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SUMMARY REPORT
OF
THE LONG RANGE RESEARCH AND DEVELOPMENT PLANNING PROGRAM

Jointly Sponsored by

Defense Advanced Research Projects Agency
and
Defense Nuclear Agency

7 February 1975

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ABSTRACT

(U) The purpose of this effort was to identify and characterize, in a systematic manner, those technologies that would have to be undertaken to provide the National Command Authority with a variety of response options as alternatives to massive nuclear destruction. The approach has been to investigate several representative conflict situations that come under the general heading of "limited Soviet aggression."

(U) These investigations sought to identify: (1) United States strategies or options that are available for deterring Soviet aggression; (2) those military capabilities that seemed to make a significant difference in our ability to cope with such aggressions; (3) possible weapon or system concepts that showed considerable promise in being able to provide these capabilities; and most importantly, (4) those technology programs that would have to be undertaken to make these systems and capabilities a reality.

(U) The strongest technology incentives to emerge from the program are those related to precise delivery of munitions.

(U) Based on the analysis it appears that non-nuclear weapons with near zero miss may be technically feasible and militarily effective. If so, such non-nuclear weapons, under some circumstances, might satisfy the current United States and allied damage requirements that now require the use of nuclear weapons. Near zero miss non-nuclear weapons could provide the National Command Authority with a variety of strategic response options as alternatives to massive nuclear destruction.

(U) Other major results are presented in Chapters IV and V.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

PRELIMINARY REMARKS

(U) The Long Range Research and Development Planning Program, a study which began in June 1973 and ended in February 1975, was supported jointly by the Advanced Research Projects Agency (ARPA) and the Defense Nuclear Agency (DNA). A Steering Group was jointly chaired by Dr. S.J. Lukasik and Dr. J. Rosengren. The study had the benefit of several senior level executives and advisors from the Department of Defense including representatives from the three Services attending the workshops and the panel meetings.

(U) The work was conducted by three working panels and four contractors. The panels included members from the government, private industry, and the academic community. The panels and their respective chairmen were: the Strategic Alternatives Panel chaired by Professor A.W. Wohlstetter, the Advanced Technology Panel chaired by Dr. D. Hicks, and the Munitions Panel chaired by Dr. J. Rosengren. The contractors were: Braddock, Dunn & McDonald, Inc., Vienna, Virginia; General Research Corporation, Santa Monica, California; Lulejian & Associates, Inc., Falls Church, Virginia; and Science Applications, Inc., La Jolla, California.

(U) Detailed analyses supporting the contents of this Summary Report are contained in the individual panel, contractor, and workshop reports. The appendix identifies the reports in detail.

(U) This report summarizes the study approach, major issues, and results.

I. FOCUS OF THE STUDY

(U) The purpose of the study was to identify and characterize those technologies that would have to be developed to provide the National Command Authority with a variety of options suitable for response to limited Soviet aggression as alternatives to massive nuclear destruction.

(U) Soviet deployment of a large and credible nuclear strike capability in the early 1970s has directed new attention to the question of deterring limited Soviet aggression against the United States and its allies, especially United States allies along the Soviet periphery. At about the time Soviet strategic forces reached "parity" or "comparability" with those of the United States, the President stated:

> At no other time in the nuclear era has it been so essential to maintain a full range of credible options for defending American interests....If allied general purpose forces are weak, aggression by conventional means or attempts at political coercion might seem more inviting.

And,

> In a strategic environment of approximate parity, nuclear weapons alone are less likely to deter the full range of possible conflicts. Our success in negotiating strategic arms limitations has thus increased the importance of maintaining other deterrent forces capable of coping with a variety of challenges.

These statements strongly suggest that at low levels of conflict, purely military actions are not practical courses of actions for a United States President; rather, the only pragmatic actions available are politico-military in nature.

(U) The focus of the study, therefore, was on conflicts of lower levels under the assumption that both the United States and the Soviet Union would continue to maintain adequate strategic retaliatory forces. As a result, realistic conflict situations were carefully developed and examined in the political context and the politico-military utility of various weapon systems was investigated and described. This approach necessitated exchange of information, opinion and analysis between those study participants who were specialists primarily in political science and those who were oriented primarily toward technology or systems. This exchange and dialogue continued throughout the study, with the principal end objective of technology identification always in the forefront.

(U) To this end, the following four questions were specifically addressed:

1. What United States strategies or options are available for deterring limited Soviet aggression?

2. What military capabilities are required to underwrite these strategies?

3. What are the most promising system concepts and specific technical approaches to make these desired military capabilities a reality?

4. What technologies should be developed and what advanced research and development actions should be taken to demonstrate technical feasibility of these concepts?

(U) To facilitate consideration, "Limited Soviet Aggression" was divided into five categories:

1. Soviet participation in wars between other nations.

2. Soviet aggression against nations peripheral to the Soviet Union.

3. Soviet aggression against a single NATO nation.

4. Soviet aggression against NATO.

5. Selective Soviet threats against specific targets in the United States homeland; including aggressions of the Cuba-missile-crisis kind.

In this period of nuclear parity, categories 2 and 3 pose difficult problems of response, and represent those lower level conflicts where politico-military solutions must be sought; such contingencies have, until recently, been given far less attention than the others, and probably less attention than they deserve. In order to further assess these possible aggressions, the emphasis of the study was devoted to categories 2 and 3 above.

II. CONFLICT SITUATIONS, TARGET COMPLEXES, AND MAJOR ISSUES

A. CONFLICT SITUATIONS

(U) A set of conflict situations exemplifying Soviet aggressions against peripheral nations was postulated and examined in detail. The objective of this examination was to develop useful guidance for the needs of future technology and R&D by sequentially addressing the four questions which provided the focus of the investigation. The examination and analysis of the different conflict situations was not for the purpose of predicting outcomes of such conflicts nor to predict the likelihood of their happening in the first place; these are matters which are sensitive to assumptions and initial conditions. The purpose of examining these specific situations was to set a background against which the political scientist/technologist dialogue could take place and the above-mentioned four questions could be investigated and answered. Insights that have fairly general application were gained with respect to identifying the political implications and those military capabilities that make a difference to outcome and identifying the more promising system concepts and technical approaches.

(U) Four of the conflict situations will be elaborated upon in this summary report. These exemplify limited Soviet aggression against peripheral nations, and consist of conflict situations involving, individually, Norway, Iran, Yugoslavia, and Japan. An additional three situations were examined to gain insight into the political restraints operating on the use of military force in lower levels of conflict involving the Soviet Union. Again, the eventual purpose was to identify possible system concepts required, and R&D programs needed. These conflict situations were an Arab-Israeli Middle East War with Soviet assistance to the Arabs, a special case of Sino-Soviet war, and a "replay" of the 1962 Cuban Missile Crisis. The Cuban situation was extremely important in that it represented a fact of history, with a specific potential target set, and specific military capability on both sides. A re-examination of the Linebacker II raids on Hanoi was conducted to compare improved, all weather precision delivered munitions with those actually used. Each of these two cases are actual instances of the discriminate use or planned use of military force in a situation requiring both political and military actions.

(U) The Norwegian conflict situation was postulated to develop from a Soviet military exercise which included a naval component such as the Atlantic Ocean phase of OKEAN (1970). The Soviet invasion consisted of a surprise air, ground, amphibious and airborne attack on northern Norway with the objective of achieving a quick occupation of the northern two Norwegian counties. One purpose of a Soviet invasion might be to test the firmness of Article 5 of the North Atlantic Treaty, the essence of which is that an attack against one of the allies will be viewed as an attack against all. Another purpose might be to obtain easier access to the Norwegian Sea.

(U) The Iranian conflict situation was assumed to arise from a surprise attack of a combined Soviet and Iraqi force consisting of air, ground, amphibious and airborne attacks with the objective of quickly taking control of northern Iranian territory, including the capital. One purpose of this invasion could derive from Iraqi aggression against Iranian territory or other Iranian interests.

(U) The Yugoslavian conflict situation studied consisted of a surprise air and ground attack on Yugoslavia by the Warsaw Treaty Organization (WTO) forces from Hungary, Romania and Bulgaria. The objective of the WTO was to gain a quick victory over the defending Yugoslavian forces, establish a pro-Soviet regime in Yugoslavia, and thus increase the capability to divide and threaten NATO's southern flank.

(U) The Japanese conflict situation was also seen to come about from a Soviet military exercise which included a naval component, such as the Pacific Ocean phase of OKEAN (1970). The Soviet invasion consisted of a Soviet air, airborne and amphibious invasion of the Japanese island of Hokkaido with the objective of seizing the industrial region of the island, the principal airfield of Chitose, and the major ports of Otaru and Nemuro. One purpose of the invasion might be to obtain full control of the La Perouse and Tsugaru Straits which are the most efficient and direct passages from the Vladivostok complex and the Sea of Japan to the Pacific Ocean.

(U) In all the conflict situations it was assumed that the Soviets would strive to make the conflict one of short duration. The Soviets would want to achieve their objectives quickly and present a fait accompli before the force of world opinion could be brought to bear in a political sense and before the threatened country and the United States, with or without other allies, could respond in a military way to frustrate the Soviets from achieving their objectives. Consistent with the above perception, the Soviets would devote considerable attention to deception by camouflaging their attack by one means or another as long as possible. Once the character of the aggression was exposed, the Soviets would then apply their forces as rapidly as they could.

B. COLLATERAL DAMAGE AND ATTACKS ON TARGET COMPLEXES

(U) Traditional measures of the military effectiveness of strategic attacks, particularly by nuclear weapons but also by conventional weapons, have been the number of targets destroyed or the percentage of the targets at risk that have been destroyed by the attack. Not only have strategic attacks been evaluated by destruction achieved, but nuclear weapons generally have been designed specifically to achieve large area destruction. The impact of relative inaccuracy of weapon delivery and resistance of targets to damage was overcome by the large area effects of nuclear weapons. In the traditional evaluation, collateral or unintended damage to population caused by a specific attack against military or industrial target complexes is either considered as an acceptable side effect or is disregarded in the calculations.

(U) Two incentives have manifested themselves in the decade 1962-1972 which suggest a reassessment of both the design criteria of nuclear weapons and the measure of effectiveness of weapon attacks against the Soviet Union.

(U) The overriding incentive is the Soviet development of a massive and credible nuclear strike force comparable to that of the United States resulting in a capability on each side for mutual assured destruction. This mutual condition appears to have denied to the United States viable responses to limited Soviet aggressions against the United States and its allies, relegating present United States strategic weapons to the role of retaliation to Soviet massive attack on the United States; a possible exception is the use of a few United States strategic weapons on remote Soviet targets. The concern is that other "limited" use of these weapons would produce very heavy collateral damage to Soviet population which could act as a strong motivation to the Soviet Union to attack United States population in retaliation.

(U) The second incentive for reassessment of the criteria by which nuclear weapons are measured is the explicit instruction of two different United States presidents in two specific historical military situations. The first was the Cuba missile crisis during which President Kennedy directed that a specific contingency plan be prepared for destruction of Soviet missiles on Cuban territory by military attack with the constraint that there be few, if any, personnel casualties; the second was the direction given to United States air forces in the 1972 bombing of North Vietnam in which casualties to civilians and damage to non-military properties were to be minimal.

(U) These incentives, in themselves, could have lead only to a somewhat academic reevaluation of damage criteria, if it were not for the fact that weapons with near zero miss distance may be technically feasible in the next several years.

(U) As a result, there were developed in the study "dual criteria" for evaluation of candidate weapon concepts as applied to attacks on Soviet targets both within the boundaries of an invaded nation and within the Soviet Union. The two criteria were: (1) to achieve the desired damage expectancy on an intended target or target system with high confidence; while simultaneously, (2) not damaging particular regions or population areas, again with high confidence. These two criteria were applied to military engagements in each conflict situation and to all attack situations in the study and examples against specific target complexes will be presented shortly.

ASW's dual-criteria

(U) It was reasoned that a United States force which could make highly effective attacks with low collateral damage would provide to the National Command Authority available options for response to Soviet limited aggression which would not otherwise be available; the effect of this capability would be to deter limited aggression in the first place, since the credibility of a United States response with this type of attack would be much higher than that of a United States response in which millions of civilians would be killed. Should such a capability not deter limited Soviet aggression, it would operate to impede or halt Soviet aggressor forces or support negotiations leading to agreement to halt the aggression.

(U) The conflict situations gave rise to three kinds of attack options against Soviet targets to which the dual criteria were applied and in which weapon system concepts were analytically tested. The first consisted of tactical attacks against Soviet forces within the boundaries of the invaded nation; the second was attack on Soviet forces, in Soviet territory, that directly supported the Soviet aggression; the third option considered was attacks deep into Soviet territory, traditionally known as "strategic" attacks. (In the study and in the panel and contractor reports, these are called "alpha," "beta," and "gamma" attacks, respectively.) Targets in the third attack category were not necessarily in direct support of the Soviet aggression. The capability for these three kinds of strikes, with very few civilian casualties, could provide a wide range of options to the United States, not now available, that would enhance deterrence of limited Soviet aggression and which would serve to impede or halt the aggression or to support negotiations should deterrence fail. These options would fall very short of massive attacks.

(U) The following table includes most of the classes of target complexes considered:

Industrial Targets	Military Targets	
Oil Refining	Submarine Bases	Northern Sea Route
Electric Power	Airfields	Kasernes
Steel	Supply Depots	Tanks
Aluminum	Amphibious Forces	Air Defense Radars
Ship Building	Mobile Missiles	
Waterways		

Analysis of attacks with near zero miss weapons on many of the above targets required pioneering the study of "microvulnerability" of target complexes, the selecting of the appropriate element of a target for destruction, e.g., the blast furnace of a steel mill.

(U) The remainder of this section will deal with some examples of attacks on target complexes. Within this representative sample, the dual criteria will be applied. Each complex will not be included in this summary, but rather the style of the analysis will be conveyed.

1. Oil Refining Facilities

(U) Figure 1 shows the distribution, by capacity, of oil refineries in the Soviet Union. Several locations (such as Baku) have more than one refinery, separated by sufficient distances that they cannot be considered single targets. Approximately 20 percent of total capacity is accounted for by the three largest refineries; 50 percent of capacity is represented by 14 refineries; 80 percent by 24 refineries.

(U) The principal targets within a refinery are the atmospheric distillation towers of the crude processing units. Some refineries have as many as eight such units; the newest and largest refineries have crude units with average capacities of 100,000 barrels per day. The area of a refinery is quite large, from 0.7 to 4 square miles for the largest refineries (400,000 BPD). The large area of a refinery means that it is possible to contain most, if not all, of the collateral effects of a low yield accurate weapon within the target.

(U) The number of weapons required to destroy a given fraction of the Soviet Union's refinery capacity for at least a six-month period is shown in Figure 2. To reduce total capacity by 20 percent requires three 1-kiloton nuclear weapons (one each for three refineries), twelve 0.1-kiloton nuclear weapons (one each against the 12 crude units), or 120 MK 83 bombs (500 lb - 20 ft CEP). The refining capacity can be drawn down to 50 percent by 25 1-kiloton nuclear weapons.

(U) Collateral effects, shown in Figure 3 from refinery attacks by nuclear weapons were calculated in terms of in-refinery worker casualties and the area outside of the refineries' boundaries exposed to that level of radiation

FIGURE 1. DISTRIBUTION OF OIL REFINERIES IN THE SOVIET UNION (U)

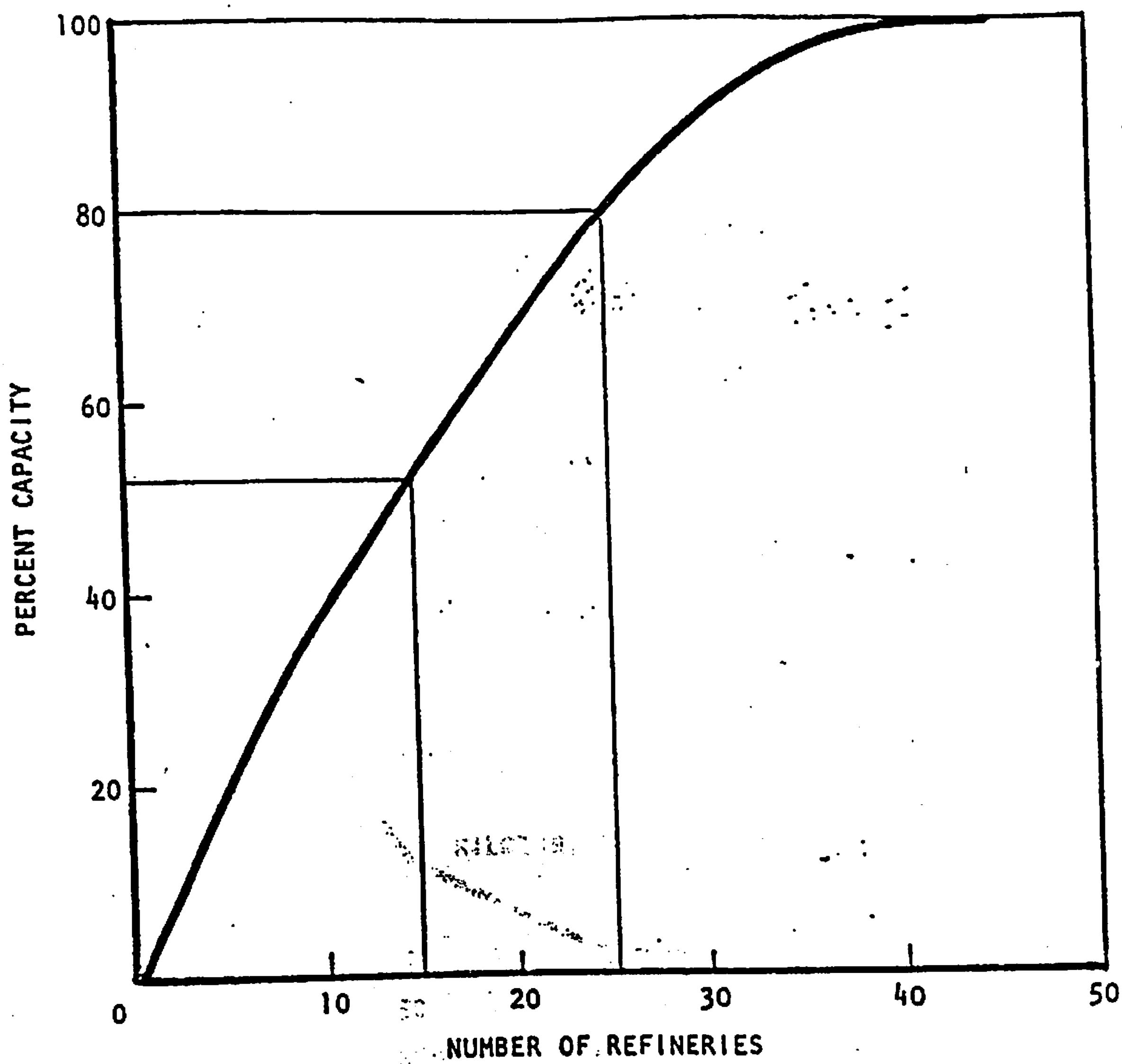

FIGURE 2. WEAPONS REQUIRED TO DESTROY SOVIET REFINERY CAPACITY (U)

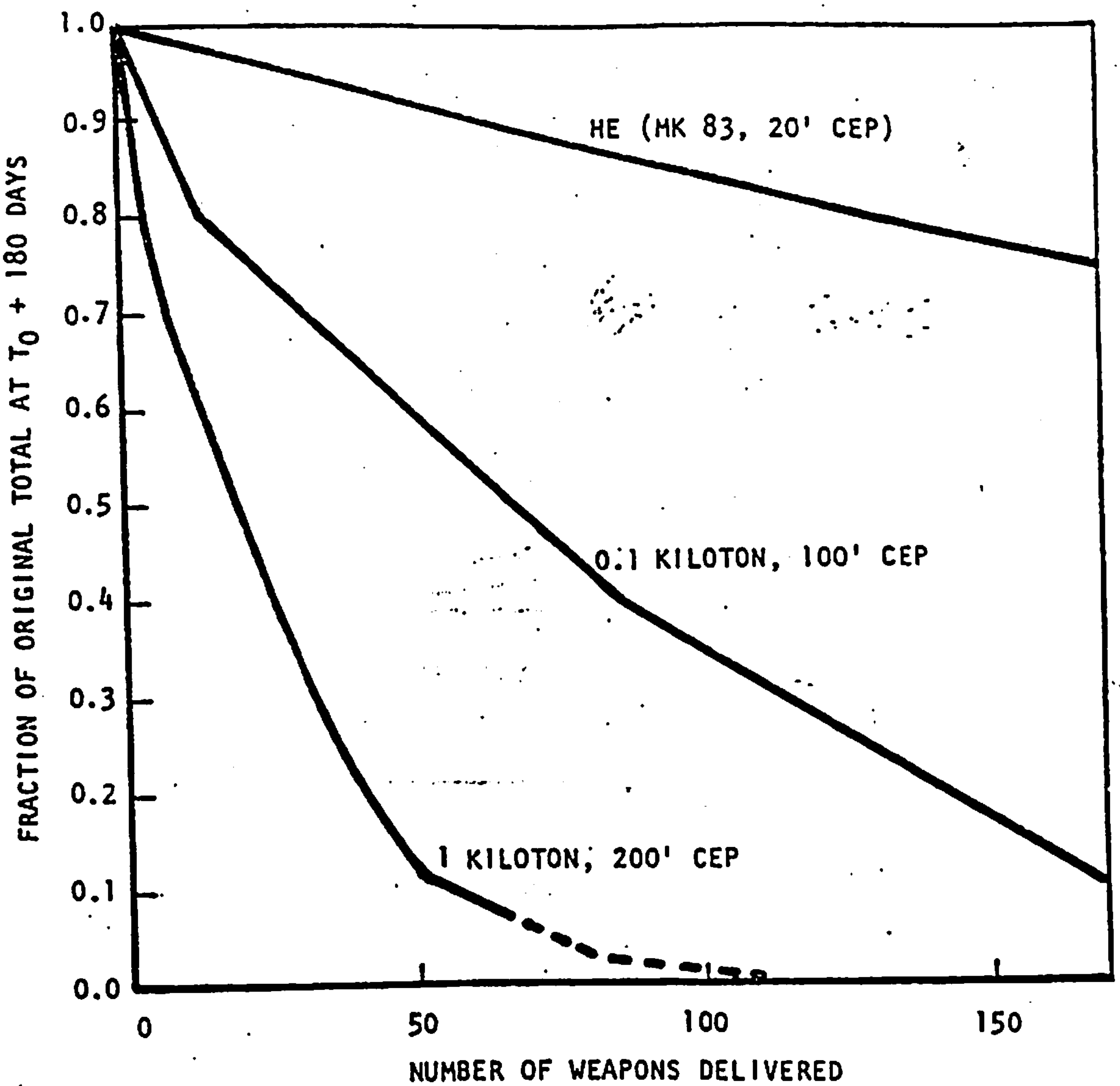

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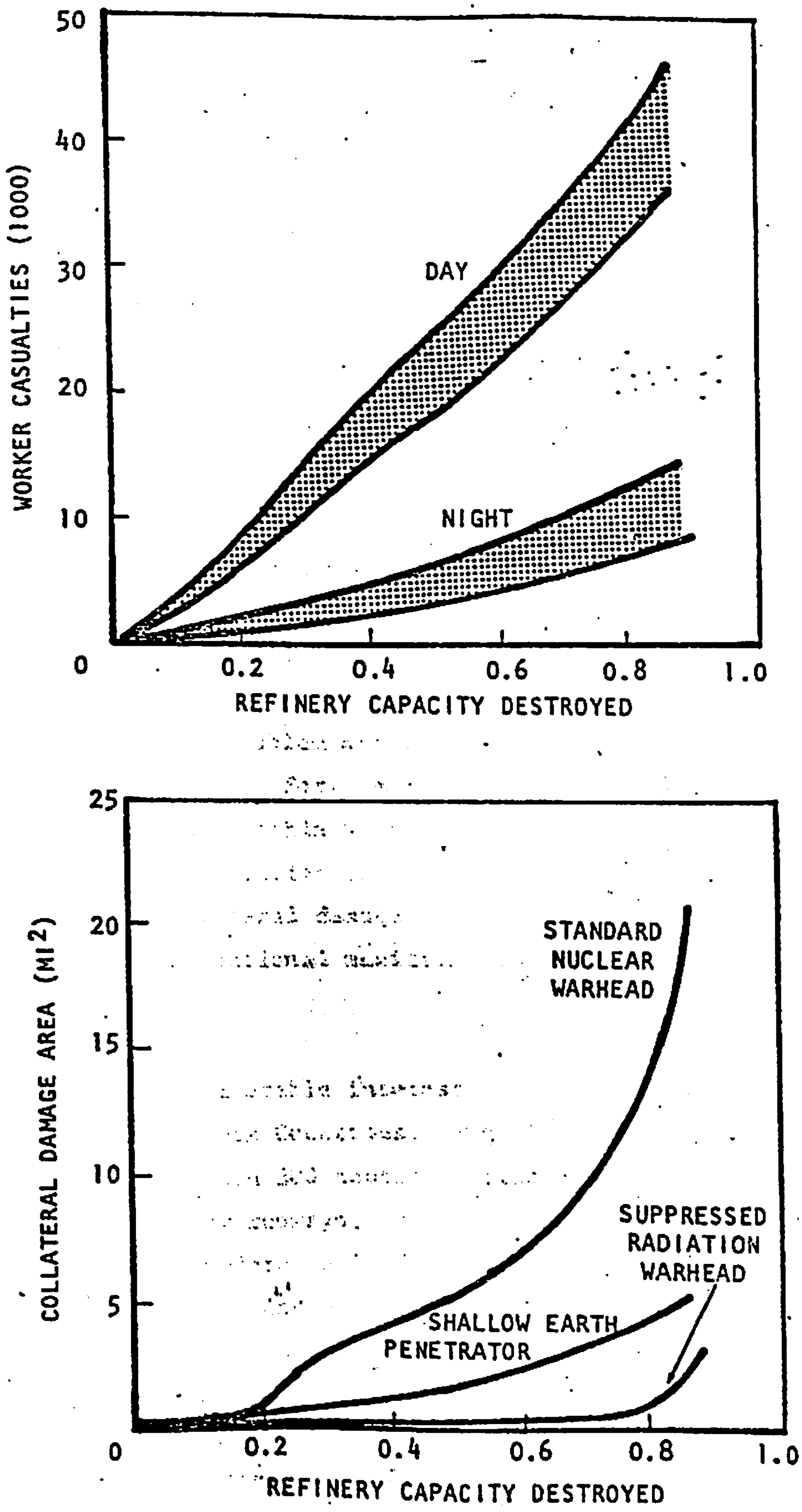
FIGURE 3. COLLATERAL EFFECTS FROM REFINERY ATTACKS (U)



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at which 50 percent of the people need assistance. The difference between night and day attacks is quite evident for worker casualties; the range of values represents various warhead options, standard, suppressed radiation or shallow earth penetrator. Using suppressed radiation warheads to attack refineries produces very little collateral damage, up to destruction of about 70 percent of the refineries.

2. <u>Electric Power Generating Plants</u>

(U) The Soviet Union's power generating capacity is dispersed with over 800 generating plants of all types. The 125 largest plants account for 60 percent of total capacity. The switch gear is judged to be the principal aim point since destruction of the switch gear and transformers can put a plant out for six months to a year -- depending upon the availability of spares. There is a relatively small target area and short distance from the aim point to the outer fence. These factors make nuclear weapons an undesirable choice against electric power plants. It has been estimated that two to four PGMs with accuracies of the order of 20 feet could successfully attack a power plant.

(U) The collateral effects problem associated with using nuclear weapons against power plants is large. For example, there are 12 power plants in the vicinity of Leningrad -- all within high population density areas. A massive attack on electric power production is costly in terms of numbers of weapons and could induce large collateral damage. Attacking power plants in a limited geographical area with conventional munitions is a possible option.

3. <u>Airfields</u>

(U) Another target of considerable interest in the study was the complex of airfields in the Eastern Block Countries. Figure 4 shows that about 300 of the major airfields lie within 300 nautical miles of the border. For the minor airfields with shorter runways, there is a somewhat larger number within that range. There is, therefore, a large number of targets. One notes that successful attack against any one airfield will require numerous conventional munitions and will probably require more than one nuclear weapon. Thus, a successful attack against this target set will require a very large payload delivery capability. Fortunately, the range is modest compared to the range of some of the targets mentioned earlier.

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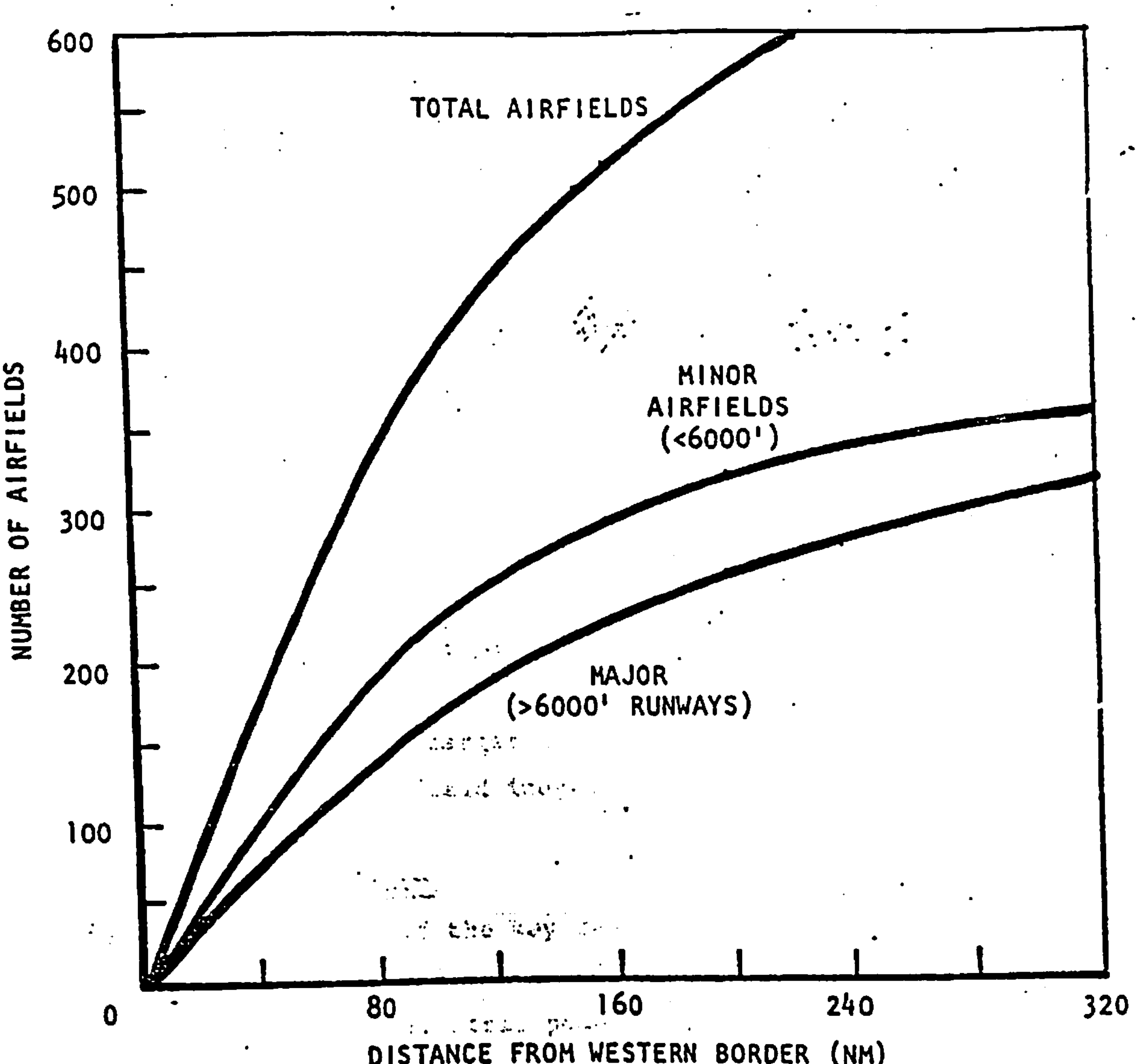
FIGURE 4. CUMULATIVE DISTRIBUTION OF EAST BLOCK AIRFIELDS (U)



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(U) It is noteworthy that a single airfield includes a number of individual targets. Airfields have many hangarettes and several runways which should be cut if operation from them is to be interrupted. The analysis of attacks against airfields shows that the delivery requirements for conventional attack against the multitude of individual high value targets in the vicinity of the airfield is a stressing situation for the offense. In the case of nuclear weapons against the airfields, blast and crater-related damage mechanisms can be effective, but still several nuclear weapons are required if the yield is to be kept to the kiloton range. Thus, the size of an individual airfield and the number of targets encourages the use of nuclear munitions and collateral damage becomes the important consideration. There are normally civilian populations in nearby towns. Like the oil refinery, the aluminum smelter, and the shipyard, the airfield is a large target. In fact, it is the largest of all those considered in the study; e.g., in Altenburg the area is about 5 square miles and the distance to the fence from typical point targets is 1000 - 3000 feet. Collateral damage reduction is possible with new weapons such as the shallow earth penetrator for this target which may be large enough to contain significant nuclear effects within the fence. It is also significant that for this target crater-related damage may be very important to rendering the airfield inoperable.

4. Target and Weapons Summary

(U) Table 1 shows a summary of the key deep targets of the study and characteristics of those targets which are relevant in considering new weapon technology and options. The electric power plants and the airfields are so great in number that any attack on them requires delivery of large numbers of weapons. In the case of oil refineries, shipyards and airfields the size of the facility is sufficient to contain many of the collateral damage effects within the area of the facility. For those targets which were considered as suitable for conventional attack, steel mills, shipyards, electric power plants and aluminum smelters, accuracies in the 50 feet or less category are required. However, for targets such as oil refineries, submarine bases and airfields, accuracies in the range of a few hundred feet are satisfactory. With the use of clean suppressed radiation nuclear weapons of low yield, collateral damage can be significantly reduced as compared to nuclear weapons of standard design.

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TABLE 1

TARGET SUMMARY (U)

TARGET	NUMBER TOTAL	NUMBER 50 PERCENT CAPACITY	KEY ELEMENTS	SIZE (MI^2)	DISTANCE TO FENCE (FT)	DESIRED MUNITION	DESIRED CEP (FT)
Oil Refinery	47	14	Crude Units	0.7	1700	1 Kiloton Suppressed Radiation Warhead	200
Electric Power Plant	800	100	Switch Yards	0.3	300	0.3 Kiloton Standard Warhead Non-Nuclear Submunitions	200 50
Steel Mill	50	14	Blast Furnace	0.4	800	Kinetic Energy Plus High Explosive Warhead	30
Aluminum Smelter	14	5	Switch Yard	0.5	1000	0.3 Kiloton Standard Warhead Non-Nuclear Submunitions	200 50
Shipyard	18	9	Assembly Bldg., Ways, Cranes	1.3	1500	Precision Guided Munitions (Non-Nuclear)	20
Sub Base	28	14	Subs	0.2	1000	1 Kiloton Standard Warhead	300
Airfield	600	300	Runway, Aircraft	5.0	2000	1 Kiloton Shallow Earth Penetrator	100

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5. Rainout and Washout

(U) An important issue that bears on the ability to conduct limited attacks with low collateral damage involves rainout and washout effects. If a nuclear weapon is burst at a sufficiently high altitude, no surface material will be drawn into the fireball, thus precluding fallout of earth material. However, fallout may still occur through either the process of rainout or washout, or both. Rainout occurs when the nuclear cloud interacts with the existing cloud base to form radioactive rain which then falls to the earth at a later time and place. Washout occurs when a nuclear cloud is rained upon by a precipitating system whose cloud base is at a higher altitude, again carrying contaminated rain to the surface.

(U) Current understanding of these phenomena is inadequate for providing high confidence calculations of collateral damage or for estimating whether a really significant problem exists. For example, analysis shows that casualties could range from tens of thousands to millions from nuclear attacks on European and Western Soviet areas with 50 to 100 1-kiloton air bursts. The large variations arise from the many possible weather systems and their movements relative to population areas. Additional but less detailed studies of other locales, such as the Caspian littoral, gave indications of serious rainout and washout problems. It is evident that a better understanding of these processes is needed in order to execute low collateral attacks with high confidence.

C. POLITICO-MILITARY ISSUES

(U) Several politico-military issues resulting from a capability for restrained, precise, and discriminate use of arms were identified; some were resolved and others remain unresolved. The issues relate to stability of the arms "competition" between the United States and the Soviet Union. The issues include: (1) crisis stability, the tendency not to use arms early in a politico-military situation, (2) nuclear threshold, the set of meaningful politico-military actions available prior to the first use of nuclear weapons, and (3) the "arms race," the notion that qualitative and quantitative actions regarding arms by one nation will inexorably result in a reaction by the other leading to spiraling increases in arms on both sides.

(U) There are three important technological possibilities that bear on each of the above issues: improved accuracy as applied to both nuclear and non-nuclear weapons; new nuclear weapons, including low yield, "clean" weapons; and specialized conventional munitions, such as fuel air explosives.

(U) One view of crisis stability holds that if the United States goes beyond what it already has, and acquires a major capability to respond to a wide range of attacks, the reduced expectancy and risk of a full scale retaliatory attack might invite an enemy to consider the possibility of the use of conventional and/or nuclear weapons as a more viable course of action than at present. As far as the United States ability to retaliate in the selective manner against very small attacks is concerned, some feel that the United States already has the necessary capability. This is a view which is shared by others who also believe that the assured destruction mission is the best, most appropriate, and the only way of using nuclear weapons in a major war. The concern is that improved accuracy might offer the prospect of improving the relative force position, thereby giving an incentive to strike first. Another concern is that the availability of small clean nuclear weapons will tempt political leaders to use them, but once used, once the nuclear firebreak is crossed, escalation will automatically occur. These are a collection of concerns which are held in a wide community as arguments against increased accuracy because crisis instability would be increased.

(U) Some discussions of these varying concerns are in order. As already mentioned the Soviet Union possesses powerful forces, equipped with nuclear weapons, many of which are hard or impossible to target; the throw weight that is available in the Soviet submarine based strategic force permitted under the SAL I interim agreement is substantial and under easily conceivable circumstances could be untargetable, thus reducing the incentive for first strike.

(U) One also notes that there was a long period of time in which the United States did have a great preponderance of nuclear power over the Soviets and did not strike. This at least suggests that an imbalance does not inexorably lead to a nuclear war.

(U) Much concern about stability focuses on what can be called bilateral stability, that is, stability in a world of two superpowers, the United States and the Soviet Union. This model of the world is oversimplified because the world contains third nations some of which possess nuclear weapons. In addition to the question of under what circumstances would one superpower attack another is the important question of the circumstances and the incentives under which one or the other of the superpowers might attack a third country. The history of crisis and conflict over the last 25 years has all involved third countries; and the United States and the Soviet Union have not come into direct confrontation except when third countries were involved. So a model of stability should probably be a multilateral model that has third countries in it.

(U) The issue of the nuclear threshold bears on the stability question. One needs to separate the case of nuclear weapons from that of non-nuclear ones. Improving the accuracy of non-nuclear delivery systems unquestionably raises the nuclear threshold, because it provides useful and effective options without resorting to nuclear weapons. On the other hand increasing the accuracy of nuclear systems may have the effect of making it more likely that a nation might resort to nuclear weapons because the war could be more manageable, with less damage on both sides. It may, therefore, be politically more acceptable; but one can also argue that having an improved nuclear capability does not necessarily imply that the nuclear weapons will be used any sooner than if the capability did not exist. Also, it is believed by some that a small force of low yield nuclear weapons, delivered with precision, is more acceptable to have, because it would appear less threatening to the Soviet Union. A key question is whether the situation would be more or less stable than in the case of the unimproved nuclear weapons. The issues of the nuclear threshold and stability therefore remain open.

(U) Regarding the issue of an arms race, critics of improvements in accuracy have argued that high-accuracy low-yield weapons will stimulate such a race; and it is argued usually that an arms race makes nuclear war likely or even inevitable. There is another body of opinion that believes that there is no evidence that improvements in accuracy will lead to more numerous or more destructive weapons. The first-order effect of an improvement in accuracy it is argued, is to make it possible to complete a given task with fewer and less destructive weapons; in many cases, some of these weapons may be non-nuclear. The relative increase in effectiveness for low collateral damage attacks may be greater for non-nuclear weapons than for nuclear ones, and the absolute requirement for delivered non-nuclear munitions may be lowered very substantially by comparison with delivered weapon requirements in past conflicts.

(U) These politico-military issues, then, were an important element of the study. This summary report will now turn to a discussion of two strategies related to limited Soviet aggression against peripheral nations; the stability issue will be further discussed in development of these two strategies.

III. TWO STRATEGIES AND SUPPORTING CAPABILITIES

(U) The strategies open to deter and halt, if necessary, Soviet aggressions against countries peripheral to the USSR fall under two general categories:

1. A strategy of coercive response. The foundation for such a strategy would be a United States declaratory or implied policy which threatened attack against limited numbers of selected targets in the USSR. The threatened attack might use conventional or nuclear weapons. (The "beta" and "gamma" attacks of the study support this strategy.)

Coercive response

or 2. A strategy of stemming the aggression. The foundation for this strategy would be the military capability on the part of the threatened country, along with prompt assistance by United States forces, of actually halting the aggression. In this strategy the Soviets are halted or impeded in that they are physically prevented from continuing the aggression. (The "alpha" and "beta" attacks of the study support this strategy.)

Aggression Stemming

A. COERCIVE RESPONSE

(U) To be successful the coercive strategy must satisfy at least three criteria: (1) it must be credible, or at the least not incredible, to the Soviets that the United States could and would successfully attack limited numbers of selected targets in the USSR; (2) these attacks would be clearly recognizable as being limited and selective in nature with due attention paid to Soviet economic recoverability, and (3) the Soviet perception of (1) and (2) above would deter them from initiating any aggression. Much the same applies for the case where Soviet aggression has been initiated and the United States is attempting to halt such aggression short of the Soviets achieving their objectives. This would be a matter of United States attacks against Soviet military or industrial targets, not necessarily directly involved in the immediate conflict. The objective of the United States attack would be to help initiate negotiations or to support ongoing negotiations involved with halting the war; the rationale might be, for example, to indicate to the Soviets the extent of the United States resolve in the matter.

Objective

Rationale: Resolve

(U) Two central questions are: (1) would the United States threat of such attacks deter the Soviets from initiating such aggressions in the first place? and (2) if such aggression is underway, how important a part would such United States attacks play in initiating or supporting negotiations to stop the aggression? Parenthetically, this same capability would also deter Soviet limited aggression against the United States.

(U) These two central questions in turn lead to other questions, such as whether or not the ability to attack Soviet targets with low collateral damage by using small-yield nuclear weapons or conventional weapons would make a significant difference. The ability to cause considerable damage to "military" targets with only a few sorties and to have little collateral damage makes it easier for the President to make the decision to launch such attacks. Thus, the "credibility" in the minds of the Soviets would be raised and the punishment to the Soviets, even for only a few United States sorties, would be high in specific areas or categories of targets.

(U) However, this raises the problem of further escalation. It is a fine line to draw to say that escalation will not get out of hand simply because there was little or no collateral damage. Nuclear weapons, whatever type and variety, will have detonated on the sovereign territory of the USSR as a result of deliberate United States attacks which will be publicly known. The Soviets would be forced to consider their options in the context of public knowledge that the United States has attacked the Soviet Union, and most probably, the Soviets would consider a limited attack on the United States.

(U) It can be argued that it is not the fear of punishment from the United States attacks themselves which would be the main deterrent; rather the main deterrent could be the fear that such United States attacks would precipitate further escalation. This fear of further escalation must be shared by both countries and operates against the credibility of such attacks; but this fear of escalation simultaneously makes it in the best interests of the Soviets to avoid provoking the United States to the point where such an attack gains credibility in the first place.

(U) The role of such United States attacks on Soviet targets in supporting negotiations, once the Soviets have embarked upon aggression, has many of the same problems attendant to deterring the initiation of aggression. There is some difficulty in pursuing such a strategy in the support of earnest negotiations. Further, it is not at all clear that an actual attack during the negotiations would indeed support these negotiations to the point where the Soviets would consider it to their best interests to halt short of their objectives. Then there is the ever present danger that the attack would again cause further escalation and/or break off of negotiations.

(U) In summary, technological advances may make the immediate expected value of such attacks more attractive and the immediate results more accurately predictable, but there remain very large uncertainties as to the subsequent moves and overall effects. It is not clear that the attendant risks will be significantly reduced.

(U) Even though there remain uncertainties in complete understanding of a strategy of coercive response, the United States should seek the military capabilities to make that strategy as viable as possible. The examination of conflict situations indicated that the following military capabilities provided much towards underwriting a strategy of coercive response:

- To attack in a selective and limited manner, with low collateral damage, military and industrial facilities in the Soviet homeland, such as oil refineries, electric power generation plants, or steel mills, and military targets such as airfields and air defense units, using a vehicle that can deliver munitions with precision guidance to a range of about 500 miles or more. It must be clearly identifiable to the Soviets that the attack is limited in nature and meant only to coerce, to show resolve, or to support negotiations leading to a halt in hostilities.
- To interfere with enemy commerce and/or naval traffic in constricted lanes, including attacking and sinking Soviet ships. The attack must be clearly distinguishable as being limited in scope with the purpose of showing political resolve.

(U) The capability to destroy military targets with little collateral damage could be of high utility under some circumstances; but always, there is the other side of the coin that the very existence of the capability makes conflict more probable. Thus one continually faces the dilemma that the more flexible the capability, the more credible the deterrent, but the higher the chance of its use. It has been said that a threat that leaves something to chance is still a threat indeed. Certainly the United States should not explicitly abandon all options that have the element of coercion. But neither should the United States place all, or even most of its reliance on such a strategy. This brings attention to the other general deterrent strategy, and probably more important one, of stemming the aggression in a military sense.

B. STEMMING AGGRESSION

(U) The United States has explicit commitments to nations that are subject to the threat of Soviet aggression such as nations that are members of the NATO alliance. To underwrite these commitments the United States has followed the strategy of deploying ground units and tactical fighter units in the sovereign territory of some of these countries to enhance military capability to stem aggression. This strategy has not been unsuccessful: for example aggression against NATO has not occurred.

(U) In other instances the United States commitment is not as explicit as in NATO. Some believe that when the commitment is not explicit, aggression is not likely to occur in the first place, and if aggression does occur, the United States can avoid undue involvement. But the cases of South Korea in 1950 and South Vietnam argue to the contrary. Threat of aggression against an ally is always serious and it is very difficult to avoid United States involvement if aggression ensues. Thus, the United States is not apt to have the best of both worlds where, for the case of the ambiguous commitment, aggression is not likely, and if it does occur, the United States can avoid undue direct involvement. Rather, with weaker strategies to underwrite its explicit or implied commitments, the United States may be faced with the worst of both worlds where the likelihood of aggression is higher and the prospect of considerable United States involvement is high if aggression does occur.

(U) Thus, considerable attention was devoted to a strategy that has as its cornerstone the military capability to "stem aggression." This seemed particularly relevant with regard to the threat of Soviet aggression against nations where there is an implied United States commitment and to "limited" Soviet aggression against a single NATO nation. From the conflict situation analyses several military capabilities were seen to be important in a strategy of stemming aggression:

- To execute military exercises and public weapon demonstrations, which may themselves deter a planned enemy attack. This capability derives from two beliefs: first, that an enemy with intentions to undertake limited aggression may be deterred from such aggression if he knows that the United States or its Allies have both the military weapons and the positioned forces to deny him the initial tactical advantage and, secondly, that no major power would initiate aggression without weighing the possible results and being willing to accept the perceived potential consequences.

- To obtain pre-attack assessment of enemy air, land, and sea movements by conducting reconnaissance and surveillance missions.

- To obtain trans-attack assessment to provide United States and Allied forces information regarding enemy forces, location and movements.

- To deny to the Soviets amphibious access to allied territory by delaying or destroying Soviet Navy forces and troop ships.

- To deny overland routes to Soviet invading forces. The capability to attack Soviet tank groups and troop formations advancing through mountain passes, and to create anti-tank barriers should operate to deter and impede aggression.

- To prevent Soviet incursion by air by attacking and destroying Soviet airborne troop transports and troop helicopters and Soviet aircraft engaging in defense penetration raids.

- To attack hard and soft, fixed and mobile targets. These include tank kasernes, airfield runways, hangarettes, bridge piers, nuclear weapons bunkers, tanks, armored personnel carriers, parked aircraft, SAM site radars, ground troop formations, mobile missiles, and trucks.

- To improve mobility of Allied troops and equipment by acquiring appropriate vehicles not limited by terrain to assist in rapid engagement of Soviet forces.

Timely response

(U) An important element in stemming aggression is the ability for timely response. This means that the threatened country and the United States must have (1) near real time and accurate assessment of the attack and (2) the capability for timely response, and (3) both capabilities must be easily perceived by the Soviet Union. The success or failure of a Soviet attempt for a quick "takeover" may be largely determined by the allied forces which can be brought to bear and how quickly they can engage the attackers. This has been a fundamental underlying principle of warfare through the ages. In terms of the conflict situations postulated in this study timeliness of response was particularly underscored.

(U) A discussion of the Norwegian and Iranian conflict situations will illustrate the importance of timeliness of response. Timeliness of Norwegian and/or United States and/or NATO response was shown to be important in varying degrees. For example, if the Norwegians use only their forces from their normal readiness posture, the postulated Soviet forces control about 80 percent of the target territory in about two days and essentially all of it in about ten days. On the other hand, if about four days warning is available so that a brigade from southern Norway can be deployed to the north before the Soviet attack begins, then the Soviets control about 50 percent of the target territory after two days and 80 percent after ten days. Similarly, if the United States 82nd Airborne Division could be deployed to Norway before the start of hostilities, or the United States aircraft in the United Kingdom are available at the beginning of hostilities, then the Soviets would control only 50 percent after two days and 60 percent after ten days. In both of these latter cases the United States/Norwegian forces are regaining territory slowly after about seven days.

(U) The Iranian conflict situation assumes a combined Soviet and Iraqi air, ground, amphibious, and airborne attack with a Soviet ground march through several Iranian mountain passes and routes that have no off-road capability. Such a Soviet march is necessitated by the topography of Iran. Timely United States and Iranian counter actions, such as blocking mountain passes by creating anti-tank barriers, destroying bridges and tunnels, and destroying Soviet forces marching along these routes, provide much assistance in delaying a quick Soviet victory. Specifically, blocking the Jolfa Pass in northwestern Iran and inducing delays of 2 to 3 days on alternate overland routes create the opportunity for Iranian forces to re-deploy from their primary southern positions and allow for the establishment of defenses at passes south of Marand. The estimated unopposed Soviet march time to Tehran is approximately three days after the initial attack; however, the estimated Soviet march time to Tehran with Iranian strike, delay, and defensive actions is approximately 15 days.

(U) The examination of conflict situations also underlined the advantage which could accrue to the Soviets from launching a disguised attack from an advanced military posture designed to achieve maximum surprise and tactical advantage. This could be achieved by launching an attack by forces engaged in appropriate large scale exercises, and using jamming operations to provide cover, similar to what the Soviets did in the 1968 Czechoslovakian invasion. In order not to cause undue alarm, the exercises could be planned and announced considerably ahead of time. The real intent could be obscured until the last moment. It seemed, then, that this tactic on the part of the Soviets should be given prime attention by the United States in evaluating the military capabilities necessary to counter such possible aggressions.

(U) The tactic of obscuring intent was employed to great advantage by the Arabs in the October 1973 War. Even though the Israelis had considerable information concerning an exercise on the part of Egyptian troops, there remained the very critical decision as to whether or not to mobilize their largely civilian army. The decision was delayed until the Egyptians and Syrians had launched a full scale attack. This gave the Egyptians and the Syrians a large initial tactical advantage.

(U) The Soviets could use a similar tactic in aggression against a peripheral nation. Any decision by the United States and the threatened country would be made difficult since useful responses on our part would have to be made prior to the time there was an unambiguous commitment to an attack on the part of the Soviets. This argues strongly for graduated responses on the part of the United States and its allies, which could be initiated as Soviet exercises "escalate." These responses must be designed to fill three difficult and conflicting criteria: (1) they must be capable of being executed without undue internal stress to the United States and its allies even though the Soviet attack may not materialize; (2) United States responses must not destabilize the situation; and (3) United States responses must deny the Soviets undue tactical advantage.

(U) One response to announced Soviet military exercises possibly being used as a cover for an attack against a peripheral nation would be to conduct United States and allied exercises that would deny the Soviets undue tactical advantage. The fact that some of the peripheral nations could not afford many such exercises argues against extensive reliance on this tactic. However, these could be lesser forms of mobilization. Also, there could be non-reactive exercises on the part of the United States and its allies by which the capability to react quickly and effectively is demonstrated. The demonstration of such a capability would surely help deter such aggressions on the part of the Soviets in the first place.

(U) However, knowledge of an enemy's intentions is not in itself sufficient to deter or halt aggression. The United States and its allies must have the means of undertaking specific and calculated actions, based on knowledge of an enemy's intentions, if the United States is to successfully meet its commitments.

(U) Lastly, in the quest for quick victory, the Soviets might plan for a short conflict, possibly a conflict capable of completion during the night or in bad weather. The Soviet naval fleet is configured for surprise attacks and short-duration combat whereby the outcome of the battle is decided by the "first salvo." For example, the principal Soviet missile ships constructed since the early 1960s are configured for first salvo encounters, having no reloads for their anti-ship missiles. Also, Soviet replenishment capabilities are limited, especially with respect to underway rearming of missiles. This configuration is in contrast to that of United States Navy ships which emphasizes conflicts of long duration. United States and allied capabilities should take into consideration the need to deny a successful first salvo strategy to the Soviets.

IV. SYSTEM CONCEPTS AND TECHNOLOGY ISSUES

(U) Many system concepts were considered in detail throughout the study, a few of which were chosen for discussion in this summary report together with the technology issues associated with each. Some of the concepts are new and some are currently being supported by the Services and defense agencies at various levels of effort. Although issues relating to command, control, and communications (C^3) continuously impacted on the study, no new specific C^3 system concepts were developed. System concepts and their designs were strongly influenced by the desired ability to conduct military attacks with associated low collateral damage. The system concepts will be grouped and discussed according to whether the system uses nuclear or non-nuclear payloads, or both, as follows:

- Nuclear or Non-Nuclear Payloads
  - Remotely Piloted Vehicles (RPV)
  - Precision Delivered Ballistic Missile
- Nuclear Payloads
  - Deep Earth Penetrator
  - Shallow Earth Penetrator
- Non-Nuclear Payloads
  - Advanced Precision Guided Munitions
  - Rapid Mining Systems
  - Guided Projectiles

A. NUCLEAR OR NON-NUCLEAR PAYLOADS

1. Remotely Piloted Vehicles (RPVs)

(U) This concept includes the family of RPVs than can conduct reconnaissance and surveillance missions over the ocean and enemy territory and can strike targets with a missile strike capability or a kamikaze strike capability, or both. Surveillance includes high altitude capabilities for large area surveillance and low altitude capabilities for battlefield surveillance and target acquisition.

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(S) One example of a member of this family is a high altitude long endurance (24 hour) RPV, such as the Air Force Compass Cope Program, for large area surveillance and attack reconnaissance. Such a vehicle could also be used as a relay for communications or RPV links.

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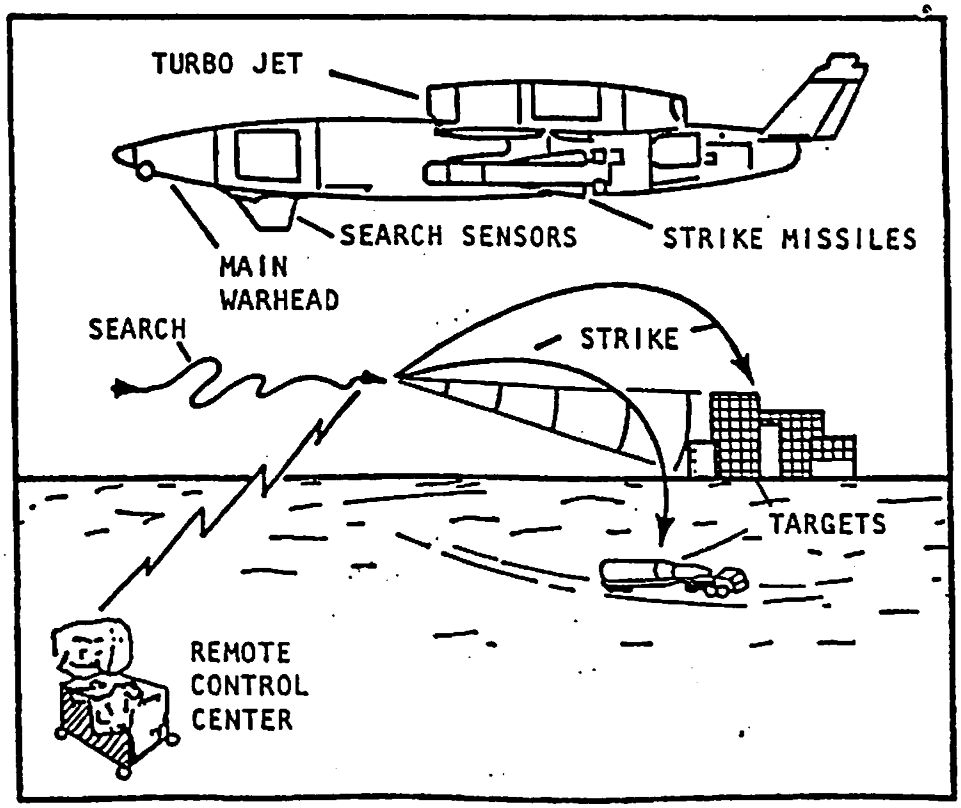
(S) Another example is a medium range RPV with a reconnaissance, surveillance, missile strike, and kamikaze strike capability. One major mission envisioned for the concept, Figure 5, would be, for example, to attack a Soviet oil refinery in a coercive attack. The RPV might be launched, travel a few hundred miles, penetrate enemy defenses by attacking the defenses with stand-off precision deliver munitions, and then, after reaching the oil facility, strike it in a kamikaze mode of attack. The RPV might include armament in the form of air-to-ground (Maverick-class) missiles, a main vehicle warhead of 1000 pounds HE for kamikaze strikes, a range of about 500 nautical miles, adequate endurance capability, and a cruise speed of Mach 0.5 with a short, low-altitude dash capability of Mach 0.8 for defense penetration. At longer ranges, target images and steering commands must be relayed via high-altitude

FIGURE 5. RPV WITH RECONNAISSANCE, SURVEILLANCE, MISSILE STRIKE, AND KAMIKAZE STRIKE CAPABILITY (U)



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aircraft or satellites to and from the RPV due to the microwave horizon. This implies a long two-way data link which must be secure and jam-resistant to enemy electronic countermeasures. A preprogrammed trajectory and search pattern is inserted at launch but can be overridden by control center commands. The reconnaissance sensors may be a combination of microwave and long-wave infrared to provide both all-weather operation and high resolution.

(U) A third possibility might be a small-size RPV with only reconnaissance, surveillance, and kamikaze strike capability and which would include a long-wave infrared search sensor, a warhead weight of about 50 pounds HE, a weight about 125-150 pounds, a speed of about 150 knots, minimum observable signatures, and a range of around 100 nautical miles with adequate endurance capability.

(U) Current programs are supporting most of the technology issues associated with this concept, including current ARPA-sponsored RPV projects as PRAEIRE, CALERE, AEQUARE, the current Army RPAODS Program, recent Air Force plans for a Strike Drone, the 1973 Air Force sponsored Multi-Mode-Modular RPV design evaluation, and various forward-looking infrared sensor projects. Continued research emphasizing the following areas is needed:

- Higher resolution, all-weather microwave sensors for improving the probability of target detection and discrimination under poor weather conditions. Predicted accuracies of the all-weather sensors in development range from 10 to 50 foot CEPs. However, test and demonstration of such systems is not adequately covered.

- Continued reduction of RPV radar cross section. Present RPV programs are partially addressing this issue.

- Reliable transmission of target images and guidance commands that are resistant to jamming. In most cases, adequate link capability exists only when there is no significant jamming. On-going RDT&E efforts are diversified throughout the various services and defense agencies, but more effort is needed if the issue of jam-resistant data links is to be resolved.

- Targeting guidance and lock-on for multiple strike attacks for the missile strike RPVs. This issue is not being addressed in any on-going programs.

- Miniaturization of sensors such as electro-optical, radiometric, and forward-looking infrared for the small size RPV. Present RPV programs are addressing this area.

2. Precision Delivered Ballistic Missile

(U) A long-range (greater than 500 nautical miles) ballistic missile, which can deliver nuclear or non-nuclear payloads with system CEPs of 50-100 feet, was carefully examined in the study. For attack of area targets or for delivery of small yield nuclear warheads, it was envisioned that the missile would employ inertial guidance plus Global Position Satellite (GPS) updating to achieve systems CEPs of about 100 feet. Terminal homing guidance is a possibility that promises to provide CEPs of less than 50 feet at ranges of flight greater than 500 nautical miles. In the near term, optical and short wave infrared homing guidance systems, together with data links, could be developed to provide weapons system CEPs less than 15 feet. Furthermore, there is a body of opinion that also believes that in the longer term, all-weather precision attacks with CEPs of about 15 feet are possible with microwave correlation followed by point homing.

(U) The technology issues associated with this concept include the following points:

- The best mechanism for slowing the reentry vehicle down after atmospheric reentry to permit proper homing guidance operation. Two methods for accomplishing this, and which must be further assessed, are maneuvering at a moderate to high altitude until the vehicle loses velocity (MaRV), or enclosing the vehicle in a low beta shell which slows down due to its drag configuration. A wide variety of MaRV concepts was evaluated by the Air Force/SAMSO between 1965 and 1970, under the Advanced Ballistic Reentry vehicle Systems (ABRES) Program; the LRR&D study examined the low beta shell concept. These two methods are illustrated in Figure 6. Two critical areas that relate to this issue of slowing the RV down, and for which there is no on-going programs addressing the areas, are the separation of the low beta shell or MaRV nose cover under high dynamic pressure flight conditions near 30,000 feet altitude and the thermal shock on the guidance sensor window during this separation stage.

- The best methods for all-weather homing guidance. Three areas presently being assessed but which need further development, include high resolution, microwave or long wave infrared sensors, effects of enemy defenses and electronic countermeasures, and effects of weapon interference. Two areas that have no on-going programs are acquiring target and non-target signatures for sensors on systems flying at low altitudes and grazing angles, and acquiring a near real time weather predicting capability for the locations where an attack may be undertaken.

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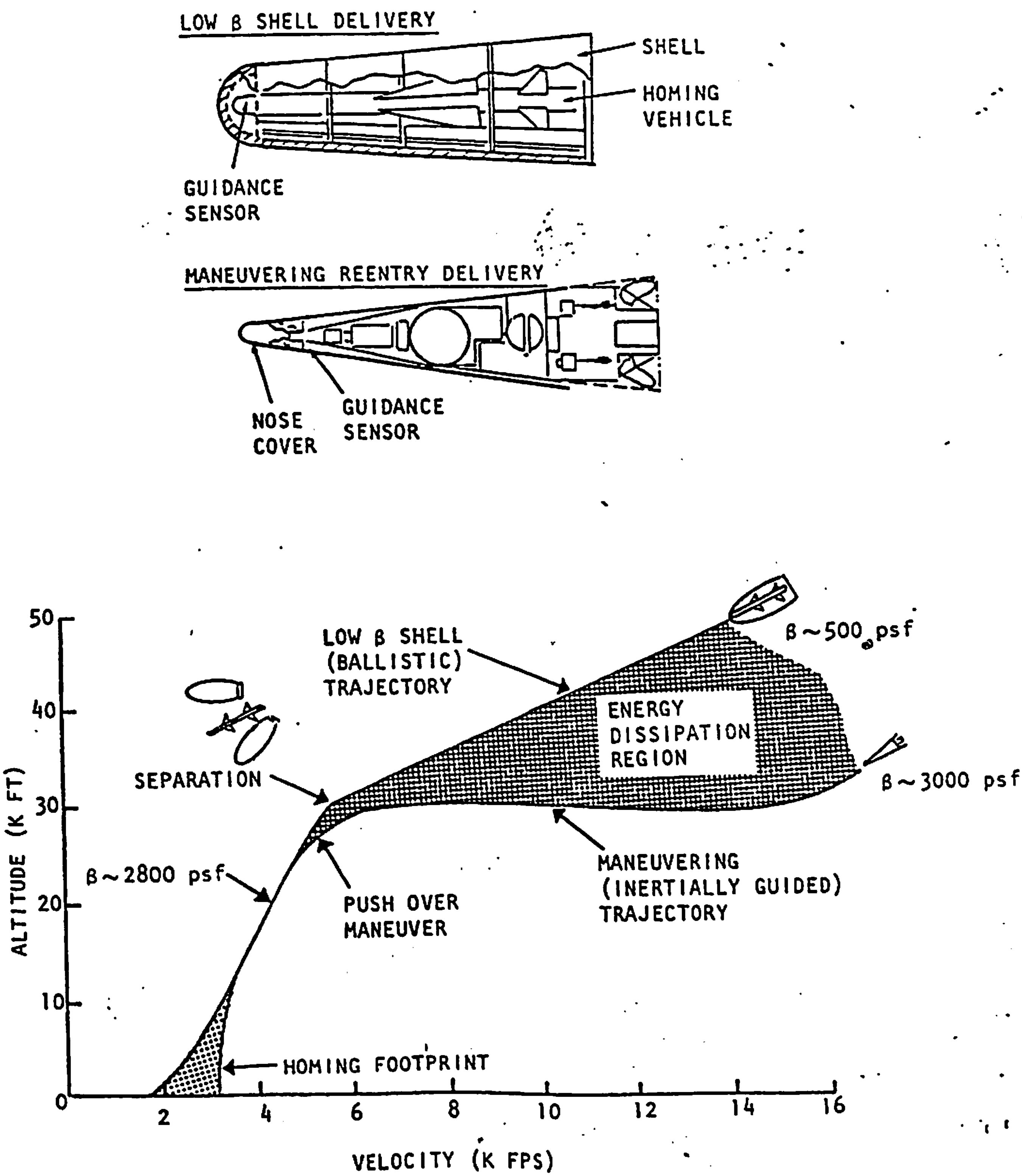
FIGURE 6. TWO METHODS OF PRECISELY DELIVERING A BALLISTIC MISSILE REENTRY VEHICLE (U)



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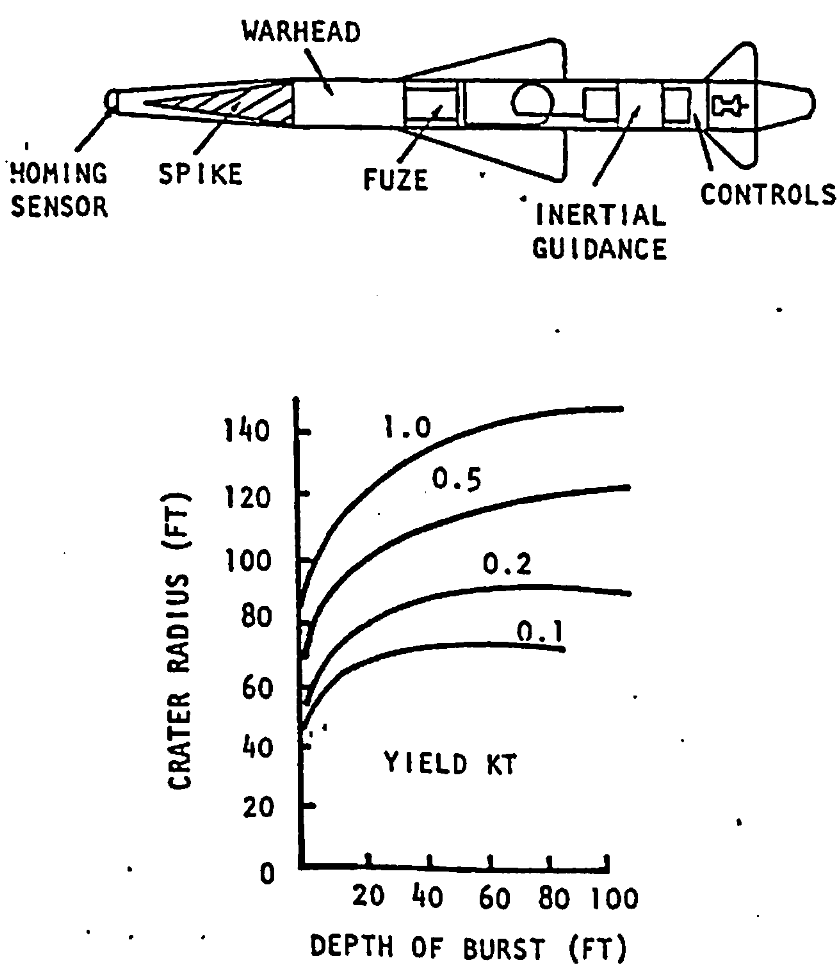
B. NUCLEAR PAYLOADS

1. Deep Earth Penetrator

(U) A precision delivered deep earth penetrator with a small yield nuclear warhead was a concept useful in several applications. Figure 7 provides data on such a penetrating weapon. Targets are destroyed by producing maximum coupling between the energy of the nuclear explosion and the target. The weapon could penetrate deep into the ground (50-100 feet) to destroy a target such as an underground bunker or could create a physical barrier such as an anti-tank ditch by creating a large crater in the earth. The weapon also could penetrate the hard shield of a target, such as a blast furnace, and then destroy the target by detonating the warhead inside the target. Deep penetration allows attacks with limited collateral damage because a large fraction of the earth material normally associated with fallout will be contained and most of the air blast and all of the thermal and prompt

FIGURE 7. DEEP EARTH PENETRATOR (U)



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radiation will be suppressed. This concept achieves deep penetration by means of a high velocity impact (1500 to 3000 feet per second) of a penetrating vehicle with a high length-to-diameter ratio ($L/D \approx 10$). The resultant design is a heavy steel spike and long steel side walls to protect the warhead and provide stability of the underground trajectory during penetration. The vehicle can be delivered by ballistic missile, cruise missile, RPV, or aircraft. Preliminary design analysis indicates that: a vehicle weight of 600 pounds is needed to deliver a 400 pound penetrator with a 60 pound, 1 kiloton nuclear warhead, the vehicle may be 116 inches in length with a diameter of 7 inches microwave or long wave infrared homing guidance can be used from approximately 10,000 feet to 25,000 feet altitude, and fuzing is based on sensing impact and a time delay of about 30 milliseconds to reach optimum depth. Further development of sub-kiloton warheads could reduce the warhead diameter to permit vehicle diameters of the order of 5 inches, thus reducing frontal area by 50 percent and permitting significant reduction of the vehicle weight. Such developments would greatly enhance the effectiveness of the concept.

(U) The technology issues associated with the deep penetrator concept which need to be resolved include these:

- Materials withstanding high impact velocities.
- Greater length-to-diameter ratio for the vehicle.
- Fuzes which can accurately fire the warhead at the desired depth in spite of variations in geology.
- Research in geology to predict with high confidence the enforceable penetration, given delivery conditions.
- Assessment of the sensitivity of the vehicle to ricochet as a function of the angle of impact.
- Development of more accurate all-weather sensing systems.

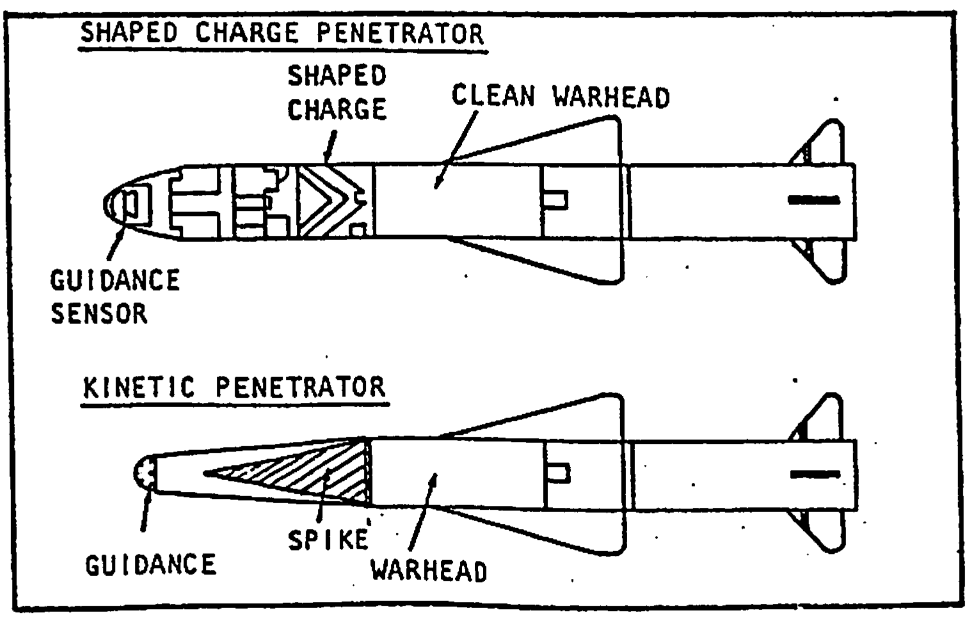
The first five issues have been the subject of several programs which have sought a basic understanding of penetration theory and which have been undertaken during the past decade. For example, Sandia Laboratories has performed a large number of tests to establish the performance of earth penetrating vehicles as a function of their design parameters; DNA's Penetrator Program is working towards developing a theory of penetration and is funding studies in some of these five technology areas; and rock and concrete penetration experiments have been conducted at the Naval Weapons Center at China Lake. The development of this concept would require the resolution of these issues.

(U) Regarding the sixth issue, various all-weather sensor systems hold promise of providing adequately small CEPs of 20 feet or less. However, more effort is necessary if these systems are to be tested and proved.

2. Shallow Earth Penetrator

(U) The shallow earth penetrator, Figure 8, is a missile which attacks a target by penetrating up to a few meters into the earth before detonating a suppressed radiation nuclear warhead and then destroys the target by the subsequent air blast. Improved cratering and ground motion efficiency over surface burst munitions of comparable yield offer additional advantages. The rationale for this concept stems from the need to attack blast-sensitive targets that are above ground, such as airfield hangarettes, logistics/supply depots, and fuel storage facilities, while constraining collateral damage.

FIGURE 8. SHALLOW EARTH PENETRATOR (U)



The constrained collateral damage evolves from the fact that: (1) the earth absorbs most of the thermal and prompt radiation from the nuclear detonation, and (2) the design specifications of the concept allow for the use of a suppressed radiation warhead which minimizes the effects of fallout. This weapon achieves penetration either by means of a shaped charge or by kinetic energy. It is envisioned that: the penetrator might be launched from an aircraft, RPV, ballistic missile or cruise missile at altitudes of about 30,000 feet; that target acquisition, lock-on and homing guidance is based on microwave, long wave infrared, or optical sensors which begin to acquire the target at ten to twenty thousand feet altitude; and that fuzing would be based on an impact signal plus a short time delay, in the order of a few milliseconds.

(U) Further development of this concept would require resolution of the following technology issues:

- Reduction of the warhead diameter below the current minimum of about 12 inches for improved penetration of a vehicle with reasonable length. There is general interest in and speculation on this issue at the various weapons laboratories such as Los Alamos Scientific Laboratory and Laurence Livermore Laboratory.

- Determination of how quickly the blast wave degrades as a function of depth of penetration. DNA's Penetrator Program for weapons effects from shallow buried bursts partially treats this issue.

- Determination of the best means of penetration, shaped charge or kinetic. There are programs presently addressing this issue for vehicles with 6-inch diameters. If warheads cannot be reduced in diameter, this determination would be needed for 12-inch warheads.

- Uncertainties in survival of the critical subsystems, such as the warhead and fuze, to damage resulting from the impact. The state of the art on fuzing necessitates no major technology programs, but a new research program would be needed to assess the penetration impact on clean warheads.

- Assessment of the interaction between the vehicle and earth at impact, such as depth of penetration as a function of earth media, impact velocity and final flight path angle. Current programs, of the DNA's Penetrator Program partially address this area.

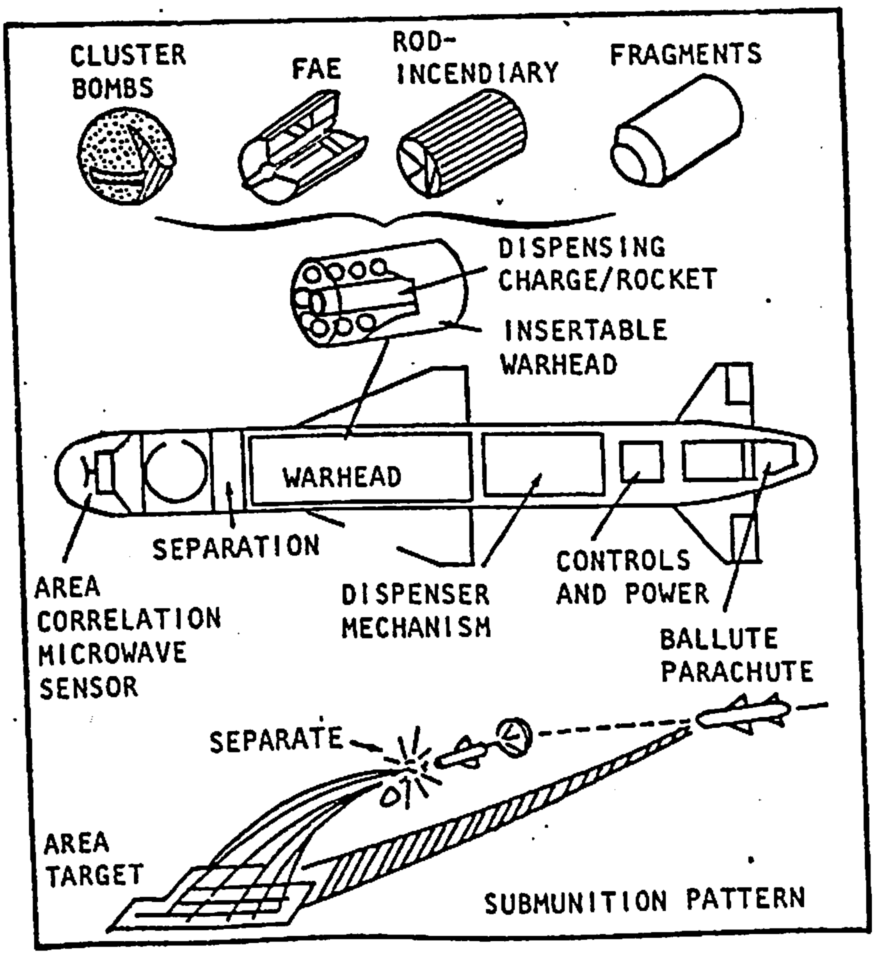
- For precision delivery, the development of all-weather sensors having CEPs less than 10 feet. Physical principles and target signatures which could lead to all-weather guidance are known but sufficient development funds have not been available to establish engineering experience of these sensors.

C. NON-NUCLEAR PAYLOADS

1. Advanced Precision Guided Munitions

(U) One concept, depending on the design, provides the capability for non-nuclear attacks of either area or hard point targets with precision guided munitions. A missile system, Figure 9, that delivers non-nuclear area munitions would be useful against targets such as logistics/supply depots and fuel storage facilities. This requires the uniform dispensing of special sub-munitions such as cluster bombs, fuel air explosives, incendaries, or kinetic fragments. A number of different prepackaged, modular warheads could be used

FIGURE 9. VEHICLE WHICH DELIVERS ADVANCED NON-NUCLEAR MUNITIONS AGAINST AREA TARGETS (U)



in a basic homing vehicle airframe which is launched from an aircraft, RPV, ballistic missile, or cruise missile. A microwave area correlation sensor can provide area acquisition and guidance sufficient to provde the main vehicle with a CEP of about 100 feet. At a preset altitude, the submunition packages would be separated from the vehicle by explosives or rockets and then the munitions of each package may be dispensed based on preset timing.

(U) Another possibility is a missile system that delivers a penetrating non-nuclear payload which could deal with hard point targets such as the blast furnace in steel mills or airfield runways. The targets are destroyed by means of munitions which penetrate the hard substance and break it into fragments by exploding from within the target. Attack of hard structures requires the penetration of media such as concrete, rock, or steel. Penetration may be accomplished either directly by the kinetic energy of penetration into the block or by a combination of kinetic energy of penetration and the energy of an added explosive charge.

(U) Serious development of the concept of second and third generation PGMs with non-nuclear submunition would necessitate the resolution of two primary technology issues:

- Identification of the optimum method for accurately dispensing the submunitions from the main vehicle to achieve a uniform spacing and density of munitions at impact. The requirement for stabilizing or guiding each of the submunition packages should be compared with other dispensing concepts. Each of the various munitions options may require different ground distributions and densities, which in turn would affect the dispensing concept.

- For large area targets, the issue of whether it is necessary to salvo launch these munitions from a single aircraft; in this case the mechanization of guidance lock-on, targeting, and firing becomes complicated.

No work has been or is being undertaken in these areas.

(U) The primary technology issues involved in the delivery of a penetrating non-nuclear payload include these:

- Identification of a significantly richer technology base detailing penetration mechanisms.

- Penetration designs.
- Assessment of the response of various hard structures to these penetrating weapons.
- Development of all-weather sensors with sufficient accuracy for destruction of small targets which requires CEPs of less than 10 feet.

Although the first three issues are being studied in some on-going programs, such as the Air Force's Hard Structure Munitions Program at Eglin, DNA's Penetrator Program, and Sandia Laboratory experiments, further research needs to be undertaken for satisfactory resolution of these issues.

(U) The development of more accurate all-weather guidance systems would benefit from increased test and demonstrations.

2. Rapid Mining Systems

(U) The concept of rapid mining includes both sea and land mining. Conceptually, land or sea mines would be laid in advance of enemy forces by using rapid launching platforms, such as missiles, RPVs, helicopters, submarines, or rocket launchers. An example of a sea mining system would be a Lance size booster having a launch weight of 3300 pounds, throwing a Propelled Ascent Mine (PRAM) to a range of about 35 nautical miles. The launch time of the system would be about 10 minutes per missile. The PRAM weight is 1900 pounds, its maximum operating depth is 6000 feet, its lethal area is a 1200 foot diameter cone and its initial operational capability is approximately 1982. Rocket deployment of these mines may require separation of the payload during reentry and parachute dropping into the water where the mine must automatically sink, anchor, and activate. An example of a land mining system is a Ground Vehicle System, which is presently under development, for on- and off-road use which can deliver from 800-1000 anti-tank or anti-personnel mines in any combination, can scatter the mines to distances of 66 feet on either side of the vehicle at the rate of 2 mines per second, and can have its dispenser reloaded in 20 minutes.

(U) In response to the present deficiencies of the United States mine capability, the services have a variety of mine development programs, all moving at a relatively slow pace. The technology issues associated with rapid mining systems include these:

- Identification of suitable rapid mine delivery platforms such as helicopters, submarines, missiles, or rockets. The ability to target, select a pattern, and salvo launch would have to be developed. Also, deployment timing and placement accuracy need to be assessed. None of the on-going service mine programs are addressing this delivery issue.

- ✓Collection of signatures of targets and background noise. Having such a data base and a simulation capability might help to identify more sophisticated sensing mechanisms than presently exist. Although several mine programs are addressing this area, such as the PRAM concept, more emphasis would be needed.

- Determination of the missile-induced environmental effects on the mine for those mining systems utilizing missile or rocket deployment. No research effort is presently studying this area.

3. Guided Projectiles

(U) This weapon concept would adapt one of the United States guided projectile programs for use with Allied 3-inch (76 mm) guns. Guided projectiles are fired from artillery guns, contain a sustainer rocket to maintain guidance response, are stabilized with folding fins, are controlled with folding control surfaces, are guided by either a passive infrared seeker or by a semi-active laser designator and have a range of between 10 to 15 nautical miles. Present United States programs include an Army 155 mm Cannon Launched Guided Projectile program and two Navy programs, an 8-inch and a 5-inch projectile program. The conflict situations indicated that providing allies with a 3-inch guided projectile capability for their ground forces and naval guns could greatly enhance their defense capabilities. Potential applications include about 3000-4000 guns in allied inventories.

(U) The technology issues associated with the development of a small diameter guided projectile include:

- Development of a guidance package with a sufficiently small diameter. No current United States guided projectile program is doing this. One body of opinion has been expressed that the technology for this development is far in the future.

- Design of a guidance and control package which is compatible with the high G force loadings which occur during firing. Some research is on-going in this area in present programs but probably not enough to resolve the issue, particular in the 3-inch case.

D. SYSTEM CONCEPTS AND MILITARY CAPABILITIES

Table 2 indicates how the system concepts just discussed relate to the military capabilities supporting a strategy of coercive response and a strategy of stemming aggression. The system concepts listed under each capability provide much toward helping to enhance that military capability. Other important system concepts analyzed in the study, but which were not discussed in this report, assist in supporting these military capabilities.

TABLE 2

SYSTEM CONCEPTS AND MILITARY CAPABILITIES (U)

STRATEGY OF COERCIVE RESPONSE	
Conduct selective, limited attacks of industrial or military targets in the Soviet homeland 1. RPVs 2. Precision Delivered Ballistic Missile 3. Deep Earth Penetrator 4. Shallow Earth Penetrator 5. Advanced Precision Guided Munitions	Interfere with enemy commerce or naval traffic in constricted lanes 1. Rapid Mining Systems

STRATEGY OF STEMMING AGGRESSION							
Obtain preattack assessment	Conduct military exercises or public weapon demonstrations	Obtain trans-attack assess-ment	Deny amphibious attacks	Deny land invasion	Deny airborne attacks	Attack Soviet tar-gets that are hard or soft, fixed or mobile	Improve mobility of allied troops and equipment
1. RPVs	1. All System Concepts	1. RPVs	1. RPVs 2. Rapid Mining Systems 3. Guided Projec-tiles	1. RPVs 2. Guided Projec-tiles		1. RPVs 2. Deep Earth Penetrator 3. Shallow Earth Penetrator 4. Advanced Pre-cision Guided Munitions 5. Guided Projectiles.	

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V. CONCLUDING REMARKS

(U) The Long Range Research and Development Planning Program had as its objective identification of those technologies that would have to be undertaken to provide the National Command Authority with a variety of response options as alternatives to massive attacks with nuclear weapons.

(U) The work of the panels and contractors benefited from wide exposure to planners from the Services and the Office of the Secretary of Defense, technologists and systems planners from industry and government laboratories and political scientists.

(U) There were identified several new concepts that repeatedly appeared to make a difference in several of the conflict situations studied. These included a variety of earth penetrating weapons, particularly the shallow penetrator, mobile on-call mining, a family of kamikaze RPVs and a long range ballistic missile with a homing warhead.

(U) The study also identified a set of existing programs and concepts which it suggested as worthwhile and which could contribute to achieving a variety of responsive options for the National Command Authority. These included various accuracy improvement programs including the Global Positioning System, several sub-munitions such as fuel-air mixture explosives and cluster bomblets, and the hard structure conventional munitions program at Eglin Air Force Base. The services are sponsoring extensive accuracy improvement programs incorporating advanced inertial guidance, global positioning system fixes, etc., which can theoretically reduce CEPs to the 50 to 100 feet regime for the delivery of nuclear weapons. ARPA already has an effort directed toward identifying advanced strategic homing techniques supporting the less than 10 feet misses required for options predicated on the delivery of non-nuclear munitions that resulted in part from this study.

(U) Several unresolved issues remain, both in the technical and politico-military areas. In the technical area, our understanding of rainout and washout is poor, as is our understanding of the extent of the degradation of the blast wave of a nuclear bomb buried up to a few meters into the earth; the general effects and lethality of very low yield weapons needs to be understood along with the microvulnerability of large area targets to conventional and nuclear weapons whose radii of effect and CEP are both very small compared to the size of the target. Among the politico-military issues not resolved are: the effect on the Soviet Union and our Allies of the United States trying to achieve and/or possessing a credible capability for responsive options; another is the effect on crisis stability and related changes to the nuclear threshold that may come about from the United States possessing a very accurate long range ballistic missile.

(U) Lastly, and perhaps most importantly, the analysis of this study very strongly suggests that non-nuclear weapons with near zero miss may be technically feasible and militarily effective. If so, such non-nuclear weapons, under a wide range of circumstances, might satisfy the current United States and Allied damage requirements that now require the use of nuclear weapons. Near zero miss, non-nuclear weapons could provide the National Command Authority with a variety of strategic response options as alternatives to massive nuclear destruction. In fact, it is not outside the realm of possibility for the United States, while maintaining or improving present military capabilities, safely to take the lead in reducing the world inventory of theatre nuclear weapons as it once led the world in the introduction of nuclear weapons.