force equivalent (U.S. Armored Division).

The division force equivalent framework was last used in 1982 to describe and produce cost estimates for five types of Army divisions.[1] The ACM uses this framework to produce cost (and personnel) estimates for TSI based on the following assumptions. First, a unit is described in terms of combat and support elements. The combat element corresponds to the division and non-division combat increments in the division force equivalent framework. The support element corresponds to the TSI in the division force equivalent framework. Second, a combat unit's TO&E, as described in the VTAADS, corresponds to the division and non-division combat increments in the division force equivalent framework. Third, the ratio of combat element (including both division and non-division combat increments) costs to support element costs, from the 1982 AFPCH, is assumed to be representative of the ratio that would prevail for the costed period. These ratios (by specific cost component) are used to estimate TSI costs for the ACM's representative units. Finally, the ratio of combat troops (including both combat and non-division combat increments) to support troops, from the 1982 AFPCH, is representative of the ratio that would prevail today. These ratios (by officer and enlisted men) are used to estimate TSI manpower for the ACM's representative units.

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[1]The five types of divisions were armored, mechanized, infantry, airborne, and air assault. These units are described in the *Army Force Planning Cost Handbook* (AFPCH), Directorate of Cost Analysis, Comptroller of the Army, Washington D.C., November 1982.

Table C.1

DIVISION FORCE EQUIVALENT

Division Increment	Non-Division Increment	Tactical Support Increment
~18,000 Personnel	~12,000 Personnel	~18,000 Personnel
6xM1 Bn	Atk Hel Bn	Decon Co
4xM2 Bn	5xEngr Bn	ChemSmoke Co
HH Co	3xEngr Co	HHC Engr Gp
MP Co	3xFA Bn	3xEngr Co
Sig Bn	Inf (TOW) Bn	HHC Engr Cmd
ADA Bn	Inf Bde	HHC Engr Bn
Engr Bn	LARS Co	2xUtils Tm
MI Bn	ACR	HHD Med Gp
Chem Co	Air Cav Bde	Med Co
3xHH Bn (Bdes)	MI (CEWI) Co	4xMed Gps
10xHH Co (Bns)	2xADA Bn	Med Air Ambl
Div Arty	2xHSB	3xStat Hosp
Cav Bde		General Hosp
HHC/MMC Supt Cmd		Field Hospital
TAMC		9xSurg Tms
5xFwd Supt Bn		HHC Ammo Gp
Maint Supt Bn		HHC Ammo Bn
Div Band		Crd Co, Ammo
		Ammo Maint
		Missl Maint
		HHD Petrl Bn
		3xSig Co
		Sig Bn
		4xSvc Co
		5xSup Co
		HHD Maint Bn
		HHC Supt Gp
		Trans Agcy
		5xTrans Co

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