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RESEARCH REPORT

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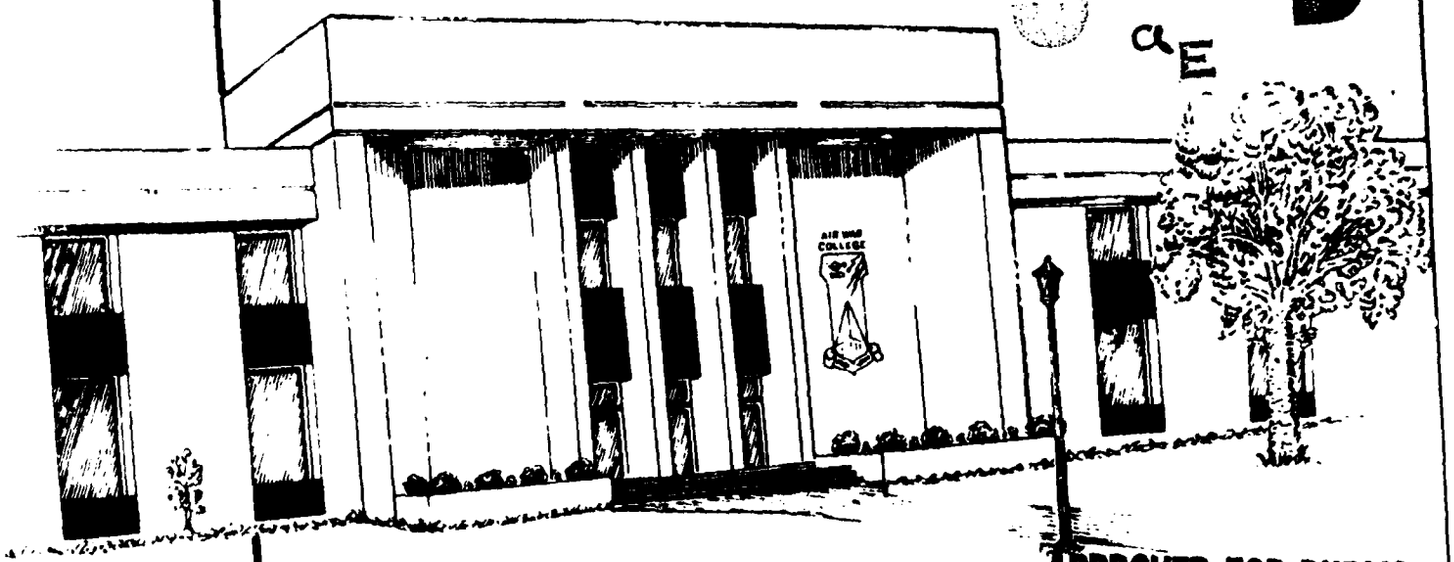
ABOUT THE NEED FOR THE MOBILE, SMALL ICBM IN THE 1990S

By LIEUTENANT COLONEL BRENT R. COLLINS



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ABOUT THE NEED FOR THE MOBILE, SMALL ICBM IN THE 1990s

by

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A RESEARCH REPORT SUBMITTED TO THE FACULTY

IN

FULFILLMENT OF THE RESEARCH REQUIREMENT

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MAXWELL AIR FORCE BASE, ALABAMA

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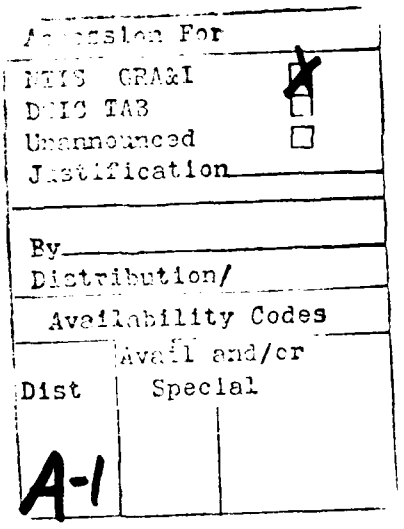

AIR WAR COLLEGE RESEARCH REPORT ABSTRACT

TITLE: About the Need for the Mobile, Small ICBM in the 1990s

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A reexamination of the merits and need for the Small ICBM is conducted in light of the changes since the 1983 President's Commission on Strategic Forces recommended the development. The history of U.S. declaratory nuclear policy and arms control issues are reviewed to set a foundation for force structure criteria and requirements. The role and effectiveness of the Small ICBM in addressing this nuclear policy and arms control issues are discussed. The new factors of a surviving basing mode for PEACEKEEPER, declining defense budgets, Strategic Arms Reduction Talks (START) progress, and the Strategic Defense Initiative (SDI) program are evaluated as they affect the original Small ICBM decision. The conclusion is reached that the rail garrison PEACEKEEPER satisfies most of the originally intended roles for the Small ICBM, at significantly less cost. But continuing development, with a slower paced production and deployment schedule is needed as a hedge on arms reductions beyond START, SDI capabilities, and future vulnerability of U.S. SLBMs.

BIOGRAPHICAL SKETCH

Lieutenant Colonel Brent R. Collins has been involved in the research, development, and operations of ICBMs since 1973. At the Space and Missile Systems Office, Norton AFB, California, he worked on the MINUTEMAN III Silo Upgrade Program between 1973 and 1974 and the PEACEKEEPER Advanced Development Program, where he was responsible for the development of the missile launch canister system, between 1974 and 1979. From 1981 through 1983 he served in the 544 Strategic Intelligence Wing, SAC, at Offutt AFB, Nebraska, where he conducted ICBM and SLBM trajectory analyses for the Joint Strategic Target Planning Staff and the SAC Warning and Control System. Between 1984 and 1987 he was responsible for the development of the Small ICBM Hard Mobile Launcher in the Ballistic Missile Office, Norton AFB, California. Lieutenant Colonel Collins is a 1983 graduate of the Air Command and Staff College by correspondence, and a graduate of the Air War College, class of 1988.

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CHAPTER I

INTRODUCTION

One year before the 1983 President's Commission on Strategic Forces, Barry Blechman, chairman of the Aspen Consortium on Arms Control and Security Issues, encapsulated the state of United States nuclear strategic thinking when he wrote:

> ...opinion about the most appropriate U.S. nuclear posture tends to be fragmented. How many strategic nuclear weapons should be deployed? Of what types? For what purposes? How can the United States most effectively deter attacks on itself and its allies? How rapidly should research programs be funded, and what types of new weapons should receive the greatest emphasis? How should resources be allocated between strategic and other types of nuclear weapons and between nuclear and conventional forces? What goals should be pursued in arms control negotiations? What specifically constitutes an equitable arms control agreement? These and similar questions permeate debate on American defense policy today, JUST AS THEY HAVE FOR THE PAST THIRTY-FIVE YEARS. (emphasis added)[1]

And then came the Small ICBM. As expected, it continues to draw debate about its development and deployment. Long term critics decry the claimed need and utility of more strategic nuclear weapons, while intervening events have introduced new factors into the original thinking that produced the development decision. With the Congressional decision in 1986 to reduce the number of silo-based PEACEKEEPERs from 100 to 50, the national consensus to deploy PEACEKEEPER missiles in existing silos, develop the Small ICBM for long-term survivability, and negotiate arms controls to enhance strategic stability broke down.

The advent of the more survivable rail-garrison basing mode for the second 50 PEACEKEEPERs potentially gave the PEACEKEEPER some of the same attributes which justified the Small ICBM.

Further, after a rocky interval in the arms control arena, a clear picture is emerging of a Strategic Arms Reduction Talks (START) treaty with promise for ratification before the end of the decade. At the same time, the Defense budget is under severe constraints which portend far reaching force structure reductions, making every program a candidate for reconsideration. Indeed, Fiscal Year 1988 was the first year that funding for the Small ICBM was cut below the requested level, while the President's budget request for Fiscal Year 1989 has cut the program severely.

It is in the spirit of this reexamination that the current analysis has been undertaken. The framework of the study starts with a review of the nuclear weapons strategy as it has evolved in the United States in order to set a foundation for the evaluation. After this review, the effectiveness of the mobile, Small ICBM is examined. Some of the engineering characteristics of the missile and its projected deployment mode are discussed in order to quantify the merit.

While the discipline of correlating the effectiveness of a weapon system to a fundamental strategy is appealing, there have historically been contradictions in U.S. declaratory policy and operational strategic nuclear weapons. Donald Snow, speaking of the connection between the three levels of nuclear strategy (i.e. declaratory; development and deployment; and employment) has written, "...each of which has strong implications for the others but which, in fact, operates in large measure independently of one another."[2] At times the arms race with the Soviet Union provided

the overwhelming influence on development and deployment decisions to reaffirm United States vigilance in the nuclear weapons competition. This resolve to remain abreast was necessary to maintain the credibility of our nuclear deterrence in the eyes of the Soviets, our allies, and third world nations. Therefore, in discussing the merits of the Small ICBM, the political factors of the arms race must be included.

In chapter IV the impacts of deploying the second 50 PEACEKEEPERs in a survivable basing mode are discussed. If the PEACEKEEPER is truly survivable, one might imagine that the Small ICBM is an expendable program. Owing to the versatility of the mobile missile, and the uncertainties of future arms control negotiations and strategic defense developments, it is argued that such is not the case.

The likely effects of the most recent START proposals are explored in chapter V. And finally, in the concluding chapter, recommendations are offered for the near term future of the mobile, Small ICBM weapon system.

CHAPTER II

PRINCIPLES OF NUCLEAR WEAPONS STRATEGY AND FORCE STRUCTURE

HISTORICAL PERSPECTIVE

Scholarly monographs on nuclear strategies abound.[1] By distilling their major thoughts it is possible to delineate the force structure characteristics required by the prevailing strategy of the United States. A review of the evolutionary process is helpful to enhance understanding of the current strategy and highlight the sensitivity of force structure to other likely strategies. Then, when primary force structure criteria are established, the added effects of arms competition can be overlaid. In this way it is possible to distinguish between complementary or contradictory requirements and draw conclusions about the final character of the preferred force structure.

The cornerstone of nuclear strategies has always been deterrence. Quoting from a recent Presidential Report to Congress:

> ...Deterrence is the most fundamental element of our defense policy and the cornerstone of our alliance relationship....Deterrence can best be achieved if our defense posture makes the assessment of war outcome by the Soviets, or any other adversary, so dangerous and uncertain as to remove any possible incentive for initiating conflict. Deterrence depends on both nuclear and conventional capabilities, and on evidence of a strong will to use military force, if necessary, to defend our vital interests.[2]

But the method of achieving deterrence has been elusive. In the beginning, when the U.S. enjoyed a nuclear weapons monopoly, and shortly thereafter a huge superiority, deterrent strategy relied on forward basing of delivery vehicles and the threat of

massive retaliation to any aggression by the Soviet Union. Soviet expansion throughout the world would be contained by the fear of attack from U.S. nuclear forces. The appeal of such a strategy was the relatively low cost required for the military forces. Large combat units were not needed to repel Soviet actions. Instead, the United States, with a limited strategic nuclear force, could deter the slightest Soviet expansion by threatening a punishing retaliation of massive proportions.

Then, in the early 1960s, the nuclear equation changed. As the Soviet nuclear capabilities grew, and the United States came to grips with the moral aspects of a strategy which prescribed annihilation of an entire society, a more flexible force structure was adopted. Nuclear weapons were no longer seen as a way to completely deter Soviet action. There were clearly cases where threats of nuclear attack had been, and would continue to be, ineffective. A flexible response strategy was adopted to overcome this deficiency. By increasing U.S. conventional capabilities across the range of the military spectrum, deterrence would be strengthened, while at the same time aggression could be countered head-on.

Requirements on nuclear forces were changed to cover only deterrence of nuclear attack against U.S. territory and NATO, and to control escalation of conventional, regional conflicts into general nuclear war. Because the Soviet nuclear force was growing, and becoming a threat to our own, deployment schemes to insure survival of U.S. forces were sought so that even if we were

attacked first we could retaliate with a massive force. As a result, the Air Force drew back vulnerable, forward deployed nuclear weapons, and accelerated deployment of the intercontinental B-52 bomber and the hardened and dispersed silo-based MINUTEMAN ICBMs. The Navy, in expressing concern about the survivability of fixed ICBM targets, and "...how the fortress concept of hardened shelters and active defences merely promoted an arms race,"[3] deployed the Fleet Ballistic Missile Submarines, giving birth to the strategic TRIAD.

Just prior to the emergence of a flexible response strategy came a debate about the targets of nuclear weapons. Having lost overwhelming superiority, it became likely that attacks on Soviet cities would draw reciprocal attacks on U.S. cities. To prevent such a scenario, or at least limit the damage if nuclear war did break out, a first strike option was contemplated by U.S. strategists. This required a capability in numbers and damage effectiveness of weapons to attack military targets, and came to be known as counterforce targeting. Eventually, whether a U.S. attack was preemptive or retaliatory, it became widely accepted that counterforce targeting was required in the event nuclear war was imminent or had actually broken out.

Then, in June 1962, Secretary of Defense Robert McNamara made what has since become a famous speech. Speaking at the University of Michigan at Ann Arbor he declared that U.S. nuclear strategy would henceforth be one of "city-avoidance". For the U.S., this strategy gave "...a possible opponent the strongest possible

incentive to refrain from striking our own cities."[4] Along with instituting flexible options to attack a spectrum of the number and types of Soviet targets, this city-avoidance policy firmly set the criteria for the U.S. strategic force structure. For the first time, thinking on limited nuclear war was implemented into targeting strategy.

While counterforce targeting received impetus from city-avoidance and flexible options, almost everyone, including its creator (and, not surprisingly, the Soviets) was skeptical about applying "rules of limited nuclear war". In a matter of two years, McNamara had reversed his declaratory policy and embraced the strategy of assured destruction. Assured destruction meant that a U.S. retaliatory strike would have the capability "...to inflict an unacceptable degree of damage upon any aggressor, or combination of aggressors--even after absorbing a surprise first strike."[5] "Unacceptable" was determined to be 20-33 percent of the Soviet population and 50-75 percent of the industrial capacity[6]. Targets of military importance were significantly deemphasized. An effort was made to use these criteria to size the force levels, but as Freedman points out the actual force size during the period was determined more by the knee of the damage expectancy (DE) curve where there was a relatively insignificant increase in DE with large increases in attacking weapons.[7]

Of course since the Soviets enjoyed a similar assured destruction capability, the mutual assured destruction strategy (MAD) of the early 1970s came into being. It was even argued that

because any level of nuclear war was unacceptable, it was in the interest of the U.S. to insure the Soviets retained an assured destruction capability so that they would feel no hair-trigger pressure to launch a nuclear first strike in times of crisis.

One would imagine that the force level might have declined in changing from a counterforce to a MAD strategy. However, during this period in 1966 the development and production go-ahead of the Multiple Independently-targeted Reentry Vehicle (MIRV) MINUTEMAN III was approved, as were accuracy improvement programs for ICBMs. One reason for the increase in warheads can be attributed to the concern about anti-ballistic missile defense systems which were still under development, and another to lingering concerns about a continuing need for counterforce capabilities.

MAD carried the U.S. through the arms control negotiations of the late 1960s and early 1970s, and the ABM and Strategic Arms Limitation Talks Treaties of 1972. Then, in 1975, Secretary of Defense James Schlesinger, concerned about the credibility of a deterrent strategy which professed mutual suicide, pronounced additional requirements for U.S. nuclear forces. Among these new requirements were "...<u>essential equivalence</u>, a basic symmetry in all factors which contribute to the effectiveness of strategic nuclear weapons and to the perception of non-super-power nations." and "... a force that, in response to Soviet actions, could implement a variety of limited pre-planned options and react rapidly to retargeting orders so as to deter any range of further attacks that a potential enemy might contemplate."[8] In short, U.S.

nuclear forces should be at least on a par with the Soviet forces (parity) and have capabilities to fight limited (and perhaps protracted) nuclear war. Promulgated by President Carter in 1980 and adopted by the Reagan Administration, this "...countervailing strategy, according to which the United States seeks to maintain military (including nuclear) forces, contingency plans, and command and control capabilities to convince Soviet leaders that they cannot secure victory, however they define may it, at any stage of a potential war...."[9] came to be the present strategy of the U.S. (Although the term countervailing was dropped to avoid the pejorative connotation that our nuclear strategy included an element of warfighting with the impractical intention of "winning.").

ARMS CONTROL

The reasons nations compete in arms races have been described elsewhere.[10] The seven listed are:

1. To improve retaliatory capability so that deterrence is enhanced (deterrence can be achieved either through denial, i.e. direct defense, or penalty, i.e. retaliation).

2. To improve warfighting capability to limit damage if war does break out.

3. To increase diplomatic leverage.

4. To react to political debates between internal rivals.

5. To pursue vested interests of bureaucracies, military, and defense industries.

6. To increase international prestige.

7. To advance technology.

Within this framework it has been argued that the purposes of arms control are threefold: a) to attempt to structure the arms race so that the opposing military forces enhance stability, b) to resolve conflicts which may otherwise be the cause of war, and c) to decrease the arms levels so that the cost can be reduced and the level of destruction limited if war should break out.[11]

During the course of the arms control talks on strategic nuclear weapons, all of these factors have been operating to one degree or another. The desire for detente with the Soviet Union, control of increasing military costs, and stabilizing the military balance in the face of potential anti-ballistic missile defensive systems deployments were the principal factors in the late 1960s and early 1970s.[12]

But as soon as SALT I was ratified in 1972, debate erupted over the features of the treaty.[13] Some criticized the inability to negotiate a one-sided monopoly on MIRVs for the U.S. in exchange for allowing deployment of "heavy" SS-18 ICBMs by the Soviet Union. Others felt that deployment of the SS-18 forces seriously jeopardized U.S. silo-based ICBMs. And another group criticized the U.S. negotiating position of balanced asymmetries which allowed opposing sides unlimited flexibility in the mix between ICBMs, SLBMs, and bombers. These critics argued instead for a concept known as equal aggregates which imposed roughly equal limits on individual weapon types.

Arms races and arms control then have had many effects on the U.S. force structure. We have tried unsuccessfully to use

negotiations to freeze technological advantages. The MIRV is a classic example of this factor. We have also tried to use the negotiations to restructure the Soviet forces into a more survivable posture by increasing the percentage of SLBMs and bombers, and decreasing the percentage of ICBMs. But in so doing, and failing, we have overlaid on our own force structure additional weapons principally to achieve essential equivalence of Soviet forces. The PEACEKEEPER missile is a good example of this factor wherein the need to threaten Soviet hardened targets just as they threaten U.S. equivalents has been seen to be essential for two reasons. First, as noted elsewhere, deterrence must be more than a bluff and therefore the ability to destroy hardened military targets must exist.[14] And second, maximum deterrence demands a capability in the area that the opposing side values most--which is ICBMs for the Soviets.

Another effect of arms control has been one of perception--both bilateral and multilateral. Proof of U.S. resolve to resist Soviet expansion, honor alliance commitments, and influence third world nations' behavior has demanded retention of rough parity. At times deployment decisions have been based principally on this factor. Both the PEACEKEEPER and mobile missiles (rail garrison or Small ICBM) may be seen as examples of this factor.

A final effect is negotiating leverage--either mutual deferral of development or deployment of systems, or mutual reductions in symmetric weapons. Indeed, Scowcroft argued that one reason

the deployment of the silo-based PEACEKEEPER was needed was to induce Soviet retirement of SS-18 ICBMs.[15]

What we have seen at times therefore, is a force structure based on the underpinning nuclear strategy, but overlaid with forces dictated by arms control considerations.

STABILITY AND INSTABILITY ARGUMENTS

Stability is the concept that holds that even if world events turn toward superpower crises, deterrence remains firm. As stated by Scowcroft:

> ...Deterrence is the set of beliefs in the minds of the Soviet leaders, given their own values and attitudes, about our capabilities and our will. It requires us to determine, as best we can, what would deter them from considering aggression, even in a crisis--not to determine what would deter us.[16]

Three attributes of stability are brought out in this extraordinary statement. First is the necessity of assessing Soviet values and attitudes in constructing our deterrent forces. Second is the factor that the deterrence must be so strong that it works even in extreme crises. And third it must be based on capabilities. So, as a crisis mounts, and threatening political and military movements occur, the force structure must be so sound that there is no doubt about the capability and will to use it in retaliation to aggression.

But if the force structure has weaknesses, then in a time of crisis the Soviets might be tempted to exploit them with military action. Even if the exploitation constitutes an irrational gamble, in a time of crisis a miscalculating leader may grab at that weakness.

But just as weakness is destabilizing, so also is excessive strength. For if one side sees the opposing force as able to disarm him, then in a time of crisis a decision might be made to launch a preemptive strike before the superior forces are used against him.

Stability, then, requires forces to be secure from destruction so that devastating retaliation is assured, but sufficiently constrained so as to not represent a completely disarming first strike capability. But it goes one step further. As Jervis has pointed out, if deterrence of all-out nuclear war becomes more stable, so that it is virtually unthinkable, then deterrence at lower levels of conflict (such as conventional war) becomes more unstable.[17] Therefore stability requires equally robust deterrence at all levels of conflict.

FORCE STRUCTURE REQUIREMENTS

The strategic nuclear weapons force structure requirements are formed on the basis of the foregoing. (Much more thorough treatments of specific requirements have been presented elsewhere[18]). As Slocombe noted, the forces must "...deter a Soviet attack on the United States itself...and...contribute to deterring attack on American allies."[19] With the current U.S. nuclear strategy to do this we can conclude the need for the following:

- Survivable, retaliatory, and enduring capability to destroy a significant fraction of the Soviet economy, leadership, military, and population.

- First and enduring second strike capabilities to threaten leadership and military targets in the event of conventional or limited nuclear war (It is noted that if our nuclear strategy were mutual assured destruction this capability is unnecessary. We either use conventional forces to attack these targets, do not attack, or retaliate with all-out nuclear war).

- Essential equivalence and roughly equal aggregates to enhance deterrence and show resolve to allies.

- Forces based on Soviet capabilities (not perceived intentions), which assume worse case scenarios in order to insure maximum stability.

CHAPTER III

EFFECTIVENESS OF THE MOBILE, SMALL ICBM

ROLE OF THE SMALL ICBM

The goals for the Small ICBM weapon system were derived in the 1983 Report of the President's Commission on Strategic Forces, commonly referred to as the Scowcroft Report after its chairman, Lt Gen Brent Scowcroft (USAF-Ret).[1] Using a rigorous discipline the report drew conclusions concerning ICBMs in general, and the Small ICBM in particular. For the ICBMs the findings were five-fold. First, the current day vulnerability of silo-based ICBMs was said to have been mistakenly overstated because the synergisms of the legs of the TRIAD had been overlooked.[2] The practice of treating ICBM retaliatory capability in isolation from the other TRIAD systems was categorically dismissed. The chief argument was that because the primary threat to our ICBMs is Soviet ICBMs, bombers on alert would have time to get airborne during the relatively long flight times of ICBM attacks. Likewise, the threat to the bomber force is submarine launched missiles which lack the accuracy to destroy ICBMs. Consequently a high-confidence, simultaneous, all-out attack against the two land-based legs of the TRIAD is impractical. The invulnerability of our SLBM force was also cited as a major deterrent towards attempting such a delicately coordinated attack.

Second, although the ICBM forces are relatively secure today, more survivable ICBM systems should be developed because "...over

the long run it would be unwise to rely so heavily on submarines as our only ballistic missile force that a Soviet breakthrough in anti-submarine warfare could not be offset by other strategic systems."[3] Third, the ICBM has unique attributes of prompt, accurate delivery with excellent command and control and strategic retargeting capabilities. As such they can threaten the specific military targets that the Soviets would value most in a massive conventional war or limited nuclear attack, and hence provide a deterrent to that type of action.[4] It was noted that without the PEACEKEEPER or Small ICBM the U.S. did not have the capability to threaten many of these hardened military targets.

The fourth point made by the Scowcroft Commission was that our resolve to extend deterrence to NATO and our other major allies was being undermined by our failure to match Soviet capabilities of the SS-18 and SS-19.[5] If the Intermediate Nuclear Forces Treaty which removes U.S. Pershing and Ground Launched Cruise Missiles from Europe is ratified, this will put even more importance on the perception of the U.S. resolve to deter aggression outside the U.S. with our strategic nuclear forces.

The fifth conclusion was that "...our ICBM programs should support pursuit of a stable regime of arms control agreements."[6] It was noted however that if the Soviets refused to enter into agreements, U.S. programs must be fashioned accordingly.

Turning to the Small ICBM, we can ask which of the five Scowcroft findings were directly related to it? In doing so it must be remembered that all candidate basing modes to solve the

PEACEKEEPER long term survivability problem were dismissed. Therefore, the long term survivability role was assigned exclusively to the Small ICBM. As the planned survivor in an all-out nuclear war, and as the hedge against an anti-submarine warfare breakthrough, the Small ICBM should be designed to absorb a massive first strike attack with sufficient survivors to inflict a devastating retaliation (the level of the attack that should be designed for will be discussed later in this section). Also, because it was to be the survivor, it should have the capacity to endure through long periods of high tension, regional conflict, massive conventional warfare, and limited nuclear attacks without appreciable losses of capability.

In the role of reinforcing the TRIAD, it would seem that two requirements are imposed. First, in the all-out warfare scenario, it would have to supplement any survivability deficiencies in the other ICBM forces. The pertinent case here would be if SLBMs, with flight times markedly less than ICBMs, achieved silo-kill accuracies. Then SLBMs could potentially threaten both silo-based ICBMs and bombers with a first strike (although coordinating a simultaneous attack against these two legs of the TRIAD would still be a formidable task). The Small ICBM should therefore be highly survivable to SLBM attack to preclude successful targeting of the entire land-based ICBM force.

Second, in the limited nuclear attack case, it would seem that it must only satisfy the condition of being the least lucrative ICBM target (with hard target kill capability) for a low

number, say 100 warheads, of weapons. In this scenario, the Soviets, in a precursor to conventional attack against NATO, would attempt to destroy those weapons which could threaten their most valued targets. If the Small ICBM satisfies the "least lucrative" condition, then it is not likely to be attacked in a limited option exchange. As an example, consider PEACEKEEPER and Small ICBM jointly deployed. PEACEKEEPER is ten times more militarily valuable than the Small ICBM (i.e. 10 RVs to 1 RV--assuming range, accuracy, command and control, and penetrability being equal).

Since classically it takes two hard-target capable RVs to destroy a MINUTEMAN silo, the exchange ratio for PEACEKEEPER would be one to five (i.e. two attacking warheads destroy ten). For the Small ICBM to be a less lucrative target, therefore, the ratio would have to be less than one to five. Or, if two attacking warheads destroy less than 10 Small ICBMs, then the Small ICBM will not be attacked until after the silo-based PEACEKEEPER. As will be discussed shortly, the basing concepts for the Small ICBM provide much greater exchange ratios than one to five.

The required survivability of the Small ICBM as a hedge against Scowcroft's concern for "...a Soviet breakthrough in submarine warfare" is a difficult question. If our nuclear submarines became vulnerable to first strike, then a portion of the SLBM target assignments would presumably be picked up by the Small ICBM. For this mission the required survivability would be quite high, and could require expansion of the currently planned operational concepts.

Next, because the Small ICBM might be used in a variety of ways, it would need the prompt, accurate, high alert rate, good command and control, and rapid retargeting capabilities of the other ICBMs.

The final role, and perhaps the most important, for the Small ICBM was its part in the arms control process. The objective of enhanced stability was said to "...be fostered by a dual approach toward arms control and ICBM deployments which moves toward encouraging small, single-warhead ICBMs."[7] Although it was recognized that large force sizes comprised of single RV missiles were considerably more expensive to produce and operate, it was said that the enhanced stability afforded by high survivability and verification simplicity of treaty limits was worth the extra cost. However, the primary hope was that mutually survivable forces could encourage bilateral arms reductions which "... would obviate the need to deploy large numbers of missiles...."[8] making mutual deterrence more assured and stable, and, as a possible consequence, less costly in the long run.[9]

While enthusiastic about advantages of reduced nuclear arms levels, the Scowcroft Commission cautioned against cuts so deep that they "...limit the number of launching platforms to such low levels that their survivability is made more questionable."[10] For example, if relatively few launching platforms are deployed, the complications and uncertainties of coordinated attack are considerably reduced. With highly MIRV'd ballistic missiles this could be an extremely dangerous force posture. Therefore, at some

point, lower force levels can become less stable.

Wholeheartedly endorsed by President Reagan, the commission findings formed the basis for the Strategic Forces Modernization supplemental budget sent to Congress in 1983. Principal Armed Services Committee members of both houses, having closely followed the commission proceedings, hailed the study and pressed to implement the recommendations. However, some Congressmen had serious reservations with the findings, as did a few expert witnesses who testified before committee hearings. Most notable among the critics were Senator Levin, Senator Exon, Dr Jeremy Stone, Director of the Federation of American Scientists, and Dr Henry Kendall, Chairman of the Union of Concerned Scientists.[11] The four major points made by these critics were first, the recommendation to deploy PEACEKEEPER in the "somewhat vulnerable" MINUTEMAN silos was destabilizing; second, that hard-target kill capable weapons were destabilizing first-strike systems; third, that more weapons based on countervailing nuclear weapons strategies were irrational (see previous chapter on mutual assured destruction versus countervailing strategy); and fourth, the cost of the proposed program was excessive.

While it is not the intention to renew the debate in this report, it is fruitful to acknowledge the arguments used against the critics. First, the need for a prompt, hard-target weapon overrode the small instabilities of PEACEKEEPER marginal vulnerability. Second, the number of proposed warheads between PEACEKEEPER and Small ICBM did not constitute a first-strike capability

because only a fraction of the military targets in the USSR could be destroyed, leaving in place an adequate Soviet retaliatory force. And third, the imbalance of the Soviets possessing a hard target weapon not deployed by the U.S. was in itself quite destabilizing in international events, because it both emboldens Soviet aggression and weakens worldwide confidence in the U.S.

As we have seen previously, the fear of the critics of a countervailing strategy is that the more "usable" nuclear weapons become, the higher the risk that they will be used in a crisis and that limited nuclear war will inevitably escalate. Regardless of the side chosen in these conundrums, it will be shown shortly what the effectiveness of the Small ICBM is for the current U.S. nuclear strategy (CASE 1), and the MAD nuclear strategy (CASE 2).

DESCRIPTION OF THE MOBILE, SMALL ICBM

Before discussing the effectiveness of the Small ICBM in fulfilling the roles described above, a review of the major elements of the weapon system is in order. As presented in a recent Congressional Budget Office report, the main features are: 1) a high performance ballistic missile capable, through the use of high energy solid propellants and lightweight composite case materials, of delivering an RV to a range of 6000 nautical miles, 2) a mobile launcher hardened against nuclear weapons effects, and 3) concepts of operations which provide survivability, through a range of threats, by making the location of the launcher uncertain within a wide deployment area and thereby forcing an area barrage rather

than a pinpoint targeting attack.[12] Although the Scowcroft Commission recommended consideration of multiple basing schemes for the Small ICBM, including superhard silos (many times the hardness of MINUTEMAN silos) and wide area mobility (relatively unhardened mobile launchers roaming large areas of the U.S.), they have since been dropped for various reasons.

The missile weighs approximately 37,000 pounds, has a 46 inch diameter, and is designed to withstand mobile, atmospheric, and nuclear weapons effects environments. It is cold launched from a canister that is erected by the mobile launcher, and it has the capability of carrying penetration aids. For its accuracy requirements it uses a variant of the Advanced Inertial Reference Sphere (AIRS) guidance system used on the PEACEKEEPER missile. Alternate all-inertial and stellar-aided guidance systems are also under consideration if they can be shown to be cost and performance competitive.

The hardened mobile launcher is a tractor-trailer arrangement, powered by a 1200 horsepower class diesel engine, and runs on high performance pneumatic tires capable of off-road travel. To achieve maximum hardness the launcher (trailer) is lowered from its normal driving height and sealed to the ground by retracting the tires. This action, along with a low drag triangular cross-sectional body, keeps the high winds created by nuclear attacks from lifting the launcher or rolling it over. When the launcher is in the lowered position the tractor can be separated or left connected for fast drive-away. Equipment is carried on

the tractor and launcher for command, control, and communications, environmental control, and nuclear security.

Two basic concepts of operation are being seriously considered. One concept deploys the hardened mobile launchers over a large area on military bases such as the U.S. Army's White Sands Missile Range and the Yuma Proving Ground. The launchers can be garrisoned during peacetime or randomly dispersed. The dispersal area of the force can be enlarged as situations warrant, up to the full extent of the bases. With tactical warning of an actual attack, the area of dispersal can be further expanded by driving some of the launchers off the bases. The advantage of this concept of operations is that location uncertainty can be continuously maintained so that the force survivability does not rely totally on strategic or tactical warning. Disadvantages are that the operations can interfere with other base missions and the cost and manpower requirements to operate the system are relatively high.

The second concept deploys hardened mobile launchers at selected MINUTEMAN bases. During normal operations, one or two launchers are parked at each MINUTEMAN launch facility (silo). With warning of attack they are driven away from the silos to generate location uncertainty. The advantages and disadvantages of this concept are just the reverse of the first, with an additional disadvantage being the adverse winter weather at the MINUTEMAN bases (it is felt that weather conditions, while having some

impact, are too unpredictable to permit Soviet pre-planned attacks which rely on bad weather).

With manpower and cost being major factors, the initial deployment plan calls for MINUTEMAN basing. If threat levels or available tactical warning times become more stressing in the future, or if arms control progress slows, one or two military bases could be opened for random area dispersal operations.

Currently the initial deployment is projected for 1992, with a force size of up to 500 launchers by 1999.[13] The cost of research, development, production, deployment, operations, and operational testing for a 15 year operational life has been estimated to be $46 billion.[14] More than anything else, it is this cost, with annual research and development expenditures of over $1 billion and annual production expenditures of over $2 billion that has raised the greatest questions about the viability of the weapon system.

Lastly, for future discussions it is noted that for programs such as the Small ICBM the production lead times are generally two to three years. Therefore, if initial deployment was wanted in 1992, production orders would be required in 1989. If deployment were delayed, then production could also be delayed or stretched out. Sometimes military construction activities become the pacing factor if program restructuring were considered.

EFFECTIVENESS EVALUATIONS

The mobile, Small ICBM achieves survivability by a combination

of hardness and location uncertainty. The location uncertainty forces an attacker to barrage an area much larger than he can cover with lethal effects. If the launchers are uniformly dispersed throughout the area then the percentage of survivors is the same as the percentage of area uncovered with lethal effects (here a "cookie-cutter" damage probability is used). If we now look at the design levels of the hardened mobile launcher, the area of uncertainty it can generate, the types of threats it might face, and the lethal radius of the threats to determine the effective barrage areas, we can determine typical survivability numbers.

Scowcroft set the design goal for the hardened mobile launchers between 30 and 50 pounds per square inch of static overpressure.[15] Since that time the actual design level has been classified so we must treat it as a range in this report. However, it has been determined that the technologies for both levels of overpressure effects are essentially the same. Therefore, it is reasonable that Soviet targeting must assume the nighest hardness (even if the design level is lower the probability of damage curve would surely dictate a higher attack level for assured destruction).

The dispersal area that the system of 500 launchers can achieve when dispersed under tactical warning of an ICBM attack has been reported to be 22,000 square miles.[16] For an SLBM attack, with shorter warning times, the area generated before first detonation would be less, but with fewer SLBMs than ICBMs in the Soviet inventory the percent of the area covered would be less.

In a highly stylized attack SLBMs could be used to block area expansion by immobilizing the launchers and follow-on with a large ICBM force. This latter attack is felt to be undeserving of serious attention because it presumes the unlikely scenario of: a) all-out Soviet attack, with b) unequivocal U.S. confirmation (i.e. nuclear detonations), and c) the absence of a decision to retaliate before the follow-on ICBMs arrive.

The threats can be derived from unclassified U.S. government publications. Currently, the Soviets have deployed approximately 6500 ICBM warheads and 3200 SLBM warheads.[17] The composite average yield for these warheads is found to be 500 kilotons.[18] The estimates for the year 1996 reported by the Congressional Budget Office are that the number of ICBM warheads is likely to grow to 11,000 and the number of SLBM warheads to 5900.[19] For both the current and 1996 estimates of Soviet warheads we should reduce the numbers by the percentage of deployed forces that is not available for launch. Again from the Congressional Budget Office report, the ICBM force availability may be as high as 95 percent[20]. For the SLBM force, the availability numbers are not given. If we assume conditions similar to the U.S. forces, then the day-to-day availability would be 67 percent.[21] Therefore the total warheads available for attack can be summarized as shown in the matrix on the following page:

MATRIX

SOVIET BALLISTIC MISSILE WARHEADS

	1987	1996
ICBMs		
- TOTAL	6,500	11,000
- AVAILABLE	6,175	10,450
SLBMs		
- TOTAL	3,200	5,900
- AVAILABLE	2,144	3,953

NOTE: TOTAL numbers are rounded to the nearest hundred. Available warheads are found by multiplying the TOTAL by 0.95 for ICBMs and 0.67 for SLBMs.

Now we have the tools to analyze the Small ICBM. To start, there is large array of conditions to examine. First there is the type of warfare option being deterred--limited Soviet attacks on our strategic weapons and command and control centers, limited attacks which escalate into all-out nuclear war, and a "spasm" nuclear war where the Soviets go for a disarming coup de grace from the outset. Second, there is the nuclear strategy in effect (CASE 1--countervailing--and CASE 2--MAD). Third, there is the arms control perspective of parity.

To organize the discussion let us first address the deterrence issues and then turn to the arms control question. The matrix on the following page shows the type of targeting likely required of the Small ICBM.

MATRIX

SMALL ICBM TARGETING REQUIREMENTS FOR DETERRENCE

NUCLEAR STRATEGY	SOVIET ACTION		
	Crisis, Mobilization, and Conventional War(1)	Limited Nuclear War(2)	All-out(3) Nuclear War
CASE 1	1. Command and Control Centers (4)	1. Same	1. Industry
	2. Troop assembly areas, airfields, shipyards, supply depots, etc.	2. Same	2. Leadership
	3. Leadership Targets(4)	3. Same	3. Military
		4. Soviet prompt, hard target weapons (counterforce) to prevent nuclear blackmail(5)(6)	4. Population centers
CASE 2	1. Military 2. Industry 3. Leadership 4. Population centers	- same -	- same -

NOTES: (1) U.S. strikes first to disrupt offensives. Targets either require prompt attack or accuracy or both.

(2) Soviets strike assembly and embarkation centers to prevent reinforcement of NATO; also Soviets could attack counterforce nuclear weapons to preempt U.S. attack on hardened, military, and leadership targets.

(3) Soviets launch all-out nuclear attack to minimize damage from retaliatory U.S. attack.

(4) Some authors have suggested that connectivity with nuclear forces should be left intact so that commanders can control escalation.

(5) Counterforce weapons must always be available to avoid the scenario where the Soviets launch a limited counterforce attack leaving the U.S. without weapons to

MATRIX (Continued)

SMALL ICBM TARGETING REQUIREMENTS FOR DETERRENCE

NOTES (5-Cont):

attack ICBM and leadership targets. Then the U.S. would have to choose between massive retaliation, prompting a similar attack by the Soviet Union, or not retaliate.

(6) Although a decision might not be made to launch U.S. nuclear forces short of all-out war, we would need the warfighting capability to deter the lesser actions.

The conversion of these requirements to numbers of warheads is done along the following lines. The Soviets have 1,318 ICBM silos (818 considered very hard).[22] Hardened command, control, and leadership bunkers, and other hardened military targets raises the total number of hard targets to approximately 2000.[23] A U.S. force approaching this size would be required. In addition, by 1996, the Soviets are estimated to have deployed 441 SS-25 mobile, 100 SS-24 mobile, and 360 SS-24 silo-based ICBMs.[24] The following assumptions are then made:

1. Ballistic missiles (land or sea-based) would not be used to attack mobile missiles (force level requirements are therefore unaffected by mobile missiles).

2. In retaliation to an all-out attack, a limited number of silos need to be attacked because most are probably empty. Even if some silos are reloaded as some suggest they might be, complete destruction of the silos in a retaliatory attack does not seem to have great merit.

3. After an all-out attack, the Small ICBM force must be able to inflict a devastating blow supported only by the bomber force because the Small ICBM is intended to be a hedge against future SLBM vulnerability.

4. If SLBMs are destroyed in an all-out attack, a minimum target set of industry, leadership, and populations is acceptable.

5. Only ICBMs would be the primary weapon used in a limited nuclear exchange because submarines disclose their location when they launch SLBMs.

The matrix of requirements can now be presented in terms of warhead requirements:

MATRIX

SMALL ICBM WARHEAD REQUIREMENTS FOR DETERRENCE

NUCLEAR STRATEGY	SOVIET ACTION		
	Crisis, Mobilization, and Conventional War	Limited Nuclear War	All-out Nuclear War
CASE 1	500 (1)	450 (2)	250 (3)
CASE 2	250 (4)	250 (4)	250 (4)

NOTES: (1) Scowcroft proposed that around 1500 ICBM hard target kill warheads were needed (compared to the 2000 discussed earlier to keep from presenting the appear ance of a first strike capability). These could be allocated between PEACEKEEPER and Small ICBM in any fashion. For separate reasons 500 was picked for Small ICBM.

(2) 10 percent loss was arbitrarily picked as a level of minor damage for this type attack.

(3) It SLBMs survive, they can supplement the hard target kill weapons. If not, 250 Small ICBMs plus the bomber force provides all the retaliatory capability. There are about 600 non-silo hard targets, plus industry and populations to worry about. 250 Small ICBMs represents a 50 percent survivability and appears to be an adequate retaliatory force, along with the bombers, to provide deterrence. However, if SLBMs are completely vulnerable, a higher survivability might be prudent.

(4) Targets are leadership, industry, population, and a few military. MAD strategy holds that attacking Soviet retaliatory weapons is unnecessary and therefore the needed Small ICBMs for lower levels of warfare are reduced. Note (3) also applies to CASE 2 for the all-out nuclear war action by the Soviets.

Notice that with this construct, the Small ICBM force level requirement is the same for the countervailing and MAD strategies. This is because the driving condition is the retaliation to all-out nuclear war--which is the same for both strategies.

How effective is the Small ICBM in providing these warheads? This can be measured in terms of cost and survivability. But rather than speak directly of survivability, it is more useful to talk of the "price to attack" (PTA). This is the force level which would be required of the Soviets to attack the force. If the PTA is too high then they would not be expected to attack. The PTA for the 10 percent and 50 percent damage allowed in the previous matrix can be converted to required Soviet warheads for limited attack and all-out attack respectively. Then, as a function of the amount of warning time, we find the following:

MATRIX

SOVIET PRICE TO ATTACK (1)

WARNING TIME	LIMITED ATTACK	ALL-OUT ATTACK
Tactical only (2) Warheads	940-1955	4700-9778
Percent of Available USSR Warheads in 1987	11-23	56-118
Percent of Available USSR Warheads in 1996	6-14	33-68
Strategic (3) Warheads	1880-3910	9400-19556
Percent of Available USSR Warheads in 1987	23-47	113-235
Percent of Available USSR Warheads in 1996	13-27	65-136

NOTES: See next page.

MATRIX (Continued)

SOVIET PRICE TO ATTACK

NOTES: (1) Ranges are shown for 30 to 50 pounds per square inch. Price to attack is for 500 kt warheads and includes launch reliability.

(2) Tactical warning is when attack is under way. Dispersal area is 22,000 square miles.

(3) Strategic warning is when indications are that attack is likely. The CBO shows this is 44,000 square miles.[25]

Three conclusions can be drawn from this matrix. First, a limited attack cannot be executed against the Small ICBM force. Roughly 10 percent of the Soviet's warheads and a kill ratio of only one Small ICBM warhead for every 18.8-39.1 (30-50 psi) warheads expended are certainly effective deterrents. Second, to destroy only one-half the Small ICBM force requires one-third to one-half the entire warhead inventory of the Soviets in 1996. This also would be an unacceptable PTA. Further, to coordinate an attack this large would require substantial preparations which would be seen as indications of imminent attack. If the force were dispersed with this strategic warning, then the PTA would be nearly two-thirds to all of the Soviet inventory in 1996. Third, the fact that the Soviets would have to treat the hardness as the upper range would significantly increase the PTA for assured destruction.

We have shown previously that the 15 year life cycle cost for the Small ICBM is estimated to be $46 billion. Normally, cost per surviving warhead is taken as a measure of effectiveness.

However, because the Small ICBM has such a high PTA it is unlikely that it would ever be attacked and therefore cost per survivor becomes a less interesting measure.

Turning to the arms control issues, we will look at three items. First, the parity issue. The comparisons of the current and projected balance of forces are:

MATRIX

BALANCE OF STRATEGIC FORCES (1) (2)
(Deployed in 1987/Planned or estimated for 1996) (3) (4)

	U.S.	Soviet Union
ICBMs		
TOTAL	2289/3450	6500/11000
HARD TARGET KILL(5)	270/1500	3080/5000
SLBMs		
TOTAL	5632/3840	3200/5900
HARD TARGET KILL	0/3840	0/0
TOTAL	7921/7290	9700/16900
HARD TARGET KILL	270/5340	3080/5000

NOTES: (1) 1996 forces include modernization of both U.S. and Soviet weapons. U.S. modernization includes 500 Small ICBMs, 50 PEACEKEEPER rail garrison, and continued procurement up to 20 Trident submarines--all equipped with the Trident II (D-5) missile. Force levels are derived from Congressional Budget Office data.[26]

(2) Bombers are not included.

(3) Year 2000 is used for U.S. forces when modernization is complete.

(4) These forces are not constrained by SALT II or START.

(5) Hard target kill is defined as having at least a .7 probability of damage against a 5000 psi target.

From the matrix it can be seen that the Soviet ICBM advantage is maintained at about three to one through 1996. With the

assumption made in this analysis that all the Trident II missiles will be equipped with the larger Mk 5 warhead, the Soviets achieve superiority in SLBM numbers, but none of theirs have a hard target capability. In total ballistic missile numbers the Soviets significantly increase their advantage. However, the U.S. achieves an overall superiority in hard target weapons. With the U.S. superiority in bomber warheads, the Soviet advantages of ballistic missile numbers are offset. With the bombers, this comparison can reasonably be considered as parity. The 500 Small ICBMs do not affect the ICBM warhead balance appreciably, but they do add hard target kill weapons and, more importantly, match a significant class of Soviet weapons--land-based, mobile ballistic missiles.

The second point concerning arms control is the incentives the Small ICBM provides for mutual reductions. As noted by Ruele, highly survivable, mobile ICBMs "...can lead to smaller force structures by eliminating the incentives for increasing the number of weapons in strategic arsenals....by reducing counterforce targeting opportunities , and through such reductions, the need for both those weapons that would carry out counterforce destruction and those weapons that would be destroyed by such reduction."[27] This presumes bomber attacks to be relatively ineffective as a means of destroying the mobile missile force.

The third point is verification. Some have argued that mobile missiles are not verifiable--and as such are destabilizing. However, this is really not the case. With fewer warheads per

launcher (one is the extreme), cheating is more difficult. Also, the advantages of cheating are much reduced.

We can conclude this chapter by returning to the roles of the Small ICBM set forth by Scowcroft. In exacting a price to attack of nearly a tenth of the Soviets warheads in 1996 to destroy only 50 Small ICBM warheads, and roughly one-half the 1996 warheads to destroy only 250 Small ICBM warheads, the deterrent stability provided by the Small ICBM force is enormous. As a hedge against future vulnerability of the SLBM forces then, it is an exceptional weapon system.

In its surviving, enduring role it provides the capability to deter conventional and limited nuclear war. In addition, the Small ICBM gives the U.S. a counterpart to the Soviet mobile ICBMs to retain a rough equivalence in force structure. Finally, as a system so difficult to attack, it provides a large incentive for the Soviets to negotiate meaningful arms reductions.

CHAPTER IV

RAIL GARRISON PEACEKEEPER OR MOBILE, SMALL ICBM--OR BOTH

In testifying before the Senate Armed Services Committee shortly after the release of the Scowcroft report, former Secretary of Defense Harold Brown, a senior counselor to the Commission stated:

> ...in the present situation, with the present Soviet forces and present arms control arrangements, I think Midgetman (referring to the Small ICBM), by itself, is not an answer to the vulnerability problem.[1]

Since the Scowcroft Commission report an alternative basing scheme has been found for the deployment of the second 50 PEACEKEEPER missiles. The concept calls for the missiles to be garrisoned on rail trains which disperse on strategic warning to achieve location uncertainty and the accompanying survivability. This new twist in the strategic modernization program raises questions. Does rail garrison PEACEKEEPER fill all the roles Scowcroft designated for the Small ICBM at significantly lower costs? Is a system which relies on strategic warning acceptable? Are the 500 PEACEKEEPER warheads sufficient or are the Small ICBM warheads still needed? Does the relatively low number of garrisons and launchers make limited nuclear attack more lucrative for the Soviets or strategic defense less stabilizing? And finally, does rail garrison PEACEKEEPER discourage arms reductions? These are the questions that will be addressed in this chapter.

A comparison of significant effectiveness parameters for the Small ICBM and PEACEKEEPER is shown in the matrix on the following page.

MATRIX

SMALL ICBM AND RAIL GARRISON PEACEKEEPER EFFECTIVENESS

PARAMETER	SMALL ICBM	RAIL GARRISON PEACEKEEPER	BOTH
COST ($Billion-FY88)(1)			
- Life Cycle (15 yr)	46.1	11.9	58.0
- Annual			
-- R&D (Maximum year)	2.2(2)	1.2	3.4
-- Production	3.8(3)	2.2	5.1(4)
-- Operations and Support	0.58	0.23	0.81
PRICE TO ATTACK (Number of Soviet 500 kt Warheads Required to Achieve 0.9 Damage Expectancy)			
- Tactical Warning only			
-- ICBMs(5)	8700-16900	200-400	8900-17300(8)
-- SLBMs(6)	4000-8000	≤100-200	4100-8200(8)
- Strategic Warning(7)	≥17400-33800	12700-22300	30100-56100(8)
ARMS CONTROL REGIME			
- Hard Target Kill Weapons (Number of Warheads in Year 2000 / Percent of Soviet Hard Target Weapons)			
-- Total(9)	4840/97	4840/97	5340/107
-- Prompt(9)	1000/20	1000/20	1500/30
- Incentives to Reduce Force Levels?	Yes	Yes	Yes
- Verification (Additional ICBM launchers required to threaten 2000 hard targets)(10)	>550	55	0
STRATEGIC DEFENSE TARGETS			
- Ascent Phase (Boosters)	500	50	550
- Reentry Phase (Warheads)	500	500	1000

NOTES: See next page.

MATRIX (Continued)

SMALL ICBM AND RAIL GARRISON PEACEKEEPER EFFECTIVENESS

NOTES: (1) Data from Congressional Budget Office (CBO).[2]

(2) Maximum year is FY 1989. Budget was the FY 1987 Five Year defense Plan. The FY 1989 President's budget submitted to Congress on 18 Feb 88 cut the Small ICBM FY 1989 budget to $200 million.

(3) Average annual funding found as follows: 15 year life cycle cost ($46.1 billion), minus R&D ($8.7 billion), minus 15 year Operations and Support ($8.7 billion), minus FY 1989-FY 1992 Production ($9.7 billion), divided by five years (assumes buy-out 1993-1997).

(4) Rail garrison PEACEKEEPER peaks in FY 1990 when Small ICBM is $2.9 billion.

(5) Rounded to nearest hundred. Area generation for tactical warning is given on page 57 of the CBO report as 22,000 square miles for Small ICBM and 1,000 track miles for rail garrison PEACEKEEPER. The range of numbers is 30-50 psi hardness for Small ICBM and 3-10 psi for rail garrison PEACEKEEPER. Inefficiencies of overlapping target circles at 0.9 Probability of Damage not included (lethal radii for 500 kt warheads used in calculations: 50 psi [3400 feet]; 30 psi [4250 feet]; 10 psi [7500 feet]; 3 psi [14000 feet]).

(6) Rounded to nearest hundred. Tactical warning time for SLBMs is assumed to be one-half ICBMs. From the CBO data this gives the area generation as 10,000 square miles for Small ICBM and less than 500 track miles for rail garrison PEACEKEEPER.

(7) Rounded to nearest hundred. Strategic dispersal is considered to be at least 12 hours. CBO data gives the 12 hour area generation as greater than 44,000 square miles for Small ICBM and 60,000 track miles for rail garrison PEACEKEEPER.

(8) It is assumed that there is no overlap in dispersal area between the Small ICBM and rail garrison PEACEKEEPER. The number of joint main operating bases (three out of ten host both systems) and the dispersal patterns make this a good approximation.

(9) Includes following warheads: 3840 Trident (D-5, assumes all are Mk 5), 500 silo-based PEACEKEEPER, 500 Small ICBM, and 500 rail garrison PEACEKEEPER. All Trident missiles are excluded from the prompt category.

(10) Assumes one PEACEKEEPER or Small ICBM warhead per target; two MINUTEMAN III (Mk 12A) per target. Force structure before additional Small ICBM or rail garrison deployment is 500 PEACEKEEPER warheads, 900 MINUTEMAN III (Mk 12A) warheads, and 500 warheads from either Small ICBM or PEACEKEEPER.

A number of remarks can be made about the data. It is obvious that the PEACEKEEPER is the much cheaper way to deploy 500 prompt, ICBM, hard target kill warheads. Also important are the annual costs. In the original Scowcroft strategy with PEACEKEEPER deployed in silos, all of the development costs would have been completed by FY 1987 and most production assets purchased by FY 1992. Therefore the majority of Small ICBM funding was to have been staggered with PEACEKEEPER. With the new schedule for rail garrison the two programs now overlap significantly.

To deconflict the overlap now would require about a three year slide in the Small ICBM program. It is also noted that in the FY 1987 Five Year Defense Plan roughly $3 billion was the maximum annual funding that was ever expected for strategic modernization of ICBM forces before the two programs overlapped.[3]

Turning to the price to attack, with adequate warning both systems demand a much higher price than the Soviets have in their entire missile inventory. The strength of the Small ICBM concept with only tactical warning is clearly shown. In short, if the Soviets wanted to destroy the Small ICBM force with ballistic missiles it would leave them without any warheads to attack silo-based ICBMs, bombers or submarines. Or, if they chose to attack these other targets, they could not destroy the Small ICBM.

On the other hand, the rail garrison PEACEKEEPER price to attack is very low with only tactical warning. Many have argued that this is a critical shortcoming of this concept on the basis that strategic warning indicators have been missed or ignored in

the past and that ICBM survivability has traditionally not depended on warning.[4] These arguments have misapplied historical lessons because they have ignored the extreme differences between past conventional wars and nuclear wars. With the advent of large standing nuclear forces because delay times of mobilization cannot be tolerated, both the U.S. and Soviet Union will be much more cautious about preempting or not generating strategic forces than in the past because the consequences of error are so much greater. For example, a limited preemptive attack like Pearl Harbor would not likely have occurred if the Japanese had to consider they were risking immediate retaliation by nuclear weapons. And, Stalin, when advised of German troop movements on his border, would have likely made more preparations before the May 1941 invasion.

If it is true then that nuclear weapons change the calculus of preemption and force generation, are there still shortcomings of reliance on strategic warning? The answer would appear to be yes for two reasons. First, the concept of limited nuclear attacks raises concerns. At the levels required to destroy the entire rail garrison PEACEKEEPER force without prior dispersal, it takes only two or three Soviet submarines or 20 to 40 SS-18 class ICBMs--certainly a peacetime posture possibility. If our possession of prompt, hard target kill, ICBMs is truly a worthwhile deterrent to Soviet coercion or invasion of NATO, then it is dangerous to have that capability vulnerable to such a small attack. In the future such a lucrative target might encourage swift escalation of regional crises to a limited nuclear attack which left the

U.S. without a hard target ICBM and only, therefore, a MAD or withhold option.

Second, and closely related, as a hedge against SLBM vulnerability, it would seem that the ICBM force should not be vulnerable to strategic warning. The case of a premeditated attempt to destroy U.S. strategic nuclear forces becomes much more problematic if our SLBMs are not highly survivable.

In looking at the arms control issues, it can be seen that 500 hard target capable warheads from either Small ICBM or PEACEKEEPER add about 10 percent to the TRIDENT II forces giving the U.S. parity in total hard target capable, ballistic missile warheads. However, in the area of prompt weapons (ICBMs), the U.S. would only have about one-fifth the Soviet total. If both Small ICBM and PEACEKEEPER were deployed this would raise the U.S. to about one-third the Soviet forces. In terms of damage expectancy against the target base of two thousand, 5000 psi hard targets, the ICBM force with only 500 warheads from either system would be about 60 percent, if MINUTEMAN III warheads were used, or 33 percent if they were not (since MINUTEMAN III has other targets and requires more than two warheads to achieve a significant damage against a 5000 psi target it would probably not be considered for those targets). If the additional 500 warheads were added, then the damage expectancy would increase to over 55 percent. While a firm line on what deployment level would prompt the Soviets to seriously consider mutual reductions of these premier type of warheads can not be drawn, it could be that threatening

one-third the targets would be adequate. Scowcroft cautioned that deployment should be "...less than that which would constitute a ...first strike against Soviet hard targets."[5] However, if further deployments were necessary, they could be achieved by more PEACEKEEPERs, not necessarily requiring Small ICBM at all.

The deployment of 500 or 1000 prompt, hard target capable warheads addresses the arms control of current force levels. But the thing that would induce reductions of force levels is if both sides found their weapons to be relatively ineffective in attacking the opposing strategic nuclear forces. This of course calls for high survivability. For example, if the Soviets can destroy the 2450 U.S. silo-based warheads (i.e. 450 MINUTEMAN II, 1500 MINUTEMAN III, and 500 PEACEKEEPER) with only 2000 warheads (2 on 1 silo targeting), but had to expend a large fraction of their remaining warheads on 500 ICBM warheads (Small ICBM or rail garrison PEACEKEEPER), then they would have incentive to reduce silo-based levels. This can be seen by considering the hypothetical case shown in the following matrix:

MATRIX
HYPOTHETICAL DAMAGE EXPECTANCIES

	Before or After Both Sides Deploy Highly Survivable Forces	
	BEFORE	AFTER
1st Strike		
Counterforce	0.6	0.4
Leadership/Countervalue	0.97	0.97
2nd Strike		
Counterforce	0.6(1)	0.4(1)
Leadership/Countervalue	0.4	0.85

NOTE: (1) It is assumed that fewer counterforce targets exist for the 2nd strike case since the 1st strike of side 1 used many of the weapons which were targeted by side 2.

The lowered damage expectancies in this hypothetical case say that an attacker's first attack against counterforce weapons (retaliatory capability) has been depreciated. However, since it is assumed that the force structure was principally designed for attacking military targets, requiring many more warheads than economic and population targets, the effectiveness against countervalue targets is not diminished for the first strike. And, since more warheads survive a first strike by the other side, the damage expectancy of a retaliatory attack against countervalue targets actually increases.

Both sides would then have the choice of deploying more weapons to restore the original damage expectancy (creating an upward spiraling arms race) or negotiating arms reductions to dismantle the other side's warheads that can no longer be destroyed. Of course it would be expected that the least survivable weapon systems would be negotiated first, leaving the residual weapons even less effective in a counterforce role. This downward spiral has the effect of forcing both sides to converge in their nuclear strategies and force more stable levels by virtue of assured survivability of retaliatory forces and common understanding of objectives and capabilities.

The foregoing has shown the effect of devaluing warheads. This is what is meant when it is said that the warhead exchange ratio (i.e. attacking warheads to destroyed warheads) has increased. But it is seen that it is a function only of the price to attack, not the number of warheads per launcher. Obviously if

there are ten times more warheads per launcher (as in PEACEKEEPER versus Small ICBM), then the price to attack the launcher must be ten times greater also. This can be achieved by always dispersing the same number of warheads over the same amount of effective area uncertainty (i.e. 500 Small ICBMs or 50 PEACEKEEPERs). We can conclude from this discussion that for both the parity issue and incentives to reduce warhead deployments, PEACEKEEPER can be as effective as the Small ICBM.

The last element of arms control is a disadvantage for PEACEKEEPER. As shown in the matrix, if the original force size deployed is limited to avoid threatening all retaliatory weapons, then pressure to verify compliance with that limit is somewhat less with Small ICBM. Put another way, the consequences of cheating or treaty abrogation are less for the Small ICBM since a few more launchers do not add appreciable capability. On the other hand, relatively few numbers of PEACEKEEPER launchers add substantially to the first strike capability and so put much more pressure on accurate verification of arms control agreements.

The final comparison in the matrix is associated with the possibility of strategic defense. The significant feature here is that in the ascent phase, rail garrison PEACEKEEPER presents fewer, and widely dispersed targets--the most vulnerable kind of system. This type of vulnerability must be considered in the evaluation of the two weapon systems. For that reason, it seems that the Small ICBM must be continued at some level as a hedge against future strategic defense deployments by the Soviets.

Returning to the questions that opened this chapter it can be concluded that the rail garrison PEACEKEEPER provides the survivability needed for a hedge against SLBM vulnerability, as well as a prompt hard-target capability. However, it does not satisfy the requirements for stabilizing deterrence of limited nuclear war nor encouraging continued, and stabilizing, arms reductions. It is in these roles that the Small ICBM has unique advantages. However, neither SLBM vulnerability nor very large arms reductions beyond the START levels appear imminent. Therefore, a prudent, and affordable, strategy would seem to be aggressive development and deployment of rail garrison PEACEKEEPER with a modest, evenly-paced continuation of the Small ICBM to account for future contingencies of SLBM vulnerability, arms control agreements, and deployments of threatening strategic defenses. This strategy requires tight coupling with the negotiating positions in the Strategic Arms Reductions Talks.

CHAPTER V

IMPACT OF THE STRATEGIC ARMS REDUCTIONS TALKS DEEP CUTS

We have seen that a major objective of the Scowcroft strategic modernization plan was to encourage reciprocal arms reductions which enhanced the stability of deterrence.[1] The deep cuts in strategic force levels, proposed by the U.S. at the October 1986 Reykjavik, Iceland summit meeting between President Reagan and Soviet Premier Gorbachev, were structured along that line. This chapter addresses the effects of those cuts on the deployment decisions for the Small ICBM.

The deep cuts proposed by the U.S. have essentially three characteristics: a) an overarching agreement in principle of a 50 percent reduction in strategic force levels, b) sublimits on specific types of weapons, and c) an agreement in principle to separately address nuclear weapon types not covered in the proposal. The details have been presented elsewhere.[2] The individual features are summarized in the matrix below.

MATRIX

SUMMARY OF THE OCT 86 U.S. PROPOSED DEEP CUTS IN STRATEGIC FORCES

Proposal	Limits
- 50 Percent Reduction	- 1600 Deployed Strategic Nuclear Delivery Vehicles(1) - 6000 Deployed Warheads(2)
- Sublimits(3)	- 4800 Ballistic Missile Warheads - 3300 ICBM Warheads - 1650 "Permitted" ICBM Warheads(4)
- Uncovered Nuclear Weapon Types	- Sea Launched Cruise Missiles

NOTES: See next page.

MATRIX (Continued)

SUMMARY OF THE OCT 86 U.S. PROPOSED DEEP CUTS IN STRATEGIC FORCES

NOTES: (1) Includes ICBMs, SLBMs, and heavy bombers.

(2) Includes warheads on ICBMs, SLBMs, and heavy bombers. ALCMs are counted separately, but bombers with gravity bombs and SRAMs only counted as a single warhead (even though more than one bomb/SRAM may be carried by the bomber).

(3) The Soviets have rejected the concept of sublimits.

(4) "Permitted" ICBMs are defined as heavy ICBMs (e.g. SS-18s), silo-based ICBMs with more than six warheads (e.g. PEACEKEEPERs and SS-19s), and mobile ICBMs if not banned (e.g. SS-24s, SS-25s, rail garrison PEACEKEEPERs, and Small ICBMs).

The impact of these limits on the Small ICBM are not significant. Nor do the limits greatly alter the trade-offs between the Small ICBM and rail garrison PEACEKEEPER. For example, full deployment of 500 Small ICBMs and the second 50 PEACEKEEPER would constitute 600 strategic nuclear delivery vehicles (counting the first 50 PEACEKEEPERs in silos also), leaving a combined total of 1000 for SLBMs, other ICBMs, and heavy bombers. All 1500 warheads could also be deployed under the "permitted" ICBM warheads limit.

However, as part of the early negotiations the Soviets have indicated a willingness to reduce by one-half the number of silo-based SS-18s. In addition, they have rejected the proposed ban on mobile ICBMs and would be expected to deploy a large fraction of their remaining ICBM warheads (after the 1540 SS-18 warheads) on the mobile SS-24s and SS-25s. Both of these moves would reduce the required number of prompt, hard-target capable ICBMs for the U.S. Although it is true that prompt retaliatory weapons

may be able to attack mobile targets, it is not likely they would be used in that manner and so the required number of ICBM warheads would decrease in the face of this Soviet force structure. It would be reasonable in light of the above to assume that the number of targets assigned to PEACEKEEPER or Small ICBM warheads would decrease, possibly by as much as one-third. If the second 50 PEACEKEEPERs were deployed this one-third reduction could be achieved best by reducing the silo-based PEACEKEEPERs by 25 missiles (actually switching them to rail garrison) and deploying only 250 Small ICBMs.

While there are a number of cases which could be considered, four of the more likely candidates are presented below.

MATRIX

LIKELY ICBM DEPLOYMENT CANDIDATES UNDER START

Case	Description	Warheads Deployed (Silo PEACEKEEPER/Rail Garrison PEACEKEEPER/Small ICBM)
1	Full ICBM Deployment	500/500/500
2	One-third Reduction	250/500/250
3	No Rail Garrison PEACEKEEPER	500/0/500
4	No Small ICBM	500/500/0

Each of these candidates have particular strengths and weaknesses. The significant effectiveness parameters for each are shown in the following matrix.

MATRIX

EFFECTIVENESS OF ICBM DEPLOYMENT CANDIDATES UNDER START

Parameter	Case 1	2	3	4
Life Cycle Cost ($ Billion-FY 1988; 15 yr)(1)(2)	59.7	38.6	47.8	13.6
Price to Attack (Thousands of Warheads for .9 Damage Expectancy)(3)				
- Tactical Warning Only				
-- ICBMs	9.0-17.4	4.6-8.9	8.8-17.0	0.3-0.5
-- SLBMs(4)	4.1-8.2	2.1-4.2	4.0-8.0	0.1-0.2
- Strategic Warning	30.2-56.2	21.4-39.2	17.5-33.9	12.8-22.4
SLBM Warheads Allowed(5)	3264(6)	3764(7)	3764	3764
Damage Expectancy Against 1500, 5000 psi Targets(8)	0.85	0.56	0.57	0.57
Incentive for Further Reductions	Yes	Yes	Yes	No

NOTES: (1) Rounded to nearest $ 100 million. No costs other than operations and support (O&S) are included since it is assumed that these have already been funded. Silo-based PEACEKEEPER O&S cost assumed to be one-half the annual $ 230 million for rail garrison, i.e. $ 115 million.

(2) Silo-based PEACEKEEPER O&S reduced by one-third instead of one-half because costs such as security, training, etc., are not proportional to the number of deployed missiles. Rail garrison PEACEKEEPER production cost reduced at the rate of $47.6 million per missile (i.e., supplying 25 of the 50 PEACEKEEPERs by removing them from silos saves $ 1.2 billion). Small ICBM costs assume deployment at only two main operating bases so base construction costs are reduced along with O&S. Effective savings estimated as one-half the 15 year O&S. Unit cost for the Small ICBM includes the missile, hard mobile launcher, launcher command and control equipment, and hardened alert shelter for the mobile launcher. Unit cost taken as $ 60 million (i.e., 250 less missiles at $ 60 million each is a savings of $ 15 billion).

MATRIX (Continued)

EFFECTIVENESS OF ICBM DEPLOYMENT CANDIDATES UNDER START

NOTES (cont): (3) Rounded to nearest hundred. Assumes 2 on 1 attacks. For the 250 Small ICBM case assumes area uncertainty is three-quarters that for the 500 case because each of the MINUTEMAN bases have their own area generation number and the two most efficient bases were picked.

(4) Silos not attacked due to inadequate accuracy.

(5) From the Congressional Budget Office data this assumes 21 B-52H bombers, 100 B-1B bombers, 132 B-2 bombers, and no other ICBM besides PEACEKEEPER and Small ICBM.[3]

(6) Forces reduction from 20 to 17 TRIDENT submarines.

(7) Permits 19 TRIDENT submarines.

(8) Damage Expectancy is calculated as follows: one warhead assigned to a target; all warheads assumed available for targeting; probability of arrival taken as 100 percent; single shot probability of kill calculated from CBO "Characteristics of U.S. Missile Forces."[4] Small ICBM characteristics are used for rail garrison PEACEKEEPER.

From this matrix it can be seen that none of the previous conclusions are altered. Deployment of significant numbers of Small ICBM missiles is still expensive, all candidate deployments charge excessive prices to attack, and pure PEACEKEEPER deployments are sensitive to strategic warning.

Two more points will be made before concluding this chapter. First, without deployments of significant numbers of Small ICBMs, it appears that any further reductions in ICBM warheads would be highly destabilizing. Without prior dispersal of the rail garrison forces, the entire PEACEKEEPER leg (including the silo-based

missiles) could be destroyed by less than 300 SLBM warheads. This of course would require the attacking SLBM accuracy to improve to be able to destroy silos--but it is likely that this could be accomplished in the not so distant future. Remembering that this could be as few as 3 Delta III submarines, the viability of these forces could be questionable. The low number of 100 missiles also has questionable capabilities to escape ascent phase strategic defenses if they were deployed.

The second point concerns affordability of the Small ICBM system. One might ask what is the maximum cost that can be expected if rail garrison PEACEKEEPER is deployed as a first priority. As an upper limit we might say that doubling the ICBM modernization cost is the maximum possible--or $13.6 billion for the Small ICBM. For that cost somewhere between 50 and 100 Small ICBMs could be developed, produced, deployed, and supported for 15 years. But would only 100 Small ICBMs make a worthwhile contribution? A comparison of effectiveness with and without the Small ICBM is shown below.

MATRIX

EFFECTIVENESS OF ICBM DEPLOYMENTS UNDER START WITH AND WITHOUT THE SMALL ICBM

Parameter	Without Small ICBM(1)	With 100 Small ICBMs
Life Cycle Cost ($ Billion-FY 1988; 15 yr)(2)	13.6	27.2
Price to Attack(3)		
- Tactical Warning Only		
-- ICBMs(4)	300-500	3600-6800
-- SLBMs(4)	100-200	1600-3200
- Strategic Warning	12800-22400	19300-35100
Damage Expectancy Against 1500, 5000 psi targets	0.45	0.57

NOTES: See next page.

MATRIX (Continued)

EFFECTIVENESS OF ICBM DEPLOYMENTS UNDER START WITH AND WITHOUT THE SMALL ICBM

NOTES: (1) Includes 50 silo-based PEACEKEEPER missiles and 50 rail garrisoned PEACEKEEPER missiles.

(2) Assumes Small ICBM O&S costs are for a single main operating base. Full deployment and operational testing programs assumed.

(3) For the Small ICBM dispersal area for one base the numbers are 8250 square miles for ICBMs and 3750 square miles for SLBMs.

(4) Rounded to nearest hundred.

While it is realized that $13.6 billion is a high cost for only 100 warheads, it can be seen from the matrix that it provides a significant capability. No longer are all ICBM forces sensitive to strategic warning. At a level consistent with limited nuclear options there is a highly survivable weapon system. It also provides a stepping stone for swap-outs of PEACEKEEPER missiles with more Small ICBMs if warhead reductions beyond START continue. And it addresses the difficulty of few ascent phase targets if strategic defenses are deployed.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

When the Small ICBM was conceived, it was intended to provide long-term survivability of prompt, hard target kill capable weapons. It would restore much of the independence of ICBM survivability in the TRIAD and serve as a hedge against breakthroughs in anti-submarine warfare which could threaten the survivability of the SLBM force. It was also a means to achieve reduced, more stable, nuclear arms levels. At its inception, it alone had the promise for high survivability of an ICBM system. But now that a surviving basing system for the PEACEKEEPER has been devised, much of the need for the Small ICBM has faded. And with shrinking defense dollars, the high cost of the system is even more of a shortcoming than in 1983.

Both the Small ICBM and rail garrison PEACEKEEPER provide the capability to deter large scale conventional war and limited nuclear attacks by threatening the hard targets most valued by the Soviets. Without one or the other, deployed in a survivable basing mode, to provide prompt response with assured command and control connectivity, there are dangerous weaknesses in our deterrence. Even if a mutual assured destruction strategy is held, the need for survivable ICBMs which can retaliate against hardened military and leadership targets are essential.

In addition, deployment of either mobile system provides the political demonstration of U.S. resolve to uphold parity to assure

deterrence for ourselves and our allies. Either weapon system also gives us negotiating leverage to balance deployments of mobile missiles in a stabilizing way or ban mobile systems altogether. In an era of approaching defense austerity, the significant lower cost of rail garrison PEACEKEEPER makes it the preferred choice for deployment. The savings will permit priority funding for conventional forces to deter the much more likely conventional wars or third world adventurism.

However, with the few number of PEACEKEEPER missiles required to deploy 500 additional warheads, the force posture becomes sensitive to strategic warning. With a secure SLBM system, this sensitivity is not a major problem. But if technology breakthroughs did erode SLBM survivability, the stability of deterrence, particularly the deterrence of conventional or limited nuclear war could become doubtful. In addition, the sensitivity of a relatively small booster force to surprise attack or ascent phase strategic defense could limit future arms reductions.

From these factors we can conclude that because the Small ICBM is the unequivocal hedge against still unforeseeable U.S. SLBM vulnerabilities, and because the character of strategic defense and arms reductions are uncertain, a slower pace of the program is acceptable, pending the emergence of any of these factors. This slowing of development and deferral of a production decision by as much as three years would provide a more affordable annual strategic budget while maintaining a viable program which could be quickly accelerated if any or all of the conditions arose.

From these conclusions, the following recommendations are derived:

1. Give top priority to the deployment of the survivable rail garrison PEACEKEEPER weapon system.

2. Continue the Small ICBM full scale development, but at a slower, affordable pace.

3. Restructure the Small ICBM full scale development program to delay the production decision until 1992, but retain the capability to accelerate if needed.

4. Restructure the planned Small ICBM force levels to provide the following capabilities:

- Deterrence of limited nuclear war.
- Deployment levels compatible with cuts beyond the current 50 percent reduction proposal.
- Capability to launch through attacks from an ascent phase strategic defense.
- Growth capability if U.S. SLBM survivability erodes.

LIST OF REFERENCES

CHAPTER I

1. Blechman, Barry M., "Perspectives on Strategic Forces," Rethinking the U.S. Strategic Posture, Ballanger Publishing Company, Cambridge, Massachusetts, 1982, pg. 2.

2. Snow, Donald M., "Levels of Strategy and American Strategic Policy," Air University Review, November-December 1983, pg. 64.

CHAPTER II

1. For thorough examinations of the history of nuclear strategies see Freedman, Lawrence D., The Evolution of Nuclear Strategy, The MacMillan Press LTD, London, 1981, and Slocombe, Walter B., "The United States and Nuclear War," Rethinking the U.S. Strategic Posture, Ballanger Publishing Company, Cambridge, Massachusetts, 1982, pp 17-46. For an excellent treatment on how nuclear strategy interrelates with national security policy see Brown, Harold, Thinking About National Security Defense and Foreign Policy in a Dangerous World, Westview Press, Boulder, Colorado, 1983.

2. "National Security Strategy of the United States," The White House, January 1987, pg. 21.

3. Freedman, pg. 167.

4. McNamara, Robert S., "Defense Arrangements of the North Atlantic Community," Department of State Bulletin, 47, 9 Jul 1962, p. 67.

5. Enthoven, Alain C. and K. Wayne Smith, How Much is Enough? Shaping the Defense Program 1961-1969, Harper & Row, New York, 1971, pg. 174.

6. Freedman, pg. 246.

7. Ibid, pg. 247.

8. Ibid, pg. 359. The author is quoting from Secretary of Defense James Schlesinger, Annual Defense Report, FY 1976, 5 Feb 1975, pp. II-3 & II-4.

9. Brown, pg. 81.

10. Gray, Colin, "The Urge to Compete: Rationales for Arms Racing," Journal of World Politics, 1972.

11. Brodie, Bernard, "On the Objectives of Arms Control," The Use of Force, 2nd ed., edited by Robert J. Art and Kenneth N. Waltz, University Press of America, Inc., Lanham, MD, 1983, pp. 420-438.

12. Freedman, pp 354-358.

13. Hoover, Robert, Lecture notes from Elective 6244, "Arms Races and Arms Control," Air War College, Maxwell AFB, Alabama, Dec 1987-Feb 1988.

14. Scowcroft, Brent et al, "Report of the President's Commission on Strategic Forces," The Pentagon, Washington D.C., 6 Apr 1983., pg. 2.

15. Scowcroft, Brent, "MX Missile Basing System and Related Issues," Hearings before the U.S. Senate Committee on Armed Services, 98th Congress, Washington D.C., 18 Apr 1983, pg. 3.

16. Scowcroft, "Report of the President's Commission on Strategic Forces," pg. 3.

17. Jervis, Robert, The Illogic of American Nuclear Strategy, Cornell University Press, Ithaca, New York, 1984, pg. 31.

18. Slocombe, pg. 17.

19. Blechman, Barry M. et al, "An Effective Strategic Force Posture," Rethinking the U.S. Strategic Posture, Ballanger Publishing Company, Cambridge, Massachusetts, 1982, pp. 247-293, and Seiler, George J., Strategic Nuclear Force Requirements, Air University Press, Maxwell AFB, Alabama, February, 1983.

CHAPTER III

1. Scowcroft, Brent et al, "Report of the President's Commission on Strategic Forces," The Pentagon, Washington D.C., 6 Apr 1983.

2. Ibid, pp.7-8.

3. Ibid, pg. 7.

4. Ibid, pg. 8.

5. Ibid. pg. 16.

6. Ibid, pg. 14.

7. Ibid, pg. 23.

8. Ibid, pg. 15.

9. Ibid, pg. 23.

10. Ibid, pg. 23.

11. "MX Missile Basing System and Related Issues," Hearings before the U.S. Senate Committee on Armed Services, 98th Congress, Washington D.C., 18 Apr-3 May, 1983.

12. Congressional Budget Office, "Modernizing U.S. Strategic Offensive Forces: Costs, Effects, and Alternatives," Congress of the United States, November, 1987, pp. 54-59.

13. Ibid, pg. 81.

14. Ibid, pg. 59.

15. Scowcroft, Brent, "MX Missile Basing System and Related Issues," Hearings before the U.S. Senate Committee on Armed Services, 98th Congress, Washington D.C., 18 Apr 1983, pg. 14.

16. Congressional Budget Office, pg. 54.

17. Soviet Military Power 1987, U.S. Government Printing Office, Washington D.C., Mar 1987, pp. 28-35.

18. Congressional Budget Office, pg. 90. The average value is calculated for area barrage effectiveness. From the data given in the CBO report the area barrage effectiveness yield is calculated from the equation: $W[avg] = (W[1]N[1] + W[2]N[2] +...+ W[n]N[n])/(N[1] + N[2] +...+N[n])$. W[1] is the yield of one size warhead (e.g. the warhead on the SS-18), N[1] is the number of these warheads in the Soviet inventory, W[2] is the yield of a second size warhead, N[2] is the number of those warheads, and so on. The exact calculations are: ICBMs = 553 kilotons; SLBMs = 452 kilotons.

19. Ibid, pg. 90. The data give missile type and number of warheads. All missiles are said to have a constant number of warheads except the SS-N-20 SLBM which has a range of 6-9 warheads per missile. The upper limit was used for these calculations.

20. Ibid, pg. 91. As noted by the CBO report, older, liquid-fueled ICBMs would have a lower availability (e.g. 85 percent), while newer, solid propellent ICBMs would have the higher availabilities. The mobile SS-24 and SS-25 might also have a somewhat lower availability. The overall aggregate of 95 percent was selected to be conservative.

21. Ibid, pg. 86. Sixty seven percent undoubtedly would represent a surge force level for the Soviets, but it is used here because periodic surging could be used as a tactic to lull the U.S. into relative inaction.

22. Ibid, pg. 31. For the number of ICBM silos in the very hard category, the CBO referenced Soviet Military Power 1987, pg. 28.

23. Ibid, pg. 31. The CBO referenced Brown, Thinking About Nuclear Security: Defense and Foreign Policy in a Dangerous World. Brown repeated the need for about 2000 hard target kill warheads in the Hearings before the U.S. Senate Committee on Armed Services, 98th Congress, Washington D.C., 18 Apr 1983.

24. Ibid, pg. 90.

25. Ibid, pg. 58.

26. Ibid. U.S. forces are listed on pages 81 and 84-86. USSR forces are listed on page 90.

27. Reule, Fred J., "Dynamically Stable Deterrence," Dynamic Stability, A New Concept for Deterrence, Air University Press, Maxwell AFB, Alabama, September, 1987, pg. 3.

CHAPTER IV

1. Brown, Harold, "MX Missile Basing System and Related Issues," Hearings before the U.S. Senate Committee on Armed Services, 98th Congress, Washington D.C., 18 Apr 1983, pg. 24.

2. Congressional Budget Office, "Modernizing U.S. Strategic Offensive Forces: Costs, Effects, and Alternatives," Congress of the United States, November, 1987, pp. 38 and 54.

3. Ibid, pp. 37-38.

4. Zirkle, Robert A., "No Way to Run a Railroad," Arms Control Today, Oct 1987, pg. 21, and Toomay, John C., "Strategic Forces Rationale--A Lost Discipline?" International Security, Fall 1987, pg. 195.

5. Scowcroft, Brent, "MX Missile Basing System and Related Issues," Hearings before the U.S. Senate Committee on Armed Services, 98th Congress, Washington D.C., 18 Apr 1983, pg. 17.

CHAPTER V

1. Scowcroft, Brent, "Report of the President's Commission on Strategic Forces," The Pentagon, Washington D.C., 6 Apr 1983., pp. 22-23.

2. Fournoy, Michele A., "A Rocky START: Optimism and Obstacles on the Road to Reductions," Arms Control Today, Oct 1987, pp. 7-13.

3. Congressional Budget Office, "Modernizing U.S. Strategic Offensive Forces: Costs, Effects, and Alternatives," Congress of the United States, November, 1987, pg. 41.

4. Ibid, pg. 86.