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DEFENSE SCIENCE BOARD

Office of the Secretary of Defense
Chief, RDD, ESD, WHS 5 U.S.C. 552
Date: 05 Dec 2012 Authority: EO 13526
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MDR: 11 -M- 1275

SUMMER STUDY
ON
Conventional Counterforce Against A PACT Attack (U)

DECLASSIFIED IN FULL
Authority: EO 13526
Chief, Records & Declass Div, WHS
Date: DEC 0 5 2012

JANUARY 1977

OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D.C. 20301

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~~DECLASSIFY ON 31 December 1990.~~

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DEFENSE SCIENCE BOARD

SUMMER STUDY

ON

CONVENTIONAL COUNTERFORCE AGAINST A PACT ATTACK (U)

JANUARY 1977

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OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D. C. 20301

14 January 1977

MEMORANDUM FOR THE SECRETARY OF DEFENSE

THRU: Director of Defense Research and Engineering

SUBJECT: Final Report of the Defense Science Board Task Force on Conventional Counterforce Against a Pact Attack (U)

The final report of the Defense Science Board Task Force on Conventional Counterforce Against a Pact Attack is submitted herewith for your consideration. In the 1976 DSB Summer Study, this Task Force studied the problems facing NATO in countering a large conventional attack by Pact forces which, as you know, have a substantial numerical advantage in both manpower and equipments. The report documents the work accomplished during the Summer Study and in subsequent efforts, and makes three major recommendations.

The first recommendation involves certain actions to be taken by NATO to improve the probability of its being in a proper posture in the event of an attack. The second recommendation concerns the development of battle management and weapon control systems which would provide a quantum step improvement in conventional capability by permitting optimum deployment and maneuver of our own forces and by greatly increasing the effectiveness of those forces by appropriate weapon control systems. The third recommendation concerns the initiation of a program to develop a capability to counter the enemy command, control, communications system (C^3) thus degrading his capability to deploy and maneuver his forces. It is believed that implementation of these three recommendations will go a long way toward offsetting the numerical advantage of the Pact over NATO. It is also believed that implementation of the second recommendation will result in a major improvement in U.S. tactical capability in any theatre.

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AMERICAN REVOLUTION BICENTENNIAL 1776-1976

The information on this page is Unclassified.

(U) I am pleased that Dr. Currie has already taken appropriate action to implement recommendation #3. Implementation of the first and second recommendations will require action from your office. I am particularly concerned about recommendation #2 because its proper implementation crosses intra- and inter-service boundaries and, therefore, presents unusual organizational and managerial problems. I believe that this will require your personal involvement and I believe the importance of the issue is sufficiently great to warrant this.

(U) The DSB has reviewed and approved the study.

Solomon J. Buchsbaum
Chairman
Defense Science Board

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OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D. C. 20301

10 January 1977

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Final Report of the DSB Task Force on Conventional Counterforce Against a Pact Attack (U)

(U) The final report of the Defense Science Board Task Force on Conventional Counterforce Against a Pact Attack is attached for your review. The report both documents and elaborates on the work done during the Summer Study of August 1976 and reported upon to the DDR&E, his Deputy Director (Tactical Warfare), and other defense officials in a briefing given at the end of the study period.

[redacted] The Task Force concluded that certain improvements in NATO's posture were important and necessary. It also concluded that there was an opportunity for a major threshold advance in tactical warfare capability by the development and deployment of systems for battle management and weapon control, and that the exploitation, deception, jamming, and destruction of enemy command, control and communications (Counter C^3) was an area of significant potential.

[redacted] The report makes three major recommendations:

(1) The warning and theatre C^3 systems in NATO should be improved to provide greater survivability and better response to warning.

(2) The DoD should take the necessary managerial and other steps to permit the rapid development and deployment of battle management and weapon control systems to achieve the available threshold improvement in tactical warfare capability.

(3) The DoD should create a focal point on Counter C^3 and mount a significant effort in this important area.

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AMERICAN REVOLUTION BICENTENNIAL 1776-1976

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The information on this page is Unclassified.

(U) As you know, Dr. Currie has taken action already on the third recommendation by creating a focal point within ODDR&E for Counter C^3, and by initiating a Defense Science Board Task Force to support him in the analysis of this area and the creation of an appropriate program.

(U) Since our study, there have been several actions taken regarding NATO improvements but, as noted above, we strongly recommend additional actions.

(U) The second recommendation is not only the most important, in my view, but undoubtedly the most difficult to implement because of the organizational and managerial problems it presents. Nevertheless, because the benefits appear to be so great, I would hope that direct and positive actions within the DoD would be taken.

[redacted]

Chairman
DSB Task Force on Conventional
Counterforce Against a Pact Attack

OSD
5 U.S.C. § 552 (b)(6)

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SECTION 1

INTRODUCTION

(U) A task force of the Defense Science Board (DSB) was convened in San Diego, California, during the period 1–13 August 1976 for the purpose of determining means for achieving major improvements in non-nuclear land warfare capabilities of the NATO force to counter a Warsaw Pact attack in Central Europe. Emphasis was given to a scenario which incorporated heavy use of artillery in support of a massive armored thrust against NATO forces. The study was primarily devoted to the engagement of ground targets in the contact region and the standoff zone. Although the importance of the tactical air battle is recognized and discussed, it was not a specific topic of the study. Both hard and soft weapons (EW) were included in the study, and consideration was given to a better utilization of modern sensors to provide standoff surveillance and improved command, control, and communications. The attempt was made to include full consideration of a realistic environment including weather, ECM, and smoke.

(U) The study was chaired by Mr. [redacted] and was conducted under the cognizance of Mr. [redacted] ODDR&E, and Mr. [redacted] ODDR&E, served as Executive Secretary.

(U) The study was organized into several teams to cover the important areas, and the assignments were as follows:

OSD
5 U.S.C. § 552(b)(6)

COUNTER ARTILLERY

Mr. [redacted]
Mr. [redacted]
Col. [redacted]

COUNTER ARMOR

OSD
5 U.S.C. § 552 (b)(6)

Dr. [redacted]
Col. [redacted]
Mr. [redacted]
Mr. [redacted]

COUNTER C^3

Dr. [redacted]
Mr. [redacted]
Mr. [redacted]
Lt.Col. [redacted]

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*Team leader

COUNTER AIR DEFENSE

Dr. [redacted]
Col. [redacted]

BATTLEFIELD INTERDICTION

Mr. [redacted]
Dr. [redacted]

WARNING & C3

Mr. [redacted]
Dr. [redacted]
Dr. [redacted]
Mr. [redacted]
Mr. [redacted]

(U) Not all of the participants were assigned to teams. In particular, the Chairman was assisted by Dr. John M. Deutch and Mr. [redacted] in coordinating the overall effort, and [redacted] also assisted in the preparation of the final report. A complete listing of the study participants is provided in Appendix I.

(U) A summary of the team findings is presented in Section II of this report and the detailed reports of the teams are provided in the Appendices of this report. Also included in the Appendices is a special report, "Air Attack of Armor from Low Altitude," by [redacted] Section IV compiles the major recommendations of the study, but does not necessarily overlap perfectly with the team reports which give a more comprehensive account of the team findings.

(U) In putting together the report, it was necessary to make judgments on several issues which may not have the complete concurrence of all study members. Although there is excellent agreement on the main points of the report, there were some differences of opinion. Although in such cases an attempt has been made to give the view of the majority, the position put forth must be regarded as the responsibility of the Chairman. Likewise, each appendix is the responsibility of the Team Leader.

*Team leader

SECTION II

SUMMARY FINDINGS

THREAT

Over the past decade, we have experienced a very significant growth in the military strength of the Warsaw Pact forces in Central Europe. This growth has produced an imbalance of military power that could increase the danger of war in Europe and could affect profoundly the outcome of such a conflict should it occur. From military theory and experience, we know that such an imbalance of military strength in war results in the swift conquest of the inferior force with a relatively small attrition of the superior force. Thus, a major imbalance of military strength between adversary powers is an open invitation for conquest and should be viewed with extreme alarm. This is not to say that the Warsaw Pact is bent on conquest – it may not be. However, it is difficult to find an alternative explanation for its enormous military force. It is tempting to argue that there are several NATO qualitative advantages that could somewhat offset the Pact numerical superiority. This may be so, but qualitative advantages are hard to measure, their impact is not clear, and some may not completely exist. The hard facts are based on: weapon counts; personnel counts; command, control, and communications facilities; logistic support; and proven performance in their use. These hard facts are clear in their portrayal of a very serious threat to the NATO alliance.

(U) A detailed account of relative Pact/NATO military strength will not be provided in this report because the information is available in several authoritative sources. But typically, the Pact forces are credited with having achieved numerical superiority in the following ratios: 3:2 in combat personnel, 3:1 in tanks, 2:1 in artillery, 3:2 in armored personnel carriers, 2:1 in tactical aircraft, and 2:1 in reserves. (There are a few important areas where NATO has the advantage, e.g., NATO has a 3:1 numerical advantage in helicopters.) The Pact has extensive C^3 capabilities and has provided a well-equipped counter C^3 force organized to both destroy and disrupt enemy C^3. It also has placed heavy emphasis on air defense with large numbers of interceptor aircraft, surface-to-air missile systems, and anti-aircraft artillery. These defenses could severely hinder NATO tactical air forces and will consume significant resources for defense suppression.

(U) Offsetting qualitative considerations should include: leadership, discipline, morale, motivation, education, tactics, training, experience, organization, and technology. An evaluation of most of these factors is difficult because they are the result of very different cultural and political systems which produce different background experiences and reactions to stress. The effect of these differences in a combat situation is debatable. As to technology, we have in the past enjoyed important advantages, but severe reductions of U.S. R&D are beginning to take their toll. It is now clear that Soviet equipment is in many instances at least the equal of NATO equipment, and the trends seem to favor the Soviet Union.

The information on this page is Unclassified.

(U) It then appears that the NATO forces must consider their options vis-a-vis a Pact force with a very considerable numerical superiority. What is the significance of this numerical superiority? What are the NATO options? What follows from them? These are the questions we attempted to answer in the DSB Summer Study. We were able to find some answers, but our success was limited.

NUMERICAL SUPERIORITY

(U) The significance of superior numbers was first made clear by Frederick W. Lanchester in his classical paper *Aircraft in Warfare* (1916). Lanchester dealt with the simple model of two homogeneous forces in contact for which the rate of attrition of each side is proportional to the surviving numbers in the opposing force. Lanchester showed that the effective military strength of such a force is proportional to the effectiveness of its weapons and to the *square* of its numbers. The effectiveness of the weapons can be related to parameters such as probability of kill and rate of fire. Figure 1 shows graphically the results of a Lanchester exchange in terms of the percentage of red and blue survivors with the ratio of their military strengths as a parameter.

(U) The graph shows the strong effect of numerical superiority; e.g., consider a red force of 100 units opposing a blue force of 50 units with equal effectiveness. Then $\rho = 100^2/50^2 = 4$. For $\rho = 4$, we see that when blue has lost 50% of his force red has lost only 10%; and when blue is annihilated, red has lost only 14% of his force. Suppose we grant blue an effectiveness double that of red, then $\rho = 1 \times 100^2/2 \times (50)^2 = 2$. We see that red need only sacrifice 30% of his force to eliminate completely the blue force. Although in this second example the effectiveness of the blue weapon is twice the effectiveness of the red weapon, the 2:1 red numerical superiority is the dominant factor.

(U) The Lanchester model is interesting, but one might conclude that it does not apply to the complex situation found in modern war where there are many weapon types and the contact of forces is constantly varied by their mobility. Unfortunately for NATO, the basic underlying mechanisms if not the exact predictions most likely do apply to modern war. More complex models can be and have been made with much the same results. Furthermore, analysis of modern wars where the conditions of the model are met tends to confirm the Lanchester prediction. Sheer numbers can and frequently do dominate the outcome of wars. The S.U. seems to understand this and is apparently influenced by it. On the other hand, the Western world seems to build its security on the development of superior weapons — not in numbers, but in effectiveness. Table I demonstrates the problem associated with this approach by showing the relative combat effectiveness required to achieve NATO parity for the force ratios given above. It must be understood that the forces in the table do not necessarily engage one another in combat, e.g., APC's do not fight APC's, but the strength they supply to the total force is in proportion to the square of their members.

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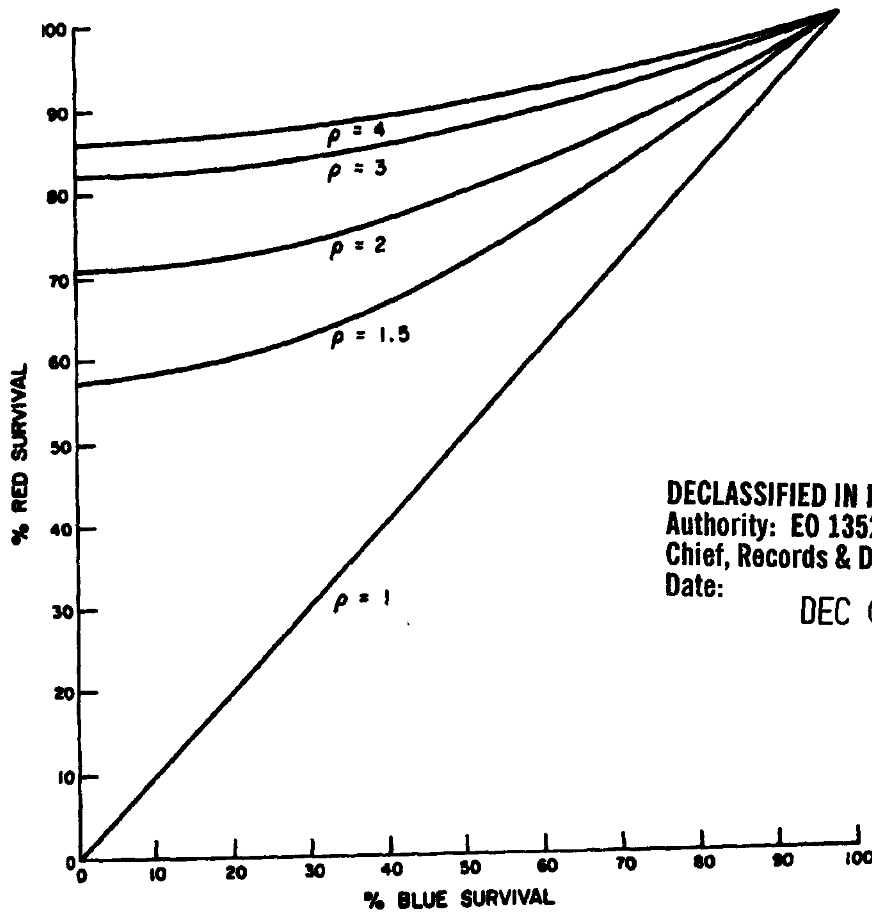

$$\rho = \frac{\text{(RED WEAPON EFFECT.)} \times \text{(NUMBER OF RED WEAPONS)}^2}{\text{(BLUE WEAPON EFFECT.)} \times \text{(NUMBER OF BLUE WEAPONS)}^2}$$

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(UNCLASSIFIED)

Figure 1. Lanchester Attrition (U)

Table I

Force and Effectiveness Ratios (U)

	Numerical Ratio Pact: NATO	Effectiveness Ratio for Parity Pact: NATO
Personnel	3:2	9:4
Tanks	3:1	9:1
Artillery	2:1	4:1
APC	3:2	9:4
TAC Air	2:1	4:1

[redacted] It does not seem likely that our technological superiority has, will, or can produce all the indicated effectiveness ratios; and if they were attained at some time, we could not be assured that they would persist. It is obvious that symmetrical contact (like forces versus like forces, e.g., an artillery duel) with the indicated ratios would have disastrous results for NATO. We are forced to conclude that we must either increase the number of NATO weapons or be prepared to trade territory for enemy attrition until the Pact numerical superiority has been cut down to size.

[redacted] This analysis suggests four approaches to offset numerical superiority. *First,* it suggests the need for a prepared and fully equipped force that is provided with sufficient warning to enable the engagement of the enemy under the most favorable circumstances. *Second,* it suggests the need for a battle management system which permits optimum deployment of our forces to engage and to disengage under the appropriate circumstances. If one could have a complete picture of the enemy forces relative to his own, he could bring to bear in an optimal way his available forces. *Third,* it suggests the need for a weapon assignment and engagement system which permits the deployment of these forces which can engage the enemy under terms which are extremely favorable. In general, this will mean asymmetrical engagements because in a symmetrical engagement the full burden of overcoming numerical superiority must be borne by the effectiveness of the weapon system. For example, it is hard to conceive of one tank being sufficiently superior to another to overcome the 9 to 1 Lanchester factor brought about by his 3 to 1 numerical superiority. However, one can conceive that we might engage his artillery with air-delivered weapons or engage his forces on the road before they arrive at positions where they can use their weapons. *Fourth,* the analysis points out the obvious advantage in reducing his ability to optimize the use of his forces by confusing, jamming, or destroying his command, control, and communication system.

[redacted] The analysis also indicates that under the present circumstances NATO is relegated to fight a defensive war of attrition. It must very carefully manage its resources to avoid unnecessary loss while at the same time maximizing the number of weapons that are effectively in contact with the enemy. Success will depend on NATO ability to perform well in the critical areas of warning, C^3, and counter C^3. Also, serious attention needs to be given to the development of better weapon systems in support of several battle functions such as interdiction, defense suppression, anti-tank, and counter-artillery. A discussion of our findings in these areas will now be summarized.

WARNING

[redacted] JS 3.3(b)(5)

(S) One of the causes for uncertainty of warning is the Soviet practice of periodically exercising forces in ways which require posturing which is increasingly similar to posturing for attack. Some NATO reaction to these practices seems warranted.

(S) Some of the readiness deficiencies of NATO forces stem from concepts developed under longer estimates of warning time. The peacetime positioning of forces and their ammunition and the non-operational status of NATO Headquarters are two very troublesome manifestations of this assumption which appear to be candidates for corrective action.

(S) There are several indicated actions for NATO in the warning area:

(S) 1. Serious consideration should be given to developing a concept for reaction by Allied forces in peacetime to Soviet exercise activities. Assignment to NATO of standing forces of land and offensive air forces in peacetime is recommended as a part of this concept. This would involve increased day-to-day operational activity by NATO military commands.

(S) 2. There should be increased effort to develop realistic means of intelligence and information support to NATO.

(S) 3. NATO countries should reposition some forces and ammunitions to reduce the time required to achieve a sound defensive posture.

(S) 4. The U.S. should take the lead in the development of concepts, organizational relationships, and procedures for both unilateral and cooperative action in response to intelligence in peacetime for both readiness and deterrence purposes.

NATO C^3

(U) In NATO's situation of numerical inferiority, it is vital to efficiently manage the NATO force to maximize the number of force elements in contact with the enemy and to utilize the NATO resources only in engagements where the effectiveness is high and the losses are commensurate with the results achieved. If C^3 can achieve this objective, it is a *"force multiplier"* of very considerable significance. Suppose, for example, that superior C^3 can increase the numbers of a weapon brought to bear on the enemy by 30% and the effectiveness of the weapon is increased by 20% as a result of the way it is used. Then, by the Lanchester model, the military strength of this weapon is more than doubled ($1.2\,(1.3)^2 > 2$). It is believed that factors far greater than two are available, and history has provided many examples of a well-managed inferior force that overwhelmed its enemy. Therefore, it is important to take every possible measure to improve NATO C^3 and there are several important opportunities that are presented.

[redacted] The NATO C^3 needs can be categorized for the sake of discussion into three convenient levels:

[redacted] 1. *Theater Command,* which determines and effects the overall theater strategy;

[redacted] 2. *Battle Management,* which is responsible for the assignment and the maneuvering of forces to engage the enemy under favorable conditions and provides the option to disengage forces from contact under unfavorable conditions;

[redacted] 3. *Weapon and Force Control,* which directs the forces in contact with the enemy and assigns and controls weapons in support of the battle. At the Theater Command level the survivability of the existing C^3 structure is dangerously deficient. There are too few nodes, and they are too soft and vulnerable to ECM. The study examined some 22 important nodes (these are listed in Table G-I of Appendix G) which if eliminated or disrupted would very seriously impair our ability to control theater forces.

All three levels need to be improved. At the Battle Management and Weapon Force Control levels there are significant opportunities for improvement by the application of existing technology. These opportunities are primarily due to the emergence of new AMTI, artillery-locating, and emitter-locating sensor systems, such as SOTAS, TPQ-37, and PELSS, which can provide near real-time surveillance of the important areas with accuracy sufficient to maneuver forces and direct weapons. Although the C^3 functions described are classical, the new sensors can provide a quantum jump in C^3 performance that can very significantly influence the battle. If the full potential of these improvements is to be realized, it will be necessary to take several important actions.

[redacted] 1. A Joint Weapon Assignment and Control Center (JWACC) should be established at the Weapon Force Control level to handle the targeting and weapon assignment functions for both ground and air forces. The JWACC should be kept simple and austere by limiting its use to ground targets and data derived from selected sensors which have the timeliness and accuracy required for target engagement, [redacted] JS 3.3(b)(5)

2. The Battle Management level of C^3 should be provided with sensor and intelligence inputs that give a clear picture of the maneuvering of enemy forces, e.g., the type of force, its size and apparent objective. Sensors [redacted] could collectively provide such an assessment. This level also should be provided with a thorough knowledge of the status, location, and availability of NATO force elements so that they can be maneuvered effectively to counter enemy threats. JS 3.3(b)(5)

3. Careful attention should be given to physical survivability and EW vulnerability of our C^3 (at all levels) and sensor assets, by the use of mobility, hardening, ECCM, AJ, and ARMS. This conclusion stems from the apparent S.U. dedication to counter C^3 through physical destruction and EW. [redacted] is to develop a family of ARMS on the frequencies used by our more important [redacted] JS 3.3(b)(5)

The C^3 structure implied by these actions is illustrated in Figure 2, where the Battle Management and Weapon and Force Control functions and their sensors' input are the areas of principal interest.

The existance of [redacted] selected intelligence at the Battle Management level will give a good picture of the deployment and maneuvering of enemy forces in real time. This information provides a basis to effectively engage elements of the enemy force and to produce local superiority by virtue of numbers and/or relative weapon effectiveness. It also provides the information that indicates the need to disengage or withdraw in response to an enemy maneuver that could upset the local balance in his favor. For example, consider a major advance of enemy armor. With [redacted] the movement of armor can be seen, possibly identified by the nature of its motion, sized by radar target counts, and its avenue of approach inferred. The decision to engage the armor with TOW units can be made and the force can be maneuvered into position. [redacted] This example, although oversimplified, still gives an indication of how the combination of high-quality sensor information coupled with good C^3 can have a very significant impact on a battle. JS 3.3(b)(5)

The impact of high-quality sensor data at the Weapon and Force Control level is more obvious. The sensors have the ability to locate targets with the accuracy needed to attack them. For example, [redacted] JS 3.3(b)(5)

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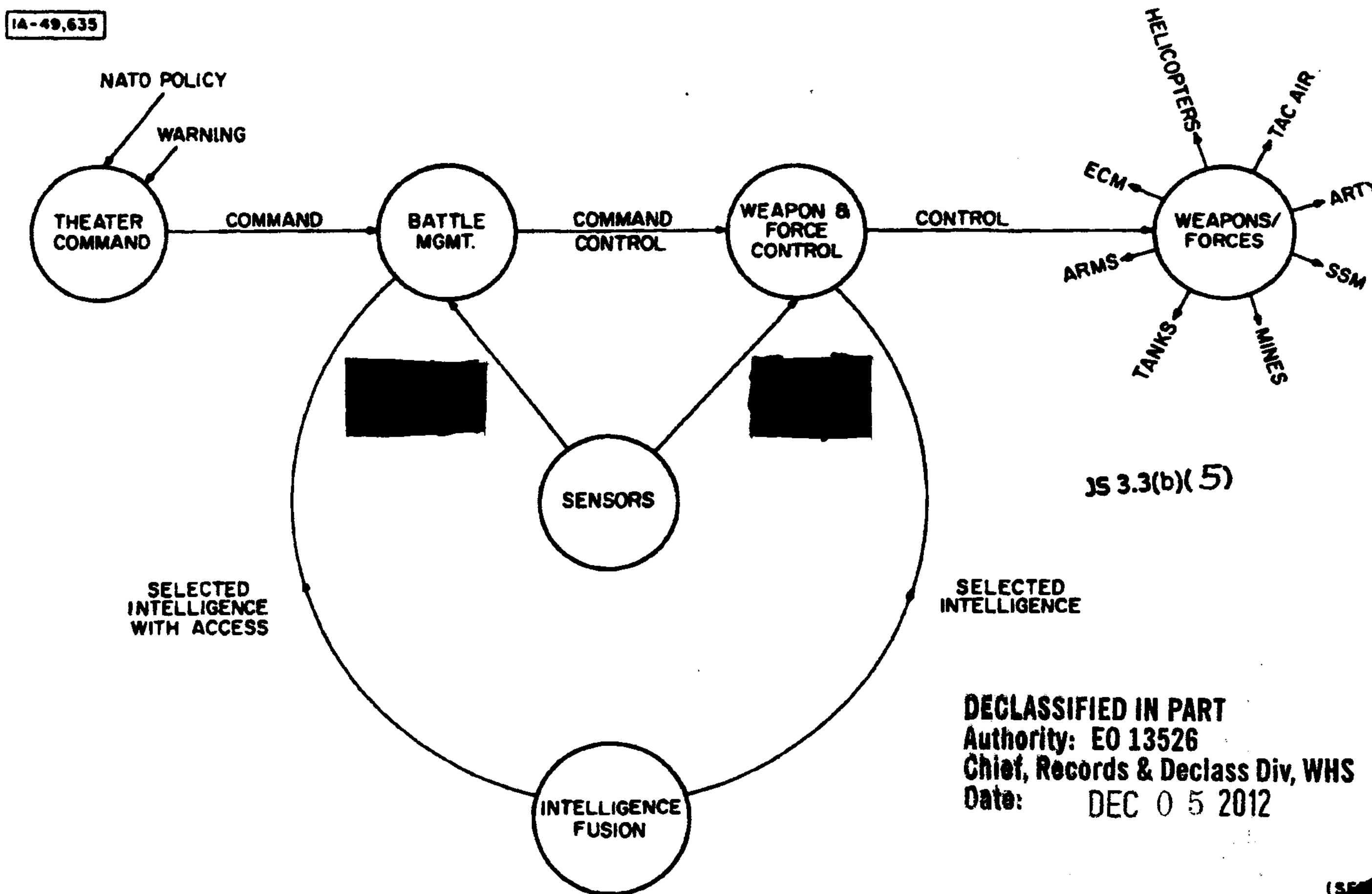

JS 3.3(b)(5)

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Figure 2. C^3 Structure (U)

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The benefit derived from the emergence of new sensor capabilities can be had if and only if we provide an effective survivable C^3 system. And if we do so, the benefits derived are thought to be very considerable. We can ill afford to pass up the opportunities offered by excellent C^3 and its supporting sensor inputs.

COUNTER C^3

If effective C^3 is a *"force multiplier"* for NATO, then it follows that the destruction and/or disruption of Pact C^3 is a *"force divider"* for the Pact. This may be especially true in view of the traditional Soviet emphasis on a strong "top down" command and control with very little latitude at the lower levels of command for initiative. This Soviet command style has historically resulted in vulnerabilities that have been exploited by their enemies, but there is evidence that they have learned from the past and have taken several precautions that will increase the difficulty of future counter C^3 actions. They have hardened several of their fixed command posts, provided alternative mobile command posts, and their communications are highly redundant and netted to provide flexible routing. The higher echelon Pact C^3 system is probably not a very attractive target because of these attributes and its distance from the forward edge of battle area (FEBA). Also, the disruption of the higher levels of C^3 probably has small impact on the battle where relief due to C^3 disruption is most needed. It is at the lower echelons of command where the greatest vulnerabilities occur and where counter C^3 can have its greatest impact on the battle. The division-to-regiment command function appears to be the best target for counter C^3 and was consequently given the most attention.

[redacted]

JS 3.3(b)(5)

Even though our analysis indicated that a jamming attack will have very great impact, we need more operational experience with ECM and should devise a series of tests to measure more exactly its impact. We must also assess the impact of our ECM on our own communications and properly limit its use to minimize this impact. Finally, we need to develop jammers which are matched to enemy systems, learn to use them, and learn to capitalize on the confusion they will create.

COUNTERFORCE

(U) Because of their special significance, the areas of counter armor, counter artillery, counter air defense, and battlefield interdiction were singled out and given careful attention. A brief summary of the findings in these areas is presented here and the detailed report of the task groups covering the areas is provided as an appendix to the report.

Counter Armor

(S) The area of counter armor is very important because of its role in the apparent strategy of the Warsaw Pact. Exercises, as well as Soviet military literature, reveal a Pact plan of attack based on a massive armor assault along a number of axes followed by exploitation of resulting breakthroughs. Under this plan we would find 400 to 500 armored combat vehicles passing through the apex of the thrust in a period of 2 to 3 hours. Bearing in mind that this plan would be implemented by a force that enjoys an overall advantage of about 3:1 in armor, it is clear that NATO must achieve a high-rate tank-killing potential that can be concentrated in space and time. This capability must be supported by good sensors, weapons, and C^3.

(U) There are two principal regions where armor vehicles in the main attacking force can be engaged. The first is the line-of-sight region, which typically extends no more than 2 to 3 km from the FEBA. The second region extends past the rear of the first echelon forces at about 40 km to the rear of the second echelon forces at about 100 km.

(S) The first region capabilities are provided by systems such as TOW and Dragon. [redacted]

JS 3.3(b)(5)

(S) In the second region, the problems are primarily target acquisition, the timely transmission of target data to the command and control system, and the near real-time targeting problem implied by the mobility of the enemy armor. Where the counter armor force is tactical air, there is also the serious problem of defense penetration, which will be discussed under counter air defense.

(S) At the present time, there are several promising new sensor systems in development or procurement which should provide accurate, timely target location with some degree of target classification. [redacted]

JS 3.3(b)(5)

as far along and capabilities, such as the JWACC discussed above, are needed if the full benefits of the new sensor are to be realized.

There are also weapon problems in this second region which require serious attention. Over the past 15 years, there has been much emphasis placed on precision-guided munitions (PGM), and these weapons have a record of proven success in Vietnam and the Middle East. However, circumstances are different in Central Europe, and weather, terrain masking, contrast, and heavy air defense may prove to be very serious problems. Also, the number of targets that must be attacked are large and high rates of kill are needed. It is clear that the PGM are not the entire answer to the NATO problem and that better area-type weapons are needed. Considerable thought was given to terminal-guided sub-munitions (TGSM), and it was concluded that increased funding to resolve the critical questions of technical feasibility and cost is indicated.

Counter Artillery

The existing knowledge of the Warsaw Pact Plan reveals an extensive use of artillery directed to the functions of infantry anti-tank suppression, counter C^3, counter battery, and destruction of nuclear capable weapon systems. The suppression function is primarily directed to the anti-tank forces employing TOW and Dragon. Army studies have revealed that the artillery suppression fire would reduce the fraction of Soviet tank kills by TOW from 45% to 10%. Hence, there is a high payoff in reducing the effects of Pact artillery by suppression or killing of his batteries.

Historically, artillery has been a very difficult target to kill or suppress. However, the existence of new capabilities [redacted] and the improved conventional munition (ICM) may well alter the situation, and these programs should be expedited. We should also ensure that [redacted] information on the location of enemy batteries is readily available so that ingress routes and unoccupied positions can be mined with artillery or air-delivered scatterable mines. [redacted] could also provide information for registration of the fire. It was also concluded that the MINI RPV development is important and will, with appropriate sensors, greatly aid in target location and designation.

JS 3.3(b)(5)

In the area of munitions, we should in addition to the ICM procurement develop a new random-delay sub-munition to increase the effectiveness of artillery suppression by further harassment of personnel. It was also concluded that the development and deployment of CLGP (cannon-launched guided projectile) and the exploratory development of a two-color IR seeker for homing in on hot barrels are desirable.

With the improvement discussed, we should have a greatly improved artillery suppression capability, but still we should take steps to reduce the numerical advantage (2:1) enjoyed by the Pact. This can be achieved by the acquisition of more tubes or by the development or foreign procurement of a surface-to-surface rocket system for general battlefield support but with emphasis on the counter-artillery mission.

Counter Air Defense

The need for tactical air in support of the interdiction and close air support missions is obvious. However, the Pact has seen fit to counter this important element of our force with a very impressive air defense. These defenses include an array of surface-to-air missile systems (SAMS) such as the SA-2, SA-4, SA-6, and SA-8, using radar, the man-portable SA-7, and the SA-9 using IR. Complementing the SAMS, there is a family of AAA systems such as the ZSU-23, a 23 mm 4-barrelled system mounted on a tank, and the dual 57 mm gun, also tank mounted. There are also 57 mm and 23 mm towed guns which are being replaced by the newer self-propelled type.

Unless some major actions are taken to counter these defenses, tactical air operations would undoubtedly suffer unacceptable attrition rates and would not in the long run prove to be effective. There are, however, several approaches to air defense suppression which should make a difference, and [redacted]

JS 3.3(b)(5)

In examining the munitions alternative, the Fuel Air Explosive (FAE) appeared to be promising and deserves serious consideration for the suppression role. It was also concluded that an artillery-launched anti-radiation missile (ARM) has promise in the region near the FEBA. Such an ARM using ICM munition was examined and it was concluded that one volley with a CEP of 25 to 50 meters can be expected to achieve high probability of kill on air defense assets. Artillery, in addition to being an inexpensive means of delivery, offers the advantage that radar will not likely shut down every time an artillery piece is fired.

Consideration was also given to the use of harassment drones employing an ARM warhead. The drones would have the capability to loiter during periods of radar shutdown and attack when the radar came up. The concept was found to be economical and technically feasible and should be given serious consideration.

Battlefield Interdiction

The Warsaw Pact strategy of massive assault and high rates of advance by its very nature is consumptive of manpower, equipment, and supplies. In order to sustain such an attack, it will be necessary to maintain a high rate of reinforcement and supply. It is logical to assume that a successful interdiction of these actions will seriously impair the momentum of the attack.

(S) Successful interdiction, as in the case of the other missions, requires good sensor data to locate and identify the enemy lines of advance, weapons that can strike 10 to 100 km forward of the FEBA, and a C^3 system capable of real-time response. New SIGINT capabilities when integrated with emerging sensor systems [redacted] and others will probably be adequate to the job; but system survivability is an issue that must be addressed. It is less clear that we will have weapons that can strike at the long ranges required or the command and control functions to be sufficiently responsive. JS 3.3(b)(5)

(S) The only currently available means for striking targets, especially moving or transient ones, out to the full range of interest (100 km) is tactical air. However, air strikes will require a major defense suppression operation if they are to be effective. There are also problems with visibility due to terrain masking and weather in Central Europe. Questions as to the effectiveness of current air-delivered munition in the interdiction mission also arise. For these reasons, it was concluded that consideration should be given to the use of surface-to-surface missiles (SSM) which are sufficiently acceptable and affordable to augment the air strike capability.

(S) Analysis of the route structure in the Fulda area of Western Germany and the traffic implied by second echelon reserve forces and supplies shows that the road density required to carry the traffic is low. Approximately 9% of the road is covered during daylight hours and 14% at night. The probability of killing a vehicle with a single large, but unguided weapon is very small. A cluster of small unguided sub-munitions increases the probability of hitting a vehicle, but the vulnerable area of vehicles to a small bomblet is small, and the resulting probability of kill is also small. It was, therefore, concluded that a weapon with terminally guided sub-munitions (TGSM) is required. There are several possible delivery vehicles, but boost/glide vehicles, cruise missiles, and RPV's have the capability of delivering the TGSM in a linear pattern which is desirable for attacking vehicles on roads. The analysis concluded that the boost/glide alternative was the lowest cost per TGSM delivered. The boost/glide vehicles analyzed cost $80K and could deliver 18 TGSM costing $5K each. The cost per TGSM delivered then came to $9.4K.

(S) The TGSM's required are being investigated by all three services, and the seeker technology includes IR, m.m. wave, and radiometric techniques. It was concluded that this work is of such importance that it should be expedited by the application of additional funds and management attention. There may also be important benefits derived by a cooperative development of all three services, and this option should be considered.

Counter Air

(S) Although counter air was not a topic covered in any detail in the study because of time and resource limitations, it is recognized to be an important consideration in the defense of Central Europe, and several discussions on the subject did take place. The conclusions resulting from those discussions must be regarded as tentative, but they are considered to be sufficiently important to mention in the hope that more attention will be given to them.

Air operations are conducted at the maximum rate when the weather is good, and it is under these very conditions that we can anticipate considerable harassment from Warsaw Pact fighters. This harassment can be expected to severely degrade the effectiveness of NATO air-to-ground operations, and the urgency of blunting the ground attack may preclude the loss in time and assets required to achieve air superiority. One suggestion put forward deserving careful study is to provide a fixed-based SSM system which could carry out an immediate heavy bombardment of 50 or so main operating bases (MOB). This would force the Pact air to the dispersed operating bases (DOB), which do not have shelters or revetments, where they would be vulnerable to air attacks from A/C such as the F111 out of the U.K. bases. Surveillance information to direct the strike could be provided by AWACS. The idea seems to have merit but certain aspects, e.g., the vulnerability of the fixed SSM's and the cost if repetitive attacks are required, require further study.

COUNTERFORCE OBSERVATIONS

The key point that emerges from the study is that we have available today the technology to develop and deploy a battle management system which would yield the advantages described, and that we have most of the technology available to develop and deploy a weapon assignment and control system to yield the advantages described. In particular, it was noted that the first and perhaps most important ingredient, i.e., the sensor inputs on targets of interest, is generally available (at least in brassboard form) today, and that some but not all of the weapons are within today's technology. These points are indicated in somewhat oversimplified form in the following sequence of figures. The basic plot, Figure 3, shows, for a number of sensors, their position on a time-accuracy plane where accuracy refers to location accuracy of targets and the time is the elapsed time from detection to readout of the information.

[redacted]

JS 3.3(b)(5)

(SECRET)

[redacted]

Figure 3. Sensor Time Response/Accuracy Plane (U)

JS 3.3(b)(5)

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appropriately displayed, the battle commander would have unprecedented knowledge of the location, movements, and probable intentions of the opposing forces. This information, combined with similar information on the disposition of his own forces, appropriately displayed and supplemented by appropriate memory and computational peripherals, would permit the battle commander to optimize the deployment, assignment, and maneuvering of his forces, and to do so with the timeliness appropriate to the battle situation.

[redacted]

JS 3.3(b)(5)

Figure 5 adds to the plot information concerning weapons. The three lines are grossly indicative of the effectiveness radius against targets of interest: for "point" or high explosive weapons, for "area" bomblet weapons, and for "TG" or terminally guided weapons. (In the case of TG weapons, the basket size is given.) It is assumed that the delivery circular error probability (CEP) to the designated location is small.

From this plot it is concluded in general terms (taking into account the known delivery problems for artillery, SSM's, and air-delivered munitions) that our location accuracy with the AMTI, TOA, CBR, and SIGINT sensor inputs is adequate and timely for a volume of artillery (point) fire. Also it is concluded that area-delivered weapons delivered with reasonable accuracy (such as GBU-15's delivered with DME guidance) to a designated location will handle some of the targets. But, more importantly, we note that if we had terminally guided munitions or sub-munitions we would indeed have a match to essentially all the targets of interest.

[redacted]

JS 3.3(b)(5)

(SECRET)

[redacted]

Figure 4. Time Response Requirement for Typical Targets Added (U)

JS 3.3(b)(5)

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(SECRET)

[redacted]

Figure 5. Weapon Accuracy for Various Weapon Classes Added (U)

JS 3.3(b)(5)

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detect and locate to the accuracy required for attack of the division headquarters units. (There are of course other roles for these sensors which relate to indications and warning, intelligence on overall dispositions, etc., which have not been treated in this report.)

Finally, it is noted that these systems for battle area management and for weapon assignment and control, although particularly appropriate for Europe to counter the numerical superiority of the Pact, would also be appropriate and extremely valuable and effective in optimizing the effectiveness of our forces in almost any kind of engagement and in almost any kind of theatre.

COUNTERFORCE CONCLUSIONS

1. The opportunity exists for a major threshold advance in tactical warfare capability by the development and deployment of a system for battle management and for weapon control.
2. The system which involves Air Force and Army sensors and weapons and control, display, and communication devices cuts across inter- and intraservice boundaries and requires joint operations in the field.
3. There is currently no focal point within OSD for the development of such a system. Because of the intimate relationship of sensors and weapons to the command, control, and display aspects of the system, we concluded that the focal point should be in DDR&E.
4. The development will present unusual managerial and organizational problems, and it is our feeling that the present arrangements will not accommodate this and that some different arrangement (such as DCPG) will be required.
5. Finally, it is concluded that this capability is sufficiently important to warrant an unusual managerial and organizational arrangement.

SECTION III

RECOMMENDATIONS

[redacted] There are many recommendations covering a broad spectrum of important NATO military needs, but three recommendations stood above the others because of their urgency and importance:

1. The warning and theatre C^3 systems in NATO should be improved to provide better warning, survivability, and response to warning. The response will require altering the state of readiness of nearly all elements of the NATO force.

2. The DoD should take the necessary managerial and other steps to permit the rapid development and deployment of Battle Management and Weapon Control Systems to achieve the available threshold improvement in tactical warfare capability.

3. The DoD should create a focal point for counter C^3 systems and mount a significant effort in this important area.

(U) Most of the recommendations resulting from the study have been discussed in the Summary Findings section, but they will be compiled for easy reference in this section. The recommendations will be grouped into the major areas covered in the study.

WARNING

[redacted] 1. Serious consideration should be given to developing a concept for reaction by Allied forces in peacetime to Soviet exercise activities. Assignment to NATO of standing forces of land and offensive air forces in peacetime is recommended as a part of this concept. This would involve increased day-to-day operational activity by NATO military commands.

[redacted] 2. There should be increased effort to develop realistic means of intelligence and information support to NATO.

[redacted] 3. NATO countries should reposition some forces and ammunitions to reduce the time required to achieve a sound defensive posture.

NATO C^3

[redacted] 1. Steps should be taken to increase the survivability of NATO theatre C^3, by increasing the number of nodes, hardening them to resist physical assault, and providing increased resistance to ECM.

[redacted] 2. A Joint Weapon Assignment and Control Center (JWACC) should be established at the Weapon Force Control level to handle the targeting and weapon assignment functions for both ground and air forces. The JWACC should be kept simple and austere by limiting its use to ground targets and data derived from selected sensors which have the timeliness and accuracy [redacted]

JS 3.3(b)(5)

3. The Battle Management level of C^3 should be provided with sensor and intelligence inputs that give a clear picture of the maneuvering of enemy forces, e.g., the type of force, its size and apparent objective. Sensors such [redacted] could collectively provide such an assessment. This level also should be provided with a thorough knowledge of the status, location, and availability of NATO force elements so that they can be maneuvered effectively to counter enemy threats. JS 3.3(b)(5)

4. Careful attention should be given to physical survivability and EW vulnerability of all our C^3 levels and sensor assets, by the use of mobility, hardening, ECCM, AJ, and ARMS. This conclusion stems from the apparent S.U. dedication to counter C^3 through physical destruction and EW. One concrete suggestion is to develop a family of ARMS on the frequencies used by our more important systems so that we are prepared to destroy jammers on these frequencies. Another suggestion is that we give far more attention to AJ protection of important communication channels, since the technology is available to greatly improve their strength against most countermeasure threats.

5. The DoD should consider creating a special organization with the responsibility of implementing this C^3 structure. A DCPG-like organization (Defense Communication Planning Group) is a good model for the type of organization needed.

COUNTER C^3

1. A program should be instituted to develop jamming equipment matched to Soviet electronic systems used for the Warsaw Pact C^3 system. Special emphasis should be placed on the jamming of division-to-regimental command links.

2. A series of realistic tests should be designed and conducted to measure the effectiveness of our EW equipment against the Pact C^3.

3. Careful attention should be given to the self-jamming created by our jammers on our electronic equipment, and means should be devised to minimize these effects without undue compromise of the effectiveness against enemy equipment.

4. We should devise better methods for the physical destruction of enemy command posts and develop the necessary weapons.

5. Serious attention should be given to the command and control of our EW assets and the weapons for physical destruction of enemy C^3.

COUNTER FORCE

[redacted] JS 3.3(b)(5)

2. Anti-armor area munitions for high- and low-altitude delivery by tactical air should be developed.

3. Increased emphasis should be placed on the development of a low-cost, terminally guided sub-munition (TGSM) for killing armor and trucks in the contact zone and for interdiction.

4. Consideration should be given to the development of a new SSM missile (probably boost/glide) which can dispense a linear pattern of TGSM for battlefield interdiction.

[redacted] JS 3.3(b)(5)

7. A random-delay sub-munition for artillery projectiles should be developed to increase the effectiveness of artillery suppression of enemy artillery.

8. The development or foreign acquisition of a surface-to-surface rocket system for general battlefield support with emphasis on and sufficient accuracy for the counter artillery mission should be expedited.

9. Take steps to assure that there is a capability to mine artillery movement routes and preplanned artillery positions determined by SIGINT information.

10. The development of the planned EW and defense suppression systems such as PELSS should be continued.

11. Serious consideration should be given to the use of the Fuel Air Explosive (FAE) in the defense suppression mission.

12. The development of an artillery-delivered ARM to kill air defense radars is recommended.

13. Consideration should be given to the development of a low-cost harassment drone employing an ARM warhead for defense suppression.

14. There should be a study to determine the effectiveness of a fixed-based SSM system to attack Pact MDB's as a counter air action.

APPENDIX A

DSB 1976 SUMMER STUDY

- **CONVENTIONAL COUNTERFORCE AGAINST A PACT ATTACK**

TASK STATEMENT

(U) The DSB is to study the possibilities and means of achieving a major improvement in non-nuclear land warfare capabilities through the development and deployment of integrated weapon systems. The environment to be considered is Central Europe and includes the heavy use of artillery in support of armored thrusts against the U.S. Forces. Consideration shall be given to:

1. Weapons (hard or electronic), delivery mechanisms, and tactics appropriate for countering the large quantities of targets associated with a Central Europe conflict;
2. Sensors to provide stand-off surveillance of battle area and battlefield interdiction targets;
3. The fusion of their surveillance data with intelligence data and with information about our own forces to provide target information of appropriate reliability, quality, and timeliness to permit engagement;
4. Appropriate command and control means;
5. Realistic environment including weather, ECM, smoke, and enemy agents;
6. The organization problems associated with the development and deployment of such systems;
7. Major improvements these systems might make in the non-nuclear land warfare capabilities, with indications of how they would fit in the force structure and which systems they would complement or replace.

STUDY ORGANIZATION AND PLANNING

(U) The Chairman for the study will be Mr. Charles Fowler. In order to make most effective use of the summer study period, certain basic briefings (e.g., scenario, NATO and WP Posture, U.S. weapons, combat results study methodology) will be reviewed prior to the summer study. The study will be under the cognizance of William Stoney, Deputy Director (TWP). Charles E. Myers, Jr., Assistant Director (Air Warfare) will be assigned as Executive Secretary and will provide assistance in providing material required for the basic studies above. Subsequent to the summer study, a report should be prepared and issued by 3 January 1977.

APPENDIX B

COUNTER ARTILLERY OPERATIONS

HISTORICAL BACKGROUND

(U) Counter artillery (counterbattery) operations had their genesis in World War I and ever since then have been a major element in operational planning and execution. They require a significant share of the ground and air resources available, with results which, historically, have been modest at best and marginal more often. Counterbattery operations have generally been more productive for the attacker than for the defender.

(U) Counter artillery target acquisition and fires have traditionally been focussed on the hostile batteries (counterbattery) and have been visualized as artillery-versus-artillery combat (the counter-battery "duel"). The usual objective of counterbattery fires has been neutralization (some casualties and damage; temporary suspension of fires) of the hostile artillery rather than destruction.

(U) The U.S. experience in counterbattery operations has, in most cases, been in situations where we have been dominant in combat strength, have been on the offensive, and have had air superiority. In these conditions observation and attack aircraft proved to be an extremely valuable asset in locating and attacking batteries. In some cases these became so effective as to force the hostile artillery to become nocturnal, rarely firing during the day. (Much of this was attribted to our ability to operate light Army/Marine observation aircraft over enemy forces.)

PRESENT AND FORECAST NATO SITUATION

[redacted] The present and forecast NATO vs Warsaw Pact situation is different from past experiences in numerous ways which influence the conduct and effectiveness of U.S./NATO counter artillery operations. Principal among these are the following:

[redacted]
- Technical advance has made possible additional ground and airborne sensors able to detect and locate hostile artillery elements in both their active and passive modes. Our target acquisition capability in combat is thus improved by some as yet unknown factor.

[redacted]
- The terminal effectiveness of our ground and air munitions has also increased by a significant multiplier. We can thus obtain the desired effect (neutralization or destruction) on engaged targets in less time, with less expenditure of munitions (numbers and tonnage), than formerly.

[redacted]
- The increasing trend to self-propelled protected weapons and command elements has reduced the effectiveness of some inventory munitions and may overcome the advantage noted above.

[redacted] • Our artillery fire control/fire direction and C^3 systems have been improved, resulting in a more efficient use of available assets (more targets engaged in a given time with optimum results).

[redacted] • U.S./NATO forces and artillery are outnumbered by Warsaw Pact forces. We are thus initially at a disadvantage in the counter artillery action and may expect to suffer a greater degree of attrition and suppression than in past U.S. experience.

[redacted] • The Soviet/Warsaw Pact air defenses may initially deny or greatly restrict our ability to use observation or attack aircraft along the FEBA or over hostile terrain. This will place a greater burden on ground target acquisition and attack elements than is visualized in current joint doctrine.

THE NATURE OF THE COUNTER ARTILLERY PROBLEM

(U) Field artillery units are inherently dispersed, closed-loop, redundant combat systems whose operating modes have made them difficult targets to locate and counter in past combat experience. Present and forecast technical advances in ground and air sensors, weapons, C^3 and operational doctrine may result in a significantly improved counter artillery capability, but this remains to be demonstrated.

(U) A field artillery unit is composed of three basic functional elements: target acquisition, fire control/fire direction/C^3, and weapons. Until the present time, target acquisition was almost wholly by ground and air artillery observers and aerial photos. Now there is a growing array of electronic and electro-optical sensors which can increase the probability of detecting the three functional elements in the various operating modes. The combat utility and survivability of these sensors is still an unknown. Many of them are not organic to the artillery (non-closed loop), which may decrease the opportunity for effective, real-time response to this target input.

[redacted] The fire control/fire direction/C^3 function has been manually performed in the past and is now becoming increasingly electronic. The men involved have been unprotected in mobile operations and dug in during static periods. There is now a trend to operate in light armored vehicles, but this is not yet evident in the Soviet army.

(U) The weapon function has been performed by towed cannon in open or dug-in positions. The weapons themselves have been hard targets, difficult to kill, but operating troops have been exposed to counterfire. A growing percentage of the artillery pieces of modern armies are now self-propelled with light armor protection for the operating crew, but many essential men are still exposed. However, self-propelled cannon are now subject to M-kills.

(U) Field artillery has traditionally had a high degree of battlefield mobility. It has also had a high degree of redundancy (operational survivability) obtained through both numbers and operating procedures. To effectively accomplish its combat mission it cannot be a passive target but must move, radiate, and shoot, and thus becomes an active target, susceptible to detection and attack.

The information on this page is Unclassified.

(U) In summary, in the past field artillery has been a difficult force element to find and attack and has been predominantly an anti-personnel target. Now there exist more methods and resources to find it and it is a target for anti-personnel, anti-materiel, and EW attack.

(U) Finally, the effectiveness of counter artillery operations is not determined solely by the quality and quantity of the hardware used by the three functions, but is in a large part dependent upon the operating doctrines, tactics, and skill of the opposing forces, a critical but non-quantifiable element of any combat model or equation.

COUNTERBATTERY ANALYSIS

Purpose and Scope

(U) The purpose of this analysis was to investigate means of countering Soviet numerical superiority in artillery in the context of a central European engagement. Specific means examined for relative effectiveness are:

1. Increasing the ordnance delivery rate either by increasing the fire rate of U.S. tube artillery or by supplementing artillery with a rocket system such as the GSRS (Army General Support Rocket System);
2. Increasing the single-round lethality of U.S. weapons with precision-guided munitions (PGM); and
3. Increasing the productivity of counterbattery fire by priority targeting.

Assumptions

(U) The scenario used in the analysis, except as otherwise noted, is considered representative of the situation in the V Corps area of West Germany. The U.S. is assumed to have 15 self-propelled (SP) artillery batteries, 80 percent (12 batteries) of which engage in counterbattery fire. These 12 batteries fire at 12 separate Soviet artillery batteries. For convenience, it is assumed that all U.S. batteries are 155 mm, range-to-target is 14 km, and the rounds fired are dual-purpose ICM. The Soviets are assumed to have 50 towed artillery batteries (Red to Blue force ratio ~3:1), 30 percent (15 batteries) of which engage in counterbattery fire. These 15 batteries engage 5 U.S. batteries in accordance with Soviet doctrine for neutralization which prescribes that 3 batteries fire at one U.S. SP battery for 15 minutes. All of the Soviet guns are assumed to be 152-mm weapons firing HE rounds at a range of 14 km. For the purpose of estimating casualties, the initial troop posture (during the first volley) is assumed to be 60 percent standing and 40 percent in foxholes. For subsequent volleys, the posture assumed is 25 percent prone and 75 percent in foxholes. In a 15-minute, noninteractive engagement, the U.S. guns fire 24 rounds per tube whereas the Soviets, with a higher sustained rate of fire, fire 40 rounds per tube. All of the figures which follow assume a 50-m target location error for both the U.S. and the Soviets.

Effects of Target Location Error and Munitions

[redacted] With this set of assumptions, the success of U.S. and Soviet counterbattery fire in destroying guns and causing personnel casualties was calculated using the Army Materiel Systems Analysis Agency (AMSAA) SNOW (QUICK III) computer model. All of the detailed model inputs (e.g., lethal areas of munitions) were coordinated with AMSAA. The effect of a decrease in target location accuracy (from 50 to 200-m TLE) was calculated for one case to illustrate the significance of this parameter. Also calculated was the kill probability (P_k) per PGM required for the U.S. to destroy the same fractional number of Soviet guns as the fraction of U.S. guns destroyed by the Soviets. Two PGM's for each SP gun were assumed in the latter calculations, since space constraints preclude the 155-mm SP from storing more than two CLGP. (CLGP is considered as a proxy for all PGM's in this case.) PGM effectiveness is the same for 50-m and 200-m target location error, since the "basket" size is greater than 200 m.

(U) The results tabulated in Table B-I indicate the marked superiority of the ICM rounds over HE in causing casualties among exposed personnel. For the anti-materiel role (gun destruction) the ICM advantage over HE is much less. The results show that the large area coverage of the ICM round cannot compensate for an increase in target location error from 50 m to 200 m. The calculations indicate that a PGM with a P_k of only about 0.1 would enable the U.S. to achieve parity in gun kill rate.

Table B-I

Effects of Counterbattery Fire (U)

	Effect of 720 HE Soviet Rounds on Each of 5 U.S. Batteries		Effect of 144 ICM U.S. Rounds on Each of 12 Soviet Batteries	
Target Location Error	50 m	200 m	50 m	200 m
% Casualties to Exposed Personnel	15	9	28	13
% Guns Killed	21	12	7	3
% Guns Surviving	93	94	98	99

Assumptions:

U.S.: 15 155-mm batteries, 12 batteries for counterbattery fire, 24 rounds fired per tube in 15 minutes.

Soviets: 50 152-mm batteries, 15 batteries for counterbattery fire, 40 rounds fired per tube in 15 minutes.

CO[redacted]TIAL

Increased Rate of Delivered Ordnance

Tube Artillery

[redacted] Figure B-1 shows the effect of increasing the U.S. fire rate on the force loss exchange ratio (percent of Soviet guns lost divided by the percent of U.S. guns lost) as a function of the artillery force ratio. The force loss exchange ratio shown in the figure is that at the end of the 15-minute non-interactive engagement. Currently the U.S. rate of fire is [redacted] represented by the lower curve. [redacted] The artillery force ratio, for this and subsequent graphs, was varied by holding the Soviet force constant at 50 batteries and changing the number of U.S. batteries. The fraction of U.S. batteries in the counterbattery role is 80 percent at all force ratios. The results indicate that the U.S. firing rate would have to be increased very greatly to balance the Soviet quantitative advantage.

General Support Rocket System (GSRS)

[redacted] Another way to increase the rate of delivered ordnance is to use a multiple rocket system such as the Army's GSRS in the counterbattery role. The characteristics of GSRS, as described in the Army's BATTLE KING report, are as follows:

Diameter: 6 in.
Weight: 200 lbs
Launcher Capacity: 25 to 30 rockets
Firing Time: 15 to 20 sec (full load)
CEP: 6 to 8 mrad

Reference 1 evaluated the effectiveness of such a GSRS, with ICM submunitions, against personnel and tanks. The report concludes that, on a round-for-round basis, the 155-mm howitzer and the 6-inch GSRS are approximately equal in effectiveness for the same conditions of fire control and target posture. The same conclusion was made in the BATTLE KING study. A GSRS offers a significant firepower advantage over tube artillery, provided the reload time for the load of 25 to 30 rockets is significantly less than the time of 15 minutes required for the artillery to fire a roughly equal number of rounds. (The Army representative to the panel quoted a figure of 5 to 6 minutes for the GSRS to fire two loads.)

Increased Round Lethality

(U) Figure B-2 illustrates the effect of PGM single-shot kill probability on the force loss exchange ratio. With artillery force ratio between about 3.5 and 5.5 to 1, the U.S. requires at least 10 percent of its ordnance load to be PGM's, each with a P_k of at least 0.3 to achieve a favorable exchange at the end of the 15-minute non-interactive interval.

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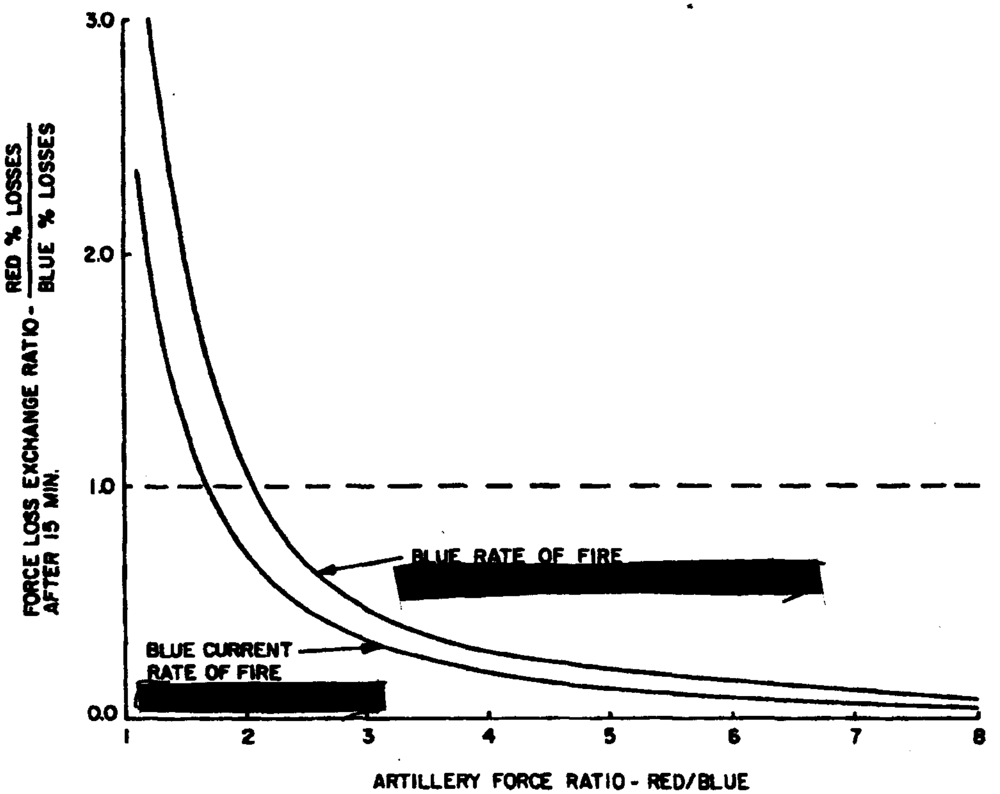

(CONFIDENTIAL)

Figure B-1. Effect of Blue Fire Rate on Artillery Force Loss Exchange Ratio (U)

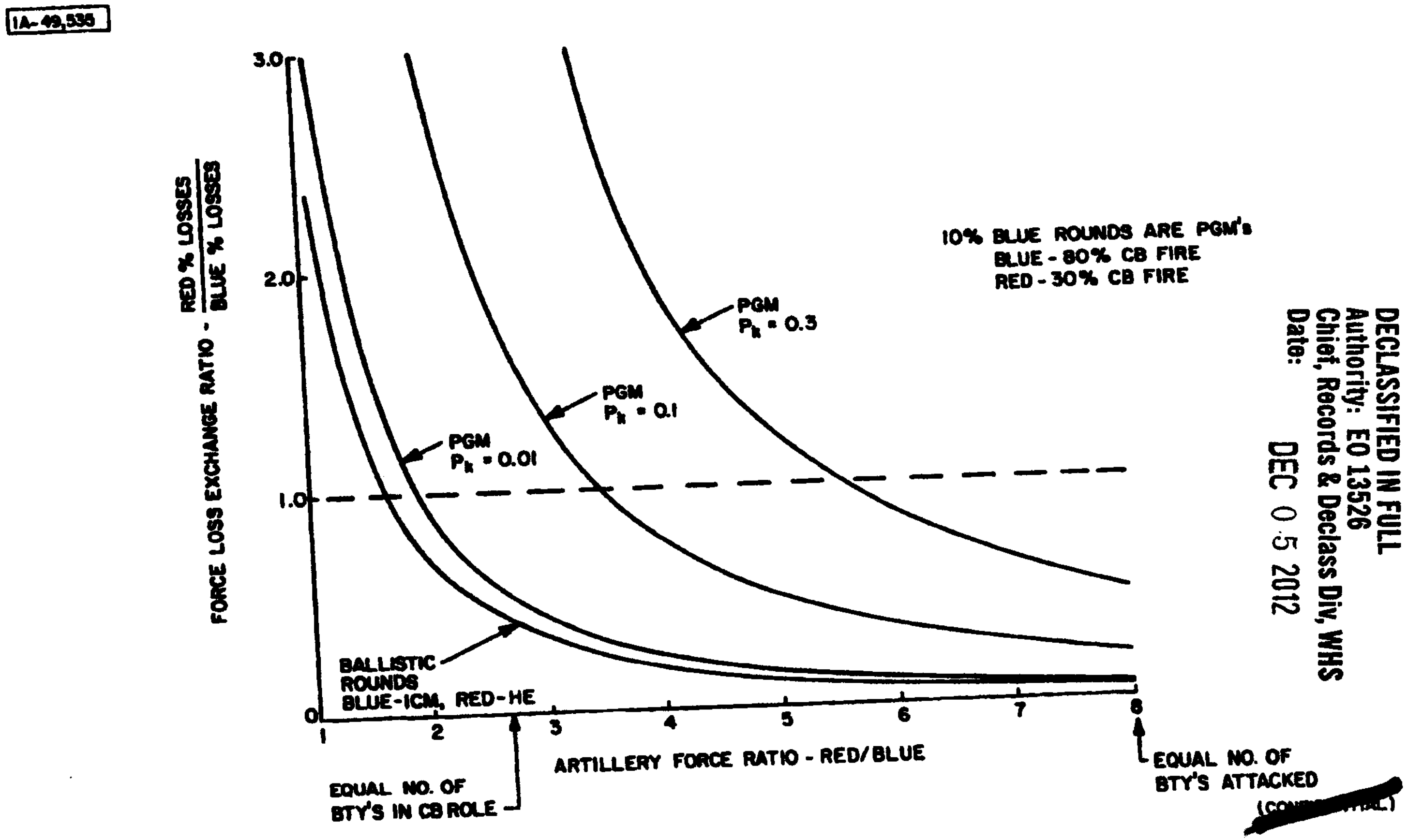

Figure B-2. Effect of PGM Kill Probability on Force Loss Exchange Ratio (U)

Soviet Counterbattery Strategy

(U) Thus far we have assumed that the Soviets employ only 30 percent of their artillery in the counterbattery role. Now let us assume a Soviet strategy that employs extensive counterbattery fire for 15 minutes prior to the normal preparatory fire in order to limit the capability of U.S. artillery to interfere with the Soviet preparatory fire. Figure B-3 shows the effect of this strategy on the force loss exchange ratio. It also illustrates the U.S. PGM requirements to meet this Soviet strategy. It is assumed that the Soviets have 50 batteries of 152-mm towed artillery, employed with 3 batteries firing HE at each U.S. battery. The U.S. is assumed to employ all of its batteries firing ICM in counterbattery fire, using one battery against each Soviet battery.

[redacted] As a comparison of Figure B-3 with B-2 indicates, this is a better strategy for the Soviets than employing only 30 percent of their artillery in a counterbattery role. Whether the Soviets would employ this strategy in wartime depends on their perception of how well they could destroy or suppress the U.S. antitank forces with and without extensive counterbattery activity. To counter this strategy, the U.S. requires at least 20 percent of the ordnance load to be PGM's with a P_k of 0.3 or greater for the expected artillery force ratios.

Interactive Counterbattery Duel

(U) A main objective for U.S. counterbattery fire is to reduce the volume of Soviet artillery fire directed against U.S. maneuver forces. Figure B-4, showing the results of a counterbattery war game, illustrates the effectiveness of the U.S. forces in doing this with conventional ammunition and with PGM's. The assumptions described earlier (page B-3) were used. The model is interactive in the sense that every 15 minutes a count is made of the guns surviving on both sides to determine the forces available for the next 15-minute engagement. Target acquisition capability was assumed to be perfect for both sides. The allocation of fire to counterbattery and enemy artillery firing at maneuver forces was made at random.

(U) Soviet forces are drawn down due to the physical loss of guns and casualties in the gun crews. At the end of a 15-minute time increment, gun crews with greater than 50 percent survival can continue to fire, but with proportionally reduced effectiveness, during the following 15 minutes. When the level of gun crew casualties reaches 50 percent, the gun is considered to be out of action. These assumptions about the effectiveness of gun crews are based on techniques developed in Reference 2. In this analysis, the U.S. artillery force effectiveness is degraded either by the destruction of guns or by guns being forced to move. An SP gun under counterbattery fire will move to a new location after expending all on-board ammunition (24 rounds), rather than attempting to reload under fire. It is assumed that 30 minutes are required for an SP gun to move (about 1 km), reload, and begin firing again. Therefore, a U.S. battery which has been under counterbattery fire for 15 minutes is out of the game for the following 30 minutes; meanwhile the Soviets acquire and fire on another U.S. battery.

(U) The results shown in Figure B-4 indicate that the U.S. requires at least 10 percent of its artillery rounds to be PGM's with a P_k of at least 0.3 to have a sizable impact on the capability of Soviet forces to conduct preparatory fires against U.S. maneuver forces.

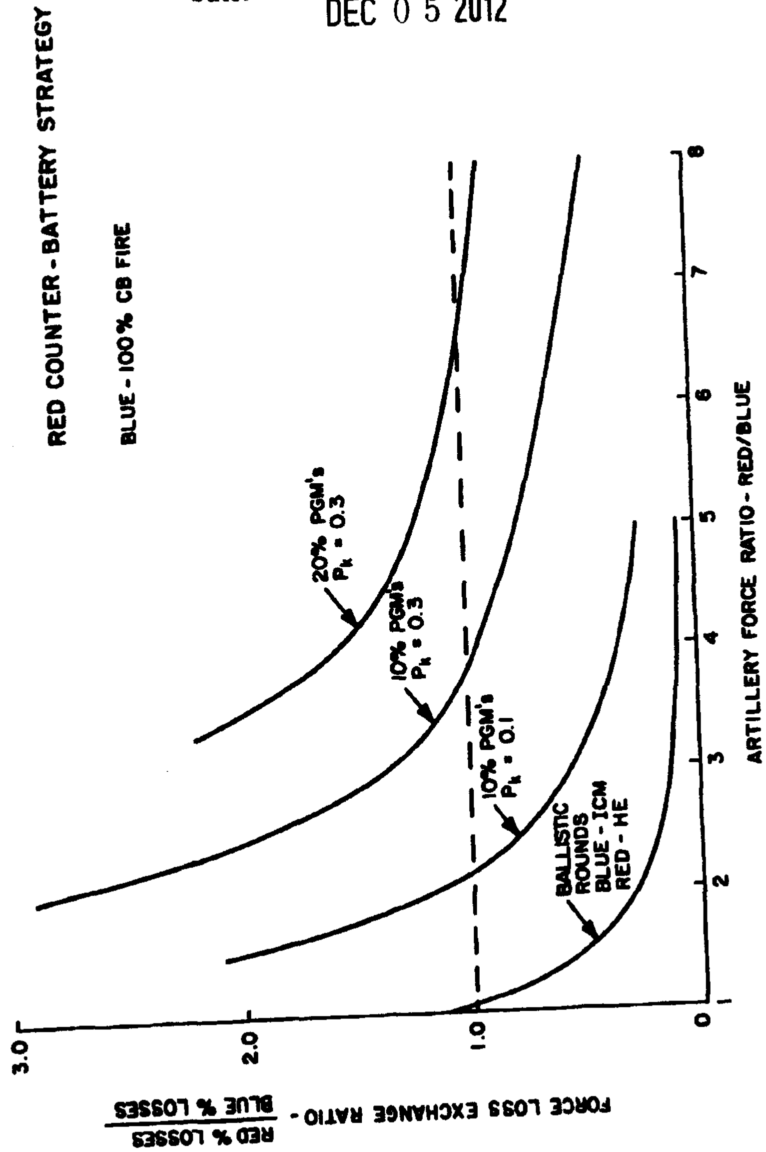

Figure B-3. Effect of PGM Load Fraction on Force Loss Exchange Ratio (U)

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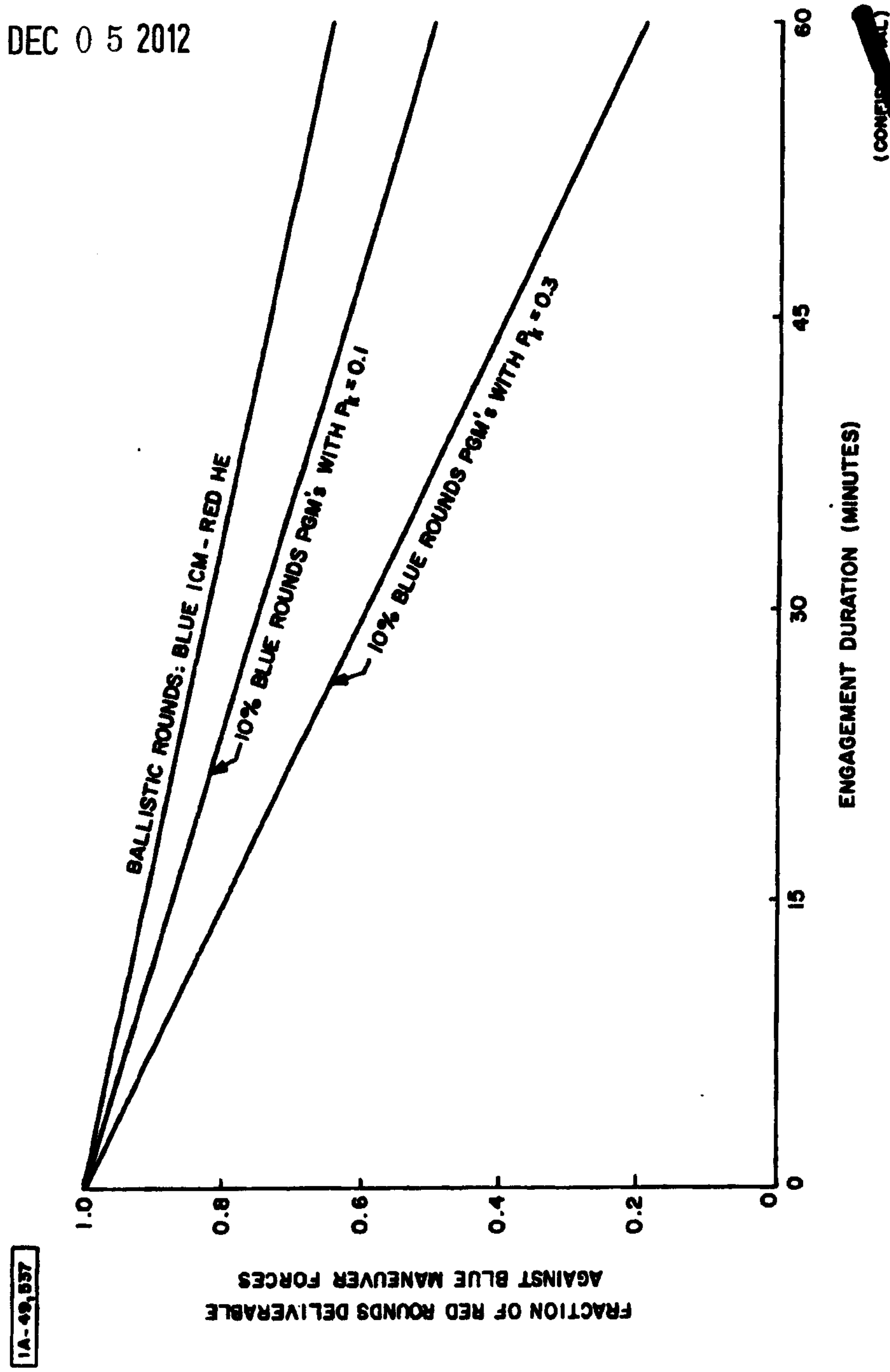

Figure B-4. Effect of PGM Kill Probability on Red Force Drawdown as a Function of Engagement Duration (U)

(U) In Figure B-4, perfect target acquisition capability was assumed for both the Soviets and the U.S. Figure B-5 indicates the effect of limiting the initial target acquisition probability. It was assumed that neither side has the capability to acquire new targets after the engagement begins. The following conclusions can be made:

- Without more lethal rounds (PGM's) the present U.S. ability to counter Pact artillery is not target-acquisition limited. It is firepower limited.
- The results of an artillery duel in a Warsaw Pact breakthrough situation are insensitive to variations in Pact initial target acquisition probability between 0.5 and 1.0.
- If the U.S. artillery is equipped with PGM's, it needs a highly effective target acquisition capability to blunt the Warsaw Pact artillery (i.e., better than 50 percent probability of initial target acquisition, and capability to locate firing guns at the rate of about 5 per minute).

Priority Targeting

[redacted] Figure B-6 illustrates the advantage to the U.S. of not only locating Soviet firing batteries but also knowing at which target each Red battery is firing. The present artillery locating radars do not have this capability. The assumptions are that the U.S. has 15 batteries, of which 12 are engaged in counterbattery fire with ICM rounds. The Soviets have a total of 50 batteries, 29 of which are attempting to destroy the U.S. antitank weapons with HE. The U.S. antitank weapons were located at particular points on a specific piece of terrain near the FEBA in the V Corps area of West Germany. Without knowing the location of the TOW and DRAGON teams, an experienced artillery officer planned the Soviet artillery fires against points where he thought the antitank weapons would most likely be located. This produced a range of target location errors from near zero to more than 500 m.

(U) The upper line on the graph shows the fraction of damage sustained by the antitank weapons when the U.S. can locate all the Soviet batteries and conducts counterbattery fire against them at random. The dashed extension to the solid line illustrates the expected effect if the U.S. had more than a 12-battery CB capability. The middle line demonstrates the effect of the U.S. forces' being able to determine which Soviet batteries are firing at their antitank weapons, but allocating U.S. counterbattery fire without regard to the accuracy of the Soviet fire. In the lower curve, the U.S. allocates counterbattery fire against the Soviet batteries that are hurting the antitank forces most, suppressing first those Soviet batteries that are "on-target"; this implies a rapid, efficient U.S. C^3 and target acquisition capability. The results demonstrate the importance of the capability to conduct priority targeting.

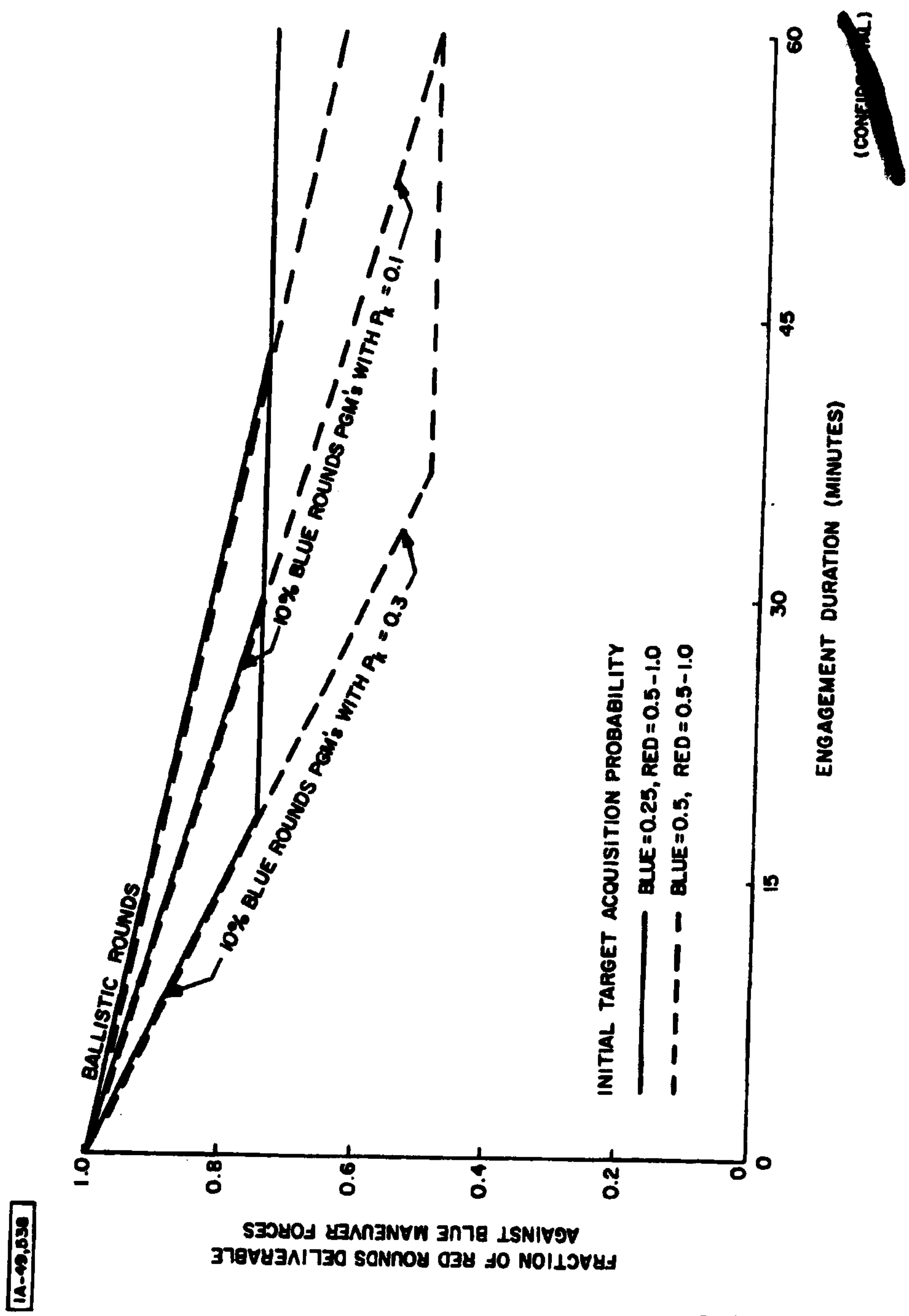

Figure B-5. Effect of Target Acquisition on Red Force Drawdown as a Function of Engagement Duration (U)

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Chief, Records & Declass Div, WHS
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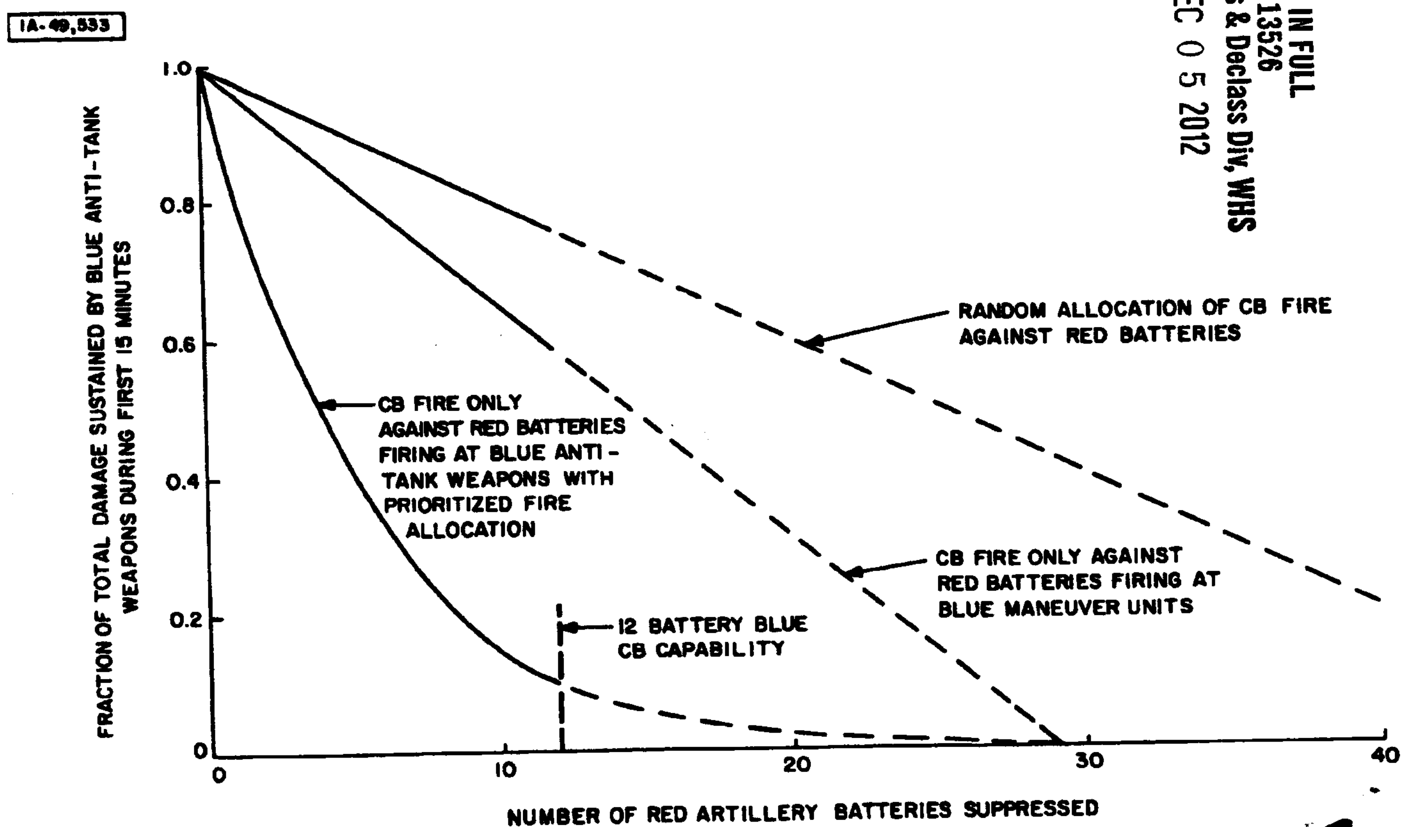

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Figure B-6. Effect of Prioritized Counterbattery Fire on Red Capability To Counter Blue Anti-Tank Weapons (U)

FINDINGS

The "Roto-Tiller" Threat

[redacted] Braddock and Wikner in Reference (3) have described a Warsaw Pact artillery deployment and strategy consistent with Soviet tactics, doctrine, exercises, and other intelligence information. In this model the Pact would deploy about 50 artillery batteries of 6 tubes each spaced 1 to 2 km apart, for good nuclear survivability. Prior to engagement of armored and anti-armor forces a massive artillery barrage would be carried out over a period of about one hour. A stylized timeline for planning, movement, and execution of the barrage is shown in Figure B-7. The Braddock model gives the Pact the capability to fire about 100 rounds per tube during this one-hour barrage. The Pact target allocation would be as follows:

No. of Targets	No. of Rounds	U.S. Targets
12	21,000	Nuclear-capable systems (8-inch, 155-mm batteries, Honest John, Lance)
2	1,400	Command & control systems
8	6,600	Anti-armor systems
4	1,400	Mortars & 175-mm batteries

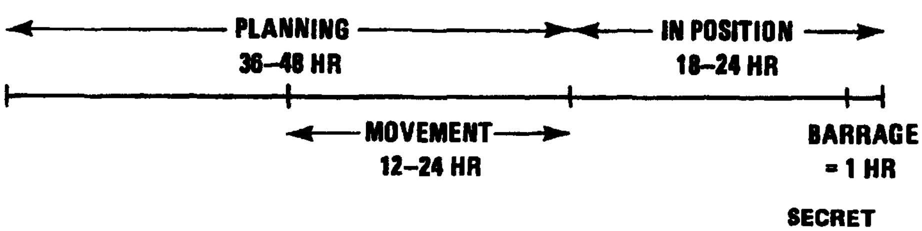

Figure B-7. Stylized Timeline (U)

[redacted] This model should be viewed as an upper limit to the threat. Without any intervention by U.S. Forces to disrupt the planning, movement, and preparation for the barrage it is theoretically possible that the barrage could be carried out as described, but the operation would require precise orchestration unlikely to be achieved in a war. The success of the barrage in destroying or suppressing U.S. targets would depend primarily on whether, and how well, the Pact can locate U.S. targets – questions we could not precisely answer during the study. It would be prudent to assume that Pact intelligence could acquire planned defensive positions and pre-surveyed weapon sites. If this were the case, one-third to one-half of these positions would be occupied after the engagement began. This knowledge, combined with battlefield reconnaissance, surveillance, and target acquisition sensors, would provide sufficient target location knowledge to make the artillery barrage very effective.

The Payoff from Artillery Suppression

[redacted] The priority targets for Soviet artillery are our nuclear-capable artillery and rockets and our infantry anti-tank forces equipped with anti-tank guided missiles. Soviet military commentary reflects the belief that their armored forces are not only numerically superior but superior in performance and firepower. On the other hand they are impressed with and respect Western ATGM's and they plan to use their artillery to suppress the anti-tank forces. It was beyond our capability in the summer study to quantitatively assess the increase in survivability of U.S. systems due to suppression of Soviet artillery. In the first place, there is not general agreement on what constitutes suppression, since this depends on such intangibles as troop motivation and bravery. A recent Army study (Reference 4) evaluated the effect of suppression of Soviet artillery on survivability and effectiveness of anti-tank forces in killing Soviet tanks. The finding was that total suppression would increase the fraction of Soviet tanks killed in an exemplary engagement from 10% to about 45%.

The Problem of Force Ratio

[redacted] The 50 Pact batteries (300 tubes) would be arrayed to concentrate fire across a 4- to 6-km wide breakthrough zone somewhere in a NATO Division front, which is nominally 50-km wide. Given sufficient warning time a U.S. division could mobilize at most about 22 batteries to defend against the breakthrough operation. U.S. doctrine would allocate one-third of these batteries to counterbattery fire. We would be outnumbered by about 2.5 to 1, with deficiencies in range and rate-of-fire compared to the Soviet batteries. Assuming both sides have about the same target location knowledge and ammunition lethality, U.S. artillery would be rapidly annihilated (according to Lanchester's law, 2.5^2 faster than the enemy is attrited).

[redacted] If this artillery battle took place today, both the U.S. and the Soviets would use more or less equivalent HE fragmenting rounds. The U.S., however, has developed and is deploying dual-purpose (anti-personnel and anti-materiel) Improved Conventional Munitions (ICM) which are about an order of magnitude more effective in the anti-personnel role.

Quality versus Quantity

[redacted] Theoretically, in a steady-state situation ICM's would enable the U.S. to balance the adverse force ratio, given perfect target acquisition, for as long as the Soviets did not have equivalent ICM's. That is to say, Red probability of kill is equal to Blue probability of kill if Blue uses ICM and Red uses fragmenting HE. There are three dangers in this strategy. First, Red could more easily gain an advantage by virtue of being the offensive force and through early strategies. Secondly, with imperfect but equal target location capabilities, Red regains the advantage. Thirdly, we cannot argue convincingly that the Soviets could not develop and deploy equivalent ICM's with little or no advance warning.

Although we can make the case that the U.S. technologically leads the Soviet Union in weapon target location capability, we have not yet fielded a significantly superior system, and the advanced systems under development are potentially vulnerable.

The calculations presented in the Counterbattery Analysis section indicate a very significant payoff from a PGM capability. Guided rounds with $P_k \approx 0.3$ deployed at about 20% of the ordnance load would give the U.S. the capability to annihilate the Soviet batteries.

The desired PGM capability can probably be achieved with the CLGP system and MINI-RPV target acquisition and laser designation system now under development by the Army. Alternatively, a passive, two-color, infrared projectile homing system combined with an artillery location system such as a projectile tracking radar would be suitable.

When we try to defeat the numerically superior force by using more lethal munitions to destroy the enemy weapons or by using the more effective ICM's to suppress those weapons, our target acquisition capability becomes critical. The outnumbered Blue force must be certain that the Red batteries not located, and therefore not threatened or suppressed, are not great enough to suppress Blue batteries or destroy them at a higher rate than Blue can achieve. On a comparative basis this means that Blue's target acquisition capability must be superior to Red's. It appears that current deployed capabilities of Blue and Red forces are roughly equivalent, although the U.S. has the technological advantage.

We found that some of the most valuable information on Red battery locations, especially prior to the beginning of the barrage, is obtainable from SIGINT. This information could be used as the basis for delivery of scatterable mines along routes leading to, and in the vicinity of, probable battery locations. We also believe there is high payoff from combining SIGINT to include COMINT, emitter location, and emitter identification, with Moving Target Indicator (MTI) radar and Fixed Target Indicator (FTI) radar data to locate and track batteries moving into position prior to start of hostilities, batteries shifting to new positions after the engagement begins, or batteries in position but not yet firing.

The "Achilles Heel"

As discussed above, it is technologically possible to overcome our quantitative inferiority with a qualitative superiority in munition lethality and target acquisition capability. On the other hand, the improvements we discuss are unproven and unfielded with the exception of ICM's. Furthermore, it would be imprudent to assume in our planning that the Soviets would not deploy parallel or equally effective qualitative improvements. After all, artillery has not changed very much in nearly a century, so why should we believe that in the next 5 to 10 years the U.S. will suddenly leap ahead of their Soviet counterparts to overcome the unfavorable force ratio of two or three to one? We conclude, therefore, that we need more artillery, or else we need to supplement what we have with other weapons, if we want assurance of adequate counter artillery capability. The most interesting options for supplementation are mines to disrupt and blunt the threat, rockets employed in counterbattery fire, and air-delivered cluster munitions.

RECOMMENDATIONS

Target Acquisition

1. Expedite the development and deployment of the TPQ-36 and 37 artillery and mortar locating radars, including modifications or upgrades to minimize the potential vulnerability of these systems to location, jamming, and attack.

2. Ensure that SIGINT information on the actual or probable future location of enemy batteries is made available soon enough so that ingress routes and unoccupied positions can be mined with artillery or air-delivered scatterable mines.

3. Continue the development of the MINI-RPV and its payloads for location and target designation of enemy artillery batteries. Sensor payload options should include video systems, MTI and ground-mapping microwave radars, laser designators, millimeter-wave target acquisition systems and designators, emitter location and identification systems.

4. Carry out Joint Service field experiments to evaluate sensor options and determine the effectiveness of merging COMINT, emitter location and identification, MTI radar and FTI radar information in real time, and closely coupling this information to strike systems.

Advanced Artillery Munitions

1. Continue procurement and deployment of ICM's.

2. Develop and deploy random-delay submunitions for artillery projectiles, tailored to increase the effectiveness of an artillery in suppressing enemy artillery.

3. Expedite engineering development and deployment of CLGP and the exploratory development of passively guided projectiles for homing on hot gun barrels (e.g., a two-color infrared seeker).

Artillery Supplements

1. Expedite development or foreign procurement of a surface-to-surface rocket system for general battlefield support, but with emphasis on the counter-artillery mission. System must have sufficient range (probably 30 to 40 km), mobility, rate-of-fire, reload capability, and accuracy to be effective in early and sustained artillery suppression and annihilation missions.

2. Expedite IOC of GBV-15.

New Initiatives

[redacted] 1. Take the necessary steps to assure that there is a capability to mine artillery movement routes and preplanned battery positions based on SIGINT information.

[redacted] 2. Develop a long-range (about 100 km) integrated surveillance/strike system with a counter-armor as well as a counter-artillery capability. This system must be capable of quick-reaction strikes against moving and deploying batteries prior to the enemy's initiation of artillery barrage. Surveillance and target acquisition should be based on a merger and correlation of information from COMINT, emitter location and identification systems, MTI radars, FTI radars, and possibly other intelligence sensors. It is important to operate the weapon system in a common spatial grid with the acquisition sensors and to close the loop between target acquisition and the weapon system at the lowest possible echelon. The characteristics of the weapon system (a Battlefield Interdiction Missile) should be determined from design and tradeoff analyses, but appear nominally to be:

   100-km range

   1000-kgm weight

   Surface-to-surface and air-to-surface capable

   Terminally guided submunitions (TGSM) and area submunition options

[redacted] The principal risks in the system concept are cost and feasibility of the TGSM's. Therefore the initiative should begin accelerated exploratory development of the TGSM guidance concepts. Since all the Services have needs and activities in terminal guidance, it is imperative that the program be joint-service or assigned to a defense agency.

REFERENCES

(U) 1. System Planning Corporation, Report 232, An Examination of Towed Howitzer Alternatives (U), dated 31 December 1975.

(U) 2. RAND Memorandum RM-6268-PR, FAST-VAL: Relationships Among Casualties, Suppression and the Performance of Company-Size Units (U), dated March 1970.

(U) 3. [redacted] "An Assessment of Soviet Forces Facing NATO – The Central Region and Suggested NATO Initiatives," Draft BDM Report.

(U) 4. Col. [redacted] verbal discussions.

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5 U.S.C. § 552 (b)(6)

APPENDIX C

ANTI-ARMOR CAPABILITIES

INTRODUCTION

In this section, armor is taken to refer not only to tanks but also to armored personnel carriers and air defense vehicles which, under the combined arms concept, would be expected to form an integral part of an advancing armored column. Based on observations of Warsaw Pact exercises and on both classified and unclassified Soviet military writings, such formations are, in fact, to be expected in the event of a massed Pact armored attack in Central Europe. Without deemphasizing the importance of tanks as a target, it is important to recognize the limitations and vulnerabilities of tanks alone without supporting infantry, artillery, and air defense. Therefore considerable value attaches to modes of attack (such as area munitions and scatterable mines) which may attrite essential supporting arms accompanying tank columns at rates equal to and usually greater than the rate at which the tanks themselves are attrited. Artillery is an important element of a combined-arms army attack and has a direct effect on the effectiveness of armor through its role in suppressing particularly the relatively unprotected but highly proliferated anti-tank weapons of the defense. However, since the artillery is not usually to be found co-located with the main armored units on the attack, it must be located and attacked by different means at different places and often at different times than the column of vehicles carrying forward the main armored thrust. For this reason, artillery is not addressed here but is dealt with in another section of this report.

Findings and Conclusions

- Given that attack is allowed to materialize, armored vehicle kill rates per attack zone of 400–500 vehicles over 2–3 hours must be achieved.
- Lack of good submunition for delivery from high, medium, or low altitude may cause high aircraft attrition depending on phase or Pact attack, weather, depth of penetration, terrain, type of target, and effectiveness of defense suppression.

[redacted]

Recommendations

JS 3.3(b)(5)

- Develop area anti-armor munitions for high- and low-altitude delivery with standoff potential.
- Place increased emphasis funding on TGSM to resolve critical technical/cost issues.

[redacted] • I²R Maverick: Test the accepted system in the operational environment as soon as possible. TAC should assist in design and conduct of such a test.

[redacted] • Integrate target acquisition/assignment for maximum cross-targeting flexibility (including cross-service transfers).

WARSAW PACT ATTACK FORMATIONS AND PLANS

[redacted] The armored forces available to the Warsaw Pact in Central Europe are estimated to be very formidable, ranging from 35 divisions without intensive mobilization to 80 divisions given 30 days for mobilization. Exercises, as well as classified and unclassified Soviet military literature, suggest that the Pact plan of attack (or defense) is to mount a massive, armored, combined-arms assault along a number of main axes and to exploit breakthroughs which develop along these axes. Very high rates of advance are called for, aided by massive artillery barrages and by battlefield nuclear weapons when needed to sustain the advance.

(U) The present report deals only with the conventional phase of the conflict. However, the Pact plans, even for conventional warfare, are definitely conditioned by complete awareness of and readiness for the possible use of battlefield nuclear weapons at any stage of the armored assault. Thus the intense force concentrations needed to force or exploit a breakthrough by conventional weapons are formed for as short a period as possible before they are to attack, and massive firepower and shock are counted on to support high rates of advance and speedy breakthrough once the attack begins.

[redacted] A schematic representation of a typical Pact armored force concentration and firepower concentration in the vicinity of a main axis of attack is shown in Figure C-1. (It should be noted that many variants of the attack configuration are possible, depending on terrain, tactics, disposition of defenses, etc.) Figure C-2 indicates the anticipated or planned timing of the attack for these forces. It is apparent from these figures that, if the attack is allowed to develop along these lines, some 400 to 500 armored combat vehicles may be expected to be encountered passing through the apex of the thrust in a period of 2 or 3 hours. Moreover, there may be as many as six to ten axes of attack, at least initially, along the Central European Front.

(U) These plans of attack to be implemented by armored forces with an overall (not local) tank advantage of 2 or 3 to 1 pose a NATO requirement not only for a very large overall armor-killing potential but for a capability to rapidly concentrate this potential at local points of maximum Pact offensive effort and to accomplish very high rates of kill in these local areas.

TARGET ACQUISITION, LOCATION, TRACKING, AND DESIGNATION

(U) For purposes of this discussion, there are two regions in which armored forces concentrated for a massive assault may be attacked. The first region is in line-of-sight of either ground or airborne observers on the defenders' side of the FEBA. To the extent that sightings are unaided-visual, and given meteorological conditions in Central Europe, the first region typically extends no more than 2-3 km from the FEBA. The second region extends beyond this, past the rear of the first echelon

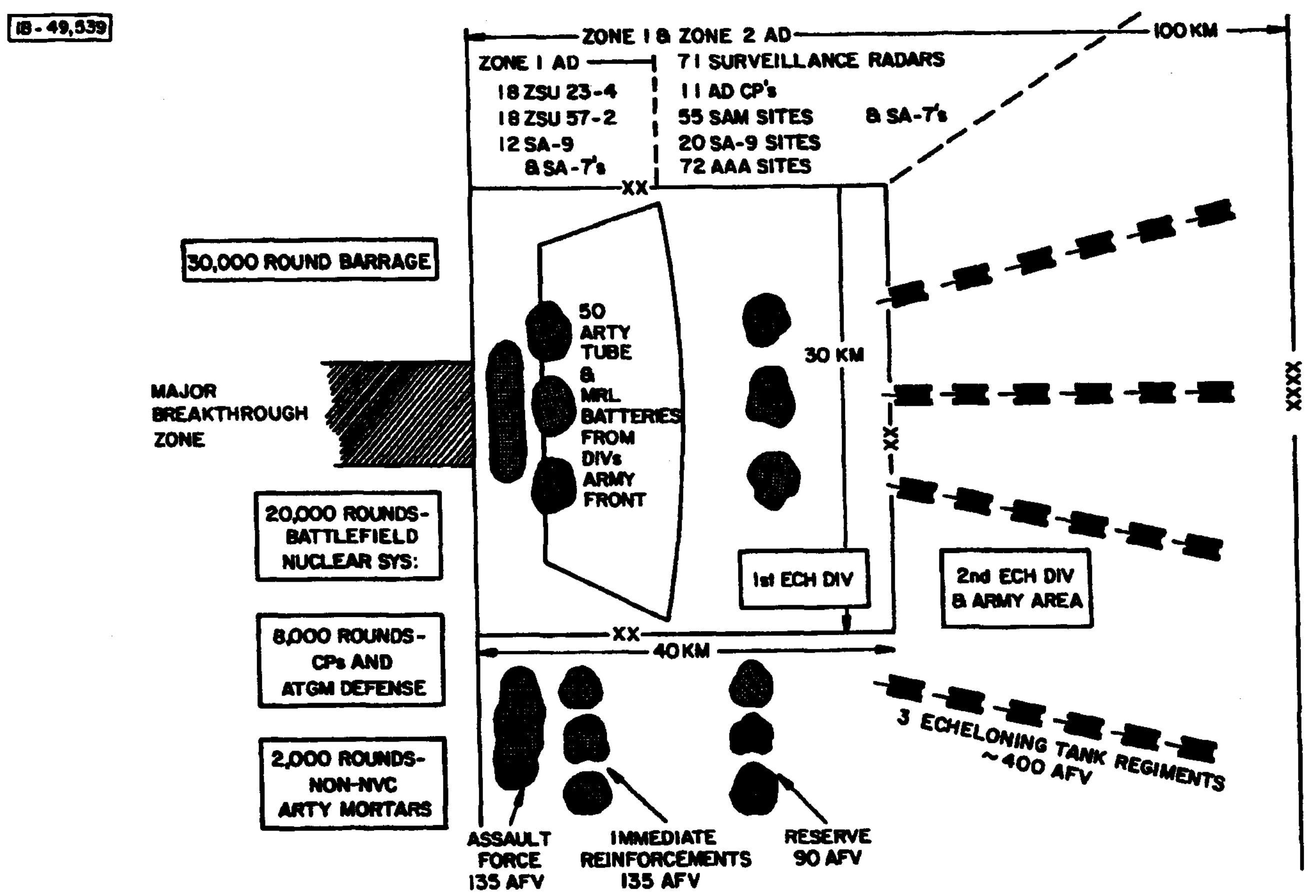

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Figure C-1. 1st and 2nd Echelon, Army and Front Assets Supporting a Single BT Attempt (U)

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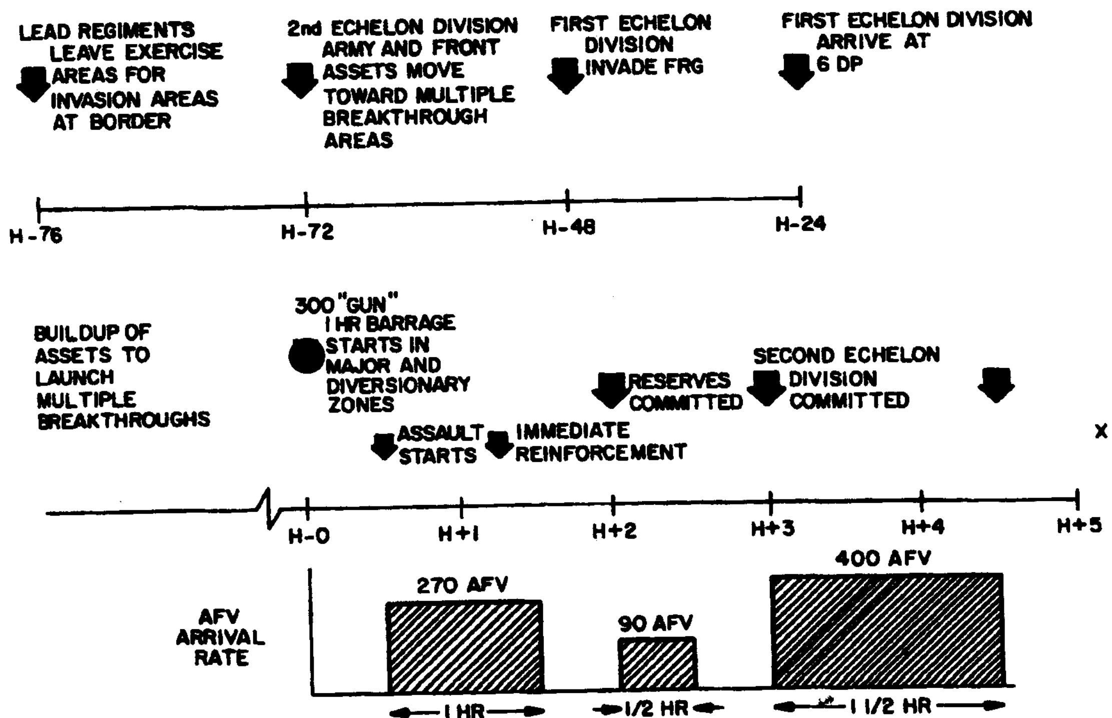

Figure C-2. Stylized Timeline (HRS) – Rapid Movement Case (U) forces at about 40 km to the rear of the second echelon forces at 100 km. In the second region, whether the attack is by artillery, rockets, missiles, or aircraft, the central problem, especially for mobile and transient target systems, is the provision of timely transmission of target acquisition, location, and tracking data from sensors into a tactical command and control system capable of near real-time targeting of specific weapon systems. (Target acquisition as used in this section includes some degree of target classification or identification since, given limitations on resources and rate of fire, it is not feasible to engage all mobile or transient targets detected in the vast area of the region beyond 3 km from the FEBA during the critical periods of the enemy massing and maximum thrust of a major attack.)

(U) At the present time, although there are a number of promising new sensors in development or procurement, and some interesting operational concepts for real-time targeting are being explored, there are no fully developed, demonstrated, and deployed operational systems for near real-time targeting of mobile and transient targets in the region beyond line-of-sight acquisition and designation range.

(U) The only current systems which, under limited circumstances of weather and enemy defense concentration, do have some capability for local target acquisition or reacquisition and for classification or identification of mobile and transient targets are tactical aircraft on strike/reconnaissance missions. However, the growing numbers and effectiveness of Warsaw Pact mobile field army aid defenses can make this mission very costly. In order to avoid tactics such as "search and destroy" and multiple passes against the same target complex which can lead to high attrition in heavily defended areas, aircraft must be guided, vectored, or directed to specific locations where moving or transient targets are to be found within the single-pass target acquisition capabilities of on-board sensors at the proper time and must deliver their weapons and withdraw without undue delay unless the defenses can be either evaded or suppressed. Thus, target acquisition and weapon delivery modes for aircraft are inextricably bound up with defense penetration tactics and mission profiles and/or defense suppression effectiveness.

(U) The use of standoff second or battlefield support region guided munitions and missiles requires long-range target acquisition systems, and for this purpose standoff sensor systems or penetrating RPV systems have been suggested. RPV's for either the latter target identification and designation function or weapon delivery are also best used in a battlefield environment in conjunction with standoff area target acquisition sensors and engagement systems, since RPV's are costly to operate up near the FEBA, being subject to both combat and non-combat attrition roughly proportional to flight hours or numbers of flights. Standoff sensor systems provide cues with respect to both location and timing which would allow RPV operations to be maximized at times and places of maximum payoff. Conversely, random search with RPV's would be minimized.

(U) The new standoff sensor capabilities for accurate target location include those based on TOA techniques for pulsed emitters, principally radars, such as the Army AGTELIS and the Air Force PELSS. Both of these have potential for extension to c.w. emitters with reduced traffic capacity.

Both of these offer considerable promise of sufficient timeliness and accuracy, if properly integrated with weapon delivery systems, to permit direct attack of several classes of transient targets (especially mobile SAM's). However, each of these systems is, under some circumstances and with respect to some area coverages and classes of emitters, highly vulnerable to ECM. Similarly, the airborne MTI radar systems of the Army (SOTAS) and the Air Force (multilateration radar) will, in appropriately implemented systems, provide for tracking of moving and transient targets when not screened by ECM. Special attention should be given in component design and integration of these systems to ECCM measures such as bistatic or multistatic operation, side-lobe cancellers, low side-lobe antennas, etc.

(U) But equally important is the provision of interface compatibility for target grid and tracking information transfer between the developing target acquisition, location, and tracking systems of the Army with those of the Air Force so they may be mutually supporting, especially in situations of severe electronic countermeasures and attrition or suppression by physical attack. In this way, the capability of the system as a whole can be made greater than the sum of the parts.

(U) Accurate navigation and friendly force identification systems such as Loran-D, GPS, PLRS, and JTIDS, which are in use or under development, also must ultimately be integrated into the target engagement systems, at least with respect to interface compatibility of communications and grid coordinate transformations.

(U) Within the framework of the target engagement systems and network described above, the usual tactical intelligence and reconnaissance information derived from longer time cycle coverage systems such as Photo, IR and SLAR imagery, as well as in special situations, unattended ground sensor (UGS) grids can be accommodated, although these systems would not depend entirely on the target engagement grid for their utility.

PRECISION-GUIDED MUNITIONS FOR ATTACK OF ARMOR

(U) For the past fifteen years much emphasis has been placed on the development of precision-guided munitions with high probability of achieving a hit and (by virtue of a shaped charge warhead) a consequent kill on a main battle tank. Included in this category are such ground force (including helicopter-launched) weapons as TOW, Dragon, CLGP, and Hellfire, and such air-delivered weapons as Maverick, Laser-Guided Bombs (LGB), Walleye, HOBO, etc. Although some of these weapons have excellent test and evaluation records in demonstrations at U.S. western, southern and southwestern military installations, and some such as LGB's, TOW, and Maverick also have shown commendably good combat service in limited numbers and situations against tanks and other vehicles in Vietnam and the Middle East, it must be noted that the air-delivered weapons have indicated some notable difficulties or potential difficulties when the weather, terrain, contrast, vegetation, scene background, and air defense environments typical of Central Europe have been taken into account either in field test environments or in theoretical analyses. For example, Maverick TV seeker lock-on distances are shorter and the break-lock tendencies are greater than experience in U.S. OT&E would have indicated. All optical seeker and externally optically guided weapons are susceptible not only to deliberately placed smoke, which is planned as a countermeasure by the Soviets, but also to the dust, smoke, and cluttered background (including vehicles already destroyed) of a battlefield. At present, TOW and Dragon crews are generally unprotected and therefore are highly vulnerable to attrition and suppression by artillery fire (although means of correcting this deficiency are currently under way for TOW).

[redacted] When the highest intensity phases of the Warsaw Pact armored assault are considered, especially in the light of Soviet doctrine and tactics calling for maximum use of suppressive fires, electronic jamming, and other countermeasures, it becomes apparent that precision-guided weapons designed for hits on a single vehicle are not likely to be most effective under these conditions and, more importantly, that they are far from adequate to provide the needed rates of fire in either of the two regions of interest beyond the FEBA. In the first region, which depends heavily on fire direction from artillery forward observers, the application of suppressive fires and smoke will greatly restrict and slow down the performance of such functions. Moreover, in this assault region, relative attrition rates might well deplete the friendly ground defenses at about the time the attacking second echelon arrives. In addition, the communications upon which such operations greatly depend will be subject to maximum jamming at such times. Also, locally situated airborne sensors such as AGTELIS and SOTAS will be subjected to the greatest intensity of harassing air attacks and countermeasures. In the second region, beyond 2-3 km, field army air defenses will be most highly concentrated during the most intense period of the attack, leading to an extremely hostile environment for aircraft and even for RPV's, especially if their detectability is enhanced by emitters such as laser designators. Moreover, jamming of standoff sensors, target acquisition systems, and related data links and communications can be expected to be maximized in the vicinity of the main attacks, leading to complete denial of sensor information in some cases and to degraded modes of operation (e.g., reduced traffic capacity and reduced accuracy in the case of certain spoofing signals to protect precise radar locations from PELSS or AGTELIS when, for example, correlation rather than pulse edge measuring techniques must be utilized, or broken and ambiguous tracks from airborne MTI radar).

(U) Thus, while the one-on-one attack of tanks by PGM's may be appropriate in some cases such as against the beginning of the assault, between the shifting of the artillery preparation and the arrival of the first wave of AFV's, or against an armored column exploiting a breakthrough when stretched out formations and lowered electronic jamming and air defense support can be expected, it seems clear that they are not entirely adequate for the many situations which may be encountered during the peak intensity period of a massive armored assault. This is particularly the case for air and artillery or missile-delivered munitions. On the ground, armored vehicles are more likely to be encountered by TOW, Dragon, and LAW crews as single targets to be engaged by PGM's as massing or advancing enemy forces come into engagement range. However, as already noted, suppressive fires, smoke, and other countermeasures are a serious problem, and increased attention should be given to reducing physical, electronic, and optical vulnerability (e.g., by providing protective cover for crews against suppressive fires and introducing optical range gating to counter smoke when applicable).

IMAGING INFRARED (I^2R) MAVERICK

[redacted] Late in the study activities of the Task Force, a specific request was received from the DDR&E that the weapon effectiveness and overall value in countering Warsaw Pact armor of the proposed I^2R Maverick be evaluated. Although there was insufficient time to undertake a detailed study of this system, the Task Force did review the technical characteristics which would affect the operational performance of this system. Again, as in the case of the TV Maverick, the most serious operational question appears to be the compatibility and timeliness of the end-to-end process through target search, detection, classification or identification as required, handover to the weapon seeker, and weapon guidance to the target. These factors are highly dependent on terrain, lighting, target arrays, and scene background. As was learned on the TV Maverick, the European environment cannot be successfully simulated at U.S. test installations.

IR sensors for aircraft and missiles, given limitations of current technology, cost, and volume available, are even more limited in detection, classification, and identification ranges than TV in clear daylight, although they are effective at greater ranges than TV at night and in climatic conditions of haze and fog and in many conditions of smoke obscuration. However, the shorter ranges available for virtually all functions in the detection-to-launch further exacerbates the already critical conditions encountered for the end-to-end target engagement process in the European environment. The mistakes made in OT&E on the TV Maverick should not be repeated. The Task Force sees no way in which the overall operational utility of the I^2R Maverick can be assessed without realistic end-to-end operational tests against armored columns using target acquisition and engagement concepts consonant with current and projected near-term tactical operational capabilities. Reasonable employment of countermeasures (such as IR smoke) should also be evaluated in these tests.

ANTI-ARMOR AREA COVERAGE MUNITIONS

(U) Area coverage munitions utilizing bomblet clusters would appear to provide the natural complement to PGM's, since they may be launched against clusters of armored vehicle targets without precise information on location and without maintaining continuous optical track on a single vehicle. Obviously, for air delivery or for air target designation for artillery or surface launched missile delivery munitions, smoke and dust may not be nearly as effective in denying target area location, as required for area munitions, as in denying continuous single vehicle visibility from aircraft detection to missile impact. However, target spacing is an important factor in the effectiveness of area munitions.

(U) At the present time, the main cluster bomblet munition in the U.S. inventory for use against armor is the Rockeye. The capabilities of Rockeye and a British low-altitude bomblet weapon (BL-755) against armored and SAM targets, along with those of PGM's, are shown in Figures C-3 and C-4. Unfortunately, at least as presently used, this is delivered in a dive-bombing attack profile which gives a very high degree of exposure to both low-altitude missiles and given defenses in the terminal area. This is made more specific and apparent in the data of the next section. As will be shown there, depending on the operational circumstances, including weather, there appear to be two modes of air delivery for area munitions which would provide vastly improved tradeoffs between weapon effectiveness and aircraft attrition leading to better overall operational effectiveness. One such mode requiring defense suppression of the relatively few high-altitude SAM's and their C^3 radar is delivery from a high enough altitude and/or slant range (10,000 to 15,000 ft) so that ZSU-23-4 AAG and SA-7 and

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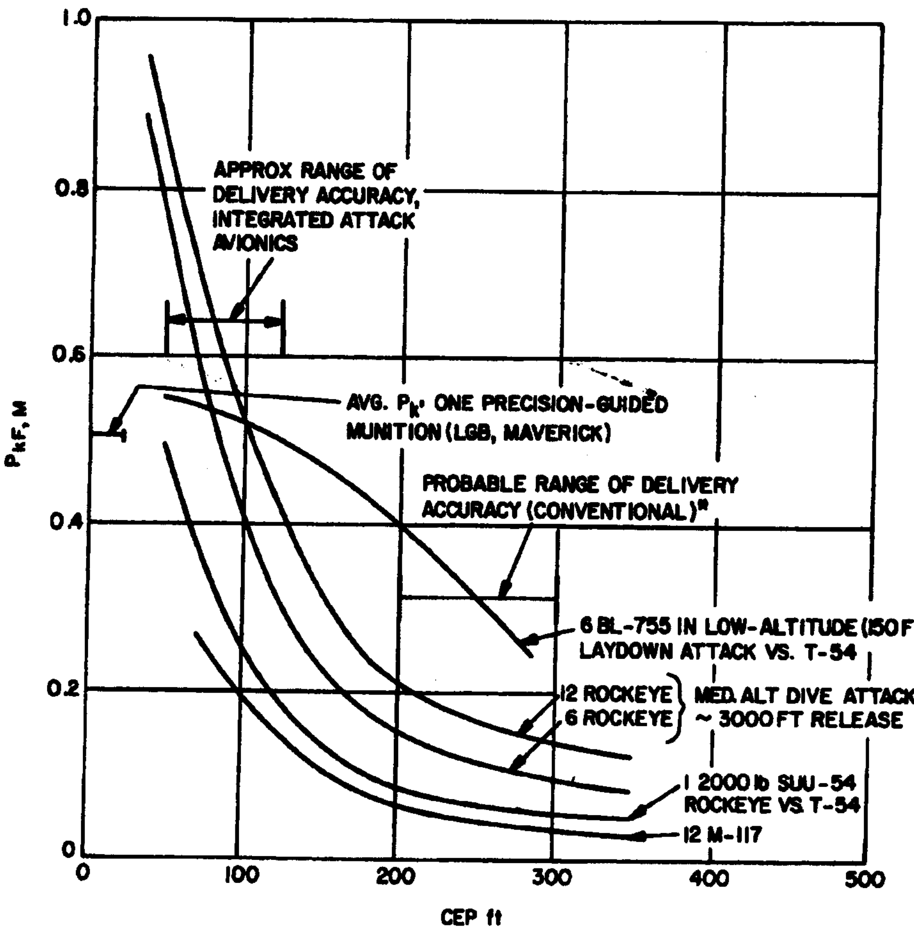

*~ 100 FT CEP ASSUMED FOR MOST FORCE PERFORMANCE CALCULATIONS

IA-49,941

([redacted]ET)

Figure C-3. Weighted average of fire-power/mobility kill versus "average" armored vehicle (0.45 medium tank; 0.30 armored personnel carrier; 0.10 assault gun; 0.15 AAA gun) for various weapon loads (release conditions for maximum $P_{kF,M}$). (U)

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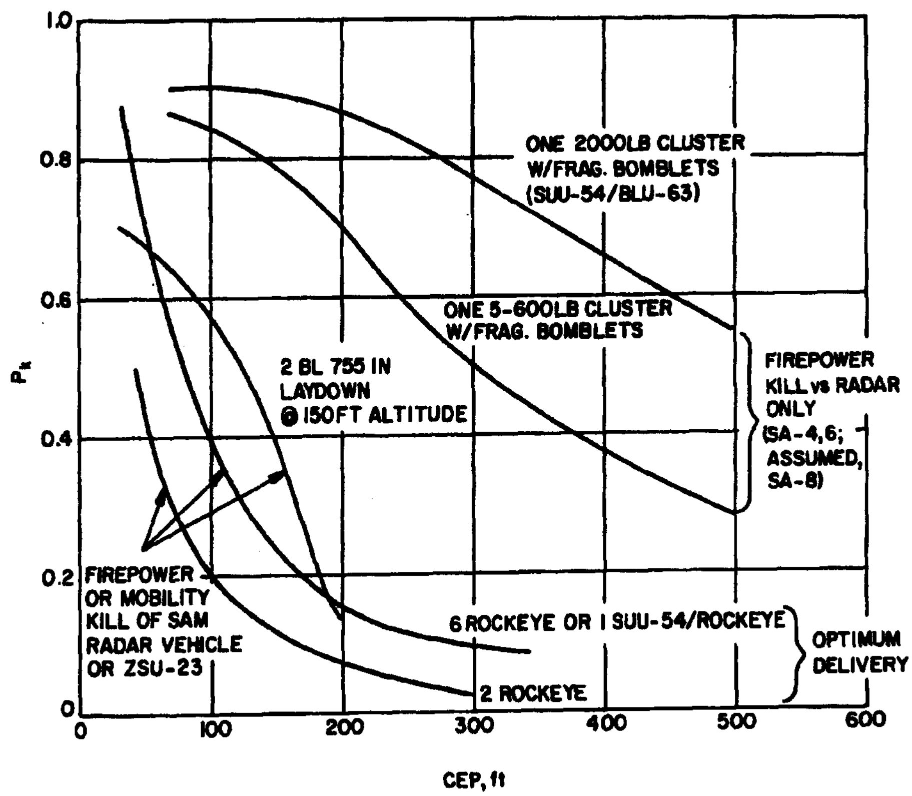

(SECRET)

Figure C-4. Typical P_k of Various Weapons Against SAM/AAA Vehicles or Radars (U)

SA-9 missiles are relatively ineffective. The other mode is a very low-altitude horizontal delivery (200 ft or less) so that as far as possible all local defenses are underflown. It would appear that, depending on aircraft fire control systems, some form of dive-toss delivery could be evolved with either visual or IR acquisition or delivery to a geographical location specified by standoff target engagement systems. This requires extensive analytical and experimental verification to determine its feasibility with existing and projected munitions (such as the short-range GBU-15).

(U) The low-altitude delivery mode can be more specifically addressed in view of the existing capabilities of the Rockeye BL-755 and other weapons in development. However, capabilities in this mode must be considered in terms of anticipated Warsaw Pact armored target areas.

[redacted]

JS 3.3(b)(5)

(S) The area target considered in the development of Figure C-6 is typical of a situation encountered in true close air support, i.e., when enemy and friendly units are actually in contact. It is interesting to consider other target postures which are equally typical. In order to achieve the high movement rates specified by the Soviet doctrine, armored forces would be forced to move on prepared roads. Doctrine and training stress the attack from the march, but, when not engaged, one would expect to find a unit moving by road. The necessity of channeling 4000-6000 vehicles into the objective area insures that many road-bound targets would be available to air forces.

[redacted]

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[redacted]

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Figure C-5. A-10/ROCKEYE Effectiveness Against a Tank Platoon
(3 T-55 Tanks in a 400' x 200' Area)
16 ROCKEYES in One Pass (U)

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[redacted]

JS 3.3(b)(5)

Figure C-6. A-10/ROCKEYE Effectiveness Against Soviet Tank Company Convoy
(10 T-55 Tanks on Road, 50m Spacing Between Tanks)
16 ROCKEYEs in One Pass (U)

insignificant. The bomblet pattern size becomes a handicap for the F-4, though it is still able to achive multiple kills per pass.

[redacted] The Rockeye weapon system has not been adequately tested in low-altitude delivery from level flight. Though all of the deliveries considered above satisfy the bomblet time of flight arming requirements specified in tech orders, it is not known to what degree bomblet reliability and bomblet dispersal can be maintained in low-altitude deliveries. The loss of effectiveness as bomblet reliability decreases is shown in Figure C-7.

ADVANCED DEVELOPMENTS IN ANTI-ARMOR MUNITIONS

(U) Previous discussion has indicated that low-level attack appears viable, from an effectiveness standpoint, against linear targets such as vehicle convoys. The length of convoy targets tends to mitigate effectiveness degradation due to the component of delivery errors along the aircraft ground track (normally termed range errors). Deflection errors (perpendicular to the aircraft flight path in the ground plane) are generally small for visual deliveries, since pilots can line up with a linear target much as they line up with a runway.

(U) Weapon pattern control is very important for dispenser weapons. Bomblets must be dispersed to ensure that the pattern is large enough so that delivery inaccuracies (though perhaps small) do not become a problem. An "optimum" pattern size for a stylized target (e.g., the convoy in Figure C-6) may be easily computed analytically, but the targets that are seen in combat vary considerably in size. An "optimum" pattern for one stylized target may well have very poor effectiveness against another of a different size. For this reason the pilot should have some ability to tailor the pattern to the situation at hand.

(U) If the dispenser concept employed is one involving multiple independent weapons, then the aircraft intervalometer provides longitudinal dispersion automatically. Lateral dispersion may be accomplished by either propelling bomblets from captive dispensers or, as with the Rockeye, relying on aerodynamic dispersal after launching the dispenser itself.

(U) Existing anti-armor bomblets rely on the shapes charge concept to penetrate armor. The bomblet must hit the armor in such a way that the shaped charge jet penetrates a vulnerable component of the target. The sum of the area of all such vulnerable components, as seen from a particular aspect angle, is termed the vulnerable area of the target. For this type of weapon the vulnerable area is limited to, and generally much smaller than the presented area of the target.

(U) Assuming proper bomblet dispersal can be achieved, there are two methods of improving the kill potential of dispenser weapons: increase the number of bomblets delivered or increase the target area vulnerable to a single bomblet. Effectiveness is proportional to the product of target vulnerable area and the number of bomblets. Generally, achieving greater vulnerable areas implies larger bomblets and reduces the number that can be delivered. Thus, in designing a new dispenser weapon, a tradeoff calculation is made to ensure that increases in bomblet lethality are not counteracted by proportionately greater increases in size or bulkiness.

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[redacted]

JS 3.3(b)(5)

Figure C-7. Sensitivity of A-10/ROCKEYE Effectiveness to Bomblet Reliability – Level/200' AGL Release of 16 ROCKEYEs (U)

The information on this page is [redacted]

(U) Figure C-8 displays the relationship of the number of bomblets in the pattern to target vulnerable area for several kill levels against the stylized convoy target used in Figure C-6. It was assumed that bomblets were uniformly distributed over a pattern whose length and width were 1300 feet and about 200 feet respectively. The assumed 25-mil delivery accuracy translates to a deflection error probable (DEP – a one-dimensional analogy to CEP) of 60 feet. A wider pattern (and more bomblets) would be required to achieve the expected kills shown if the delivery inaccuracies were significantly larger.

[redacted] The shaded, labelled areas show where various munitions lie on the graph. STREBO, a product of West Germany, uses a large captive dispenser to eject about 4700 1-lb shaped charge bomblets. The vulnerable area shown in Figure C-8 for this bomblet is a very rough estimate of the M or F kill vulnerable area of a T-55 tank. It should be noted that the STREBO dispenser ejects the bomblets simultaneously to both sides, perhaps resulting in poor pattern control. No under-wing obstructions such as fuel tanks or other ordnance may be present because of the side ejection. The BL-755 is produced by the United Kingdom. The container is rather large, 8 feet long and 16.5 inches in diameter, and carries 147 2-lb shaped charge bomblets.

[redacted]

JS 3.3(b)(5)

(U) As Figure C-8 shows, all three systems are theoretically quite effective against the convoy target. None appears clearly superior given adequate pattern control, bomblet arming, and aircraft compatibility. Uncertainties are present in all of these areas, however. Test drops should be made for the three systems and further target vulnerability studies run to be assured of the bomblet lethality.

[redacted]

JS 3.3(b)(5)

[redacted]

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Figure C-8. Dispenser Weapon Parametrics — Expected Kills vs. Target Vulnerable Area and Number of Bomblets (U)

JS 3.3(b)(5)

[redacted]

(b)(5)

(U) Potentially, such submunitions, if feasible and within the range of current cost estimates, could be an extremely valuable adjunct to improving the effectiveness and survivability of medium and high-altitude delivery systems (utilizing standoff delivery both horizontal and vertical) not only in clear day weather but also at night and under poor weather conditions. (However, the questions regarding effects of meteorological conditions on radiometric emission require resolution.) The Task Force believes that the potential of TGSM's is great enough to warrant some degree of concentration of effort, objectives, and funding to effect an earlier resolution of critical feasibility issues than would be possible under the presently planned program.

AIRCRAFT VULNERABILITY AND DEFENSE SUPPRESSION

(U) There is in process a heated debate among various advocates in the U.S. and in the NATO nations concerning the effectiveness and viability of close air support and battlefield interdiction given current numbers and effectiveness of Soviet field army air defense weapons. The four major positions being taken are:

(U) 1. The close air support and battlefield interdiction missions can no longer be performed at acceptable attrition and cost, at least by manned aircraft.

(U) 2. These missions, to the extent they can be performed, can only be performed by aircraft penetrating at low altitude (less than 200 feet) so as to underfly all defenses.

(U) 3. Given defense suppression of the relatively few high-altitude SAM's and their supporting C^3 radars, close air support and battlefield interdiction can be performed from vertical/slant range standoff outside the range of highly proliferated weapons (such as the ZSU-23-4, SA-7, SA-9).

(U) 4. All high-altitude defenses as 3 above can be suppressed and the proliferated low-altitude weapons such as the ZSU-23-4, SA-7, and SA-9 can be locally attacked and suppressed or countermeasured (e.g., by IR flares), thus permitting aircraft to attack armor with relative impunity.

(U) Although there have been various analyses based on assumptions more or less favorable to one or another of these positions, these analyses taken as a whole are unconvincing to the Task Force. Most of the arguments seem to be based on opinions augmented by anecdotal data. There is little solid evidence based either on operational experience or OT&E to support any of these positions.

(U) The most objective and complete analysis of this problem, although far from entirely adequate, is the one done by Panel 7 of the NATO DRG (U.S., U.K., and FRG are the major contributors) which contemplated various levels of air defense, various military situations (e.g., second echelon FEBA and armored columns in exploitation phase), and various weapon delivery modes corresponding to positions 2, 3, and 4 above. The limited OT&E available was utilized. The results of this study, summarized in Table C-I, indicate that no one delivery mode is best for all situations and that defense suppression is desirable or necessary in some situations.

[redacted] Although levels of attrition per sortie corresponding to the cases portrayed in Table C-I run to as high as 30 to 60 percent in some cases, most attrition levels lie between 0.03 and 0.20 (Figure 2 of the DRG report). Attrition at these levels has a profound effect on total combat sorties available even in a relatively short war, as shown in Table C-II for attrition levels between 0 and 0.15 for a 10-day conflict with aircraft programmed at two sorties per day (the theoretical zero-attrition level of total sorties per aircraft is thus 20). It may be noted that the effect of attrition on total sorties in the range of attrition of the DRG studies may reduce available sorties to less than half. This is reflected in the armor killed data of Table C-I, where the aircraft had the same individual per sortie capability in the various situations. Thus, clearly, attention must be given to cost-effective measures of defense suppression.

Table C-1

Force Performance in One Day Over a Range of Conditions and Tactics (U)

[redacted]

JS 3.3(b)(5)

Table C-II

Achieved Total Sorties Per Aircraft versus Attrition* (U)

Attrition	0	.01	.05	.10	.15
Total Sorties/Aircraft	20	18.2	12.8	8.8	6.4

(*Ten days of conflict at a programmed level of two sorties per day)

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APPENDIX D

COUNTER C^3

THE SOVIET/PACT COMMAND, CONTROL, COMMUNICATIONS STRUCTURES*

GENERAL

[redacted]

OSD 3.3(b)(1)(5)

*(U) References: (a) "Soviet Ground Forces: The Command and Control Communications of a Front," 3/AA/APP/J28L/1-76; (b) "Soviet Command and Control System for Frontal Forces," 3/00/13038-76, 18 May 1976.

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Date: DEC 0 5 2012

COMMAND POST STRUCTURE AND NUMBERS

Ground-Based Command Posts

[redacted]

OSD 3.3(b)(1),(5)

Airborne Command Posts

[redacted]

OSD 3.3(b)(1),(5)

THE MOVEMENT OF COMMAND POSTS AND REMOTING OF COMMUNICATIONS

[redacted]

OSD 3.3(b)(1),(5)

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[redacted]

DISTANCES FROM THE FEBA

OSD 3.3(b)(1),(5)

[redacted]

OSD 3.3(b)(1),(5)

Distances Behind NATO FEBA (kilometers)

Fwd CP	Main CP	Rear Control Point
Varying distances behind NATO FEBA		

[redacted]

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OSD 3.3(b)(1)(5)

(U) As already noted, the transmitters serving these CP's may be remoted and the additional separation must be taken into account.

SOVIET/PACT AIR SUPPORT COMMAND AND CONTROL

[redacted] To ensure coordinated planning and execution of air and ground combat operations, both controllers and operations groups are used.

SOVIET C^3 VULNERABILITIES

[redacted] Historically, the Soviets have displayed vulnerabilities in their command and control structure. The direction of battle has always come from high echelons with little room for initiatives at lower levels. During World War II, they relied heavily on HF radio and land lines for their communications. They also used mobile headquarters in trucks and vans at the lower echelons.

(U) In 1941 at Smolensk and again at Bryansk the German forces were able to make major advances on the Soviets by attacking their command posts. This totally disrupted the Soviet command and control network and the defense collapsed. In addition by cutting off the railroads and the logistic support to the forces, their capability to fight was crushed.

(U) Large numbers of prisoners and equipment were captured. At Smolensk 348,000 prisoners were taken as well as 3,000 tanks and 3,000 guns. At Bryansk, a total of 673,000 prisoners were taken and 1,242 tanks and 5,400 guns were captured.

(U) Let us examine the present Soviet command structure compared to that of the World War II era.

[redacted]

OSD 3.3(b)(1),(5)

COUNTERING THE ENEMY C^3

[redacted]

OSD 3.3(b)(1),(5)

[redacted]

OSD 3.3(b)(1),(5)

[redacted]

JS 3.3(b)(5)

LOCATION AND IDENTIFICATION OF ENEMY CP's

[redacted]

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[redacted]

Figure D-1. Contours of Equal Power Density (U)

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JS 3.3(b)(5)

(S)

[redacted]

Figure D-2. Contours of Equal Power Density (U)

14-49,638

JS 3.3(b)(5)

RECOMMENDATIONS

We must:

1. Recognize the importance of C^3 as a target and give these targets high priority in the first hours (day) of the attack.
2. Recognize the potential of jamming to counter the Soviet's C^3.
3. Perform analyses to further substantiate the potential and develop operational procedures for implementing the technique.
4. Try to carry on complex military exercises in the face of heavy communications jamming.
5. While jammers exist in most of the frequency ranges, they were built for other purposes, and development of optimum jammers for counter C^3 should be developed.
6. Develop concepts on how to operate our C^3 in such an environment.
7. Develop better ways of finding and striking enemy command posts.

APPENDIX E

COUNTER AIR DEFENSE

INTRODUCTION

The problem addressed concerns countering a restricted set of Soviet air defenses — surface-to-air missiles (SAM's) and anti-aircraft artillery (AAA) which protect the concentration of assets which support breakthrough operations. Typically, the concentration of fire and maneuver assets supporting a major and minor breakthrough are derived from an army, which might have four or five divisions, plus army and Front assets to aid in this operation. The zone of a first-echelon army might be 100 kilometers in width and 100 kilometers in depth. Defense against NATO air attacks on this lucrative set of targets is derived from SAM, AAA, and manned interceptors supported by search and acquisition radars enmeshed in a command and control structure.

The essentials of the problem are definitized and quantified by considering the operations attending a breakthrough along a major sector of 4 to 8 kilometers in width. This might take place in a division sector 10 to 30 kilometers in width and 40 or more kilometers in depth. Typically, three divisions are on line and one or two in reserve, that is, in second echelon.

The target structure which would be attacked by NATO air forces would include assaulting regiments, immediately reinforcing regiments, massed artillery, and reserves drawn from the first echelon and those units of the second echelon committed to maintain the momentum of the attack into the breakthrough area. Typically, these involve 25 to 50 batteries of artillery, 50 to 70 echeloned tank and motorized rifle companies, reconnaissance and anti-tank units, as well as logistic support needed for the echeloning forces. Initially, these targets would be distributed over a zone whose width might be as great as 30 kilometers and whose depth might be as great as 60 to 80 kilometers. As the more rearward elements approach the breakthrough sector, narrowing of their frontage occurs so that finally they enter the breakthrough sector at whatever its appropriate width happens to be at that time. The overall operation might require two days for a buildup of the necessary assets in the zone of the first- and second-echelon divisions. The actual operation, starting with the bombardment and then proceeding onward to the attack of the echeloned maneuver units, might encompass a period of time as short as 4 hours and as long as 12 hours. The penetration depth which the Soviets hope to achieve against a NATO defense in depth might vary from 10 to as many as 25 kilometers for a half-day operation.

Figure E-1 outlines, in cartoon fashion, the army zone previously described, the division sectors in first echelon, and the supporting zone in the rear of the first-echelon forces. It additionally identifies two depths to which air attacks would proceed. The first involves a depth of penetration of approximately 15 kilometers in which attacks would cover initial assaulting and reinforcing companies, as well as artillery. Significant portions of the command and control and a sizable fraction of the

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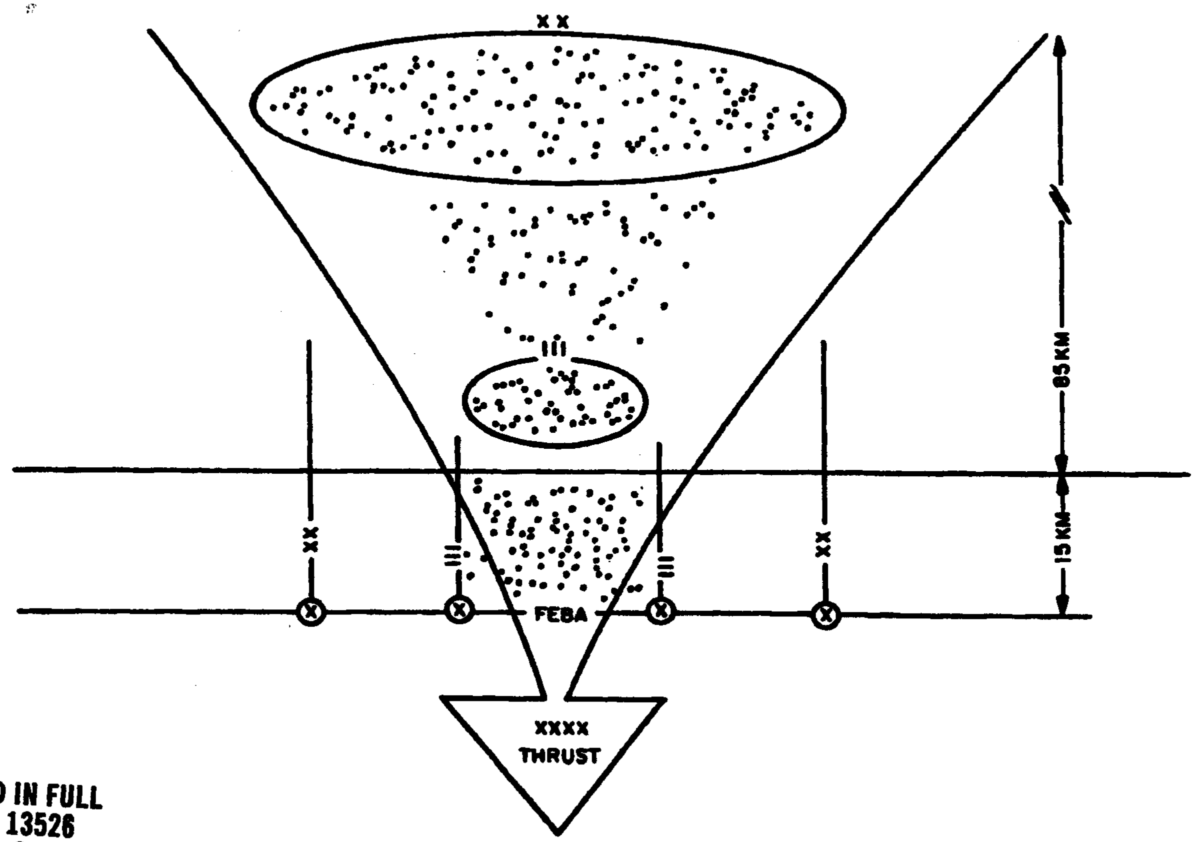

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Figure E-1. Breakthrough Thrust (U)

logistics support would also be contained in this zone. The deeper zone, extending as far back as 100 kilometers, would contain the reserves of the first-echelon and the second-echelon divisions, as well as rear area support and significantly more logistics and command and control.

DESCRIPTION OF THE SOVIET AIR DEFENSE

(U) The variety of Soviet air defense systems includes a family of SAM systems (the SA-2, SA-4, SA-6, and SA-8) which require active radar tracking of targets. In addition, there are passive systems (the SA-7, a man-portable system, and the SA-9, which has a cluster of IR missiles) which employ infrared seeking guidance. Complementing this set of active and passive systems is a family of AAA systems. The most modern of these is the ZSU-23, a 23-mm 4-barrelled system mounted on a PT-76 tank hull. In addition to this, there is a dual 57-mm air defense gun, also mounted on a light tank hull, and previously deployed single and dual 57-mm towed guns as well as a dual 23-mm towed gun. These latter towed units have been or are being replaced by the self-propelled types. Technical characteristics, range, engagement envelope, warhead type, engagement time, flight time, etc., were obtained from the DIA organization guide documentation.

[redacted]

JS 3.3(b)(5)

Table E-I

Number of Threat Sites (U)

[redacted]

JS 3.3(b)(5)

[redacted]

ALTERNATIVES CONSIDERED

JS 3.3(b)(5)

(U) The panel addressed the problem of countering Soviet air defense by considering three somewhat independent approaches. The first was to examine very low level altitude penetration. The second concerned itself with the use of electronic warfare and the augmentation of current penetration tactics. The third concerned itself with destructive attacks against air defense with enforcement features.

Very Low Altitude Penetration

[redacted]

JS 3.3(b)(5)

(U) While the approach might be viable, and even more than that, successful, it is not clear that the issue can be settled by analyses alone. The recommendation of the panel is to submit the studies to Project ALPHA, the joint U.S. Army (TRADOC), and U.S. Air Force (TAC) group working the close air support problem jointly in Langley AFB/Ft. Monroe area. It is recommended that this group review the findings and, if necessary, conduct a series of experiments/tests to settle the issue.

Electronic Warfare

(S) The ongoing development program associated with electronic warfare features such as improved [redacted] is all part of the current procedure for penetration as practiced by U.S. Air Forces in Europe. It is clear from looking at the array of air defense possessed by the Soviets that suppression means are going to be needed. Unless we plan to

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[redacted]

OSD 3.3(b)(5)

DESTRUCTIVE ATTACKS AGAINST PACT AIR DEFENSE SAM AND AAA

(U) The previous enumeration of air defense threat sites makes it obvious that a large-scale effort is needed for their defeat. Several sizing calculations will be reported on to quantify munitions needs, and along with these, localization errors and reaction times. This will provide a setting in which one can examine the context of destructive attacks.

[redacted] First, though, the functional character of the air defense organization ought to be described before considering destructive attacks. The Soviets possess a large number of acquisition and tracking radars and, as indicated previously, 11 major command air defense command posts are employed in this analysis to perform battle management. In addition, there could be alternate command posts located at designated sites with fallback and reconstitution planning permitting other sites to pick up these chores. However, the major function that is executed by the command and control structure is the management of assets in an optimal and reponsive manner. In addition, the employment of the acquisition and tracking radars and the command posts reduces the necessity for each radar site to have its own emitters operating, thus lessening the detectability of each site. It is seen, then, that one may [redacted]

JS 3.3(b)(5)

needs do not increase with the square of the localization and delivery error, but rather somewhat more slowly. Since the air defense management structure is typically more rearward, long-range assets would be required. This would necessitate employing ballistic or some form of cruise missiles, launched either from the ground or from the air. It is seen, however, that there might be as few as 72 tons of munitions delivery required or as many as 140 tons of munitions required for this task. In either case, the number of munitions needed is such that sizable air assets would be employed simply to carry these to launch positions.

[redacted]

JS 3.3(b)(5)

(S) After de-netting (destroying command posts) has been accomplished, many of the air defense systems must operate autonomously. Those which possess relatively long-range radars, like the SA-6 for example and to some extent the SA-8, could provide information over impromptu or hastily organized radio communications nets which might actually exist in backup and reconstitution modes of operation. These would again provide the means to lessen the emitter operation at the gun systems. Therefore, attacks against these are required as well. It is seen from the proliferation of the numbers that again several hundred tons of munitions will be required with accurate delivery and very short response times. In the case of these latter systems, only those in the penetration area have to be removed because the reaction range of the systems is limited to only a small fraction of the total army area which is required to be covered.

[redacted]

MUNITIONS ALTERNATIVES

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(S) It was seen previously that several tons of munitions are required to attack even the softest sites and tens of tons are required to attack the harder sites. In examining alternative munitions, the [redacted]

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[redacted]

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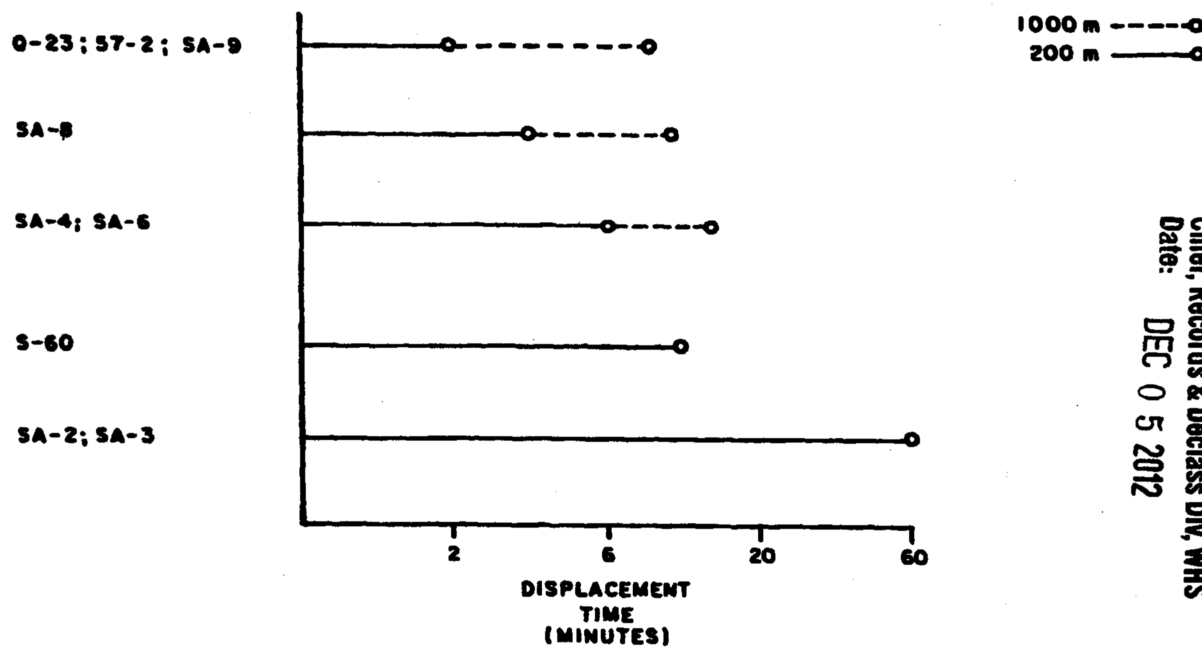

Figure E-2. Delocalization Due to Movement (U)

Table E-II

Munition Required — 50 m Effective CEP, 60% Damage (U)

[redacted]

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[redacted]

(CONFIDENTIAL)

Figure E-3. Effects of FAE and Related Free-Field Environment/Range (U)

[redacted]

JS 3.3(b)(5)

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[redacted]

Figure E-4. Minimum Target Acquisition Error for Standoff Systems (U)

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COMMAND AND CONTROL PROBLEMS

Table E-III and Figure E-5 display the various localization systems and their accuracies. Only a few are usable for targeting with reasonable tonnages of munitions. It is seen that, with current concepts, targeting information could enter a JTOC and be communicated to a DTOC to the artillery element. Additional command and control delays would ensue as the element passed the target data to the battery. It is seen, then, that the entire process even with data links connecting sensors to various command posts involves at least two or three steps of decision making. This is essentially incompatible with the movement times previously discussed. If strikes with small tonnages of munitions are going to be effective, then surveillance-strike systems are going to be needed to support the suppression of air defense. These should react in time less than 2 minutes to gain the benefits of low tonnages of munitions expended. This would require the means to directly connect or bypass certain sensor information directly into fire units designated for that mission at that time. Such planning should be considered, to take advantage of the leverage associated with minimizing the numbers of munitions employed.

OTHER ENFORCEMENT ALTERNATIVES

[redacted]

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Table E-III

Emitter and Locater Pairings (U)

[redacted]

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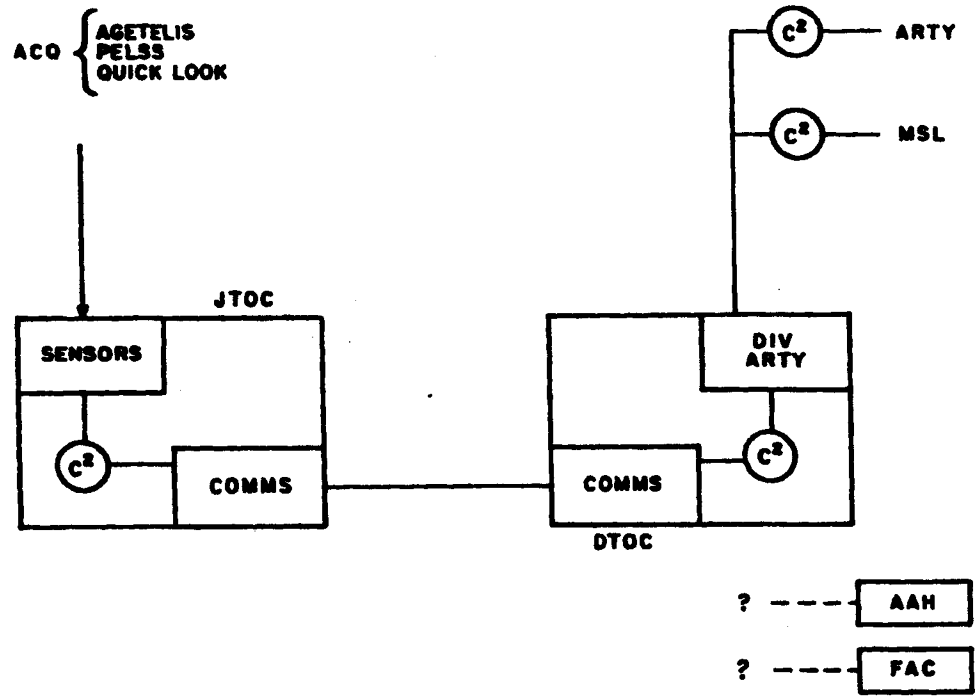

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Figure E-5. Candidate "System" With Successful Integration (U)

[redacted]

Figure E-8. Employment Zone, 30 km Width, 10 km Depth (U)

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[redacted]

JS 3.3(b)(5)

CONCLUSIONS

[redacted] While a number of issues have been explored by the panel, the focus of these conclusions and recommendations is on technology. Tests have been recommended as well as a review of studies by the Project Alpha team.

[redacted]

JS 3.3(b)(5)

[redacted] The currently planned suppression avionics systems appear to be needed unless the recommendations of Project Alpha solidly support low-altitude penetration tactics.

APPENDIX F

BATTLEFIELD INTERDICTION

INTRODUCTION

Definition

(U) Battlefield interdiction may be defined as that mission which seeks to disrupt, impede, delay or stop the enemy from supporting or reinforcing his assault forces with troops, supplies or equipment. It seeks to isolate his forward elements from the remainder of the battlefield such that the continuity and momentum of the attack is diminished and the tactical advantage swings to the defender.

(U) In a classical USSR breakthrough posture in Allied Central Europe, the interdiction zone is taken as extending from roughly 10 km to 100 km forward of the FEBA. This area, looking from the friendly side, contains elements of the Soviet first echelon force plus logistics (e.g., POL, ammunition) and the second echelon division(s) with their support. Augmentation from Army may also be included.

The Threat Scenario

(U) Figure F-1 displays the Soviet forces that might be facing a U.S. division (+) across roughly a 90-km front. The area of the actual penetration is as narrow as 4 to 8 km as shown in Figure F-2. One might expect the following numbers of targets to be facing the division in the 10- to 100-km area when forces are in contact – along the FEBA.

Tanks:	550
APCs:	350
Artillery Tubes:	400
Trucks:	4000
Air Defenses:	160

Mission Options

(U) In analyzing the interdiction task, some battlefield options* to consider are:

- Destroy the "soft" targets, especially the trucks carrying the ammunition and POL. This would deny needed resupply and hopefully limit the extent of the main attack.

---

*(U) These options can apply also to the situation when the Soviets cross the border and advance toward our General Defensive Positions (GDPs).

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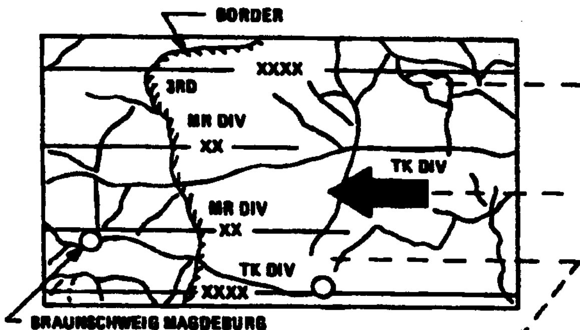
3RD ARMY PLUS AUGMENTATION (TOTALS)

PERS	55000+	GUNS	400	SCUD	18	TRKS	5700
TKS	1100	MRLS	72	SCBD	6	ADG	106
APCS	1100	FROG	18	MORT	180	SAMS	80



TK DIV

PERS	11000	GUNS	90
TKS	333	MORT	18
APCS	200	TRKS	1300
FROG	4	ADG	58
MRLS	18	SAMS	0

BREAKTHROUGH FORCES

	DIVS	AUG	TOT
PERS	25000	2000	27000
TKS	800	–	800
APC	500	–	500
GUNS	162	132	294
MRLS	36	–	36
SSMS	8	24	32
TRKS	2650	400	3050
ADG	104	0	104
SAMS	0	80	80

MR DIV

MORT	54
PERS	14000
TKS	266
APCS	300
GUNS	72
MRLS	18
FROG	4
TRKS	1350
ADG	46
SAMS	0

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Figure F-1. Assets in Army Sector and by Division (U)

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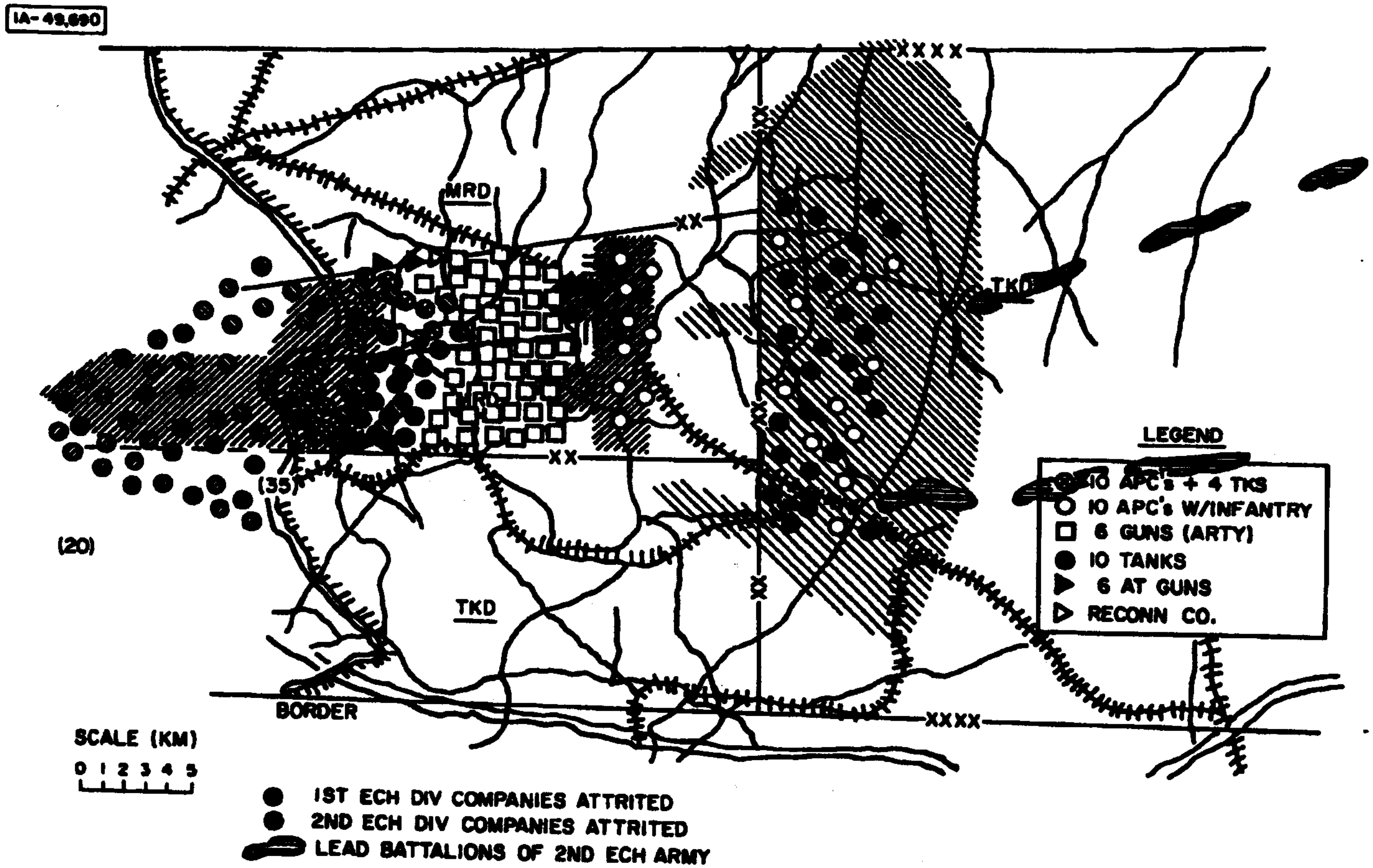

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Figure F-2. MRD in Breakthrough (H-1 and H+8 HRS) With 2nd Echelon TK Div. and Army (U)

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- Attack and immobilize or destroy the hard targets (i.e., tanks and APCs) at such a rate that the second echelon force is effectively neutralized.*
- Create barriers and impede his road and cross country mobility such that his timetable is destroyed and he is forced into a more vulnerable posture.

(U) The following rationale supports the conclusion that no single option should be emphasized at the expense of the others.

(U) POL and ammunition trucks once detected are easier to destroy. However, even if one could succeed in eliminating all of the 4000 or so trucks, the fuel and ammunition on board the tanks and APCs could carry the attack for better than two days.** In that amount of time the attack according to Soviet figures (20 to 30 km/day in the breakthrough to 50 to 80 km/day after breakthrough) could advance upwards to 100 km into Western Germany before the ammunition (not POL) was exhausted.

(U) Attacking the hard targets successfully would at once impact on the battle. However, this is a difficult job and one which places the most demands on weapons and munitions.

(U) Barriers created by bridge destruction, road cratering and minefields can be done and are useful as delay tactics. The immediate payoff is not certain. A resourceful enemy will either clear the obstacle, bridge it or find a new route. If he can do this quickly without "bunching up," the payoff is slight. If he takes time and has to concentrate his forces in a restricted area, the potential payoff can be large providing one can take advantage of the opportunity as it occurs.

ELEMENTS OF THE INTERDICTION MISSION

(U) In order to perform effective interdiction, the following are necessary and should be closely integrated:

- Wide area surveillance/target acquisition (The targets must be detected, located and tracked.)
- Attack systems
  - Weapon delivery and control, and
  - Munitions effects.

*(U) Estimates based on Soviet doctrine places the attrition rate as 30 to 60 percent in 4 to 8 hours.

**(U) Assuming commitment of first echelon reserves, second echelon division and ammunition redistribution.

Wide Area Surveillance/Target Acquisition

(U) As a practical matter, detection of non-emitting targets at ranges greater than 3 km beyond the FEBA is limited by ground LOS considerations to essentially airborne systems. A requirement for both wide-area and all-weather surveillance in Europe implies the use of a radar sensor.

(U) At the present time, there are three relatively near-term (1980s) sensors or sensor systems in various stages of development. These are the Army's Stand-Off Target Acquisition System (SOTAS), the Air Force's Multilateration Radar Surveillance and Strike System (MRS^3) and the DARPA Hostile Weapons Location System (HOWLS).

(U) Table F-I lists key characteristics of the SOTAS test bed and the MRS^3 systems, as currently defined. The MRS^3 system is currently in the feasibility development phase, employing the Multiple-Antenna Moving-Target Surveillance Radar (MASR) being developed by Lincoln Laboratory. Flight testing of the initial (Phase I) MASR configuration began in FY76. A Phase III prototype system will be used to conduct a MRS^3 experiment, starting in the third quarter of FY77. Based upon this schedule, deployment of MRS^3 is not likely until well into the 1980s. The MRS^3 parameters in Table F-I represent, therefore, an initial starting point and may change considerably before deployment.

(U) The SOTAS program is also in the initial phases of development. A modified APS-94 radar is being used as a test bed to evaluate the SOTAS concept. SOTAS is scheduled to undergo engineering development as early as FY78 or FY79, although the program provides for fielding of an interim system in late FY80. Like MRS^3, SOTAS is likely to undergo considerable evolution during the next five years.

[redacted] The HOWLS program objective is to develop and demonstrate concepts for detection, location and classification of enemy indirect firing weapons. Demonstration of low-cost, light-weight radar implementations, suitable for remotely piloted vehicles (RPVs) and emphasizing real-time processing and display for both fixed and moving targets, is also an objective. A K-band, phased-array radar (Table F-II) is also under development; all radar processing will be performed on the ground. The radar is designed to provide both coherent and incoherent operation, and the ground station can perform both real and synthetic aperture processing of the radar data. The present radar is a test bed and is not designed for RPV use. Airborne measurements, using this radar and off-line ground processing, are scheduled for completion in 1976. Aspects of the HOWLS program which are particularly applicable to the interdiction surveillance mission include the use of RPVs with short-range radars to supplement coverage in areas masked by terrain, foliage or ECM for range multilateration to improve location accuracy on selected targets and for target identification. Also, the HOWLS radar program includes development and evaluation of algorithms for target identification purposes and provides a capability for collecting detailed radar return characteristics for key targets and clutter, which are then subjected to detailed off-line processing to determine statistical characteristics and compare different signal processing techniques. At the present time, the HOWLS program is concentrated upon locating hostile artillery weapons, as opposed to armor and other vehicular targets, but extension of the HOWLS radar capability to the latter is a distinct possibility.

Table F-I

Preliminary System Characteristics for SOTAS and MRS[3] (U)

[redacted]

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Table F-II

HOWLS Experimental Airborne Radar Characteristics (U)

[redacted]

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[redacted] The key areas of concern common to the three programs are:

- ECM resistance,
- Platform survivability, and
- Command, control and data management.

[redacted] The issue of platform survivability impacts directly on the cost effectiveness of the system and is sufficiently important to warrant R&D emphasis. The Army solution in the near term is to use a rotary-wing aircraft flying at low altitudes, 15 to 20 km behind the FEBA, hoping that the SOTAS will be "masked" from effective SAM engagement. The Air Force prefers a high altitude, longer standoff posture using either a drone or a U2-type aircraft flying out of SAM range. Both versions are costly to achieve a 24-hour surveillance capability. (Ten-year life cycle costs for a single SOTAS can be on the order of $50 million while the MRS^3 can be five times that amount.) New approaches to lower cost platforms which are less vulnerable to enemy action (and to weather) are needed.

(U) A survivable, high data rate and accurate AMTI radar system will significantly enhance long-range battlefield target detection. However, radar systems suffer from target recognition and false alarm problems as their "processed data" is displayed for human interpretation. One powerful tool that is available to aid in the recognition process is SIGINT information especially ELINT with DF. Guardrail and ELS can locate and identify communication emitters. PELSS, AGTELIS and QuickLook can detect and locate radar emissions from SAMS or guns. Integrating the output of these systems with the AMTI data and displaying the combined results on an output device for the human operator would represent a major step toward realizing the benefits of sensor integration.

(U) In summary, successful battlefield interdiction requires the applications of the combined arms. No one strategy can be employed which by itself will do the job. Long-range target detection is needed to reduce the need for vulnerable overflights of the battlefield. The Services are pursuing medium-to-long range AMTI systems which can provide this capability. The ARPA HOWLS technology is applicable especially for any advanced airborne surveillance radar capability but also in the near term to evaluate SAR techniques and fixed-target detection usefulness. Survivability is a major consideration and must be addressed if a cost-effective system is to be fielded. Integration and display of SIGINT data with AMTI on a near-real-time basis offers payoff in terms of target validation and recognition. This should be pursued on a joint-Service basis.

Attack Systems

Weapons Options

[redacted] Once the targets are detected, located and tracked, various attack options should be available. [redacted]

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[redacted]

(U) Air strikes are the only currently available means of attacking battlefield targets out to the full range of interest (100 km). But successful interdiction by air is hampered by:

- Expected high aircraft losses without suppression,
- High costs of defense suppression, and
- Munitions which have a low kill rate capability, e.g., MAVERICK, a "one-on-one" weapon, or ROCKEYE, an ineffective area munitions against armor.

(U) Figures F-3 and F-4 show the relatively poor effectiveness of these current air-delivered munitions. In Figure F-3 – given one pass per sortie with ROCKEYE (probably reasonable in a non-permissive environment), 190 sorties would be needed to kill 100 tanks deployed in the attack march formation and 27 sorties (8 to 9 passes each) of aircraft armed with 6 MAVERICK missiles each to achieve the same effect. It is doubtful that 8 to 9 passes are even feasible. Figure F-4 displays the low kill capability of the MK-20 ROCKEYE. The need for a more effective "one-on-many" ammunition is evident if TACAIR is to achieve a favorable cost-exchange ratio in the interdiction mission. In addition to airstrike, which can be weather- and priority-limited, a surface-to-surface weapon must be available as an attack option. It should be closely integrated with the target detection system and must be affordable. Figure F-5 shows the problem. Operating and Support (O&S) costs of today's tactical missile systems are driven by the cost of manpower (a LANCE battalion has 450 men, Improved HAWK – 238 men, NIKE HERC – 254 men and SAM-D – 182 men). At the extreme end of the spectrum are the non-mobile, permanent, "hardsite" installations such as the SPRINT. With minimum manpower requirements, the yearly O&S costs for missiles on launcher are low as shown. (Initial investment costs would, however, be high.) The operational merits of a mobile versus a fixed weapon system should probably be examined in more detail. Unless otherwise shown, it is assumed that a flexible, highly mobile surface-to-surface attack option is at least, highly desirable.

Comparison of Weapon Alternatives

(U) **Target Array Vs. Weapon Effectiveness.** An examination of the route structure available to the Warsaw Pact second echelon and reserve forces for moving toward the Fulda River shows a maximum of four possible through-routes using main and secondary roads. In order to move in divisional strength, each of the four regiments constituting a Pact division is assumed to use one route with one-fourth of the division's vehicles. Table F-III illustrates the vehicular spacing, the total lengths of the columns and the times required to traverse 50 km for both day and night movements.

(U) Tanks, APCs and self-propelled guns and missile carriers constitute about 29 percent of the total number of vehicles in a Soviet tank division. If we add to these "high value" targets, command

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Figure F-3. Sorties to Kill 100 Tanks (U)

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Chief, Records & Declass Div, WHS
Date: DEC 0 5 2012

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Figure F-4. Wide-Area Kill Implications (U)

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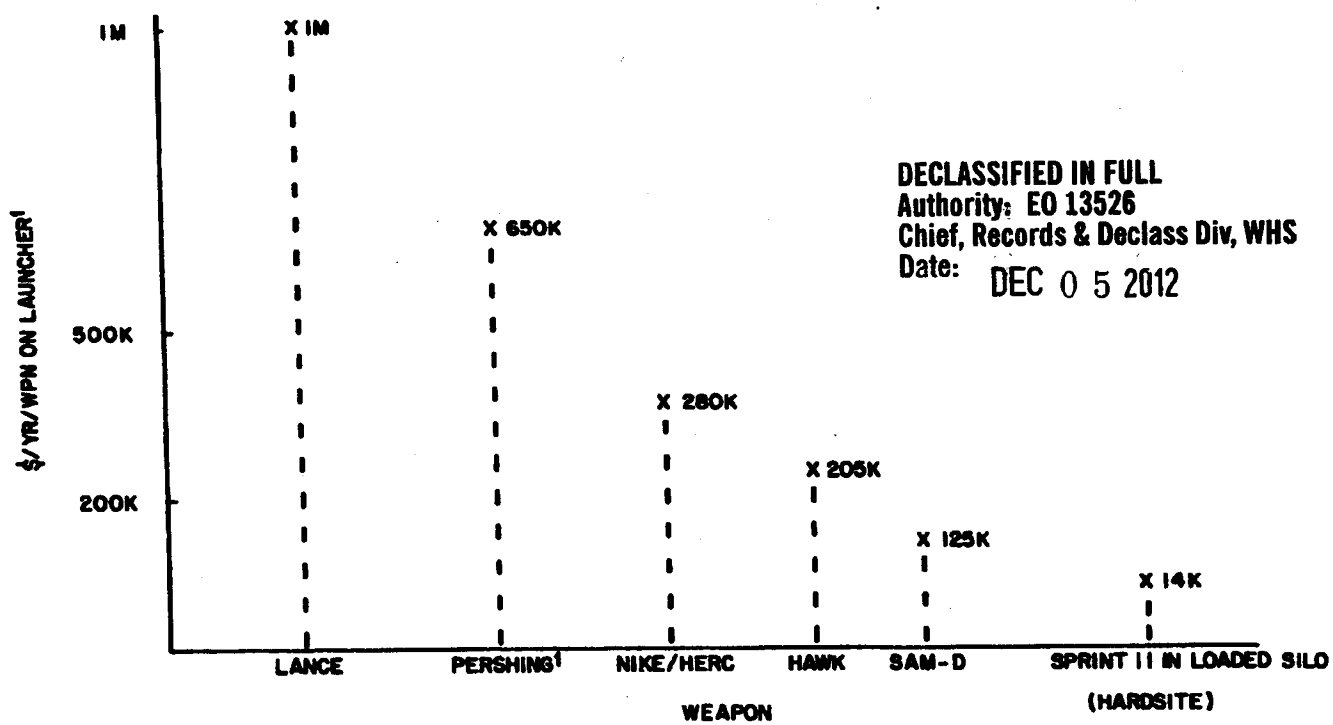

[1] DOES NOT ACCOUNT FOR RELOAD CAPABILITY

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Figure F-5. The O&S Problem (U)

Table F-III

Unopposed Movement of Second Echelon or Reserve Soviet Tank Division (U)

	Day	Night
Number of vehicles	540 + 122 trailers	540 + 122 trailers
Vehicle speed	25 km/hr	17.5 km/hr
Vehicle spacing	37.5 m	22.5 m
Space between 6 vehicles	187 m	112 m
Space between 18 vehicles	675 m	382 m
Total length of columns (road distance)	41.8 km	26.6 km
Average length of individual vehicles	3.8 km	3.8 km
Time for lead element to traverse 50 km	2.25 hr	3.6 hr
Time for last element to traverse 50 km	3.9 hr	5.1 hr

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and other vehicles, over one-third of all the essential vehicles, over one-third of all the vehicles are significant targets.

(U) There are several points worth emphasizing about the table. The percent of road surface covered by vehicles is relatively small, being 9 percent during a daylight movement and 14 percent at night. This implies that the probability of a hit of a vehicle by a single large munition without terminal homing will be quite small; a hit, or a very near miss by a large weapon, is required to kill a tank or an APC. A cluster of small, unguided bomblets or submunitions would improve the probability of hit, particularly if the pattern were tailored in a long, narrow fashion. However, the vulnerable area of vehicles to a small submunition is relatively small, and if the submunition is increased in size so as to insure a kill when given a hit, the probability of a hit would decrease. In short, this target array points toward a requirement for a terminal homing weapon of sufficient size to insure a high probability of kill when a hit is achieved.

(U) Another important fact emerging from the above is that a column of vehicles in regimental strength, which is moving any significant distance, is on the road for a considerable length of time. However, target movement rates are relatively high and large target location errors could result if there is significant delay in final weapons guidance commands and weapons impact.

(U) **Delivery Accuracy.** Based on the above target arrays, delivery systems that can release the submunitions in a linear pattern are desirable. Boost/glide vehicles, cruise missiles and strike RPVs can fly above the target arrays and release the submunitions at predetermined intervals, Figure F-6. Release of submunitions directly above the intended targets has two major advantages — the search area is minimized and the acquisition range requirements are decreased. By minimizing the search area, the probability of target acquisition is increased, the probability of acquiring false targets is decreased, and the probability of multiple hits against a single "hot" target is decreased. The decreased acquisition range requirement leads to a simpler, lighter, and lower cost submissile. A ballistic missile with a near vertical trajectory is constrained to dispersing its submunitions in a radial pattern (Figure F-7); this radial pattern is especially disadvantageous when a large number of targets (10 to 20) are attacked simultaneously.

(U) The delivery accuracies of TGSMs by Nonnuclear LANCE (NNL), cruise missiles, strike RPVs, boost/glide vehicles and guided ballistic missiles are summarized in Table F-IV. The delivery accuracy estimates indicate that when a large number of submissiles are delivered by a ballistic missile, a significant fraction of the submissiles will fall outside the accuracy envelopes attainable by boost/guide vehicles and cruise missiles; however, the delivery accuracy of ballistic systems are comparable to the other systems when a small number (4 to 6) of submunitions is delivered. When delivering a large number of submunitions, the boost/glide vehicle has both an accuracy and a payload advantage over ballistic systems; it also has a payload advantage over cruise missiles and strike RPVs.

[redacted]) **Costs of Alternatives.** The costs of a TGSM delivered to the target area by several delivery vehicle alternatives are estimated in Table F-V. The "target area" was defined as being within 100 m of a target. The submunitions delivered to this specified target area can be assumed to have equal effectiveness. The results indicate that a TGSM delivered to the target area with NNL is significantly more expensive ($43K) than the other alternatives ($9 to $16K). Delivery of TGSMs by large boost/glide vehicles appears to be the lowest cost alternative ($9K).

(U) The costs of expended equipment per target killed are estimated in Table F-VI. Again, large boost/glide vehicles appear to be the most cost-effective alternative. Cruise missiles and ballistic missiles appear to have equal effectiveness, but are approximately 50 percent more costly than large boost/glide vehicles. The estimated annual peacetime ownership costs of the attack systems concepts, including delivery vehicle costs, personnel costs and logistics requirements, are presented in Table F-VII. Forces capable of killing approximately 10,000 targets were assumed. Although the actual capabilities of the forces may not be accurately estimated, the forces presented should have approximately equal capabilities; the relative costs should therefore be reasonably accurate. The costs of maintaining strike RPVs appear to be significantly higher than those of the other alternatives. Again, large boost/glide vehicles appear to be the least costly of the alternatives.

(U) **Survivability.** The survivability of subsonic boost/glide weapons vis-a-vis ballistic missiles has been shown by the Army to be relatively poor. However, the weapon's survivability can be enhanced by: flying above AAA range even in the terminal area, use of multiple launches to saturate SAM

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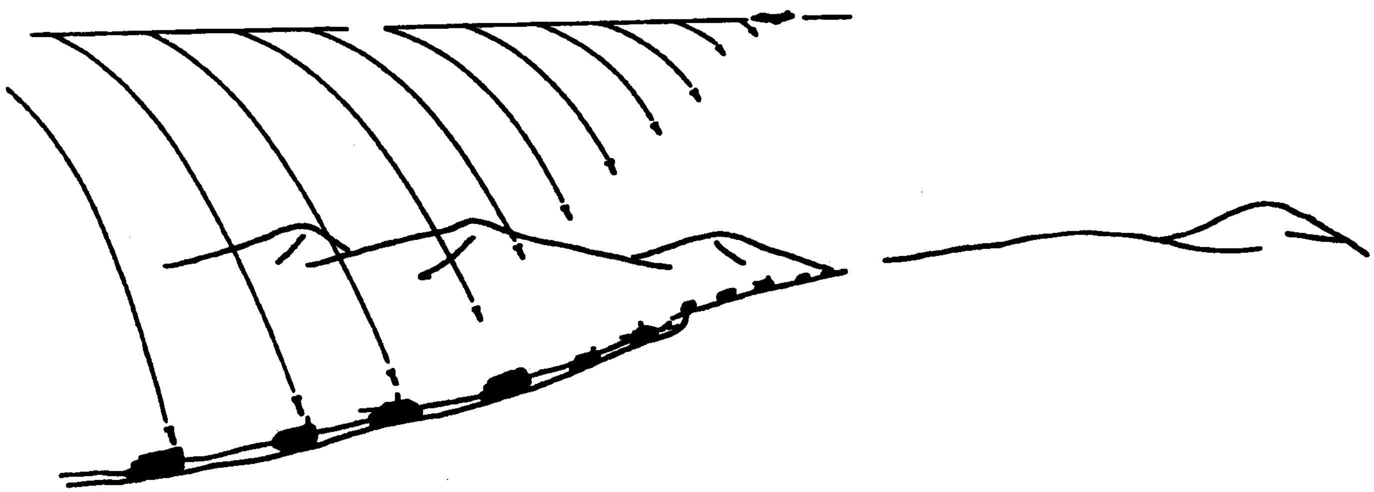

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Figure F-6. Dispersion Pattern of Submunitions by Boost/Glide Vehicles, Cruise Missiles and Strike RPV's (U)

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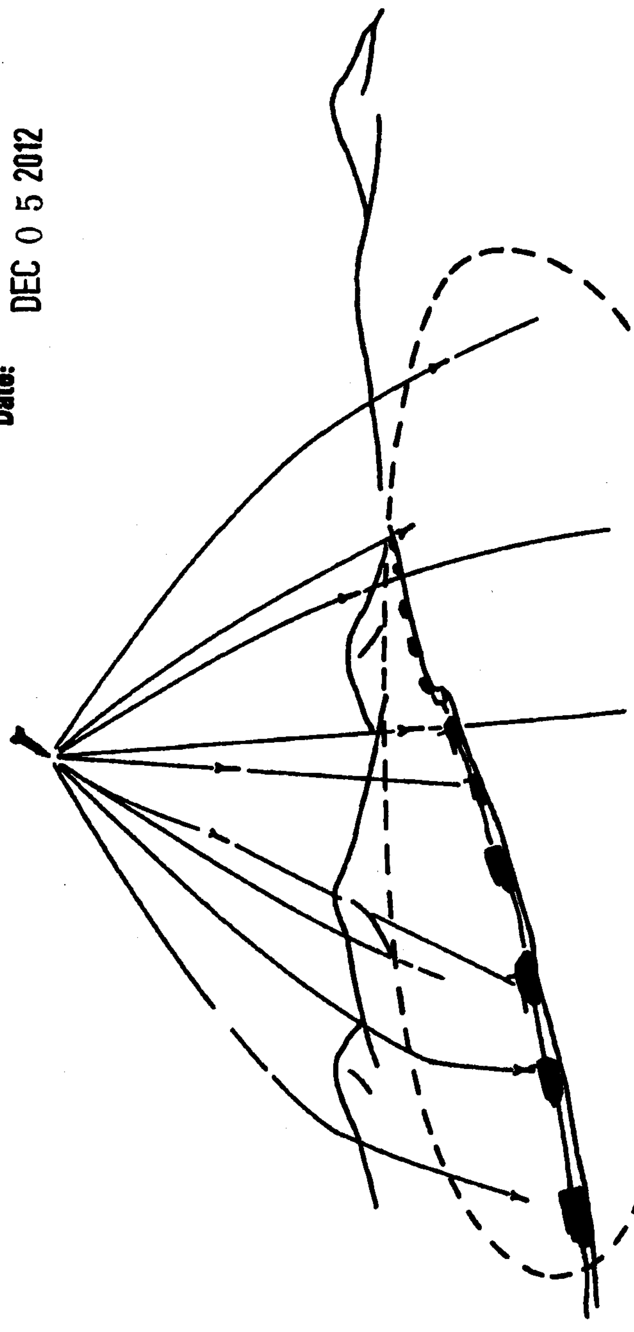

Figure F-7. Dispersion Pattern of Submunitions by Ballistic Missiles (U)

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Table F-IV

Submunitions Delivery Accuracies
(Range 60 km) (U)

	Non-nuclear LANCE	19-ft Cruise Missile	Recoverable Strike RPV's	TOA/DME 19-ft Ballistic Missile	19-ft Boost/Glide Vehicle
Delivery Vehicle					
Delivery Error (m)	180	45	45	20	45
Target Location Error	50	50	50	50	50
Angular Approach Error (10 deg) (m)	0	27	27	0	27
Road "Bends" (m)	0	50	0	50	50
Total Delivery Error (m)	187	88	72	73	88
Submunitions					
Wind Drift (m)	50	50	50	50	50
Range-to-Target From Circumference of Circle (m)	206	0	206	0	0
Total Error (m)	283	101	224	89	101
Submissiles in Vehicle	12	10	12	12	18
Submissiles Delivered Within Boost/Glide Accuracy (100 m)	4	10	6.6	12	18

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Table F-V

Estimated Costs of Weapons

	Non-nuclear LANCE	18-ft Cruise Missile	TOA/DME 18-ft Ballistic	18-ft Boost/Glide
Delivery Vehicle				
Airframe	20	30	20	20
Guidance and Control }	100	30	15	15
Propulsion }		40	15	10
Wing Kit		0	0	15
Dispersal System	10	20	10	20
	130K	120K	60K	80K
Submunitions				
TGSMs (@ $5K)	60	60	60	90
Total Cost	190K	180K	120K	170K
Cost/Delivered Submunition	16K	15K	10K	9.4K
Cost/Submunition in Target Area (100 m from Target)	43K	15K	16K	9.4K

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Table F-VI

Equipment Costs Per Target Killed

	Non-nuclear LANCE	Recoverable Strike RPV's	19-ft Ballistic Missiles	19-ft Boost/Glide Vehicles	Cruise Missiles
Delivery vehicle cost (K)	130	1000	80	80	120
Loss/sortie-missile	.08	.02[a]	.08	.08	.08
Sorties-missiles/kill	5.40	2	3.20	2	2
Delivery vehicle cost/kill (K)	58	40	15	9	19
Missile cost (K)	5	5	5	5	5
Missile cost/kill (K)	27	10	16	10	10
Total cost/kill (K)	86	50	31	19	29

[a](U) RPV launches 10 submissiles per sortie

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Table F-VII

Peacetime Ownership Costs of Attack Systems

	Recoverable Strike RPV's	19-ft Cruise Missiles	19-ft Ballistic Missiles	19-ft Boost/Glide Vehicles
Delivery Vehicle Costs				
Number of Vehicles in Force[a]	1,000	1,600	2,560	1,200
Cost/Vehicle (K)	1,000	120	60	80
Flights/Year/ Vehicle	4	.01	.01	.01
Loss/Flight[b]	.001	1.00	1.00	1.00
Vehicles Lost/Year	4	16	26	12
Cost/Year (K)	4,000	1,920	1,530	960
Ten-year Operating Cost (K)	608,000	117,000	188,000	88,000
Launch Facilities	High	Very Low	Very Low	Very Low

[a](U) Force is capable of killing 10,000 targets.

[b](U) Loss includes partial damage.

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defenses and employing maneuver (e.g., 3g). It can be shown in fact that the multiple launches (15 weapons/salvo) 8 km apogee, and 3g maneuver, force survivability can be as high as 80 percent.

(U) **Munitions Effects.** There appears to be no question of the need for better munitions capable of effectively crippling multiple armored targets. This drives the solution toward some form of "smart" or terminally-guided submunition which can be very expensive compared to conventional bomblets (~$5K per submunition). On the other hand, the SADARM (Sense and Destroy Armor) system, employing a scanning sensor and self forging fragment (SFF) concept, claims to be a much cheaper approach although its real operational effectiveness may be degraded by a combination of background contrast and fuzing problems. Tests are needed. All three Services are investigating TGSM technologies and hardware. Seekers include IR, mm-wave active/passive and radiometric homing. The combined level of effort is around $2M in FY77 and slightly more in FY78 and FY79. If costs can be held down, and effectiveness demonstrated, the whole area of TGSM for both air- and surface-delivered munitions appears to offer high payoff in terms of number of targets destroyed or immobilized. For this reason, the Services should enter into a cooperative effort and funding should be substantially increased by an order of magnitude with emphasis on cost reductions.

SUMMARY

(U) In summary, a better surface-to-surface interdiction weapon is needed as an option to air attack. Boost/glide weapons with terminally-guided submunitions can be an attractive approach and should be pursued by the Army. Maximum advantage should be taken of the Air Force GBU-15 development.

(U) Both air- and surface-delivered weapons lack a high kill-rate capability. A new one-on-many munition is needed. The potential of terminally-guided submunitions is such that a significant increase in R&D expenditures is warranted. Cooperative Service efforts would assist program direction, foster an exchange of ideas, and avoid unnecessary duplication.

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APPENDIX G

WARNING AND C^3

THE WARNING ISSUE

The Nature of the Problem

The U.S. and NATO posture for the defense of Europe is based on the availability of at least 48 hours' warning of a Warsaw Pact attack. The term warning as used here is intended to describe that collection of evidence which would be sufficient to persuade the 14 nations of the Defense Planning Committee that an attack is imminent. A few examples of ways in which this dependence on warning is manifest are:

1. NATO land forces are not in their General Defense Plan (GDP) positions. The time required to bring them on line in these positions varies by nation and [redacted] JS 3.3(b)(5)

   The majority of U.S. Army European formations have not been issued their basic load of ammunition and must travel considerable distances to a limited number of ammunition storage areas to get it.

2. NATO War Headquarters are almost all physically separated from their peace headquarters locations by several tens of kilometers. Transition to a war posture would require significant movement of personnel and material; and procedures in the new location will not be well practiced.

3. For each NATO headquarters the wartime intelligence flow is envisioned to be handled by an intelligence staff which would be augmented at Alert declaration. The procedures for providing information to this staff and their methods of handling that data will not have been practiced.

If their present trends continue, Soviet exercise patterns coupled with their weapon modernization efforts make it increasingly difficult to distinguish between posturing for exercise and posturing for attack, thus reducing the assurance of obtaining 48 hours' warning. Present Soviet personnel and equipment stationing, FTX practices, CPX modes, and troop rotation capabilities can be combined to make an attack out of exercise posture a contingency which NATO must not leave uncovered. Examples of Soviet practices which are representative include:

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1. Sizeable annual exercises routinely take place in exercise areas near the border areas.

2. Temporary restricted areas are routinely established in ways which could obscure the movement of forces within East Germany.

3. Large numbers of tactical and long-range air forces are regularly exercised in extremely provocative formations. As an example, Brewers often prosecute simulated launch operations against West German locations even through simulated ASM firings before peeling off.

4. Frontal and strategic command post exercises are regularly combined with forward area FTX activities.

5. Increasingly rapid capability to airlift 100,000 new forces into the forward area has been displayed.

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The U.S. and NATO cannot afford to permit the provocative practices to continue unchallenged. In addition to the direct military readiness issue, there is an equally important threat to NATO solidarity and resolve. A significant consensus is already developing in the U.S. and European public domains that an unreinforced attack out of an exercise is a credible threat and that NATO is not postured to respond. If permitted to grow and fester, this consensus will cause serious erosion of political will within and among NATO countries. Further, if NATO continues to give no response to this situation, the Soviets can reasonably assume a true lack of will and capability.

The Elements of a New Warning Strategy

The U.S. should advocate a concept of maneuver and posturing for the purposes of deterrence in response to intelligence in addition to the existing objective of mobilization in reaction to an anticipated military attack. The basic objective is to provide NATO and member nations the institutional capability to gain a common current perception of events and to act in response to those events at levels of tension well below situations involving perceived risks of imminent attack. This stimulus and response process must be exercised in such a way as to lower the threshold of common action. The present procedures make the political penalties of a false alarm so severe that it greatly reduces the probability of a legitimate warning signal getting through.

The Soviets need to observe that the Allies are paying attention and have the capability and will to respond. The Allied command and control structure needs to be exercised more nearly in its crises/wartime posture both to deter and to be prepared for a surprise attack. This kind of behavior on the part of NATO will give it credibility to its citizenry and contribute to a more coherent Western political resolve.

Essential to this concept is the means to bring U.S. intelligence to bear on the NATO decision process. There are at least three elements of thrust to the intelligence issue:

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2. At one end of the intelligence sharing spectrum is the strategic warning issue. To solve the problem, the U.S. needs to develop new mechanisms and procedures for providing the assessments it can produce from its broad intelligence access into an Alliance decision process. These assessments can be made so as to obscure sensitive issues and methods. The U.S.-NATO arrangements should be augmented by separate bilateral and multilateral arrangements with NATO members. These bilateral and multilateral arrangements will support more comprehensive intelligence exchanges than those with NATO and will contribute to the credibility of the NATO process.

3. At the other end of the intelligence spectrum is the support of combat forces. NATO and member nation reactions to Pact activities must range from the strategic political level down to rapid and low-echelon military response. To support the latter, new mechanisms are needed to obtain and fuse current intelligence, reconnaissance, and surveillance data in a form which can be used as the basis for immediate reaction by NATO military commands.

Organizational changes must be made to create a responsive NATO military command structure. The U.S. should advocate the assignment of a standing force of land and offensive air forces to NATO in peacetime. There are precedences in the Air Defense and standing Naval forces.

This would create a permanent operational structure with which to maneuver and respond and cause a shift in attention and activities of the NATO commands by adding a peacetime operational mission. Such a command structure would become a competent recipient of current intelligence and would have a constructive impact on the process of providing intelligence to NATO.

In addition to achieving an operational NATO command and control posture, steps are needed to provide for the survivability of that posture. The static war headquarters programs being implemented by NATO should be continued, the land mobile program should be expedited and strengthened to increase the dispersal of command centers, and multiple airborne command posts should be acquired.

NATO COMMAND, CONTROL AND COMMUNICATIONS

The Importance of Command and Control

Command and Control emerges as a function of primary importance to deterring or defeating a Warsaw Pact attack. The major elements of NATO and U.S. strategy, our weapons and defensive posture in Europe, place heavy dependence on the ability to retain control of forces at all echelons. However, our present command and control posture in Europe is dangerously deficient. Command and control is clearly an important part of our posture in Europe, but the overriding urgency of addressing the area derives from these outstanding deficiencies. Improvements will provide a force-multiplying factor of critical dimension.

The rationale for judging that Command and Control is of primary importance includes the following points:

1. The Warning issue emerges as critical. The allied ability to develop a common perception of the threat to Western Europe and act in concert, in time, is important for deterrence and, should deterrence fail, an important aspect of readiness for conflict. The U.S. and NATO peacetime posture is based on receiving at least 48 hours of warning of Warsaw Pact attack. In peacetime our forces are not stationed properly to resist attack and must move to their general defense positions. U.S. land forces have the additional burden of obtaining their ammunition, which is not carried with the units in peacetime. The peacetime headquarters of NATO commands are in soft and vulnerable locations and not postured to operate forces. To become operational in their wartime headquarters they must usually move several tens of kilometers and into conventionally hardened facilities.

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[redacted] 3. Independent of the nuclear requirement, the allies need an effective C^3 system to preserve flexible use of the forces. Of particular importance is the need to identify and respond to the main thrusts of attack to assure that the engagement ratios are not catastrophic.

[redacted] 4. At the combat level the importance of command and control is multiplied by the concepts and weapons we are now developing. To deal with the unbalanced force ratios and capitalize on our advanced technologies, we are turning to weaponry with increased range and accuracy which requires extensive target acquisition capabilities and a rapid response between target acquisition and force application. Stand-off delivery, terminal homing systems, and precision-guided munitions are examples of weapon characteristics requiring a rapid command and control system. The ability to place a weapon with 50-foot accuracy is not very useful if one has no way of detecting and locating targets with that accuracy. In parallel, improvements in intelligence and information handling systems provide new opportunities to couple accurate and timely sensor data to the fire control loop. The coupling of these new weapons and new target acquisition systems is of critical importance to combat effectiveness.

[redacted] 5. The modern weapons of the air forces and armies overlap in space, in type, and in time of application. The reconnaissance systems of the air forces, armies, theatre systems, and national-level systems also overlap. This "integrated battlefield" demands cross-service information exchange and weapons management. The command and control procedures for achieving this must be developed. In Europe these problems are all made more complicated because they cross national lines as well.

Posture Assessment

[redacted] Our warning posture is not credible. The U.S. has the potential to develop a comprehensive perception of Soviet activities but does not have the mechanism for transferring that perception with the credibility necessary to persuade its allies to act in a timely fashion.

[redacted] The survivability of the existing command and control structure is dangerously deficient. In it there are too few nodes in the system, they are too soft, and they are vulnerable to electronic countermeasures. For demonstration purposes, Table G-I lists 22 facilities which, if destroyed, would seriously impair our ability to control theater forces. It is likely that they could be eliminated conventionally but most certainly with nuclear weapons.

[redacted] The intelligence and information handling process surrounding the U.S. and allied command structure in Europe is fractionated and compartmented. Provision of intelligence to NATO commands is a national responsibility and is done separately by each nation. Within the U.S., there is a fractionalization of intelligence, reconnaissance, surveillance, and electronic warfare. Allied Headquarters are not operationally postured in peacetime to receive, handle, and distribute national products, and their ability to mobilize quickly to do so is suspect.

Table G-I

Survivability of NATO Command and Control (U)

[redacted]

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[redacted] We are developing a number of battlefield systems which aim to produce large volumes of information. The concepts and equipment to cope with this information explosion are not defined.

[redacted] The NATO communications posture is inadequate at both the strategic and the tactical levels. Although the NATO Integrated Communications System (NICS) is being improved with heavy investments, these actions do not affect the tactical level. At the tactical level, our systems are incompatible and not interoperable. Lack of cryptographic security at all levels is a serious deficiency.

[redacted] The interservice and international procedures for exchanging tactical information and mixing weapons dynamically between services and nations are not well developed and are demonstrably inadequate.

Conclusions and Recommendations

[redacted] Any strategy for countering a Warsaw Pact attack in Europe must deal with the warning problem. One of the most critical factors associated with being militarily prepared for such an attack is the time required to posture for crises or war. To address this issue requires a combination

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improved intelligence, improved NATO ability to respond to intelligence, and an improved peacetime posture which reduces the "mobilization" time.

[redacted] Of equal importance is achieving a survivable European Command and Control system. Multiple hardened and mobile headquarters are needed and a redundant communications system is required which will withstand determined conventional or nuclear attack.

[redacted] At the combat level, successful application of our new weapons and concepts demands a rapid closing of the loop between target acquisition and force/weapon control. The standoff and precision weapons being developed, which could provide the leverage needed to counter Warsaw Pact force-ratio advantages, will not be effective without the ability to target them. The large number of battlefield information systems being developed will not be effective if the using commands have no way of coping with this explosion in information or using the real-time information to control the precision munitions. Concepts, doctrine, procedures, and perhaps some equipment are needed which will bring the information systems and weapons control function together within the services, across service lines, and across national lines in NATO.

[redacted] Some specific actions which the DoD should take are recommended. It is recognized that they are in no way an exhaustive or even comprehensive list of actions, inasmuch as the task force did not attempt to treat these issues completely. They are, however, important initiatives needed now which can contribute to the larger solution.

[redacted] 1. DoD should take the initiative to develop an improved tactical command and control system.

[redacted] 2. In parallel, experimental combined air force-army tactical operations centers should be established immediately in Europe and in the U.S. The purpose of these experimental or pilot centers is to begin now to develop, by practice, field operational perspectives in air-ground procedures for information exchange and weapons allocation and assignment. The coming explosion of battlefield information needs an operational test outlet for evaluation and education.

APPENDIX H

AIR ATTACK OF ARMOR FROM LOW ALTITUDE*

(U) The apparent Air Force plan for tactical air operations against enemy armor in Central Europe involves an assemblage of strike and support aircraft reminiscent of strikes in heavily defended areas of North Vietnam. Though this concept arises naturally from experience gained in our latest combat, one must question whether such tactics would achieve the desired results in a European high-intensity war. In Southeast Asia operations, the large "gaggles" of ECM, defense suppression, air superiority, and strike aircraft, with their complex interrelationships, took many hours, sometimes days, to put together. This type of approach to counter armor operations would certainly pose a severe constraint on the number of strike sorties that could be flown during critical short periods such as the time when enemy breakthrough forces are forming.

(U) In the past, TacAir responsiveness in attacking tactical targets (not in contact with friendly forces) has been limited by intelligence gathering, interpretation, and targeting. Considerable effort and funds are being expended today so that this process will be accomplished much more quickly and efficiently by the 1980s. Given success at those endeavors, the limiting factor in TacAir responsiveness will surely be the formation of strike operations. If that is necessary, then many of the gains brought about by PELSS and associated equipment, SOTAS, and proposed joint targeting centers will be negated.

(U) The USAF approach to counter armor operations has its origins in a healthy respect for Warsaw Pact mobile forward area defenses. Thus, the primary anti-armor strike aircraft would be heavily reinforced with ECM and defense suppression aircraft which are to actively suppress defenses. Two studies presented to the Defense Science Board, however, suggest that the Pact forward mobile defense capability is already severely degraded in attempting to deal with aircraft flying at extremely low altitude (100 – 300 ft. AGL).

[redacted]

*(U) Some but not all of the material presented in this paper is digested in the Counter Armor report. The paper is included because of the additional information it provides relevant to the efficacy of low altitude strike tactics.

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(U) Similar results have been presented for years and contributed to the assumption that low and fast tactics would be successful in North Vietnam. There, however, aircraft were forced to fly well-known penetration routes (for navigation purposes) against static defenses which essentially knew the moment when attack sorties left the home airfield. Not surprisingly, such raids suffered extremely high attrition rates, primarily to small arms and automatic weapons fire.

(U) RDA's presentation on Pact mobile air defenses, taken from work performed for the Net Technical Assessment Office, indicates that forward defenses are degraded severely (compared to the static situation) when they are forced to move in support of an echeloned attack. This degradation increases as the attacking force moves faster, due to the fact that the number of defenses that are repositioning is an increasing function of the attacker forward speed. Additionally, the necessity to quickly deploy a gun or missile defense system which is on the move would often result in relatively high masking angles due to local terrain or foliage. Though Pact forces would be expected to attach additional army or front air defense units to attack echelons in an attempt to mitigate the above problems, the trends shown in the RDA analysis are still valid.

(U) All of the above suggest that low-level tactics be re-evaluated in the context of a European scenario. British and West German air forces train in and plan to use low-level, autonomous tactics. They are familiar with the terrain (since they feel they will be fighting on their own territory) thus eliminating most of the navigation problems. They recognize that communications with the ground forces would be poor at best, limiting the degree to which true close air support could be employed. Of course, one could argue that our NATO allies have not had the benefit of eight years of recent combat air operations. On the other hand, it could be said that their planning process is not encumbered by such an experience.

(U) In addressing the low-level attack problem two factors are considered here: first, would such an approach improve our forces' rate of kill of armored vehicles; and second, are adequate munitions available to perform such a task.

FORCE CAPABILITY

The 1982 USAF program deployments to Europe are such that the in-place forces more than double during the first three weeks after M-Day (the first day of a U.S. mobilization). In this analysis, however, we are concerned with altercations that arise with relatively short warning time available to NATO forces (e.g., 2 or 3 days). That being the case, it is doubtful that the beginning of a war would see many more than the in-theatre aircraft on hand. A good assumption is that the 72 A-10's programmed for permanent stationing in Europe would constitute the primary (and perhaps only) dedicated anti-armor aircraft in the early phases of a Central European war.

The A-10 aircraft is capable of carrying a formidable array of anti-armor weaponry. If [redacted]

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Figure H-1. A-10A/GAU-8 Effectiveness Against Single Soviet T-55 Tank 2-Second Burst (120 Rounds) (U)

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Figure H-2. A-10/ROCKEYE Effectiveness Against a Tank Platoon
(3 T-55 Tanks in a 400' x 200' Area)
16 ROCKEYEs in One Pass (U)

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Figure H-3. A-10 ROCKEYE Effectiveness Against Soviet Tank Company Convoy (10 T-55 Tanks on Road, 50m Spacing Between Tanks) 16 ROCKEYEs in One Pass (U)

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[redacted]

Figure H-4. Sensitivity of A-10/ROCKEYE Effectiveness to Bomblet Reliability — Level/200' AGL Release of 16 ROCKEYEs (U)

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(S) The commitment rate of Soviet vehicles is considerably slowed and the availability of convoy targets increased if effective mining tactics are used. Scatterable mines are not the sole answer since they are very visible on hard surfaced roads and may easily be removed. Tactics must be developed to cut roads and mine the surrounding area to effectively backlog vehicle flow. The DDR&E should ensure that an air-deliverable scatterable mine is developed and procured. The USAF should develop tactics for its efficient use. JS 3.3(b)(5)

(S) The primary criticism of low-level tactics is the vulnerability to ground fire, i.e., company-sized weapons and AAA. The A-10 has been designed to be survivable in that environment [redacted] Thus, an approach that relies heavily on defense suppression tactics must ensure that the defense environment is degraded by at least a factor of five over the low-level situation in order to break even from an aircraft attrition standpoint. JS 3.3(b)(5)

MUNITIONS FOR LOW-LEVEL ATTACK

(U) Previous discussion has indicated that low-level attack appears viable, from an effectiveness standpoint, against linear targets such as vehicle convoys. The length of convoy targets tends to mitigate effectiveness degradation due to the component of delivery errors along the aircraft ground track (normally termed range errors). Deflection errors (perpendicular to the aircraft flight path in the ground plane) are generally small for visual deliveries, since pilots can line up with a linear target much as they line up with a runway.

(U) Weapon pattern control is very important for disperser weapons. Bomblets must be dispersed to ensure that the pattern is large enough so that delivery inaccuracies (though perhaps small) do not become a problem. An "optimum" pattern size for a stylized target (e.g., the convoy in Figure H-3) may be easily computed analytically, but the targets that are seen in combat vary considerably in size. An "optimum" pattern for one stylized target may well have very poor effectiveness against another of a different size. For this reason the pilot should have some ability to tailor the pattern to the situation at hand.

(U) If the disperser concept employed is one involving multiple independent weapons, then the aircraft intervalometer provides longitudinal dispersion automatically. Lateral dispersion may be accomplished by either propelling bomblets from captive dispersers or, as with the Rockeye, relying on aerodynamic dispersal after launching the dispenser itself.

(U) Existing anti-armor bomblets rely on the shaped charge concept to penetrate armor. The bomblet must hit the armor in such a way that the shaped charge jet penetrates a vulnerable component of the target. The sum of the area of all such vulnerable components as seen from a particular aspect angle, is termed the vulnerable area of the target. For this type of weapon the vulnerable area is limited to, and generally much smaller than, the presented area of the target.

(U) Assuming proper bomblet dispersal can be achieved, there are two methods of improving the kill potential of dispenser weapons: increase the number of bomblets delivered; or, increase the target area vulnerable to a single bomblet. Effectiveness is proportional to the product of target vulnerable area and the number of bomblets. Generally, achieving greater vulnerable areas implies larger bomblets and reduces the number that can be delivered. Thus, in designing a new dispenser weapon, one must be certain that increases in bomblet lethality are not counteracted by proportionately greater increases in size or bulkiness.

(U) Figure H-5 displays the relationship of the number of bomblets in the pattern to target vulnerable area for several kill levels against the stylized convoy target used in Figure H-3. It was assumed that bomblets were uniformly distributed over a pattern whose length and width were 1300 feet and about 200 feet respectively. The assumed 25-mil delivery accuracy translates to a deflection error probable (DEP – a one-dimensional analogy to CEP) of 60 feet. A wider pattern (and more bomblets) would be required to achieve the expected kills shown if the delivery inaccuracies were significantly larger.

[redacted]

[redacted]

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Figure H-5. Dispenser Weapon Parametrics – Expected Kills vs. Target Vulnerable Area and Number of Bomblets (U)

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[redacted]

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(U) As Figure H-5 shows, all three systems are theoretically quite effective against the convoy target. None appears clearly superior given adequate pattern control, bomblet arming, and aircraft compatibility. Uncertainties are present in all of these areas, however. Test drops should be made for the three systems and further target vulnerability studies run to be assured of the bomblet lethality.

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CONCLUSIONS

[redacted]

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APPENDIX I

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