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ANTISUBMARINE WARFARE AND ARMS CONTROL:

Analysis and Proposal

by

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A thesis submitted to the Faculty of
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Abstract

Advances in weapons technology are making the retaliatory forces of the superpowers vulnerable to preemptive strikes. Manned bombers and intercontinental ballistic missiles are becoming particularly vulnerable, making the safety of submarine-based strategic weapons increasingly important. Enormous efforts are being made by both superpowers to develop antisubmarine warfare (ASW) capabilities, some of which threaten to degrade the security of submarine-based strategic forces and further erode the strategic balance.

Arms control is seen as a way of alleviating the destabilizing effects of evolving weapons technologies. After analysis, the author concludes that the most frequently discussed ASW arms control proposals (submarine sanctuaries and limitations on the number of attack submarines) are not feasible. He presents an alternative which calls for attack submarines at sea to periodically report to established stations during patrol, making it more difficult for them to trail submarines carrying strategic missiles.

The undersigned recommend to the Faculty of Graduate Studies acceptance of the thesis "Antisubmarine Warfare and Arms Control: Analysis and Proposal" submitted by Kevin Cunningham Gallagher, B.A. Hons., in partial fulfilment of the requirements for the degree of Master of Arts.

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INTRODUCTION:

ARTICULATED ASSUMPTIONS

The purpose of this paper is to examine the potential for a strategic arms control agreement between the United States and the Soviet Union in the area of antisubmarine warfare (ASW). The paper will address both the need for such an agreement; the factors relevant to the feasibility of such an agreement, and, finally, a model of a viable ASW arms control agreement.

An attempt has been made to keep this study wholly empirical. The body of theory used in this paper has been kept to a minimum. However, the interpretation of empirical information, no matter how objective, relies on the biases and assumptions which an analyst brings to his work. No analysis can be properly assessed without understanding 1) the assumptions of the analyst and what they imply, and 2) whether the analyst was aware of the biases imposed by those assumptions and tempered his analysis accordingly. For this reason, following the example of J. David Singer, I am using this Introduction to articulate the assumptions that underlie the analyses in this paper.¹

In examining the potential for strategic arms control in the area of ASW, there are two fundamental questions which must be addressed. First, is there reason to believe that such an agreement is desirable, and second, is there reason to believe that such an agreement is feasible. In order to answer these questions it is first necessary to establish some criteria of acceptability against which the facts can be measured. In this paper these criteria derive from two models, one for assessing the stability of the strategic relationship between the superpowers, and the other describing

some fundamental historical characteristics of arms control agreements.

The first concern of this paper is to establish whether the control of the superpowers' ASW capabilities would reduce or increase the chances of nuclear war between them. The model used in this assessment, without great enthusiasm, is the model associated with the theory of deterrence and the American concept of mutually assured destruction (MAD). In its most basic form, the concept of deterrence entails nothing more than convincing an opponent that "the costs and/or risks of a given course of action he might take outweigh the benefits."² A deterrent is used to prevent something from happening. It is a threat to impose sanctions in the hope that they are never used. Because of this, the most critical aspect of a deterrent is the ability to create a perception in the eyes of an opponent that he had best not risk those sanctions.

This is an intuitively elegant concept, and one which undoubtedly does, and must, play a role in the formulation of foreign policy. However, there is a fundamental assumption of system-wide rationality underlying the theory of deterrence, an assumption that is very difficult to apply to the reality of international affairs. Ultimately, any assessment of rationality is based on the perceptions and biases of those acting in the system, and what appears as rational from one perspective can appear as lunacy from another.³ Starting from this point, the following discussion will explore why the use of deterrence as the foundation for a foreign policy can be seriously questioned.

Attempting to apply the concept of deterrence to policy analysis reveals a number of critical problems.⁴ First, it is nearly impossible

to determine whether a deterrent threat is working, or how much effect it is having. The application of a deterrent threat to restrain an opponent implies a belief that the opponent intends to take the action that is presumably being restrained. This assumption may not be justified. It thus becomes difficult to judge whether the inactivity of the opponent is due to the deterrent threat, or due to an lack of interest in engaging in the activity the deterrer wishes to restrain. A conclusion drawn in either direction can lead to a dangerous misperception of the opponent's motivations.⁵

Second, the logical structure of deterrence problems tend to be too simplistic to encompass the complex variety of factors that go into policy decisions. Nations never take, or decline to take, actions for singular reasons. There are two distinct sets of factors that apply to the policy decision process. The first set are the environmental factors. In foreign policy these include military capability, economic strength, public opinion, and other factors that define the limits of a nation's ability to act. Though some of these factors are more volatile than others (e.g. public opinion is more volatile than military capability), they are all, to some degree, measurable. It is from these factors that the spectrum of policy options on a given issue is derived.

However, the selection of a particular policy from the spectrum of options also relies on another set of factors, which I refer to as operational factors. These include a wide variety of variables whose effects cannot be "rationally" predicted. They include the misperception or missing of signals from the other side, miscalculation of the environmental factors due to faulty or inadequate information, the personalities

and biases of the actors involved in making the decisions, and the misinterpretation of the intentions or actions of the other nation. These factors are fundamentally incalculable. But, because they play such a large role in the decision-making process, they seriously undermine the applicability of analyses based on rational models of behavior, such as the theory of deterrence.⁶

While the attempt to apply deterrence to analysis is bothersome, the attempt to apply it as actual policy can be dangerous. The attempt to establish a military deterrent capability may actually create or intensify hostility between nations. This possibility derives from the fact that nations view events in the international system in terms of how those events benefit or threaten them. Reactions to changes in the international system are not judged on how they will affect the system as a whole, but rather how they will affect national interests and domestic stability. As Richard Neustadt so succinctly put it, "foreign policy begins at home."⁷

In 1964 Johan Galtung developed a matrix which describes the logical interplay of this attitude with regard to increases in military capability between two powers. It illustrates how "rational" parochial decisions by actors in the systems can lead to a clear double standard within the system as a whole. (See Figure 0-1).

Galtung states that there are two different types of reaction to technological advances which effect the strategic balance. The first, Theory I, assumes that changes unfavorable to an adversary will make him "feel restrained, admit his inferiority, and be more willing to negotiate" while changes favorable to the adversary will make him feel "tempted to attack, blackmail, or in other ways to use

Figure 0-1: Galtung Matrix on Theories Concerning Reactions to Changes in Balance.

	Changes Favourable to Adversary	Changes Unfavourable to Adversary
Theory I	Adversary will feel tempted to attack, blackmail, or in other ways to <u>use</u> his power.	Adversary will feel restrained, admit his inferiority, and be more willing to negotiate.
Theory II	Adversary will feel more at ease, relax, enjoy his superiority and be more willing to negotiate.	Adversary will feel frustrated, frightened and desperate, and will do his best to change the balance of power.

a) From Johan Galtung "Deterrence: A Logical Inquiry", Inquiry Vol. 7, 1964.

his power." The second, Theory II, assumes that changes favorable to a protagonist will make him feel "more at ease," relaxed and willing to negotiate while unfavorable changes will make him feel "frustrated, frightened, and desperate" and will do his best to change the balance of power back in his own favor. Galtung asserts that parties to balance of power situations tend to apply Theory I to their opponent and Theory II to themselves. Each side tries to increase its own advantages and decrease those of its opponents, both in the name of security.⁸

It is easy to see how an escalation of suspicions, threats, and hostility could occur in such an environment. If a nation "X" decides to upgrade its military capabilities to ensure that nation "Y" is deterred from engaging in military adventurism, X will see this as a purely defensive action. However, nation Y, observing this build-up, would realize that X is increasing its ability to attack. Furthermore, not thinking it had done anything to provoke such an arms build-up, Y would assume that X's actions signal an aggressive shift in attitude. Thus Y would undertake to match X's build-up, and perhaps go a bit farther to create a margin of safety. Nation X, observing Y's military build-up, would recreate Y's reasoning and continue to increase its military capabilities while probably congratulating itself for its foresight in predicting Y's newly aggressive posture.

The above example illustrates how each nation can react prudently and rationally from its own perspective, while the relationship between them continually deteriorates. In this sense deterrence can be seen as ultimately destructive to the peace it is intended to promote. This paradox has not escaped notice among strategic analysts. One Soviet commentator has observed, "(a)mong the prime factors hampering the

military detente is undoubtedly the tendency to regard armed strength as an absolute, a tendency which is inherent in the foreign policy of imperialism. Western political and military theorists believe that the relaxation of international tensions should naturally run against a background of a sustained build-up in strength."⁹

Ironically, the case for using deterrence as a foreign policy option grows progressively weaker as the international system moves towards crisis.

Patrick Morgan has observed that successful deterrence "presupposes a very ample capacity on the part of governments to do the necessary calculations, have the necessary information, and be so inclined, a capacity we have very good reason to doubt exists."¹⁰ The complex variety of factors involved in formulating a foreign policy position were discussed above. The presence of a crisis atmosphere further complicates matters because, even among allies, crisis behavior tends to be "woven from four strands: muddled perceptions, stifled communications, disappointed expectations, and paranoid reactions."¹¹ In other words, the less calculable operational factors in the decision-making process tend to take increasing precedence over the calculation of the environmental factors. This further erodes the already shaky foundation of rationality on which the concept of deterrence depends.

Despite the serious problems of applying deterrence as an element of foreign policy, the concept of deterrence does have a valid use in the analysis of foreign affairs. The concept of deterrence is very useful in the analysis of the environmental factors inherent in measuring military force capabilities and needs. Such analysis does not require consideration of subtle political motivations or of the uncertain nature of international signalling. Instead it is limited to analyzing

the status of one of the environmental factors in international relations, the military balance of power.

The analysis of military capabilities requires the adoption of a "worst case" mentality due to the rigid nature of weapon capabilities. A military analyst observing the growth of military capabilities in a foreign power must measure his country's position in relationship to the capabilities of the weapons being acquired by that foreign power. The analyst is forced to realize that the potential threat posed by weapons-in-being is constant, and that a change in the attitude of that power could make those weapons a threat for which he must be prepared. As the Chairman of the American Joint Chiefs of Staff observed when asked about Soviet intentions in their arms development program, "no matter why they are building the weapons, they've got them and they are a threat."¹²

The concept of deterrence provides a means of determining a point or condition where a nation can reasonably conclude that its military strength is sufficient. Although the determination of the level of military strength required as a credible deterrent against a given foe may be arbitrary, and will always be arguable, it is possible for a nation to conclude that its forces will threaten the necessary amount of damage and no increases in military capability are needed. Thus a parameter can be imposed on the analysis of this central environmental factor in international relations. It is for this limited purpose that the concept of deterrence is being applied in this paper.¹³

Even within this limited application there are some fundamental assumptions about deterrence relationships that must be more-or-less taken on faith. One critical assumption regards the stability of

systems where a situation of mutual deterrence exists. The assumption is that a situation where two powers each maintain a credible deterrent threat against the other is essentially stable. This assumption is particularly critical to this paper because the paper sees strategic arms control as a means of promoting peace and international stability by ensuring the continuation of mutual deterrence between the superpowers. The desirability of pursuing an arms control agreement will depend on its ability to promote mutual deterrence.

Like the broader concept of deterrence itself, the stability of a situation of mutual deterrence is an intuitively elegant concept. If each superpower can retain a credibly destructive retaliatory force in the face of any attack the other might initiate, neither should see any advantage in launching an attack. In strategic nuclear parlance, this relationship is known as "mutually assured destruction," or MAD. The actual mechanics of maintaining a MAD relationship, and the current status of that relationship between the superpowers, will be discussed in the next chapter.

However, there is a flaw in the assumption of the stability of MAD relationships which must be mentioned. In a crisis confrontation between the two MAD partners, the lack of a clearly inferior party doesn't provide any clue as to which party should back down to avoid a war. In the Cuban missile crisis, the considerable strategic superiority of the United States in that confrontation forced the Soviets to back down.¹⁴ Should such a confrontation occur again, the inability of either power to demonstrate clear strategic superiority, or the attempt by one to demonstrate a local military advantage, could allow a demonstration of national will to get out of hand. The crisis could escalate to the

point where one side perceives that war was inevitable and decides to gain a marginal advantage by launching a preemptive or damage limiting strike.¹⁵

Nonetheless, this analysis will assume that the preservation of MAD is the best way to assure strategic stability between the superpowers. There are two types of development that can undermine the stability of a MAD relationship. The first means of destabilization occurs when technological innovations in weapons technology threaten the ability of one or both of the superpowers' ability to maintain a credible deterrent in the face of the first strike capabilities of the other. Any weapons innovation that threatens an increased counterforce potential is assumed to be destabilizing, and, conversely, any innovation that decreases the vulnerability of strategic strike systems is assumed to be stabilizing. The capabilities of current strategic forces in this regard are discussed in the following chapter.

The second means of destabilizing a peace founded on MAD is through the escalation of a minor conflict into a major nuclear war.¹⁶ This is a difficult factor to account for in a deterrence-based analysis because the escalation of a conflict is so reliant on operational, as opposed to environmental, factors. It is difficult to accommodate these factors in the calculus of a deterrence scenario.

This analysis recognizes two major factors which can serve to control the danger of escalation to the stability of the current strategic balance. The first, again, relies on the maintenance of MAD. The assumption is that the threat of a minor conflict escalating into a major nuclear war serves as a powerful deterrent against taking actions which might result in such minor conflicts. Of course, to maintain

this threat in the minds of both opponents it is necessary for each of them to believe that they could not escape unacceptably severe damage if escalation occurred. This, in turn, requires that both sides retain secure retaliatory strategic forces.

The second means of controlling the danger of escalation is to create a means of stopping the climb up the "escalation ladder" after it has already begun. Theoretically, this is done through the mechanism of "thresholds" (also known as "firebreaks"). A threshold is a point on the escalation ladder, the crossing of which clearly indicates, to both sides, that a significant act of escalation has occurred. Conversely, the decision not to cross a threshold indicates a desire to keep the conflict limited. The most commonly discussed threshold is the first use of nuclear weapons in a conventional conflict, but there are a wide variety of other possible thresholds as well (e.g., invasion of a neutral country, first strike against a homeland, etc.). However, in order to be effective, both sides to a conflict must have a common perception of what constitutes a threshold in that particular conflict.¹⁷

This paper also assumes that the best way to establish recognizable thresholds is to promote as much parity as possible in conventional and theatre nuclear military capabilities. The reason involves the ability of a nation to meet an attack from an opponent with an appropriate and comparable response. For example, if a nation can successfully contain an attack with conventional forces using a conventional military response, there would be less of a temptation for it to resort to escalatory options to protect itself. However, if that nation is without a conventional capability then they would be faced with a

choice between escalation to the nuclear level and defeat. Wargame simulations have shown a strong tendency for decision-makers to choose escalation when given this option.¹⁸

Finally, a roughly parallel force structure between two powers makes it easier to utilize thresholds to control escalation. If both sides have similar force structures, then the steps they take towards escalation are more likely to be similar. This should promote an ability of one power to recognize that the other is remaining below a threshold. However, if the sides have dissimilar structures it increases the possibility that one side will incorrectly interpret the action of the other as being intentionally escalatory. Thus, any actions taken to bolster MAD and control the threat of escalation are assumed to promote international stability and peace.

In this paper, arms control is seen as a method of maintaining MAD. Thus, in order to assess the desirability of an arms control agreement regarding ASW, it is necessary to determine whether protecting submarines from ASW forces will bolster or erode the MAD relationship between the superpowers. If the presence of submarines is beneficial to strategic stability then arms control limiting ASW forces is appropriate. If not, then no restrictions should be put on ASW forces.

In making this assessment, this paper will first determine the importance of submarines in the current strategic balance. The analysis will first discuss the broader mechanics of the current MAD relationship between the superpowers, and will discuss the current trends in military technology trends affecting strategic stability. This discussion will focus particularly on the increasing vulnerability of land-based strategic nuclear deterrent forces.

The next step is a closer examination of the effects of submarines on the stability of MAD. This analysis will differentiate between the missions and tactics of fleet ballistic missile submarines (SSBNs) and attack submarines. It will explain why the survivability of SSBNs is increasingly important to the stability of MAD. It will also point out the severely destabilizing threat posed by the attack submarine forces of both sides.

At this point the first major question in this analysis will have been answered. The functioning of some submarines is beneficial to the maintenance of MAD, while the functioning of other submarines erodes the stability of MAD. This evident paradox makes it clear that ASW forces can neither be banned entirely or allowed to operate with complete freedom. It remains to be seen whether it is possible to differentiate between the effectiveness of specific types of ASW forces against SSBNs and attack submarines. Chapter III demonstrates that this can be done by closely examining the strengths and weaknesses of the four primary types of ASW against the current capabilities of the superpowers' submarine forces.

Having determined that discriminations between types of ASW forces and their capabilities against different types submarines are possible, this paper proceeds to determine whether there is a method of matching these capabilities in such a way that an ASW arms control agreement is feasible. The methodology used in this assessment is somewhat crude. The arms control literature provides extensive discussions on the need for arms control, dire warnings on the consequences of the failure of arms control, and ideas for structuring arms control agreements, but

little work has been done on a model which would predict the likely success of a given proposal.¹⁹ Thus I have developed my own model for this paper.

The model used herein was derived on a purely empirical basis by examining the terms of a number of modern arms control accords. Chapter IV lists these agreements and examines their characteristics, defining a typology and deriving principles common both within and between these types. These principles are held to have predictive value on the assumption that the motivations behind, and the concerns about, arms control are relatively constant across time and between nations. Any arms control proposal whose terms meet these principles is thus held to be feasible. Conversely, any arms control agreement that fails to meet one or more of these principles would be of questionable feasibility.

Next, these principles will be applied to the data available about ASW and to proposals made by others about arms control in this area. It will clearly define those areas of ASW where an agreement is unlikely, and explain why those proposals made to date are critically flawed. Finally, a proposal will be presented that meets the fundamental principles derived above and provides a means of stabilizing MAD against the effects of ASW technologies and escalation.

There are two other points that must be made about the assumptions which underlie this paper. First, the structure and missions of the superpowers' navies are distinctly different. This creates some difficulty in predicting the sort of conflict they might fight, or the outcome. The parochial paranoia of strategic analysts on both sides tends to lead them towards the "zero-sum" analytic trap, in which the analyst

is forced to assume that the primary mission of the enemy is to prevent what his forces are trying to achieve.²⁰ I have tried to avoid this trap by assuming that the navies of both the superpowers will do what they have demonstrated their intention to do by either word or deed.

The final point that must be made about the analysis that follows is that this paper is based primarily on information found in the open literature on ASW and strategic nuclear weaponry. There is no way of knowing for certain the accuracy of this information because it is among the most closely guarded information in the world. I have been fortunate in having had access to people who have seen some of this classified material. My interviews with them provided the basis on which I resolved conflicts between various sources in the literature when such conflicts appeared. Every effort has been made to present a realistic appraisal of the situation surrounding ASW and arms control. However, there remains a very distinct possibility that some of the information crucial to the conclusions drawn in this paper is wrong, and that the analysis presented in this paper is not a realistic appraisal, but is merely an academic fantasy.

NOTES: INTRODUCTION

1. J. David Singer, Deterrence, Arms Control, and Disarmament, pp. 3-17
2. Thomas Schelling, The Strategy of Conflict, p. 35.
3. For a related discussion, see C. Wolf, Jr. "Perceptions of the Military Balance: Models and Anecdotes," RAND Paper No. 5402, which presents four different "logical" models of the balance, which differ primarily in the assumptions on which they are based.
4. The following critique of deterrence theory and its application to foreign policy is based primarily on discussions in: Thomas Schelling, The Strategy of Conflict; Alexander George and Richard Smoke, Deterrence in American Foreign Policy; Andre Beaufre, Deterrence and Strategy; Patrick Morgan, Deterrence: A Conceptual Analysis; Philip Green, Deadly Logic; and S.H. Hoffmann, "International Relations: the Long Road to Theory" in Arend Lipjhart, World Politics.
5. This point is raised by Dimitry Proektor in "Military Detente: A Soviet View" Survival, Vol. 18, (1976): p. 265 and John C. Harsanyi "A Simple Probabilistic Model of Nuclear Multipolarity" in Richard Rosecrance (ed.) The Future of the International Strategic System, pp. 100-102.
6. This breakdown of the factors involved in foreign policy making is loosely derived from the structure of the discussion in Quincy Wright, A Study of War. Additional discussion of the role of what I term "operational factors" can be found in Alexander George and Richard Smoke, Deterrence in American Foreign Policy, pp. 522-580; John G. Stoessinger, Why Nations Go to War; Kenneth Waltz, Man, the State, and War; and Graham T. Allison, The Essence of Decision.
7. Richard Neustadt, Alliance Politics, p. 61.
8. Johan Galtung, "Deterrence: A Logical Inquiry" Inquiry, Vol. 7, 1964, pp. 280-281. Examples of this tendency are easy to find. For example, see Soviet Chief of Staff Sokolovsky's interpretation of American military doctrine in Sokolovsky, Soviet Military Strategy, pp. 52-117. On the American side, see articles on Soviet doctrine in W.F. Hahn and J.C. Neff (eds.), American Strategy for the Nuclear Age, especially articles by Anne M. Jonas, "Changes in Soviet Conflict Doctrine," and Thomas W. Wolfe, "Soviet Strategies of Disarmament."
9. Proektor, "Military Detente" p. 264.
10. Morgan, Deterrence, p. 58. See also Philip Green, Deadly Logic, pp. 157-213.

11. See Lt. Cmdr. J.T. Westwood, "Soviet Naval Strategy 1967-78: A Reassessment" US Naval Institute Proceedings, May, 1978, p. 116. See also Matthew P. Gallagher "The Military Role in Soviet Decision-Making" in M. McCWire; K. Booth, J. McDonnell, Soviet Naval Policy: Objectives and Constraints p. 46-48; and Beaufre, Deterrence and Strategy, p. 53.
12. Neustadt, Alliance Politics, p. 56.
13. General David C. Jones in testimony before the U.S. Senate Armed Services Committee, February 1, 1977. See also Arnold Wolfers "Peace Strategies of Deterrence and Accommodation" in Linda Miller (ed.), Dynamics of World Politics, p. 15.
14. See G.H. Snyder in Lipjhart, World Politics, pp.271-72. The United States currently feels that the ability to destroy one-half to three-fourths of essential Soviet industry (with between 50 and 100 million in collateral civilian casualties) serves as a credible deterrent (Senate Armed Services Committee, Hearings on FY 78 Authorizations for Military Procurement, and Active Duty, Selected Reserve, and Civilian Personnel Strength, p. 801). Some interesting discussions of what level of strategic force would serve as a viable deterrent in different international environments can be found in Rosecrance (ed.), The Future of the International Strategic System.
15. See Morgan, Deterrence, p. 17; and Allison, Essence of Decision.
16. It is also sobering to recognize that Narroli, Bullogh, and Narroli (Military Deterrence in History, pp. 328-343) found no evidence that defensively oriented military strength tends to reduce the chances of war in the "conspicuous states" they studied. Afheldt and Sontag, ("Stability and Strategic Nuclear Arms" p. 6), point out that deterrence was only intended as a stopgap measure until international peace-keeping structures could be put in place. This point has been carried further in George and Smoke, (Deterrence, p. 606), where they suggest a "theory of inducements" is needed to supplement the theory of deterrence.
17. This discussion of escalation is based primarily on discussions in Herman Kahn, On Escalation: Metaphors and Scenarios.
18. The Soviets profess to believe that the escalation of a minor tactical nuclear exchange into a full scale nuclear war is logically inevitable (Gennadi Gerasimov, "A Soviet View of the Nuclear Directive, Washington Star August 27, 1980, p. A19). This view is also held by some American strategists (e.g. Leslie Gelb, interviewed on ABC News Close-up "The Armageddon Game," April 28, 1981).
19. This observation is based on confidential interviews with strategic analysts who have either conducted or participated in such wargames. These results tend to support Soviet expectations (see note 18, above). However, a more optimistic view of a controlled escalation

scenario can be found in General Sir John Hackett et al., The Third World War: August 1985. The Soviets have also admitted that their strategic planners have worked with the idea of limited nuclear exchanges, but emphasize that this is not Soviet doctrine. (Dusko Doder, "Heated Defense Debate of U.S. Campaign Worries Soviets" Washington Post, August 24, 1980, p. A22).

20. Examples of arms control models include Thomas Schelling, "A Framework for Evaluating Arms Control Proposals" in Franklin Long and George Rathgens, Arms, Defence Policy, and Arms Control which discussed bargaining scenarios relating to weapons systems of various to the parties; W.F. Biddle, Weapons Technology and Arms Control which discusses the necessary scope of an arms control treaty; and David W. Wainhouse, et al. Arms Control Agreements: Designs for Verification and Organization which deals with practical problems of verification. None of these treatments can be considered comprehensive or predictive regarding the feasibility of arms control for specific strategic systems.
21. For a discussion of the zero-sum trap, see Westwood, "Soviet Naval Strategy," p. 117.

CHAPTER I

THE EFFECT OF CHANGES IN WEAPON TECHNOLOGY ON THE STRATEGIC BALANCE

This chapter is designed to provide a brief overview of the status of the current strategic balance between the United States and the Soviet Union. It will begin with a brief discussion of the revolution in weapons technology which led to the current reliance on MAD to achieve strategic stability. Included in this discussion will be a simple mathematical model of a MAD situation designed to illustrate the factors that threaten the stability of a MAD environment. Finally, the strategic nuclear forces of the two superpowers will be discussed with particular emphasis on those current and emerging technologies which either enhance or erode the strategic balance.

Lenin once observed that "(m)ilitary tactics depend on the development of military equipment."¹ Events of the twentieth century have conclusively proven that innovations in military hardware have profound effects on the development of military strategy. The most profound change that has taken place is the adoption of the theory of deterrence to replace the traditional reliance on armies to provide national security.

Prior to the First World War, nations relied on armies to shield them from the aggressive behavior of the neighbors. Wars consisted of one body of men attempting to reach a territorial objective and another body of men forcibly blocking their way. Battles would take place before the attacking army achieved its objective to determine whether or not that army would be able to achieve that objective. If the defenders won the territory they were protecting were safe because

there was no way for the attacker to project a threat beyond the range of his guns. If the defenders lost, they had an opportunity to come to terms with the attacker before actual physical damage was done to the defending nation. Though wars between the French Revolution and World War One tended to increase in the size and scope of their destructiveness, it remained a fact that an army had to be defeated before a threat of sanctions could be applied against its homeland.²

The application of the airplane to military affairs during World War I began to change this situation. The principle advantage of the airplane was its ability to bypass armies on the ground and bomb areas in the rear. Armies need no longer be defeated, or even engaged, in order to threaten or deliver sanctions against an enemy's homeland.

The aircraft of World War I were not effective strategic weapons. But the potential they demonstrated was enough to inspire a new school of air power theorists, including men like Billy Mitchell of the United States, Jonathan Griffin of England and Guilio Douhet of Italy. Their arguments centered around the thesis that the traditional concept of the balance of power between nations would be replaced by new "balance of terror." Their position was based on twin premises. The first was that, because of their high mobility and ability to make full use of the three-dimensional airspace, airplanes would be unstoppable weapons. The second was that the destructive payload each plane would be able to carry would be enormous. They concluded that air attacks would pose a mortal threat to any target at which they were aimed. The logical conclusion was that the only way to discourage such an attack would be the threat to launch similarly destructive counterattacks by air (deterrence) or to preemptively attack air bases before attacks

could be launched from them.³

The experience of World War II indicated that the assumptions made about the relative impotence of antiaircraft defenses were largely correct, even in the face of technologies (e.g. radar) which dramatically increased anti-aircraft capabilities. However, the destructive effects of the bombloads carried by the strategic bombers was grossly overestimated by these air power theorists.⁴ But World War II also spawned new weapons technologies which gave discussions of a balance of terror new meaning. The first was the development of ballistic rocketry, which provided a delivery vehicle of practically unlimited range. The second was the introduction of atomic, and later hydrogen bombs which provided exponentially higher destructive capabilities.

The post-World War II world began with the United States in sole possession of atomic weaponry. This superiority allowed them to adopt a position of massive nuclear retaliation as a deterrent against the presumed expansionism of the Soviet Union. However, as one Soviet strategic analyst pointed out, "In our day and age it is impossible to maintain a monopoly on one or another type of armament."⁴ By the early 1960s both the United States and the Soviet Union had demonstrated their ability to develop and deploy intercontinental ballistic missiles (ICBMs) tipped with nuclear warheads. This led one American analyst to observe that, "in such a situation of nuclear parity where both sides had the capability of destroying one another, there was no place for a policy of massive nuclear retaliation except as a deterrent to total nuclear war or as a reprisal if one began."⁵ The situation had shifted from American deterrence of Soviet expansionism to mutual deterrence against nuclear attack:

The fundamentals of maintaining a stable strategic balance can be illustrated in a simple example.⁶ The key element in maintaining stable mutual deterrence is the preservation of the capability for mutual assured destruction (MAD). Each side must be able to maintain sufficient retaliatory forces to survive a first strike by the other (a counterforce strike) and deliver a debilitating counterstrike against targets of high social value (a countervalue strike).⁷ At a basic level of technology MAD is relatively easy to maintain. For example, imagine a situation where two powers, Nation X and Nation Y, each have 1000 missiles equipped with one nuclear warhead. If all of the missiles in both forces operated perfectly, the balance would also be perfect. If X decided to preemptively attack Y's missile force with 500 missiles, both X and Y would have 500 missiles left. Neither side would gain an advantage and the balance would be unaffected.

Because missiles are not perfect, deterrence under these conditions is actually easier to maintain. Realistically, if X launched half of its force against Y, all of these missiles would not arrive on target. Some would malfunction in flight and some would simply miss their target. If X lost one-fifth of its force to this sort of attrition, it would actually shift the strategic balance against itself. Nation X would only have 500 missiles left, but because only 400 of its missiles got through to their target, Nation Y would have 600 missiles left. Nation Y could also add to the number of missiles saved by introducing passive defenses for its missile force, such as putting its missiles in blast-resistant underground silos, making them harder to destroy. Because of this operational degradation of first strike capabilities, a viable nuclear balance could be maintained even if one of the parties

to the balance was numerically inferior in weapons. (See Figure I.1).

-This simple model of the strategic balance applied reasonably well to the superpower balance until the introduction of multiple, independently targeted reentry vehicles (MIRVs) in the late 1960s. This technology allowed each missile to carry a number of warheads, all aimed at separate targets. Thus if Nation X MIRVed each of its 1000 missiles with four warheads, his situation in relationship to Nation Y changes dramatically. If X chose to launch half its force at Y's 1000 missiles, and suffered a thirty percent operational attrition in its force (rather than the twenty percent mentioned in the previous example), it would still have 1400 warheads delivered on target. This would be enough to wipe out Y's entire missile force. Meanwhile, Y would retain a reserve force of 500 missiles and 2000 independently targetable warheads. This gives X absolute strategic superiority and makes launching a first strike against Y a viable military option.

There is no way to achieve a balance in this situation if the warheads of both parties have accuracies and explosive power sufficient to insure the destruction of a target if hit. In order to provide itself with a survivable deterrent in the face of the force described for X above, Y would have to build on the order of four times the number of missiles possessed by A. This is an incredibly expensive option, especially considering that four is by no means the upper limit on the number of MIRVed warheads per missile. In so protecting itself, Y would also be providing itself a first strike threat against X because it would then have on the order of 4000 warheads to throw at A's 1000 missiles.

If Y simply decides to MIRV its own missiles, the system again reaches

absolute instability. Nation Y has not increased the survivability of its own forces at all. It simply made X's force vulnerable to a preemptive strike as well.

The difference between deterrence without MIRVs and with them is clear. In situations without MIRVs, a reasonably balanced increase in the numbers of missiles in the system tends to enhance system stability. When MIRVs are present, the opposite is the case.

In situations where MIRVs are present, strategic stability can be maintained only where the explosive power and the accuracy of MIRVed warheads is too poor to provide a reasonable chance of destroying significant numbers of the enemy's retaliatory missiles during a preemptive strike. Technological improvements in both the explosive yield of warheads and in their accuracy serve to increase the threat to opposing forces and hence decreases stability. Of the two, increasing a warhead's accuracy is a much more effective way of increasing warhead efficiency than increasing explosive yield. Doubling the accuracy of a warhead produces nearly ten times the amount of destructive effect on a target as would doubling that warhead's yield without improving its accuracy. (See Figure I.1). The recent trend in strategic nuclear weaponry has been to keep warhead explosive yield about constant (or even to decrease it), while dramatically increasing warhead accuracy. (See Figure I.2).

The Current Strategic Situation

What is the current status of the strategic balance between the superpowers, and how stable does this balance seem to be for the near future?

This is a fundamental question that must be answered before the need

FIGURE I-1: Comparative effects of improvements in blast yield and warhead accuracy on the lethality of nuclear warheads^a

The figure above represents an illustration of the comparative effects of improvements in blast yield and warhead accuracy on the destructiveness of a missile warhead against a discrete target such as a missile silo. The lethality of a warhead against a silo rises much more rapidly with improvements in accuracy than with improvements in yield (note logarithmic scaling). A weapon with a yield ten times greater than that of a Minuteman III warhead, given the same accuracy, is five times more effective in destroying a silo, but a warhead with the same yield as a Minuteman III warhead, but which is ten times more accurate, is one hundred times more lethal to a silo.

a) From SIPRI Yearbook: 1975, p.5

FIGURE I-2: Trends in ballistic missile warhead accuracy^a

This figure represents a graphic illustration of the trend towards higher accuracies for the ICBMs of both of the superpowers. The figure above represents the judgment of Colin S. Gray, a strategic analyst. The values correspond with those from other official, semi-official, and unofficial sources.

a) From Colin S. Gray "The Future of Land-Based Missile Forces" Adelphi Paper No. 140 Winter, 1977, p.5.

for strategic arms control can be properly discussed. The following is a brief overview of the capabilities and vulnerabilities of the superpowers' strategic nuclear forces at present and in the immediate future.

Each of the superpowers has mounted its strategic nuclear force in one of three delivery modes; strategic bombers, intercontinental ballistic missiles (ICBMs), or ballistic missile submarines (SSBNs). The United States has balanced its deployment of nuclear weapons across the three modes in what it calls its "strategic triad." The Soviets have placed the primary emphasis of their nuclear force on ICBMs, with an increasing commitment to SSBNs and minimal attention to strategic bombers.

However, it is necessary to emphasize that the apparent similarities in the superpowers' strategic nuclear forces does not imply that their political or military doctrines are similar. On the contrary, though influenced by similar considerations relating to their dyadic relationship, the doctrines of the United States and Soviet Union differ considerably in philosophy and orientation. The American approach to maintaining peace has historically been status quo in orientation. The Americans tend to "draw a line, and then threaten to go to war if that line is crossed by an opponent."⁸ They declare a sphere of influence and then insist on the right to defend the prerogatives they have assumed. This tendency has appeared in the Monroe Doctrine, the Open Door policy in China, and the policy of "containment" against the Soviet Union, which has had its most recent affirmation in the declaration of the Carter Doctrine towards the Persian Gulf region.

American strategic military doctrine has, necessarily, attempted to

keep in step with this diplomatic strategy. Thus American strategic nuclear doctrine has also attempted to keep pace with this policy orientation. American strategic nuclear policy utilized the strategy of massive retaliation as a means of supporting the containment policy while getting "more bang for the buck" in the 1950s.⁹ In the 1960s, as Soviet strategic nuclear capabilities grew, the credibility of the massive retaliation posture began to erode. American strategists began talking about limited wars and a strategic doctrine known as "flexible response." Under this doctrine, the strategic nuclear arsenals of the two superpowers would serve to deter a global nuclear war, while local wars were to be fought with conventional forces (possibly supplemented by tactical nuclear weapons). The Americans have always drawn clear distinctions between conventional and nuclear warfare, and have tried to establish escalation thresholds that would serve as points where a conflict could be contained before it reached the level of a general cataclysm. Throughout, the American attitude towards strategic nuclear weapons has been that they are for deterrence, and if the need to use them ever arises, then they have failed.

Soviet strategic nuclear doctrine is somewhat more difficult to identify. Soviet doctrine "tends to say contradictory things ambiguously."¹⁰ However, there seem to be two primary factors that drive Soviet perceptions of strategic doctrine. The first has to do with the history of the Soviet state, and its wars and purges. The Bolsheviks seized power in Russia after the collapse of the czarist government and a disastrous experience in World War I. Immediately thereafter came a brutal civil war (supplemented by an invasion of the Kola Peninsula by British, French, and American forces), Stalin's massive and bloody purges, and

the World War II, which cost the Russians over twenty million casualties. As a result, the Soviet conceptualization of war tends to be as a total, and brutal, fight for survival. In 1963, Soviet Minister of Defense Malinkovsky went so far as to call the concept of limited war "twaddle,"¹¹ and though the Soviets show no doctrinal inclination to start a war, they seem fully committed to winning any war they find themselves in at whatever cost.

Second, the Soviets display an ingrained distrust of the West that approaches paranoia. The invasion of Murmansk during the Russian civil war did little to win Soviet trust, and neither did extensive delays by Western nations in recognizing the legitimacy of the Soviet regime. The Soviet distrust of the West is reflected in their interpretation of the diplomatic maneuvering that preceded World War II. They feel the Western powers maneuvered Hitler into attacking the Soviets.¹² Recent Soviet interpretations of NATO and American activities continue to reflect this attitude. They apparently expect NATO to seize the first opportunity to launch a surprise attack, an attitude that has been dubbed the "June 22nd syndrome."¹³

Soviet nuclear weapons doctrine has always been fully integrated with their overall military war-fighting doctrine at both the tactical and strategic levels. Between the mid-1950s and the early 1960s the Soviets blustered publically about their ability to destroy the United States with strategic weapons. But they were acutely aware of their inferior position relative to the Americans, and were actively considering the use of preemptive, damage-limiting strategic strikes if the diplomatic situation seemed headed towards war. They also spurred the integration of nuclear weapons at the theatre level in response to the American

doctrine of flexible response. By the late 1960s the Soviets had a survivable second strike capability against American cities, and political pressure began to build from some quarters to move towards strategic superiority as a part of a war-winning strategic posture.¹⁴

Since the late 1960s the strategic doctrines of both superpowers have continued to evolve. Under Presidential Directive 59, the Americans have announced their intention to develop selective counter-force military options which would allow for the conduct of a limited strategic nuclear war. This doctrine is designed to increase the deterrent threat of nuclear weapons by making their use more credible in a wider variety of circumstances, and to convince the Soviets that they could not win a war with the United States or NATO.¹⁵ The Soviets continue to develop military capabilities that would enhance their war-winning capabilities, but they have also seemed to acknowledge the stabilizing effects of mutual deterrence.¹⁶

For the purposes of this analysis, the more subtle implications of the comparative strategic doctrines are irrelevant. The important point to recognize is that the strategic doctrine of each superpower is based on its ability to carry out its mission after surviving a massive first strike by the other. Each must have a secure second strike capability in order to feel safe. Thus, for the system to remain stable, MAD must be in place. The following discussion details the increasing vulnerability of strategic nuclear forces to preemptive attack which is resulting from dramatic advances in military technological capabilities.

Strategic Bombers

The first type of strategic nuclear delivery vehicle developed was

the manned strategic bomber. These are aircraft of intercontinental range that are equipped with gravity bombs and/or short-range attack missiles (SRAMs). The chief operational advantage of manned bombers is their high degree of flexibility. They can "strike at targets of opportunity, conduct strike/reconnaissance missions, and complete the hard-target counterforce task against weapons either pinned down in their silos by the effects of preceding missile strikes or being held in reserve."¹⁷ They may also be launched and recalled as part of a political signalling effort. However, bombers are a poor first strike force because they are too slow to preemptively strike "time urgent" targets such as missile silos before those missiles could be launched in retaliation. Because of this, large bomber forces would not pose a great threat to the strategic balance.

The deterrent provided by strategic bomber forces is subject to degradation from two sources. First, bombers on the ground can be destroyed by preemptive attacks from land- or submarine-based missiles. Second, they can be shot down by air defenses designed specifically to intercept them before they reach their targets.

The United States manned bomber force consists of approximately 365 B-52s. This force carries about 20% of the total number of nuclear weapons in the American arsenal and accounts for approximately 50% of the deliverable megatonnage.¹⁸ These bombers are most vulnerable when sitting on the ground. The United States expects that the basing posture of its bombers would radically effect the number of airplanes surviving an initial strike. For example, a surprise attack made by Soviet intercontinental ballistic missiles (ICBMs) on the U.S. B-52 force in its normal day-to-day alert status would be expected to

destroy over two-thirds of that force on the ground. However, if the force is in a "generated alert" status then about three-fourths of these planes would be expected to survive.¹⁹

Theoretically there is another threat to manned bombers on the ground that could be developed by either side, and that would reduce the number of surviving bombers considerably. The number of bombers that get safely off the ground in an attack is largely a function of the amount of warning they receive. This warning time now ranges between 15 and 30 minutes for ICBM attacks, which is enough time to save the large percentage of forces on generated alert. However, it is possible to develop submarine launched ballistic missiles that operate on high thrust, low trajectory flight paths. If these were launched from positions off the coast of either country, warning times for the airbases would go down below seven minutes. In the American Strategic Air Command, B-52s are expected to get off the ground in six to seven minutes when on generated alert. This obviously would cut the margin of safety for these aircraft to virtually nothing. Neither side is reported to be testing missiles in this mode, but it remains well within the capability of both superpowers to develop such a system.²⁰

After getting into the air, strategic bombers must penetrate active air defenses before getting to their target. The Soviet Union has invested over \$100 billion in an air defense system consisting of between 6500 and 7000 early warning and surveillance radars, over 2500 interceptors, and between ten and twelve thousand surface-to-air missile launchers located at over 1000 sites in the Soviet Union. These forces are designed to layer the airspace over the Soviet Union, each type of

system designed to operate in a specific range of the middle and upper altitudes.

They are currently upgrading this system with a new "look down" radar system capable of detecting low-flying aircraft from above. This system is currently mounted on ten Tu-126 Moss and eight Il-76 Candid airplanes. This system is being supplemented by the development of an analogous air-to-air missile capable of a "snap down" attack on low-flying bombers from interceptors above. There are also recent reports of a new Soviet surface-to-air missile (SAM) with an increased capability against low-flying aircraft.²¹ These developments have led one knowledgeable analyst to comment that "SAC (B-52) bombers fighting their way through Soviet defenses-in-depth face increasing competition that reduces penetration capabilities considerably."²² In fact, the American Strategic Air Command has grave doubts that even a new generation of manned bomber could penetrate Soviet airspace in the early 1990s.²³

The Soviet manned bomber force currently consists of 140 obsolete airplanes which may soon be phased out of service.²⁴ However, there are also reports that the Soviets are developing a new generation of manned strategic bomber.²⁵ These bombers would be prone to the same threat of preemption by ICBMs and SLBMs as the American strategic bomber force. They would also be forced to penetrate past the Pine Tree Line of early warning radar stations stretched across central Canada and American and Canadian interceptor aircraft.

Recently, American dedication to air defense has waned. Between 1970 and 1977 the United States deactivated 351 of its 621 active and reserve interceptor aircraft. It also reduced by nearly half its force of SAM launchers, from 1852 to 990. However the Americans are

taking steps to upgrade their antiaircraft defenses. The United States is currently considering the deployment of an air defense radar system employing a new over-the-horizon radar system (OTH-B) on its east and west coasts. It has also assigned eight of the new Airborne Warning and Control (AWACS) aircraft, which have a "look down" radar system superior to the Soviet system, to the defense of American airspace. AWACS can locate low-flying aircraft at a range of 250 miles over land or sea, and can direct fighter interception operations against those aircraft.²⁶

The development of these new technologies in air defense is eroding the credibility of the deterrent threat posed by manned strategic bombers. The current generation of strategic bombers possessed by both superpowers is getting old, and they are less and less likely to be able to penetrate to target as time goes on. Both superpowers are engaged in research to develop new generations of bombers that are masked from radar defenses, with some success claimed for the American "Stealth" program. The deployment of bombers invisible to anti-aircraft radar would put increasing pressure on the superpowers to engage in a preemptive first strike in a situation where war at any level seemed inevitable so these aircraft could be destroyed on the ground where they could be seen. This would be particularly true of a country adopting a damage limiting strategy.²⁷

Because of the erosion of the credibility of the deterrent threat posed by the manned strategic bomber, and because the new technologies under study to counter this erosion are likely to make a damaging limiting first strike a more credible military option, the strategic bomber's usefulness in maintaining a stable strategic balance is declining. (Figures I-3 and I-4 summarize the superpowers' current bomber forces).

Figure 1-3 American Strategic Bombers

Weapons Payload

Type	IOC ^a	Number	Weapon	Load	Range	Yield	Notes
B-52 D	1956	365	Bomb	4	Gravity	1	
G/H	1959		Bomb or SRAM	4 6	Gravity 100	1 .17-.2	Typical load is a mix of four weapons
FB-111	1969	60	Bomb or SRAM	4 4	Gravity 100	1 .17-.2	A modified FB-111 is being considered as an interim strategic bomber between the B-52 and its successor. The US does not currently consider the FB-111 a strategic bomber.
(B-52 CM)	?	(165 max.)	ALCM	20	2600	.2	The air launched cruise missile (ALCM) would have a single shot kill probability of .99+ against targets hardened to resist 2000 psi blast overpressure

a) IOC means "initial operational capability." This is the year the first of these aircraft became operational.

Figure I-4: Soviet Strategic Bombers

Type	IOC	Number	Weapon	Weapons Payload		Yield	Notes
				Load	Range		
Tu-95 Bear	1956	113	Bomb or AS-3	1 1	gravity 400 mi.	20	Turboprop engines
Mya-4 Bison	1956	43	Bomb	1	gravity	5	Jet engines
Tu-22M Backfire	1974	80	Bomb or AS-4	2 2	gravity 300 mi.	.2	

The Soviets do not consider Backfire a strategic bomber. The building rate does not exceed 30 per year.

Intercontinental Ballistic Missiles

The second delivery mode for strategic nuclear weapons is the intercontinental ballistic missile (ICBM). These are land-based missiles designed to hit targets in the Soviet Union from the Contiguous United States, or vice versa. There are 1059 ICBMs currently in the American inventory, over half of which are MIRVed. The Soviets maintain an ICBM force of about 1398 ICBMs in silos throughout the USSR, many of which are also MIRVed.²⁸ (See Figures I-5 and I-6 for details on ICBM capabilities).

ICBMs have four chief strengths. The first is their extreme accuracy. The ICBM is the most accurate first-strike counter-force weapon in both superpowers' nuclear arsenals. Second, because the ICBM takes less than thirty minutes to reach its target, it is a significant threat to time urgent targets. Third, the ICBM is virtually immune to interception after it has been launched. Finally, the ICBM has the most reliable communications, command, and control (C³) system of any of the strategic weapons systems.²⁹

However, there are also significant disadvantages to ICBM weapons systems. First, once an ICBM has been launched the "bullet is out of the gun." There is no way to recall or destroy the missile in flight if the launching is a mistake.

Second, ICBMs on the ground present stationary targets to an attacker. Once they have been located they can be targetted well in advance for a preemptive attack with absolute confidence they will still be where they were. For this reason both the United States, and the Soviet Union protect their ICBMs in silos hardened against the blast effects of nuclear explosions. The silos for the American Titan

Figure I-5: American ICBMs

Type	IOC	Number	Warheads	Yield ^a	CEP ^b	SSK ^c	Rel. ^d	Notes
Titan II	1963	53	1	5-10	.5	.28	.75	Most authors assume 9 Mt yield
Minuteman II	1965	450	1	1	.3	.27	.8	Radiation hardened. Equipped with penetration aids.
Minuteman III	1970	550	3 MIRV	.17	.2	.19	.8	Radiation hardened. Penetration aids. Being converted to Mk-12A warhead (possibly completed).
(Mk-12A)			3 MIRV	.34	.1	.74	.8	
(MX)		200	10 MIRV	.34	.05(?)	.99+	.8	Basing mode not decided. With AIRS and NAVSTAR, CEP could drop to 30-100 feet.

a) Yield measured in megatons.

b) GER means "circular error probable." The CEP represents the radius from a target within which fifty percent of the warheads are expected to land.

c) SSKP means "single shot kill probability." These SSKPs and those in other tables were calculated for targets hardened against 2000 psi blast overpressures using the "cookie cutter" formula from Davis and Schilling, "All You Ever Wanted to Know About ICBM and MIRV Calculations But Were Not Cleared To Ask," Journal of Conflict Resolution, June 1973, p. 215.

d) Rel. means "reliability." This is the projected percentage of missiles that will function properly from launch to warhead detonation.

Figure I-6: Soviet ICBMs

Type	IOC	Number	Warheads	Yield	CEP	SSKP	Rel.	Notes
SS-9(mod. 1)	1965	100	1	18-25	.7	.38		Being replaced by SS-18.
(mod. 2)			3 MRV	4-5	.7	.15		Mod. 2 has a counter-force "footprint."
SS-11(mod. 1)	1966	638	1	1-2	.7	.08	.7	Being replaced by SS-17, -19
(mod. 3)			3 MRV	1-.3	.7	.04	.7	
SS-13	1968	60	1	1	.7	.06	.7	SS-16 follow-on banned in SALT II.
SS-17(mod. 1)	1975	200	4 MRV	.9	.25	.35	.75	A .1 nautical mile CEP capability has been demonstrated and is presumably being deployed. This would give a SSKP of .86 to the SS-18(2) and -19(1). The test of the SS-17, -18, -19 force would have SSKPs of .99+.
(mod. 2)			1	5	.25-.3	.74	.75	
SS-18(mod. 1)	1975	100	1	18-25	.25	.98	.75	
(mod. 2)			8 MRV	.6	.25	.28	.75	
SS-19(mod. 1)	1975	300	6 MRV	.6(?)	.25	.28	.75	
(mod. 2)			1	5	.25	.74	.75	

II ICBM force are hardened against a blast overpressure of 550 pounds per square inch (psi). The American Minuteman ICBM force has just undergone a program to harden their silos to resist blast overpressures of 2000 psi. The degree of Soviet silo hardening is a matter of some contention. It is generally accepted that the silos for their older missiles (SS-11 and older) are hardened to between 450-550 psi. Some analysts say their newer missile silos have no greater blast resistance than this, but other analysts believe that the silos of the newer generation of missiles have been hardened as much as the US Minuteman force.³⁰

However, silo hardness is rapidly becoming a moot point in the face of emerging ICBM technologies. Both the United States and the Soviet Union are currently upgrading the counterforce capabilities of their ICBM systems. The United States has a number of programs in development. In addition to the NS-20 accuracy program which recently improved Minuteman III accuracy from an average of 1500 ft to 700 ft, the Americans are investing in the development and deployment of the Mk-12A warhead for these missiles. This warhead increased the explosive yield of the Minuteman III warhead from a 150 kiloton (kt) to a 340 kt blast retaining an accuracy of 600 ft CEP.³¹

The United States is also in the process of installing a satellite-based navigation system to be used to provide guidance for warheads in flight. The system is called NAVSTAR. When completed it will consist of 24 satellites in geosynchronous orbit capable of relaying position fixes to a warhead accurate to within ten meters of its actual position, and within 1/10 feet-per-second of its velocity with better than ninety percent reliability. This system will be used for mid-course

corrections to MIRV warhead "busses" before they release individual warheads allowing for increased accuracies. Elements of the NAVSTAR system are now in place and initial tests indicate its accuracies will be as good as, or better than, planned.

Because a great deal of the remaining inaccuracy in ICBMs comes from conditions that occur during reentry, the US is also working on a program to develop maneuverable reentry vehicles (MARVs). One of these MARVs, the Mark 500 Evader, has been tested on Minuteman missiles and is scheduled for tests on the new Trident SLBM. The maneuvering capability of this warhead is being coupled with a program designed to develop terminally guided reentry vehicles (PGRVs) in a project known as AMARV. This system is to be developed for the Trident II SLBM and the new MX land-based ICBM. This program is expected to achieve a CEP for these missiles of about 300 feet. There is also a follow-on stage to this program designed to develop a radar assisted terminal guidance system which would self-correct during the final stages of reentry and result in a virtual no-miss accuracy.

The new generation ICBM mentioned above, the MX, will initially deploy the Mark-12A warhead designed for the Minuteman III. The MX could carry as many as 10-15 of these warheads. In addition, a new guidance system is being developed for MX called Advanced Inertial Reference Sphere (AIRS) which expects to provide a CEP of 100-400 feet. Later, when combined with NAVSTAR, this accuracy could go down to 30 feet CEP.³² Using conservative estimates of the MX's capabilities, one analyst has figured that a force of 300 MX missiles could destroy 92% of Soviet land based missiles.³³

One final technology has been developed by the United States which

increases both the retaliatory and the first strike capability of its ICBM force. Through projects named Hybrid Explicit and Satan Four the United States has been able to increase the number of target options for the Minuteman III missile force and speed up the retargeting procedure. Retargeting that previously took days can now be done in thirty minutes. The entire Minuteman III force can be retargeted in ten hours. This means that Minuteman missiles surviving a Soviet first strike attack could be rapidly retargeted to allow that force to cover the largest number of retaliatory targets as possible. This enhances the deterrent threat of this force.

However, this capability also significantly enhances the first strike capability of the Minuteman force. A first strike attack could be launched holding some missiles in reserve to be retargeted to cover areas missed due to malfunctions in the first wave. This can improve the effectiveness of the strike by as much as 25-50%. The Soviets are assumed to be working along similar lines.³⁴

The Soviet Union is also rapidly improving the counterforce capabilities of its ICBM force. Through developments in stellar inertial guidance and other technologies they have managed to improve the CEPs of newly deployed ICBMs to 1500 feet. Recent tests also indicate that they are working on a guidance system for SS-17 and 18 missiles which reduces the CEP of their warheads to about 600 feet CEP.³⁵ Soviet accuracy improvements have developed to the point that, by 1985, they will probably be able to destroy 90% of the American ICBM force in its silos.³⁶

The rate of improvement in ICBM capabilities forces the conclusion

that any fixed target that can be found can be hit and destroyed. Thus, for both sides, fixed ICBM forces are increasingly at risk. One analyst claims that both sides will have a "possibly total" hard target kill capability by the mid-1980s.³⁷

These developments have prodded both superpowers to develop alternate methods of insuring the survivability of a second strike ICBM force. The United States is currently considering several mobile basing alternatives for the MX missile. One option is to have the missile shuttle between widely separated, blast-hardened shelters on a random schedule. The idea is to provide the Soviets with too many targets to be covered by their missile force. Even though most of them would be empty, the Soviets would be forced to target all of these shelters because there would be no way of knowing which of the shelters actually housed the missile at any given time.³⁸

A major problem posed by the American shelter approach to mobile missile basing is the temptation it presents to the other side. The safety of this program's defense is not that the shelters would be too hard to destroy, but that there would be too many of them to destroy. This puts pressure on the other side to deploy enough warheads to cover all of the new sites. It is not a question of capabilities, just one of numbers. Thus the Soviets could be expected to deploy more warheads to cover the targets rather than simply acquiesce to the Americans having a secure system.

Alternate basing modes for the MX missile are also being discussed. One, known by the acronym SUM, involves putting the MX or old Minuteman missiles on small coastal submarines to patrol along the continental shelves of the United States. This option is getting considerably more

attention as opposition increases in the United States to plans for the land-mobile basing plan.³⁹

The Soviets also have a mobile ICBM in development, the SS-16. A variant of the SS-16, the SS-20, is being deployed as a medium-range ballistic missile on open transporters and in old missile silos. However, full development of the SS-16 as an ICBM is banned under the terms of the SALT II agreement.⁴⁰

The ICBM forces of the superpowers also have a poor future as protectors of the strategic balance. Each improvement in the capabilities of the ICBM force of the one side decreases the survivability of the ICBM force of the other. The trend in terms of more accurate ICBM warheads for both sides is serving to erode rather than reinforce mutual deterrence.

Submarine-Launched Ballistic Missiles

The third type of strategic nuclear delivery system is the submarine-launched ballistic missile (SLBM). These missiles are deployed on submarines that patrol the oceans submerged to avoid detection. The chief advantage to these systems is their presumed immunity from preemptive attack. However, their missiles currently lack the accuracy of their land-based counterparts due to difficulties in determining the precise location of the launching submarine. This lowers the SLBM's value as a counterforce weapon. Also, because of their extreme isolation, command and control is a difficult problem. However, both sides value their SLBM force as the most surviveable strategic system in their arsenal. Both sides are currently engaged in developing new ballistic missile submarines (SSBNs), and more capable SLBMs to put on them.

They are also both increasing the percentage of their deliverable

nuclear warheads mounted in submarines. The United States currently has 656 SLBMs deployed on 41 ballistic missile submarines. Of these, 496 SLBMs are MIRVed with at least 10 warheads each. The Soviets have about 878 SLBMs deployed on 86 ballistic missile submarines. About 96 of these SLBMs are thought to be MIRVed.⁴¹ SSBN capabilities will be discussed in much greater detail in the next chapter. (See Tables I.5 and I.6 for details on SLBM capabilities).

Other Technologies

There is one final type of strategic weapon with the ability to affect the strategic balance, the cruise missile under development and deployment by the United States. This is a small, pilotless jet aircraft with a 200 kt nuclear warhead and an advanced terminal guidance capability. These are designed to be launched from aircraft (ALCM), submarine torpedo tubes (SLCM), surface ships, or ground stations. Cruise missiles have a potential range of up to 3000 miles, and, owing to a terrain-contour (TERCOM) guidance system, could achieve accuracies of between 30 and 300 feet CEP. They would be nearly impossible to intercept owing to their extremely low-level flight path the "radar profile of a golf ball." Their accuracy and warhead yield would give them a very good hard-target kill capability.⁴²

The steady increase in the capability of the superpowers to deploy hard-target capable strategic weapons is just as steadily eroding the ability of the superpowers to maintain a survivable strategic retaliatory force. One American strategist has observed that "(1)t is clear that in the future both the present bomber and ICBM forces will prove inadequate to meet their needs; the B-52 because of its decreasing ability to penetrate the projected air defense, and the Minuteman because of its

Figure I-7: American SLBMs

Type	IOC	Number	Warheads	Yield	CEP	SSKP	Range ^a	Notes
Polaris A3	1964	160	3 MKV	.2	.5	.05	2500	Penetration aids
Poseidon C3	1971	496 (192 max.)	10-14 MIRV	.04	.3	.04	2500	Penetration aids, radiation hardened. Twelve SSBNs are being converted from C3 to C4.
Trident C4	1980		8 MIRV	.1	.3	.09	4000	
(Trident D4)	?		17 MIRV	.1	.1	.21	4000	Under development. May eventually have terminal guidance for warheads for CEPs < .05 nm.

a) Ranges for SLBMs in nautical miles.

Figure I-8: Soviet SLBMs

Type	IOC	Number	Warheads	Yield	CEP	SSKP	Range	Notes
SS-N-4/5	1961/65	78	1	1-2	1.5-2	.02	350/750	Not counted in SALT II. Being phased out.
SS-N-6(mod. 1,2)	1964	192	1	1-2	1.5	.02	1750	
(mod. 3)	1974	288	3 MKV	.6(?)	1.5	.01	2000	
SS-N-8	1973	266	1	1-2	.8	.07	4800	
SS-N-17	1977	12			.8		3000+	Tested with MIRVs.
SS-N-18	1978	144	3 MIRV	1-2	.8	.07	5000+	
SS-N-?								Possible new SLBM being tested for use on Typhoon-class SSBNs.

expected inability to survive with adequate payload a dedicated attack by future Soviet ICBMs."⁴³ The Soviets face much the same dilemma. Only SLBMs appear secure as surviveable nuclear retaliatory systems because they are mobile and cannot be targetted like fixed-site systems.

Thus it appears that the SLBM and the submarine that carries it is the key to the maintenance of strategic nuclear stability through mutual deterrence. This makes guaranteeing the safety of this system an extremely high priority, both for the superpowers' military strategists and for those interested in strategic stability through arms control. The balance of this paper is dedicated to determining what is the threat to the survivability of this system, and whether that threat can be minimized by means of a practical arms control agreement. The next chapter will begin this investigation with a close look at the threat submarines pose to the security of the superpowers.

NOTES: CHAPTER I

1. Quoted in Sergei Gorshkov, "Soviet Naval Strategy," US Naval Institute Proceedings, January 1974, p. 20.
2. See Andre Beaufre, Deterrence and Strategy, pp. 26-27. For excellent overall treatments of the relationship between social and military technologies and the conduct of warfare see Theodore Ropp, War in the Modern World, and Alfred Vagts, A History of Militarism.
3. See Giulio Douhet, The Command of the Air, pp. 3-19; Alexander George and Richard Smoke, Deterrence in American Foreign Policy, pp. 18-23.
4. A.I. Anatov, cited in Robert W. Herrick, Soviet Naval Strategy, p. 129.
5. Maxwell Taylor, Uncertain Trumpet, p. 61.
6. This example is based on models presented in Beaufre, Deterrence and Strategy pp. 46-48; Horst Afheldt and Philip Sontag, "Stability in Strategic Nuclear Arms" World Law Fund Occasional Papers #1, pp. 29-52; and discussions in Albert Wohlstetter, "Strengths, Interests, and New Technologies," Adelphi Papers No.46 (1968).
7. For excellent discussions of the distinction between countervalue and counterforce military doctrines, see Roy L. Beavers, "Counterforce or Countervalue?" US Naval Institute Proceedings, April 1974. See also Thomas Schelling, The Strategy of Conflict, p. 233.
8. Richard Rosecrance, International Relations: Peace or War, p. 46.
9. Taylor, Uncertain Trumpet, p. 13, 62-68. See also George and Smoke, Deterrence, pp. 26-31; Henry Kissinger, Nuclear Weapons and Foreign Policy, p. 7; Morton Halperin, Contemporary Military Strategy pp.
10. Matthew P. Gallagher "The Military Role in Soviet Decision-making" in M. McCwire, K. Booth, J. McDonnell, Soviet Naval Policy: Objectives and Constraints, pp. 55-56.
11. C.J. Jacobsen, Soviet Strategy - Soviet Foreign Policy, p. 58.
12. Soviet Information Bureau, "Soviet Rebuttal: The West Deliberately Appeased Hitler," in John L. Snell, (ed.), The Outbreak of the Second World War: Design or Blunder?, pp. 28-35.
13. Richard C. Head, "Technology and the Military Balance" Foreign Affairs April, 1978, p. 551. For examples of Soviet attitudes see M. Petrov, "The NATO-ites Beat the Drum," n.d. (JPRS Transdex No. 70765), E.G. Gerasimov "U.S., NATO Submarine Developments Discussed" Voyennyye Znaniya No.8, August 1977, (JPRS Transdex No. 69824); and Sergei Gorshkov "Guarding the Accomplishments of the Great October" Morskoy

Sbornik No. 11, Nov. 1977, (JPRS Transdex No. 70689).

14. Jacobsen, Soviet Strategy, pp. 58-63.
15. "Carter Directive Modifies Strategy for a Nuclear War" Washington Post, August 6, 1980, p. A10. "Changes in U.S. Nuclear Strategy" Washington Post, August 14, 1980, p. A3. For more on the U.S. Defense Department's position, see Senate Armed Services Committee, Hearings on FY 78 Authorizations for Military Procurement, and Active Duty, Selected Reserve, and Civilian Personnel Strength, pp. 802, 838-839.
16. John M. Collins, American and Soviet Military Trends Since the Cuban Missile Crisis, p. 78; Jacobsen, Soviet Strategy, p. 23.
17. Colin S. Gray, "The Future of Land-Based Missile Forces," Adelphi Paper No. 140, p. 3.
18. Collins, Military Trends, p. 108.
19. U.S. Congressional Budget Office, Retaliatory Issues for the U.S. Strategic Nuclear Forces, June 1978, pp. 57-58. These predictions are probably optimistic. A report on the "NBC Nightly News" of March 16, 1981, indicated that seven out of eight B-52s taking part in a drill were forced to delay takeoff for up to two hours for mechanical reasons.
19. U.S. Congressional Budget Office, Counterforce Issues for the U.S. Strategic Nuclear Forces, January, 1978, pp. 22-23. During the recent SALT negotiations the superpowers discussed an agreement not to engage in such testing, but the issue was tabled. (Strobe Talbot, Endgame: The Inside Story of SALT II, pp. 206-9).
20. See International Institute for Strategic Studies, The Military Balance: 1979-80, p. 9; Collins Military Trends, p. 137; "Soviet Defense Would Be Useless Against Cruise, Pentagon Says" Washington Post November 15, 1978, p. A12; "Cruise Missile Called Costly to Counter", Aviation Week and Space Technology, June 12, 1978, p. 20.
21. Collins, Military Trends, p. 137.
22. "SAC Questions Value of Bomber Proposals" Washington Star, February 19, 1981, p. A3.
23. C.A. Robinson, Jr., "Soviets Developing Two Bombers, Extending Range of Backfire", Aviation Week and Space Technology, February 19, 1979, pp. 17-18.
24. Collins, Military Trends, pp. 133-37. "Cruise Missile Called Costly to Counter" Aviation Week and Space Technology, June 12, 1978, p. 20. The eight E-3A AWACS assigned to defense of American airspace could be supplemented by others from the general purpose AWACS

force. There are currently fourteen AWACS operational with six more on order. (International Institute for Strategic Studies, The Military Balance: 1979-80, p. 8).

25. George C. Wilson, "'Stealth' Alters Military Balance, Brown Asserts," Washington Post, August 22, 1980, p. A1.
26. International Institute for Strategic Studies, Military Balance: 1979-80, pp. 5, 9.
27. See General George S. Brown, United States Military Posture for FY 79, January 20, 1978, p. 23; See also testimony of General David Jones before Senate Armed Services Committee, FY 78 Authorizations, p. 108 ff.
28. International Institute for Strategic Studies, Military Balance: 1979-80, pp. 5, 9.
29. Colin S. Gray, "The Future of Land Based Missiles Forces" Adelphi Paper No. 140 (1977), pp. 3-10.
30. Interestingly, Nikita Khrushchev claims that he came up with the idea of missile silos first, but his advisors thought it wouldn't work. (Nikita Khrushchev, Khrushchev Remembers: The Last Testament, (1974), pp. 50-52). For data on the hardness of American and Soviet ICBM silos see Congressional Budget Office, Counterforce Issues, pp. 31, 44.
31. In March 1978, the deployment of Mark 12A warheads on the 300 Minuteman III missiles scheduled to receive it was 90% complete. It has presumably been fully completed by now. ("ICBM Vulnerability Shifts Strategic Posture" Aviation Week and Space Technology, March 13, 1978, p. 37; Arms Control and Disarmament Agency, Fiscal Year 1979 Arms Control Impact Statements (1978), p. 2-6.
32. Data on American ICBM accuracy programs from Robert C. Aldridge, The Counterforce Syndrome (1978) pp. 13-28, and Doug Richardson "World Missiles Directory" Flight International, May 14, 1977 p. 1328. For more information on NAVSTAR see James S. Finan "A Survey of Some Major Developments in Strategic Weapons Technology" Operational Research and Analysis Establishment Staff Note 77/6, (1977), pp. 7-8. The U.S. Arms Control and Disarmament Agency, Fiscal Year 1979 Arms Control Impact Statements (1978), contains information on all major American weapons research.
33. Congressional Budget Office Counterforce Issues, pp 33-36.
34. See Aldridge, Counterforce pp. 21-22; Lynn E. Davis and Warner Schilling, All You Ever Wanted to Know About MIRV and ICBM Calculation But Were Not Cleared to Ask," Journal of Conflict Resolution, Vol. 17(2), June 1973, pp. 218-223; Brown Military Posture p. 23. See also Edward Luttwak, Measuring Strategic Power (1976), pp. 58-61, and

Congressional Budget Office, Counterforce Issues, Appendix B, pp. 59-65, for models of counterforce attacks where retargeting is factored in.

35. See Clarence Robinson "Soviets Boost ICBM Accuracy" Aviation Week and Space Technology, September 4, 1978, p. 24.
36. "Soviet Forces Gain in Attack Capability" Aviation Week and Space Technology, September 4, 1978, p. 24.
37. Colin S. Gray, "A Problem Guide to SALT II" Survival, September/October, 1975, p. 234.
38. For discussions of the MX option, see Gray, "Future," pp. 16-19; Gen. John W. Hepfer "M-X and the Land-Based ICBM," Astronautics and Aeronautics, February 1975, pp. 57-61; Aldridge, Counterforce pp. 26-28. Senator Mark O. Hatfield has stated that 200 MX missiles would give the United States "the ability to destroy every Soviet ICBM site." (Mark O. Hatfield, "SUM Strategy," Washington Post, April 7, 1980, p. A9). This statement is also supported in the Congressional Budget Office, Planning U.S. Strategic Nuclear Forces for the 1980s - Budget Issue Paper (1979) p. 40.
39. Several American analysts support placing the MX aboard small coastal submarines instead of using a land-based system. (Hatfield, "SUM Strategy," p. A9; Richard Garwin, interviewed on ABC News Close-Up "The Apocalypse Game," April 28, 1981).
40. Collins, Military Trends, p. 88; Richardson, "World Missile Directory," p. 1330.
41. International Institute for Strategic Studies, The Military Balance: 1979-80, pp. 5, 9, 86-87.
42. For more on cruise missiles, see Kosta Tsipis "Cruise Missiles," Scientific American, February 1977, pp. 20-29; J. Philip Geddes "The Sea Launched Cruise Missile," International Defense Review, April 1976, pp 198-201; Wilson, "Soviet Defenses" p. A12; "Cruise Missile Called Costly to Counter," Aviation Week and Space Technology, pp. 20-21; SIPRI Yearbook: 1975, pp. 330-331.
43. Senate Armed Services Committee, FY 78 Authorizations, p. 809.

CHAPTER II

THE SUBMARINE THREAT

The purpose of this chapter is to examine the effect submarines have on the stability of the strategic relationship between the super-powers. The first point that must be made in this discussion is that submarines are not themselves weapons. Instead they are weapons platforms. They are vehicles which carry weapons to the point where they are to be used. For this reason, submarines mounting one particular type of offensive weapon may have a vastly different set of offensive capabilities and missions than a submarine mounting a different type of weapon. However, both types of submarine would possess a similar set of operating characteristics, particularly with regard to their ability to operate submerged. This means that they are both vulnerable to similar antisubmarine warfare (ASW) techniques. This is the primary difficulty in trying to devise an arms control agreement that protects one type of submarine while leaving other types vulnerable.

There are a variety of types of submarine currently operational. For the purposes of this paper these will be reduced to two categories based on the characteristics of their missions. The first type of submarine to be discussed will be the ballistic missile submarine (SSBN), which was mentioned briefly in the previous chapter. The function of the SSBN is to serve as a survivable nuclear retaliatory force, and thus as a credible deterrent. To serve this end, SSBNs use their mobility and their ability to hide undersea to avoid attack by, or contact with, enemy forces.

The other type of submarine is the attack submarine. This classi-

fication encompasses a wide variety of submarine classes with different operational abilities, but they all share the same general mission.

Instead of being directed at strategic targets on land, attack submarines are directed against warships and merchantmen in time of war.

Attack submarines use their stealth and their ability to hide to approach targets undetected and attack them. The attack submarine tries to create trouble where the SSBN attempts to avoid it.

The discussion below explains in detail the operational capabilities of these two types of submarines, and the effect they have on the stability of the strategic balance.

Strategic Ballistic Missile Submarines (SSBNs)

The United States currently maintains a force of 41 SSBNs, which constitutes the most potent submarine threat to the security of the Soviet Union. There are currently three classes of SSBN operational in the American navy. All three classes are equipped with sixteen submarine launched ballistic missiles (SLBMs). Five of these SSBNs are of the George Washington class and five are of the Ethan Allen class. These are the oldest SSBNs in the American fleet. They are each armed with sixteen Polaris A-3 SLBMs which carry three 200 kt warheads that are not independently targetted. All ten of these submarines are stationed in Guam to patrol the Pacific coast of the Soviet Union.¹

The other thirty-one American SSBNs are of the Lafayette class. They each carry sixteen of the more advanced Poseidon C-3 missiles. The Poseidon SLBM is equipped with between ten and fourteen MIRVed 40 kt warheads. These Poseidon-armed SSBNs are stationed either at Holy Loch

in Scotland or at King's Bay in Georgia. They patrol the North Atlantic and the Mediterranean. The United States is currently in the process of backfitting the new Trident I SLBM into twelve of the Poseidon-armed SSBNs based at King's Bay. Trident I carries MIRVed 100 kt warheads, and has a significantly greater range than the Polaris or Poseidon SLBMs. It is reported to be operational, and has met or exceeded all of the performance goals in terms of range and accuracy set for it.² Trident I is also scheduled to be the first SLBM deployed on the new Ohio-class SSBN currently being built by the United States.

The relatively poor "hard target kill" capability of current American SLBMs means that they are probably aimed at countervalue targets such as factories, communications centers, and cities, or soft counterforce targets army bases. This also means that these missiles are relatively useless as a first strike weapons system against hardened targets like ICBM silos. However, the United States is continuing development on a Trident II missile which will use the MARV and NAVSTAR technologies discussed in the previous chapter to provide it with a hard target kill capability.³ (See Figure I-1 for a summary of American SLBM characteristics).

There are two factors which determine the areas SSBNs will use for their patrols. The most important factor in determining what the patrol area of an SSBN is the range of its SLBMs. The range of both the Poseidon and the Polaris missiles is approximately 2880 miles. Thus, in order to be able to strike a significant portion of Soviet industry, the patrol areas for these boats would necessarily exist within an arc extending from target areas in the Soviet Union outward to the coast of Morocco, across the Atlantic to the southern tip of

Greenland, across the northern tier of Canada to Alaska, and across the Pacific from Anchorage through Guam and across to Singapore. The increased range of the Trident missile extends this arc over 1000 miles further out from Soviet targets, increasing by a factor of sixteen the amount of sea space these SSBNs can patrol.

The second factor in determining the value of a patrol area is the amount of time it takes the SSBN to arrive on station. If the time it takes for them to get to a given area wastes a significant amount of this patrol period, it greatly reduces the utility of that area as a patrol station. For example, in terms of target coverage, the optimum patrol areas for American SSBNs are the northern Arabian Sea and eastern Mediterranean Sea. However, American SSBN patrols only last a maximum of sixty-eight days. It would take an SSBN twelve days to reach a patrol station in the Arabian Sea from Guam, and sixteen days to reach a patrol station in the Mediterranean from King's Bay. Use of these areas would require that substantial amounts of patrol time be used in transit, and thus they are probably not frequently used.⁵

It is possible that the United States is using the territorial waters of allied nations as SSBN patrol areas. Coastal areas of a number of American allies would provide excellent target coverage possibilities, particularly the coastal areas off of Norway, the British Isles, Japan, and Korea.⁶ The use of allied coastal area would also provides a number of other advantages. One important advantage would be a relative immunity from Soviet ASW efforts. Soviet naval forces would not be allowed to operate in these waters to track the American boats. Furthermore, shallow coastal waters tend to baffle sounds emitted by the submarines, and will not promulgate them over great distances, so that

they would be difficult to detect from outside these waters. Shallow water also transmits the shock wave of explosive blasts less efficiently than deeper water.

Yet another advantage of using coastal areas would be the potential for improvements in missile accuracy. The guidance systems aboard Polaris and Poseidon SLBMs are constantly updated by the ship's inertial navigation system (SINS) so that the missiles can be launched at their target at any time during the patrol. However, the SINS system, although a highly accurate dead reckoning system, is prone to some degree of error. Errors in position at the time of launch significantly increase the likelihood that a missile miss its target. SSBNs will occasionally approach the surface to check SINS accuracy with a radio or stellar position fix, but they are reluctant to do so because approaching the surface increases their risk of detection. However, if the submarine could use a particular coastal underwater landmark (e.g. a particular Norwegian fjord) as a reference, navigational errors in positioning could be virtually eliminated, thus enhancing the accuracy of the missiles on board. There has also been discussion of planting sonar beacons on the ocean floor to serve as navigational aids.⁷

However, operations in shallow waters would also increase an SSBN's detectability by nonacoustic means. These factors will be discussed in the next chapter during the discussion of ASW technologies. Officially, American SSBNs prefer operations in deeper waters, although their operating depths on patrol are reported to be around three hundred feet.⁸

Maps II-1 and II-2 illustrate likely patrol areas for American SSBNs based on considerations discussed above. All of these

Map II-1: U.S. SSBN patrol stations - Atlantic

Maximum range of Polaris/Poseidon to strike major Soviet industrial targets

Maximum range of Trident I to strike major Soviet industrial targets.

High probability patrol areas.

Routes from bases to high probability patrol areas.

Map II-2: U.S. SSBN patrol stations - Pacific

Maximum range of Polaris/Poseidon to strike major Soviet industrial targets

Maximum range of Trident I to strike major Soviet industrial targets.

High probability patrol areas.

Routes from bases to high probability patrol areas.

areas are within range of the SLBMs aboard, and very little patrol time is wasted in reaching the patrol area. Furthermore, the routes to these patrol stations are all across open ocean. No straits or narrows (referred to as "choke points") need to be traversed except to enter the Mediterranean. Further, many of these areas are near busy sea lanes where the ambient noise from passing ships would mask the few sounds emitted by the SSBNs.

The United States keeps over half of its SSBN force at sea at any given time. Fifty-five percent of the force is at sea, 25% is in port for routine maintenance and upkeep, and 20% is out of service undergoing major overhaul and system upgrading.⁹ The American navy claims that, at any given time, 72% of its SLBMs at sea are ready to be launched.¹⁰ In the Atlantic alone this means that there are at least 1760 operational nuclear warheads on 176 Poseidon SLBMs that are ready for firing. This is enough to destroy between 80-85% of the industrial base of the Soviet Union.¹¹

While actually in their patrol areas, American SSBNs operate at very low speeds to reduce the ship's output of noise. The full energies of the ship are utilized to avoid detection. In its "patrol quiet condition" each SSBN is so quiet that "you would practically have to collide with it to detect it." American SSBNs are reported to put less than one milliwatt of omnidirectional sound into the water.¹²

The United States SSBN force is undergoing constant operational improvement due to technological innovations added during overhaul periods. Since 1973 there has been a 100% improvement in the patrol quiet condition, sonar has been upgraded, operations at periscope depth have been minimized, submarines have been provided with frequent

intelligence updates on the operations of Soviet ASW forces, and other classified steps have been taken.¹³ These steps all help to increase the survivability of the SSBN fleet.

The time that an American SSBN on patrol is in the greatest danger of detection is when it approaches the surface to receive communications. American SSBNs are capable of routine operations at depths of 1500 feet. However, because seawater is highly resistant to penetration by electromagnetic radiation (such as radio waves), these SSBNs cannot receive instructions by radio at patrol depths. At pre-arranged times they must run an antenna to within about thirty feet of the surface to receive instructions from very low frequency (VLF) transmitters based at Cutler, Maine or on the North Cape of Australia. In order to reduce the risk of detection, these submarines do not respond to, or even acknowledge, these messages.

Command and control over these SSBNs is obviously a problem. Command authorities on shore are forced to assume that their messages have been received by their submarines, and that the submarines are even out there to receive them. The submarine could also be placed in an awkward position. If the submarine does not receive a message at an appointed time, its captain has no way of knowing whether the communications system has simply broken down, or whether it was the victim of a first strike. The only back-up for the current VLF communications system is a system based on command aircraft. The American Navy feels this system is insufficiently reliable.¹⁴

Improvements have been proposed for the submarine communication system. A program titled Project Seafarer (formerly Project Sanguine) is planned to develop an extremely low frequency (ELF) transmitter

capable of communicating with submarines operating at patrol depths anywhere at sea. This system would also be able to successfully ride out a preemptive nuclear attack. The ELF transmitter would avoid attenuation from lower atmosphere disturbance, be resistant to jamming, and would suffer minimum disruption from the electromagnetic effects of nearby nuclear explosions.¹⁵

An American SSBN on patrol need never surface, not even to fire its SLBMs. If called upon to launch its missiles the SSBN would rise to a depth of between 100 and 200 feet. The missiles would be ejected from their tubes and towards the surface by compressed air. When safely clear of the submarine the rocket engine would ignite and the missile would proceed to target. A missile can be launched like this once every thirty seconds. All sixteen missiles could be launched in about eight minutes. This is too little time for an ASW force to mount a reaction before the entire salvo has been launched.¹⁶

The United States is about to introduce a new class of SSBN, the Ohio class, which will be a qualitative improvement over its predecessors. The ship is enormous. Instead of carrying 16 missiles, it will carry 24 of the highly capable Trident I missiles, and will eventually be the only SSBN to carry the more capable Trident II SLBM. Significant reductions in noise output will be achieved through improvements in the nuclear reactor, equipment sound isolation, and quieting onboard pumping systems. The Ohio class SSBNs will be capable of patrol depths of about 4000 feet. A hovering capability is also being developed. The ship's counterforce capabilities are being enhanced by the installation of a targetting computer with rapid retargetting capabilities similar to those currently available to the Minuteman III ICBMs.¹⁷

Figure II-1: American SSBNs

Class	Number	Submerged Speed	Operating Depth	Weapons	Number	Notes
Washington	5	30+ kn.	1500 ft.	Polaris A3	16	First operational in 1959. Near the end of hull life. Being retired as Ohio class SSBNs are commissioned.
Ethan Allen	5	30+ kn.	1500 ft.	Polaris A3	16	First operational in 1961. Being retired as Ohio class SSBNs are commissioned.
Lafayette	31	30+ kn.	1500 ft.	Poseidon C3 (Trident I)	16	Twelve of these ships are being retrofitted with the new Trident I SLBM.
Ohio	(1)	30+ kn.	4000 ft.	Trident I (Trident II)	24 24	First of class currently in sea trials. This class will carry the Trident II SLBM when it becomes operational. Contains advances in quieting radiated noise.

Much less detail is available about the Soviet SSBN fleet, but enough is known to conclude that it has the potential to be a highly effective retaliatory force. The Soviets currently maintain four different classes of ballistic missile submarine in its fleet. The "Golf" series (I-IV) is the world's only diesel-powered ballistic missile submarine class. These boats are slow, noisy and carry missiles of very short range and extremely bad accuracy. They are thoroughly obsolete, but they continue to be deployed in the Soviet's Pacific and Northern fleets. The USSR also deploys a largely obsolete nuclear powered ballistic missile submarine known as the Hotel class. Five of these are currently deployed in the Atlantic and two in the Pacific. They are equipped with the same short range missile as the Golf II class and they are expected to be phased out in favor of more advanced SSBNs.¹⁸

The largest class of SSBN currently deployed by the Soviet Union is the Yankee class. These ships are roughly equivalent to the oldest of the American SSBNs. These submarines are equipped with sixteen SS-N-6 missiles having a range of 1500 miles and between 1 and 3 warheads (not MIRVed) of one megaton yield. There are currently about 30 of these submarines operational. One Yankee class SSBN has been modified to carry the SS-N-17 SLBM which has a range of about (4800) miles and carries three MIRVed warheads. There is no indication that the rest of the Yankee class ships are undergoing this conversion. In fact, the Soviets seem to be converting their Yankee SSBNs into attack submarines. To date, three Yankees have had their SLBM tubes removed.

The most advanced class of SSBN operational in the Soviet fleet is known as Delta. These boats demonstrate a significant improvement in

quieting over earlier models. This may have been accomplished in part by sacrificing some of the speed of the earlier Yankee class SSBNs.

Three versions of this class are operational in the Soviet navy.

Delta I (18 operational) carry twelve of the SS-N-8 SLBM, which carries a single one-megaton warhead and has a range of 4800 miles. The Delta II class (4 operational) was stretched to carry sixteen SS-N-8s. The Delta III class (10 operational) carries sixteen of the more advanced SS-N-18 SLBMs which can carry three MIRVed warheads 4800 miles.

Like the United States, the Soviet Union is constrained in choosing patrol areas for their submarines by the range of their missiles. The Golf and Hotel class boats are equipped with a missile (SS-N-5) that has a range of only 900 miles, and thus must deploy off of the coast of the United States. Furthermore, the accuracy limitations of the SS-N-5 mean that cities are the only feasible targets for these missiles. Yankee class submarines, with the 1500-mile SS-N-6 missile on board, deploy somewhat further out. In the Atlantic they deploy in the vicinity of Bermuda, and in the Pacific to the northeast of Hawaii. The Delta I and IIs with their SS-N-8 missiles, the Yankee II with its SS-N-17s, and the Delta IIIs with their SS-N-18s can all cover targets at a range up to 4800 miles. This means that these SSBNs can cover virtually all of the United States from their home ports at Murmansk and Petropavlovsk.

Deployment of the Golf, Hotel, and Yankee class SSBNs has been a problem for the Soviets. In order to reach their patrol areas in the Atlantic, the Soviets are forced to use significant portions of their patrol time. This is not as much of a problem in the Pacific. However, these SSBNs are all forced to transit choke points controlled by the

Map III-3: Soviet SSBN patrol stations - Atlantic

○ ○ ○ ○ Maximum range of SS-N-5 to strike continental United States (CONUS)

— — — — Maximum range of SS-N-6 to strike CONUS.

· · · · · Maximum range of SS-N-17 to strike CONUS.

x x x x x Maximum range of SS-N-8/18 to strike CONUS.

High probability patrol areas.

Routes to high probability patrol areas.

Map II-4: Soviet SSBN patrol stations - Pacific

o o o o Maximum range of SS-N-5 to strike continental United States (CONUS)

- - - - Maximum range of SS-N-6 to strike CONUS.

- - - - Maximum range of SS-N-17 to strike CONUS.

x x x x x Maximum range of SS-N-8/18 to strike CONUS.

High probability patrol areas.

Routes to high probability patrol areas.

United States or its allies. In the Atlantic they are forced to pass through the Greenland-Iceland-United Kingdom (GIUK) gap. This is a choke point that can be easily patrolled by the NATO alliance. In the Pacific the Soviets solved the problem of choke points around the Sea of Japan by moving their SSBN base from Vladivostok to Petropavlovsk on the Kamchatka Peninsula.

The Soviet philosophy of SSBN deployment is distinctly different from that of the Americans. Whereas the Americans strive to keep over half of their SSBN force at sea at all times, the Soviets keep only about eleven percent of their SSBN force at sea at any given time. On a day-to-day basis, Soviet deployments are almost token. In the Atlantic there is typically one Hotel class submarine on patrol off Nova Scotia, two Yankees patrolling near Bermuda (with perhaps another in transit), and one or two Deltas in the Barents Sea. A comparable level of deployment holds for the SSBNs deployed in the Pacific.²⁰

This reflects a fundamental difference between American and Soviet military doctrine and practice. The Soviets believe in a highly centralised command and control structure. Soviet officers in the field do have a much more restricted degree of authority to make command decisions than do their American counterparts. Faced with the same SSBN command and control problem as the Americans, the Soviets have apparently chosen to leave the bulk of their SSBN in port rather than put them to sea with a tenuous link to command authorities ashore. In assuming this posture the Soviets have apparently decided that secure command and control over their forces is more important, than the risk of their SSBNs being caught in port by a preemptive American first strike.²¹

There may also be a more mundane reason for the Soviet SSBN deployment posture. The continual deployment of submarines is very taxing to the systems on board. Soviet submarine construction values, especially for their older submarines, are far poorer than those for American submarines. The Soviets may be keeping their submarines in port as an economy measure designed to maximize their operational lifetime.²²

Not only do the Soviets have fewer submarines at sea, they have far fewer warheads at sea as well. Despite the fact that Soviet Yankee, Delta II, and Delta III class SSBNs carry as many missiles as their American counterparts, few of these SLBMs are MIRVed. Most of these missiles can engage only one target. Thus the Atlantic force described above could, at most, engage 130 targets, as opposed to the minimum of 160 targets that could be engaged by a single Poseidon-armed American SSBN.

Emerging Soviet strategic doctrine indicates that, in the event of war, SLBMs will be held in reserve during initial strikes, and be used as "second echelon" forces for use in follow-up strikes. In order to fulfill this role, the Soviet SSBN fleet would have to "surge" out of port at or before the outset of hostilities in order to avoid preemptive strikes. This necessity puts the Soviets at a significant strategic disadvantage. If they surge these forces prior to hostilities it would provide the Americans early warning that the Soviets expected hostilities to break out. If they surge these forces after the initiation of hostilities, they would suffer attrition from ASW forces before many of their SSBNs reached their patrol stations.

Like the Americans, the Soviets are also preparing to introduce a new SSBN into their fleet known to Western analysts as the Typhoon class. First reported under development in the mid-1970s, The first Typhoon has been launched and is currently undergoing sea trials. The Typhoon is enormous, displacing 27,000 tons as opposed to the Ohio class American SSBN which displaces about 18,000 tons. Despite its larger size, the operational characteristics of the Typhoon are reported to be similar to the Ohio. It will reportedly carry 22 to 24 of the newer generation Soviet SLBMs, will contain advances in the quieting of radiated noise, and will presumably operate in or around Soviet home waters. Its size has also suggested to some Western analysts that it may have the ability to reload SLBMs at sea.²³

SSBNs are the most powerful submarines currently operational. Both of the superpowers have made, and are continuing to make, a substantial investment in maintaining potent SSBN forces. Though the American SSBNs appear technologically superior to Soviets SSBNs, each superpower has an SSBN force that poses a significant retaliatory threat to the countervalue targets of the other. In the face of rapidly eroding confidence in the survivability of ICBM and manned bomber forces, the ability of SSBNs to remain secure from enemy ASW forces is increasingly important to the stability of the strategic balance between the superpowers.

Attack Submarines

The second type of submarine is the attack submarine. The primary mission of the attack submarine is to intercept enemy naval forces and disrupt enemy sea lines of communication (SLOCs). This is

Figure II-2: Soviet SSBNs

Class	Number	Speed	Weapons	Number	Notes
Hotel I	1	26 kn.	SS-N-5	3	Near end of hull life.
II	7				
Yankee	31	30 kn.	SS-N-6 SS-N-17	16 12	One Yankee carries SS-N-17. Twelve Yankees carry the single warhead SS-N-6 (Mod. 1) and 18 Yankees carry the 3 MRV (Mod. 3). Three Yankees have had their SLBM tubes removed and now serve as SSNs. Yankees may have a dive depth of 1500 ft.
Delta I	18	28 kn	SS-N-8	12	Three Delta IIs currently building.
II	4		SS-N-8	16	
III	10		SS-N-18	16	
Typhoon	1	?	SS-N-18 or new SLBM	20-24	Largest submarine in the world displacing 27,000 tons. Expected to have improved speed, quieting, and dive depths of up to 3000 ft.

a completely different orientation than that of the SSBN. As an American admiral said, "he (the attack submarine) is looking for trouble, not staying away from it."

The American attack submarine fleet is currently made up of nuclear-powered submarines (SSNs). The United States currently operates a fleet of 80 attack submarines, seventy-three of which are SSNs. A "moderately austere" fleet of 90 SSNs is planned for the late 1980s. These SSNs are based along the east and west coasts of the United States and in Hawaii. At any one time, one-third of these ships are on forward deployment, one-third are deployed for local operations and weapons certification out of their home ports, and the rest are in port for upkeep and overhaul.²⁵ (See Table II.3 for American SSN operating characteristics, and Maps II.1 and II.2 for SSN bases).

As mentioned above, the primary missions of attack submarines are to attack enemy naval forces and to disrupt enemy SLOCs. The current American SSN force was developed specifically for a conflict with the Soviet Union, and the peculiarities of the Soviet relationship with the sea have shaped the American SSN force in terms of its mission.

The Soviet Union is a land-oriented country. Despite its enormous coastline, it has very poor access to the open ocean. Seaborne communication between eastern and western Russia follows only two routes. The first is the tortuous route from the Black Sea through the Dardenelles and the Suez Canal, across the Indian Ocean, around China and past Japan and into Vladivostok. This path requires passing through no less than five strategic choke points, any of which could be easily closed during a conflict. The chances of this route remaining open during any significant conflict are negligible.²⁶

The other Soviet SLOC was used in World War II to connect central Russia and Murmansk. It extends from the mouths of the Russian rivers that flow into the Arctic Ocean, along the Arctic coast of Russia and into Murmansk. This route is relatively free from the risk of interdiction, but can only be used effectively for, at most, half of the year because of ice conditions in the winter.²⁷

Also, during the time the American SSN force was being planned, the Soviet ability to deploy a surface navy which could leave the waters near Russia and threaten the American interests on the open seas (a "blue ocean" navy) was negligible. The primary naval threat against American interest at sea was the Russian submarine force. Thus American SSNs were designed for the primary task of antisubmarine warfare. Their capabilities in this role will be further discussed in the next chapter of this paper.

The American SSN force is suitable for a number of missions besides ASW. The torpedoes and ASW detectors deployed aboard these boats and the ASW detectors can be used as or more effectively against surface ships, both civilian and military. The United States is upgrading this capability by giving its SSNs the Harpoon antishipping missile. This is a missile which is launched from an SSN torpedo tube, has a 500 lb. conventional warhead, a range of about sixty nautical miles, a sea-skimming flight profile, and an internal target acquisition capability that has excellent hit probabilities against destroyer-sized targets.²⁸

The extremely long range of SSNs, provided by virtue of their nuclear propulsion, and their extremely quiet operation also make American SSNs highly effective intelligence gathering ships.

American SSNs have embarked on intelligence missions since the early 1960s, reportedly penetrating Soviet territorial waters and even into Vladivostok harbor. Special electronic equipment aboard these submarines has reportedly allowed them to monitor Soviet missile tests, tap into Soviet undersea communication cables, monitor fleet exercises, and record the sound signatures of Soviet ships and submarines. This program, code named Holystone, (also known as Pinnacle and Bollard), will apparently be reinforced. Several of the new Los Angeles class SSNs being delivered to the American fleet are being especially outfitted for intelligence work.²⁸

The United States is also planning to increase SSN capabilities in another area as well. A sea launched cruise missile (SLCM - also known as the Tomahawk), is being designed to operate from the standard torpedo tubes of these SSNs. This weapon would have the accuracy and payload of the cruise missiles described in the Chapter I, and a range of up to 2500 miles. This would be sufficient to cover any target in the USSR from just off the Soviet coast. Such a capability would provide the SSN with a potential for unambiguous, controlled single weapon response and as an invulnerable reserve force. SSNs would take on a capability to destroy hard targets similar to that of the most advanced ICBMs. This capability would not, however, change the SSNs role to that of a strategic weapon delivery system. Its primary role would continue to be as an ASW platform.²⁹ (See Figure III-3 for American SSN characteristics).

It is somewhat more difficult to assess the intended role of the Soviet attack submarine force, largely because that role seems to be evolving rapidly. The Soviet Union does not have a history

Figure 11-4: Soviet SSNs

Class	Number	Speed	Weapons	Notes
November	13	30 kn.	torpedoes	Operating depth of approximately 1500 ft. Nearing end of hull life.
Echo I	5	28 kn.	torpedoes	Converted from cruise missile carrier. Considered obsolete.
Victor I	16	32 kn.	torpedoes	
II	6	33 kn.	torpedoes SS-N-15	Carries 10 ASW cruise missiles (SS-N-15)
III	2	33 kn.	torpedoes (SS-N-15)	
Yankee	3	30 kn.	torpedoes	Converted from SSBN.
Alpha	4	42 kn.	torpedoes	Reported 3000 ft. dive depth. In slow series production. One building.

as a seagoing power. Nor does it have a set of oversea commitments (Cyba notwithstanding) that provides a clear cut mission to the Soviet navy in terms of protecting SLOCs vital to the security of the USSR or its allies. Traditionally the Soviet navy has had the sole task of protecting the Soviet mainland from attack by sea. Because of the inability of the navy to define a broader mission, and because the primary military threat to the Soviet Union has always come from the land, the navy been the most junior service in the Soviet military. As such, it has traditionally been last in line for budgets and new hardware.

The development of a sea-based threat to the Soviet mainland, first in terms of American and British aircraft carrier strike forces and later in the development of Polaris- and Poseidon-armed SSBNs, has given Soviet naval programs higher priority than they have had in the past. A great deal of the growth of the Soviet navy has been in the area of attack submarines of several types. The Soviets have a long-standing orientation towards attack submarines. The Soviet navy has had an off-again, on-again fixation with attack submarines for decades. It began after the First World War where the attack submarine had made its debut as a major threat to SLOCs. The "Young School" of naval strategy developed in the Soviet Union claiming that surface warships were obsolete and that a fleet of submarines could serve to adequately interdict the sea approaches to the Soviet mainland. This philosophy was in disrepute under Stalin, but Khrushchev revived submarine-oriented thinking. Throughout the past two decades the Soviets have built a variety of attack submarines designed to play integral roles in fulfilling Soviet naval mission.³¹

The Soviet navy has six different wartime missions which can be ranked in the order of their priority. These are "1) defense of offshore areas, 2) countering enemy strategic strike systems, 3) sea control in SSBN operating areas, 4) strategic strike, 5) disrupting enemy SLOCs, and 6) defending friendly SLOCs."³²

The role of coastal defense is filled by small coastal patrol boats, land-based aircraft and a large fleet of small, diesel-powered patrol submarines. These forces are apparently designed to defend against any penetration of Soviet sea space by amphibious, or other naval forces that might threaten the Soviet mainland. The patrol submarines (SS) dedicated to this mission are small, have limited range, and when operating with their diesel engines they are the most vulnerable submarines to modern ASW techniques. However, when operating submerged on battery rather than diesel power, they become the quietest submarines and the most difficult to detect. The drawback to battery power in submarines is the relatively short amount of time that the batteries can operate before they are drained and have to be recharged by the diesel engine.³³

Although the Americans have largely given up on them, the Soviets retain a commitment to the SS type of submarine. They have recently developed a new class of SS known as Tango, and they have reportedly made significant strides in the development of long lasting batteries. They have, or will soon have, the capability to operate these boats submerged for several days at relatively high speeds.³⁴

The role of defense against strategic strike systems involves operations against two distinctly different targets. The first is American (and British and French) aircraft carrier task forces.

This has been a major concern of the Soviet Navy since the early 1960s, and their submarine development program shows efforts to meet this threat. In 1962 and 1963 respectively, the Soviets introduced the Juliett and the Echo II submarines, both equipped with the SS-N-3 surface-to-surface cruise missile. This missile has a range between 150 and 250 miles and either a high explosive or nuclear warhead.

However, the SS-N-3 must be fired from the surface, which greatly increases the vulnerability of the submarine launching it. The SS-N-3 also has limited guidance and target acquisition capabilities. To be effective it requires support from other planes or ships in the vicinity of the target. Developing this coordination was a major effort for the Soviets in the late 1960s, when it was observed that "Soviet naval attack training operations center around their submarines and aircraft for that unique form of antisurface warfare wherein the very small numbers of aircraft carriers are the target."³⁵ The Soviets have recently replaced the SS-N-3 with the more capable SS-N-12 on twenty Echo II submarines. This missile has a 350 mile range and an internal target acquisition capability. The Soviets have equipped their Charlie class submarines with the SS-N-7, which has a thirty mile range and internal target acquisition capabilities.³⁶

The counter-SSBN task is the other form of strategic strike defense that is the obligation of the Soviet Navy. However, this is an ASW task, and will be discussed in detail in the next chapter. The same applies to the pro-SSBN role of the Soviet forces, because of the ASW orientation of the American attack submarine force. The role of strategic strike was discussed earlier in this chapter.

The task of disrupting SLOCs is one that appears to be emerging as a realistic operational mission of the Soviet fleet for the first time. In 1963 Khrushchev announced that the interdiction of SLOCs would be a primary task of the Soviet submarine fleet. Soviet strategists presented a scenario for a Soviet-American conflict which predicted that such an attack (using a conventionally-powered submarine force - there were very few nuclear powered submarines in the fleet at that time) would necessarily occur at the outset of hostilities with the NATO countries. However, Soviet naval exercises throughout the next decade demonstrated very little preparation for such activity. Instead, emphasis continued to be placed on ACW and ASW, perhaps reflecting a change of heart by the post-Khrushchev Soviet leadership.³⁷

However, during the major global naval exercise known as OKEAN '75 the Soviets first demonstrated an operational capability to attack SLOCs with submarines. In addition to practicing ACW and ASW barrier techniques, the Soviet navy demonstrated tactics apparently designed to interdict escorted convoys. Some analysts believe that this is a sign of the army reasserting its position as the senior military service and demanding naval support for potential operations in Europe by intercepting American and Canadian reinforcement efforts to NATO. Given the current force imbalance between NATO and Warsaw Pact in Europe, this is a grave threat to NATO security and to the maintenance of deterrence in Europe on the theatre level.³⁸

The task of protecting Soviet SLOCs is a minor one for the Soviet navy, though submarines have participated in such operations in

the past. The only major SLOC the Soviets have to defend extends to Cuba. During the Cuban missile crisis of 1962, the Soviets provided a six submarine escort to their freighters carrying missiles to Cuba. These boats were quickly neutralized by the U.S. Navy, and the idea of using submarine escorts for overseas convoys seems to have been abandoned.³⁹

Unlike the Americans, the Soviets do not seem to use their attack submarine force on intelligence gathering missions. Instead they rely on specially outfitted surface vessels.⁴⁰

Soviet attack submarines are deployed at four bases throughout the Soviet Union. (See Maps II-3 and II-4). The deployment of these boats at sea follows the same conservative pattern that the Russians use in the forward deployment of their SSBNs. A typical deployment for attack submarines in the North Atlantic would include as few as one to three torpedo or cruise missile attack submarines at any given time.

Because of this, during time of war the Soviet attack submarine force would also be required to "surge" out of port and into the North Atlantic and Pacific in order to threaten the SLOCs of the United States and its allies. Access to all of these SLOCs can only be gained by transiting choke points controlled by NATO countries or Japan. The Soviets have reportedly practiced this surge capability through the GIUK gap.

The Soviet submarine fleet would be forced to traverse these choke points frequently for resupply during a prolonged war, suffering attrition each time they crossed through enemy held waters. For this reason the Soviets have also considered setting up forward

bases for submarine resupply. Cuba would be the best site to locate a base for operations against the United States. From Cuba Soviet submarine forces could threaten American SLOCs to Europe, operate more effective ASW exercises against SSBNs operating out of King's Bay and Charleston. Further, positions in the Caribbean are screened from the American ASW detection systems along the Atlantic coast. The Soviets began the development of base facilities at Cienfuegos in the 1970s, but aborted this effort, more due to political pressure from the United States than a lack of military feasibility. Attack submarines continue to visit Cuba regularly.⁴¹

In summary, both the United States and the Soviet Union face significant threats from the submarine forces of the other. Both sides are threatened by the steadily growing capabilities of the other's SSBN forces. This is a good thing according to the model of deterrence and strategic balance being used in this paper. As long as these systems can operate in safety then a secure retaliatory capability should be assured for both superpowers.

However, the attack submarine fleets of both powers are potentially destabilizing. Both powers operate attack submarines on ASW missions, which poses a threat to the security of the SSBNs. This will be discussed in detail in the next chapter. Further, the Soviet attack submarine force poses a potentially destabilizing threat to strategic stability due to its ability to threaten NATO SLOCs. This weakens the perception of America's ability to come to the aid of its NATO allies in time of war and to protect other vital sea lanes, and thus threatens the credibility of the deterrent presented by NATO's defensive capabilities.

Figure 11-4: Soviet SSNs

Class	Number	Speed	Weapons	Notes
November	13	30 kn.	torpedoes	Operating depth of approximately 1500 ft. Nearing end of hull life.
Echo I	5	28 kn.	torpedoes	Converted from cruise missile carrier. Considered obsolete.
Victor I	16	32 kn.	torpedoes	
II	6	33 kn.	torpedoes SS-N-15	Carries 10 ASW cruise missiles (SS-N-15)
III	2	33 kn.	torpedoes (SS-N-15)	
Yankee	3	30 kn.	torpedoes	Converted from SSBN.
Alpha	4	42 kn.	torpedoes	Reported 3000 ft. dive depth. In slow series production. One building.

Figure 11-5: Soviet SSCNs

Class	Number	Submerged Speed	Primary Weapons	Number	Notes
Echo II	29	22 kn.	SS-N-3 SS-N-12 torpedoes	8	Twenty Echo IIs carry the SS-N-12, nine carry the SS-N-3. These ships are becoming obsolete.
Charlie I	11	27 kn.	SS-N-7 torpedoes	8	Possible operational depth of 1500 ft.
II	4	33 kn.	SS-N-7 SS-N-15 torpedoes	8	Carries SS-N-7 antishipping cruise missile and probably the SS-N-15 ASW cruise missile.
Papa	1	30 kn.	SS-N-7 (torpedoes)	10	Reported dive depth of 3000 ft. None others building.
Oscar	1	(40) kn.	(SS-N-12)	many	Very large. Currently in sea trials expected to carry cruise missile with 200+ mile range, which is the range of the SS-N-12.

Figure II-6: Soviet SSs

Class	Number	Submerged Speed	Weapons	Notes
Quebec	4	15 kn.	torpedoes	Fifteen currently in reserve. Nearing end of hull life.
Whiskey	40	15 kn.	torpedoes mines	One hundred currently in reserve. Nearing end of hull life.
Romeo	12	16 kn.	torpedoes mines	Can carry either 18 torpedoes or 36 mines. Eight have been decommissioned.
Zulu IV	12	17 kn.	torpedoes mines	Can carry either 24 torpedoes or 40 mines and 4 torpedoes. Nine have been placed in reserve.
Foxtrot	60	18 kn.	torpedoes	
Tango	12	16 kn.	torpedoes SS-N-15	New class. Equipped with SS-N-15 ASW cruise missile.

The next chapter is designed to look at the superpower response to the submarine threat, and to determine whether the ASW forces in the superpower inventories are stabilizing or destabilizing to the overall strategic balance.

NOTES: CHAPTER II

1. These SSBNs were brought into service in 1959 and 1961 respectively and have reached the expected limit of their hull life. They are scheduled to be replaced as Ohio-class SSBNs become operational. (Gerard Kenneth Burke, "The Need for Trident" US Naval Institute Proceedings November, 1978, p. 34). Basing information from General George S. Brown, United States Military Posture for FY 1979, p. 30. Data on SLBM characteristics from International Institute for Strategic Studies, The Military Balance: 1979-80, pp. 3, 5; Robert C. Aldridge, The Counterforce Syndrome, pp. 8, 15; Doug Richardson "World Missile Directory" Flight International, May 14, 1977, pp. 1328-29, John M. Collins, American and Soviet Military Trends, pp. 96-102.
2. Unit Citation issued by the Secretary of the Navy to the Strategic Systems Project Office, U.S. Department of Defense, n.d.
3. For data on Polaris/Poseidon/Trident retirement, see Collins, Military Trends, p. 102 and Aldridge, Counterforce, p. 25.
4. For more information on the Trident II SLBM, see Aldridge, Counterforce, pp. 25-26; IISS, Military Balance, p. 3.
5. G. Jukes, "Soviet Policy in the Indian Ocean" in Micheal McGwire, Ken Booth, and John McDonnell, Soviet Naval Policies: Objectives and Constraints, p. 311.
6. In 1968 the SSBN Robert E. Lee was snagged in the net of a trawler in the Irish Sea. (SIPRI Yearbook, 1977, p. 57). On April 9, 1981 the SSBN George Washington rammed and sank a Japanese trawler just south of Japan. "US Missile Sub Sinks Jap Trawler" Washington Post April 10, 1981, p. A1.
7. An error in position at launch causes an error fifteen times as great at the target (SIPRI Yearbook, 1968-69, pp. 104-107). There are unacknowledged reports of navigation stations in Norway to help SSBNs determine their position. If true, there may be such bases elsewhere as well. (Duncan Campbell, "Sabotage, Submarines and the Norwegian Connection," New Statesman June 2, 1978, p. 730). One source claims the Americans operate up to six VLF stations, which may also be supplemented by underwater sonar beacons in the future. (SIPRI Yearbook: 1969/70, pp. 117-119; SIPRI Yearbook: 1968/69, p. 105). For a more detailed discussion of submarine navigation problems, see H. Schoville and D.G. Hoag, "Ballistic Missile Submarines as Counterforce Weapons" in Tsipis, Cahn, and Feld, The Future of the Sea Based Deterrent, pp. 36-43.
8. Factors relating to the effects of oceanographic conditions on the detectability will be discussed in detail in Chapter III. For indications that American SSBNs prefer deep water operations, see Senate Armed Services Committee, FY 78 Authorization for Military

Procurement, and Active Duty, Selected Reserve, and Civilian Personnel Strengths, Part 8, pp. 6541-6695; and Gerard Kenneth Burke, "The Need for Trident" U.S. Naval Institute Proceedings, November 1978, p. 36. However, other sources indicate that the preferred patrol depth of American SSBNs is around 300 ft. (Tom Buckley, "Inside Subs" Esquire April, 1977, p. 186).

9. U.S. Navy, Nuclear Power: Challenge for the 1980s (1979), p. 6.
10. Senate Armed Services Committee FY'78 Authorizations, p. 6622. Four hundred of the Poseidon warheads at sea are reported to be dedicated to missions for the Supreme Allied Command for Europe (SACEUR). International Institute for Strategic Studies (IISS), Military Balance, p. 5.
11. Congressional Budget Office, Retaliatory Issues for the U.S. Strategic Nuclear Forces, pp. 54-55. The most pessimistic estimate of the American SSBN strike potential indicates an ability to destroy 35% of Soviet industrial capacity and all of Soviet urban centers of over 50,000 after a full-scale Soviet ASW effort (Burke, "Trident," p. 39).
12. Senate Armed Service Committee, FY'78 Authorization, p. 6695; SIPRI Yearbook: 1968/69, p. 107.
13. Collins, Military Trends, p. 102; Senate Armed Services Committee, FY'78 Authorizations, pp. 6790, Senate Armed Services Committee, FY'78 Authorizations pp. 5392-5482, Senate Armed Services Committee, FY'78 Authorizations p. 828.
14. Tom Buckley, "Inside Subs," Esquire, April 1977, p. 136. The Soviets recognize this as a weak link in the American SSBN deterrent (Kenneth R. McGruther, The Evolving Soviet Navy, p. 52).
15. SIPRI Yearbook: 1969/70, pp. 117-119.
16. SIPRI Yearbook, 1968-69, p. 108; Buckley, "Inside Subs," p. 82.
17. Burke, "Trident," pp. 35-36. Senate Armed Services Committee, FY'78 Authorization, pp. 823-845, 6621-6644.
18. Except where otherwise noted, data on Soviet SSBN numbers is from IISS, Military Balance, p. 9. Information on submarine capabilities from Jane's Fighting Ships, 1978-79. Information on Soviet SLBMs from Aldridge, Counterforce, and Richardson, Missile Directory, p. 1330. IISS, Military Balance p. 87.
19. Jane's Fighting Ships: 1980-81, p. 474.
20. Robert G. Weinland, "The State and Future of the Soviet Navy in the North Atlantic," in Micheal MccGwire, Ken Booth, and John McDonnell, Soviet Naval Policy: Objectives and Constraints, pp. 411-412.

21. Khrushchev reports that the Soviets use satellites for communications with submarines at sea, (Khrushchev, Khrushchev Remembers p. 296). However, current technology requires an antennal above the surface where it can be detected for satellite communication to work, as opposed to VLF communication in which the antenna can remain 25-30 feet below the surface (Senate Armed Services Committee, FY'78 Authorizations, pp. 6695-97).
22. McGruther, Soviet Navy, pp. 57-58; Robert W. Herrick, Soviet Naval Strategy, pp. 125-127. The Soviet deployment may also be an attempt to extend the operational life of their ships. Continual deployment is wearing on the equipment and Soviet submarine construction values are especially for the older models, far poorer than American submarines. See Colin Gray, "The Future of Land-Based Missile Forces" Adelphi Papers No. 140, p. 4; Roy Varner and Wayne Collier, A Matter of Risk, pp. 244-245.
23. Congressman Les Aspin, "SALT II or No SALT," (1978), unpublished, pp. 11-12.
24. Testimony of Admiral Kaufman, Senate Armed Services Committee, FY'78 Authorizations, p. 6697.
25. Department of the Navy. Nuclear Power: Challenge and Future 1980, pp. 6-7; International Institute for Strategic Studies, Military Balance, p. 7.
26. Wegener, Soviet Naval Offensive, pp. 91-94;
27. Captain N. Noga, "Operations of the Northern Fleet to Defend Arctic Sea Lanes," Voyenno-Istoricheskii Zhurnal, pp. 20-28; (JPRS Transdex No. 69454).
28. Harpoon is currently only deployed on Los Angeles class SSNs, International Institute for Strategic Studies, Military Balance, p. 7; General George S. Brown, United States Military Posture for FY 1979, p. 80; Kosta Tsipis, "Cruise Missiles" Scientific American, February 1977, p. 23.
29. Seymour M. Hersh, "Submarines of U.S. Stage Spy Missions Inside Soviet Waters" New York Times, May 25, 1975, p. 1; Seymour M. Hersh, "A False Navy Report Alleged in Sub Crash," July 6, 1975, p. 1; confidential interviews.
30. Senate Armed Services Committee FY'78 Authorizations pp. 848-849; J. Philip Geddes, "The Sea-Launched Cruise Missile," International Defense Review, p. 199.
31. The evolution of the Soviet Navy is discussed in Herrick, Soviet Naval Strategy; Wegener, Evolving Soviet Navy; Robert G. Weinland, "The Changing Mission of the Soviet Navy," Survival, May/June 1972; Harlan Ullman, "The Counter-Polaris Task" and John P. Hardt, "National Economic Priorities and Naval Demand." in McGwire, Booth and McDonnell, Soviet Naval Policy; Sergei Gorshkov, Seapower and

the State; C.G. Jacobsen, Soviet Strategy-Soviet Foreign Policy, Chapter Five.

32. McGruther, Evolving Soviet Navy, pp. 47-48. These missions do not include the numerous peacetime missions for political purposes undertaken by Soviet Naval units. There is some evidence that Gorshkov's strong advocacy of these peacetime missions was an attempt to save the expensive surface forces that had been designed originally for ASW operations against the early American Polaris force. Ironically, Gorshkov was elevated to command of the Soviet navy because his predecessor, Admiral Kuznetsov, pushed too hard to preserve a surface navy and Gorshkov had experience in submarines. Gorshkov has since been trying to educate (apparently successfully) his colleagues and the Soviet High Command on the value of surface seapower. (John Erickson, "Soviet Defense Policies and Naval Interests," in McGwire, Booth, and McDonnell, Soviet Naval Policy p. 62; Weinland, "Changing Mission," pp. 131-132. Khrushchev, Khrushchev Remembers, pp. 23-30; Hardt, "Economic Priorities," pp. 138-142; Ullman, "Counter-Polaris Task," pp. 586-592; McGruther, Evolving Soviet Navy, pp. 66-69).
33. McGruther, Evolving Soviet Navy, pp. 48-49; Herrick Soviet Naval Strategy, pp. 138-139. Evidence that the other services feel this is the primary mission of the Soviet Navy is found in Sokolovsky, Soviet Military Strategy, p. 134 and throughout.
34. K.J. Moore, M. Flanigan, R.D. Helsel, "Developments in Submarine Systems: 1956-76," in Mcc III p. 155; Micheal McGwire, "Soviet Naval Developments" in Micheal McGwire and John Mc Donnell, Soviet Naval Influence: Domestic and Foreign Dimensions, pp. 341-342. It has been reported that the technology exists in the West to build a fuel cell powered submarine that could be competitive with a nuclear powered submarine for operational periods of twenty days. John P. Craven "Ocean Technology and Submarine Warfare" Adelphi No. 46, pp. 41-42.
35. Lt. Cmdr. J.T. Westwood "Soviet Naval Strategy, 1968-78: A Reassessment" USNIP May 1978, p. 119.
36. Jane's Fighting Ships: 1980-81, pp. 477-481; Richardson "Missiles Directory," p. 1337. Surface and air forces would also be involved in ACW operations (McGruther, Evolving Soviet Navy pp. 49-50).
37. Herrick, Soviet Naval Strategy, p. 131; D.C. Daniel, "Trends and Patterns in Major Soviet Naval Exercises" Naval War College Review Spring 1978, pp. 35-37. Khrushchev may have been simply bluffing. In his discussion of the evolution of the submarine force in his memoirs, Khrushchev notes the deterrent and defensive capabilities of Soviet submarines with apparent pride, but doesn't mention a role for them in SLOC interdiction. If this had been a central element of Soviet naval strategy, he might have mentioned it (Khrushchev, Khrushchev Remembers, pp. 29-30).

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38. Dirk Hennings and Alexandra Herrman "Navy, Navy Doctrine in the Soviet Union" Befreivng No. 9, May 1977, (Transdex #69673) p. 10; Daniel, "Trends and Patterns" pp. 35-37. If a war escalated beyond the local conventional level, several strategists have speculated that the Soviets would simply destroy the ports of destination rather than attacking SLOCs with submarines. (See Herrick Soviet Naval Strategy; McGruther, Evolving Soviet Navy pp. 60-61. The real need of NATO to achieve resupply across the Atlantic is detailed in Collins, Military Trends, pp. 321-392).
39. Gary Charbonneau, "The Soviet Navy and Forward Deployments" US Naval Institute Proceedings, March 1979, p. 35.
40. Senate Armed Services Committee, FY'78 Authorizations, p. 6616, McGruther Evolving Soviet Navy, p. 50.
41. See Micheal MccGwire "Soviet Naval Interests and Intentions in the Carribean" in Micheal MccGwire, Soviet Naval Developments: Capabilities and Context; B.M. Blechman and S.E. Levinson, "Soviet Submarine Visits to Cuba" in MccGwire and McDonnell, Soviet Naval Influence; Geoffrey Jukes, "Soviet Policy in the Indian Ocean," in MccGwire, Booth, and McDonnell, Soviet Naval Policy.

CHAPTER III

ANTISUBMARINE WARFARE: THE STATE OF THE ART

Antisubmarine warfare (ASW) is a form of military endeavor designed to counter the threat posed by enemy submarines. It has been defined as "the destruction or neutralization of enemy submarines and their supporting services, operating bases, and building yards. The aim of antisubmarine warfare is to deny the enemy effective use of his submarines."¹ Both of the superpowers have spent billions of dollars developing and deploying ASW forces throughout the oceans.² The purpose of this section is to examine the strengths and weaknesses of the superpower ASW forces, now and in the near future, and the effects these forces have on the maintenance of the strategic balance. Because submarines do not pose a homogeneous threat to the strategic balance, a detailed look at ASW technologies is necessary to differentiate between those that are a particular threat to SSBNs and those that are particularly effective against attack submarines.

Before any discussions of ASW can begin, it is necessary to understand some of the properties of seawater, the medium in which both submarines and ASW forces must operate.³ The sea is a nearly ideal place in which to hide a submarine for two reasons. First, its fluid nature makes submerged mobility possible. Locating an airbase or an ICBM silo on land once is sufficient. It can be targetted in advance with full confidence that its position in the future will not change. However, locating a submarine at one point in time reveals little about where it will be found the next week. For this reason ASW forces are confronted with continuous relocation and retargetting problems.

Second, seawater is nearly impervious to electromagnetic radiation.

Neither light waves nor radio waves will penetrate more than a maximum of a few hundred feet into the sea before the seawater absorbs them. This makes visual and other speed-of-light detection systems (e.g. radar) useless beyond this range against submarines that are operating submerged. It also means that such systems are also denied to the submarines themselves, which interferes with communication and navigational capabilities. However, the balance of these inconveniences works heavily in the favor of the submarines.

The only form of energy that seawater carries with any reliable efficiency is sound. In locating submarines, ASW forces are forced to rely primarily on underwater sound detection equipment known as sonar. Sonar systems are composed of three separate elements. The first is a hydrophone constructed with piezoelectric elements capable of translating pressure from sound waves into electrical impulses. The second is a communications system which transmits those electrical impulses to a signal processing unit for analysis. The third element is a signal processing unit capable of sorting out the sounds picked up by the hydrophone and identifying those sounds associated with submarines.

Sonar can operate in both passive and active modes. In the passive mode the sonar hydrophone listens for the sounds generated by the target submarine itself. There are basically two sources of submarine-generated sound. The first, known as cavitation, is the noise made by a submarine during its passage through water. Hydrodynamic imperfections in the shape of the submarine hull or in its propeller create pockets of air which produce a detectable hissing, churning noise when they collapse. As speed increases, so does the level of noise generated by

cavitation effects. For this reason submarines in hiding prefer to use extremely low speeds. It lowers the amount of noise generated by cavitation and reduces their detectability.

The other source of submarine-generated noise is sound radiated from the submarine during the operation of machinery on board. The most common sources of such noise are systems designed for cooling the reactors aboard nuclear-powered submarines, and those designed for pumping water from one part of the submarine to another (for ballast, for trimming the boat, for clearing torpedo tubes, etc). Any piece of moving machinery on the boat is a potential source of radiated sound.⁴

Put together, cavitation sounds and submarine-generated sounds produce a "signature" for each individual submarine that is practically as unique as a fingerprint. Thus passive systems are not only capable of locating a submarine, but with proper signal processing equipment, they are also capable of identifying the particular submarine they have located. Even if the exact submarine cannot be identified, the ability to recognize a signature pattern greatly increases an ASW forces ability to determine whether a submarine it has detected is a friend or foe.

The simplest way of deploying passive sonar systems is to have a single passive hydrophone aboard a ship which has the capability to take a directional bearing on detected submarine sounds. The ASW force can then follow that bearing to its source to locate its quarry. These passive systems can also be placed in small packages known as sonobuoys. A sonobuoy consists of a hydrophone that is deployed in the water from a floating platform. This platform also has a radio transmitter on board to relay the information from the hydrophone to a signal processing unit. These are small devices (on the order of a

foot in diameter) which can be used alone, but which are usually laid in arrays from airplanes or helicopters.

An array is the most effective way to deploy a passive sonar system. In an array a series of hydrophones are deployed in a one-, two-, or three-dimensional pattern and hooked up to the same signal processing unit. That unit receives information from a sound impulse from each of the hydrophones in the array, and from the differences in signal strength, time of arrival, etc., a far more precise localization of the target submarine can be achieved. Hydrophone arrays can be deployed as fixed systems on the ocean floor, fixed along the sides of submarines, on cables towed behind surface ships or submarines, or as patterns of sonobouys. As will be seen, there are also efforts underway to deploy array systems that can be moored to the bottom or suspended in the water. (See Figure III-1).

The weakness of a passive sonar systems lies in the varied nature of submarine sound signatures. A submarine with a very weak signature would be very difficult to locate and identify using only passive means. Even submarines with pronounced signatures can be difficult to find. Cavitation noises tend to fall with the same spectrum of sound, but the same does not apply to submarine generated noises. Low frequency sounds generated by submarines tend to travel relatively long distances in sea water, and be omnidirectional in nature. Thus a receiver located at any quarter would be able to pick up the sounds of the submarine's passage. However, if the submarine is putting out high frequency sound, it is entirely possible that its sound signal will only penetrate a very short range and be relatively unidirectional in nature. (see Figure III-2). Thus this submarine would only betray itself to fixed passive

Figure III-1: Passive accoustic sonar detection

For a noncooperating target submarine, four hydrophones are needed to accurately determine its location. The target emits an identifiable sound at some unknown time and the time difference of the arrival of the sound at various pairs of hydrophones is measured. The locus of points satisfying the time relation for each pair (e.g. AB, AC, BC, CD) is a hyperbola in two dimensions, a hyperboloid in three. Intersection of the four hyperboloids locates the origin of the sound, though with some ambiguity.

a) From Frank Leary, "Search for Subs" Space/Aeronautics, September 1965, p.65.

sonar systems if the cone of sound it was emitting swept across one of the fixed receptors, and then only briefly. A mobile passive system would have to remain within that cone of sound to maintain contact with the submarine. In summary, passive sonar systems are good for detecting and identifying submarines, but they can be weak in localizing them.⁵ (See Figure III-2).

The form of sonar that is good at localizing submarines is active sonar. An active system is like a passive system in most ways. The chief difference is that the active system supplies its own sound rather than relying on the target submarine to supply it. In an active system, one or a series of hydrophones are deployed in an area, and a pulse of sound is sent out through the water to bounce against the hull of the submarine. The echo of that pulse is detected by the hydrophones and by calculating the difference in time between the generation of the pulse and the echo detected at each location, the submarine can be located with considerable precision. (See Figure III-3).

A major drawback of active sonar systems is that any submarine being hunted by such a system will know instantly that it is being hunted, and, if the system is not a fixed or airborne system, it will know the bearing of the attacking ASW force with absolute certainty. Furthermore, because of the weakening of the signal pulse with distance, the target submarine could be warned of the hunt considerably before the hunters came into range of the sonar hydrophone's ability to pick up the echo. The target submarine could easily end up with more information about its attackers than the attackers have about the target submarine.

Nonetheless, if the ocean was a homogeneous medium, hunting submarines by sonar, active or passive, would be a very straightforward proposition.

Figure III-2: Characteristics of low- and high-frequency sound in water.

A) Low frequency emitted sound B) High frequency emitted sound

- ⊗ Hydrophone currently receiving sound signal.
- ⊙ Hydrophone received sound signal in the recent past but is not currently receiving a signal.
- Hydrophone never receives sound signal.

The figure above illustrates the differences in the sound patterns of submarines emitting low- and high frequency sounds. In (A) above, the submarine is emitting low-frequency sounds which tend to travel long distances omnidirectionally. Thus all of the hydrophones placed around the submarine can receive the signal and aid in tracking.

In (B) above, the submarine is emitting only high-frequency sound, which tends to travel for limited distances in a relatively unidirectional fashion. Thus only the hydrophone at B is currently receiving a signal. The hydrophone at C received a signal as the cone of sound from the submarine swept across it, but contact was lost rapidly. Neither of the hydrophones at A or D ever received a signal.

If trying to follow these submarines, the submarine in A could be followed from a position on any quarter, but the submarine in B could only be followed by maintaining a position within the cone of emitted sound.

Figure III-3: Active accoustic sonar detection

This figure illustrates how an active hydrophone array can locate an enemy submarine. The active element at point D sends out a sound pulse. The observed time interval between the pulse from point D and the reception of the echo at point A defines an ellipse with its foci at points A and D. The information from each hydrophone is used to draw an ellipse, and the point of intersection between these ellipses is the location of the target submarine.

- a) From Richard Garwin "Antisubmarine Warfare and National Security"
Richard Garwin (ed.) Arms Control, p.255.

However, the ocean is not homogeneous, and changes in the ocean environment (the "sea state") have profound effects on the way sound is transmitted through it. The behavior of sound in water varies with changes in temperature, salinity, density, currents, and virtually every other phenomena to which the ocean is prone. The most significant phenomena affecting sound in the ocean is the presence of thermoclines. These are layers of water that are distinctly different in temperatures from the water around them. Both active and passive sonar sets have been developed which can circumvent, or even take advantage of these thermoclines. (See Figure III-4).

Another significant problem regarding the use of sonar in the detection of submarines is the presence of ambient noise in the oceans. The oceans are full of sounds from many sources. Whales, schools of fish, undersea volcanoes and earthquakes are among the natural phenomena that create noise in the water. In addition to natural sounds, there is a tremendous amount of man-made sound in the oceans. This comes from the passing of ships, and the use of drilling and mining equipment to recover the resources (e.g. oil) found undersea. This level of man-made noise is steadily increasing. The only way for sonar systems to keep track of submarines in the increasing cacophony undersea is to develop increasingly sophisticated signal processing systems capable of sorting submarine sounds from the ambient noises in the seas.

There are other ways besides sonar to detect submarines, but none of them can currently accomplish this task at a range more than a few thousand feet from a submarine. One such method is known as magnetic anomaly detection (MAD). This technique is based on the fact that significant amounts of metal in relatively small areas will cause a

Figure III-4: The behavior of sound in seawater

- A) Where water temperature drops continuously with depth, not uncommon in clear tropical seas, sound energy entering the water at conventional angles is bent downward, thus enlarging the dead-ahead shadow zone.
- B) Where a thermocline exists, only that portion of the sound injected at a high angle penetrates the lower layer of water; the remainder is reflected by the thermocline, deceptively creating a large shadow zone in the water below.
- C) Driving the sound beam straight down ("bottom bounce") minimizes the distortion effects of water temperature discontinuities. The injection angle can be adjusted slightly so the signal sweeps an optimal target zone.
- D) Alternatively, the reflections that occur with shallow injection angles and thermoclines can be used by ship-, submarine-, or bottom-mounted sonars to achieve long-range "ducting" coverage within discrete isothermal layers.

From Frank Leary, "Search for Subs" Space/Aeronautics, September 1965, p.61.

slight disturbance in the magnetic field of the earth MAD equipment can detect the distortions caused by the metallic mass of a submarine at a range of about a thousand yards. Accurate use of this technology requires a previous knowledge of the earth's magnetic field in the area of operations because mineral deposits on the ocean floor or hulks of sunken ships can cause the same sort of distortion as produced by a submarine and cause a false reading of a submarine contact.

Infrared (IR) detectors are also currently deployed for ASW work. These are designed to detect heat from diesel exhaust and from the reactor cooling systems of nuclear submarines. Also used are devices known as autolycus (or "sniffers") which can detect the presence of diesel exhaust at levels of fractions of a part per million used by aircraft for detecting diesel-powered submarines using snorkels, and low light level television (LLLTV) systems which detects the biological phosphorescence caused by submarine wakes. All of the above systems are subject to a high false alarm rate, particularly when operating near major shipping lanes (or, in the case of LLLTV, schools of fish), but they do make good backup and localization systems for the final phases of an attack run on a target submarine.⁶

There is currently an extensive and diverse deployment of ASW forces by the superpowers. Fixed ASW sensors are currently deployed on the ocean floor. Mobile sensors and ASW weapons are deployed on platforms such as surface ships, submarines, helicopters, long- and short-range aircraft. These platforms are armed with ASW weapons such as depth bombs, torpedoes, missiles, and mines. Satellite detection capabilities are also being explored. The discussion below will examine ASW tactics currently in use, the systems used in executing those tactics, the

capabilities of those systems, and the effects of these capabilities on the maintenance of strategic stability.

ASW Operational Typology

For the purposes of this analysis, ASW operations are separated into four distinct types. These are broad ocean interception, area search, barrier interdiction, and point defense. Each type of operation has particular requirements which are best met by particular types of ASW equipment. Different types of ASW equipment are complementary in detecting and destroying submarines of any type. However, the mode of operational deployment and the tactics followed in using this equipment affect the vulnerability of SSBNs and attack submarines differently. The discussion below will compare and contrast the ASW abilities of the US and USSR in each of these areas and attempt to determine how their abilities enhance or threaten the strategic balance.

Broad Ocean Interception

The greatest threat to patrolling SSBNs of either superpower is a broad ocean interception capability. This involves the ability to locate, track and destroy submarines anywhere on the open ocean. This is by far the most difficult of the ASW tasks. The ocean is an enormous place in which to hide, particularly for SSBNs carrying missiles with ranges of several thousands of miles. The ASW forces looking for submarines at these ranges must rely primarily on acoustic detection devices, and they must be able to cope with all of the distortions in sound signals caused by changing ocean conditions over these distances. Further, ASW forces have no way of predicting with any degree of precision where an SSBN is likely to be at any given time or which direction it will be going.

The United States began to develop its broad ocean ASW capability in the late 1950s in response to the Soviet development of missile carrying submarines. These primitive missiles (SS-N-4) had a range of only 300 miles, which meant that the submarines carrying them had to penetrate close to the US coastline in order to pose a threat. The United States began to deploy a series of hydrophone chains along each coast known as the sound surveillance system (SOSUS).⁷ A chain known as Caesar was implanted on the continental shelf of the east coast followed later by a chain deployed along the west coast known as Colossus.

As Soviet submarine and SLBM capabilities improved, the United States continued to supplement and upgrade SOSUS. In the Atlantic, Project Artimus created an active sonar capability by operating a freighter with a giant sound transducer off of Bermuda which produced enormous sound impulses which would reflect off of submarines and be detected by the hydrophone arrays. Another massive sound transducer was mounted on a platform known as the "Texas Tower" off of the coast of Bermuda.

Additional arrays in the Atlantic have been placed off the coast of Canada, Bermuda, the Azores (the Azores Fixed Acoustic Range, AFAR, designed to monitor submarine traffic through the Straits of Gibraltar) and in the Greenland-Iceland-United Kingdom (GIUK) gap. Most recently an array system has been placed in the Caribbean south of Puerto Rico to monitor submarine traffic around Cuba. It has also been reported that the United States operates an ASW surveillance station in northern Norway near Murmansk.⁸

In the Pacific, Colossus has been supplemented by acoustic arrays

planted around Hawaii, off the coast of Japan guarding the exits from the Sea of Japan, and along the Aleutian Island chain and the Kuriles-Kamchatka trench near the Soviet SSBN bases near Petropavlovsk. There are also reports that a nuclear-powered moored array ("Sea Spyder") has been anchored on the Emperor Sea mount south of Attu in the Aleutians.⁹ Midway Island, Wake Island, and the Mendocino Escarpment north of Hawaii are also sites where arrays placements have been reported or proposed. (See Maps III-1 and III-2).

Efforts are continuing to develop systems to upgrade the coverage of these listening posts. The SOSUS system is in its fifth generation of development. Aided by the Soviet Union's apparent inability to adequately quiet its submarines, SOSUS is reported to locate Soviet submarines to within fifty miles at ranges of up to one thousand miles fairly routinely. In abnormal ocean conditions, sensors off the East coast of the US have detected submarines off the coast of Spain, and sensors in Hawaii have tracked a submarine off of the Philippines. The range of these sensors can also be seriously degraded by deteriorating ocean conditions.

The United States has both of the major northern ocean basins well covered by acoustic detectors. With the Soviet's development of the SS-N-8 and the MIRV-capable SS-N-17 and -18 SLBMs, Soviet Delta class SSBNs no longer need to enter the Atlantic basin to threaten targets in the US. Possibly in response to this, the Americans are developing hydrophone array systems which can be deployed in forward ocean areas by aircraft or submarines. One, known as the Moored Surveillance System (MSS), is composed of a set of hydrophones which deploys itself in an array at controlled depths, moors itself to the bottom at depths

Map III-1: Approximate locations of American fixed sonar sites
in the Atlantic

Approximate location of fixed sonar site

Map III-2: Approximate locations of American fixed sonar sites
in the Pacific

of up to 3000 fathoms, and transmits information by radio to aircraft or satellites. This array would reportedly have an active life of up to 90 days.¹⁰ This system would give the United States the ability to significantly increase its detection capabilities during a crisis.

Plans have also been made to deploy another bottom-anchored hydrophone system known as the Suspended Array System (SAS). This enormous project would involve mounting acoustic transducers on a tripod tower in 3000 fathoms of water which are capable of scanning an entire ocean. This project is expected to cost close to one billion dollars, and may be scrapped in favor of another system which has shown promise of a breakthrough in ASW detection capability.¹¹

This other system, the Surveillance Towed Array Sonar System (SURTASS), consists of an array of hydrophones towed behind a trawler-type ship (known as TAGOS) on a cable at extremely slow speed and at variable depths. This cable may be as much as two miles long or longer. The SURTASS system is expected to be able to detect submarines at extremely long ranges. It also has the added feature of mobility. It can be deployed where needed to supplement other ASW efforts. There are plans to procure twelve of these ships.¹²

This effort to collect the sounds of submarines from the oceans would be useless if these sounds could not be separated from the enormous volume of other sounds in the oceans. The true key to the acoustic detection of submarines lies in signal processing techniques. There is some evidence that the United States has achieved a breakthrough in this area. It began in 1973 when the Navy's Long-Range Propagation Project determined that it is possible to predict the path of sound waves through the ocean, given knowledge of oceanographic conditions

and current sea-state data. A computer model was devised which could predict ambient sea noise at a given point in time. When these noises were factored out of actual sonar readings, leaving only the sounds of passing submarines.

This knowledge is being implemented by the Defense Advanced Research projects Administration (DARPA) under a project known as Seaguard. A system of six ocean surveillance satellites (Seasat) is being deployed to constantly monitor and report ocean conditions. The information collected includes wind velocity and direction, wave height, shape, and length, sea surface topography resulting from currents, tides, and storms, depressions in the ocean bottom, surface temperatures, and ice floes. When fully deployed (circa 1985), this system will be able to update ocean conditions at half-mile intervals over 95% of the earth every six hours.

This information will be fed into the Illiac-4 computer located at Moffet Naval Air Station in California. Illiac-4 is an computer which operates as if 64 powerful computers were hooked up to operate in parallel. The information from Seaguard will be used to determine the paths of the sounds collected by ASW sensors around the world. These sounds will be processed and the sounds made by patrolling submarines will be isolated, identified, and located. It is expected that this computer will make it possible to determine the location and direction of travel of target submarines with relatively high accuracy fast enough to make an effective military response against them.¹³

When fully operational these systems should provide a reasonably good ability to detect and track submarines, particularly SSBNs, in the broad ocean. However, in order to be effective an ASW system must also be able to

destroy the submarines it locates. The best systems to date devised for hunting and destroying nuclear submarines are other nuclear submarines. The United States currently operates a force of seventy-three SSNs (which it intends to increase to a force of about ninety by the mid-1980s) primarily designed for ASW operations against SSBNs. Based on intelligence data from the broad ocean surveillance systems, these nuclear-powered attack submarines can patrol an area where an enemy submarine was detected, locate it, and proceed to trail that submarine until ordered to attack.

American SSNs are very capable of acquiring and tracking submarines over substantial ranges. The older American SSNs (Permit and Sturgeon classes) are equipped with hull-mounted active and passive sonar arrays. The detection ranges of these systems are 30 miles active and 100 miles passive.¹⁴ The new Los Angeles class submarines currently being introduced are equipped with a wide aperture array (WAA) passive sonar system which is expected to significantly improve the SSNs passive sonar detection range.¹⁵

One reason for this good sonar performance is the SSNs inherent suitability as a sonar platform. The extremely quiet operation of the ship when submerged reduces the amount of ambient interference with sonar reception. The nuclear reactor provides the active sonar system (primarily used for fire control) power enough to send a detectable pulse three times farther than possible on a diesel-electric submarine. Finally, for both active and passive sonar systems, the SSN is itself a variable depth platform. The captain of the submarine can search out the optimum depth for the operation of the ship's sonar sensors given the prevailing sea state.

Another advantage of the SSN is the fact that it is the equal of the SSBN in terms of speed, patrol endurance, and ocean accessibility (e.g. the ability to operate under the polar ice pack). The SSBN cannot outrun, outlast, or hide from an SSN pursuer once detected. The SSBN's hopes of evasion lies in either operating so quietly that the SSN loses contact or "spoofing" the SSN into following a decoy.

The United States Navy first successfully trailed a Soviet submarine in 1959. There is evidence that they have continued to do so, especially on intelligence gathering missions connected with operation Holystone. The American SSN USS Gato is reported to have collided with a Soviet submarine it was following off of Murmansk in 1968. According to the report, the Soviet submarine was not aware it was being followed until the collision occurred. There have been reports of at least nine collisions between American SSNs and Soviet ships, including one in which the USS Pindato collided with a Soviet Yankee class SSBN off of Petropavlovsk.¹⁶

American SSNs mount two types of ASW weapons. The first, known as SUBROC, is a missile which is launched from a standard torpedo tube. After being expelled from the tube by compressed air, the engine ignites and it rises out of the water, flies through the air at supersonic speed to the approximate location of the target, and releases an atomic depth charge. The range of this weapon is approximately 30 miles, and the nuclear warhead can destroy a target approximately one mile from the epicenter of the explosion.¹⁷

Torpedoes are also used as ASW weapons. There are currently two types of torpedo deployed aboard American SSNs. The Mark-45 ASTOR is the older of the two. It is a one-ton, wire-guided torpedo

with a range of ~~between~~ eight and fifteen miles, and which carries a nuclear warhead. Mark-48 is a more sophisticated torpedo which has its own active/passive sonar system and a wire-guidance system which allows it to use information from the submarine's sonar for guidance systems as well. The Mark 48 carries a conventional warhead, and has a range of about twenty-five miles. The Americans have initiated a program to upgrade this torpedo's performance even further.¹⁸

The logistics of SSN deployment can be difficult when trying to establish SSBN trailing operations. Without the benefit of intelligence from other sources, the SSN must travel from its home port to a station off of the SSBN port and loiter there until an SSBN should happen to leave. This would usually use up large portions of the SSN's patrol time, thus cutting down the amount of time it can spend trailing the SSBN. If other intelligence is available the SSN can be guided to the area where an SSBN has been detected and begin trailing operations in the open ocean. However, the SSN must still spend time reaching this station and searching for the reported SSBN.¹⁹

Under wartime conditions, the rule of thumb for attack submarine deployment is that one-third are on station, one-third in transit, and one-third in port. In peacetime the US generally has about 20% of its SSNs at sea on forward deployment at any given time.²⁰ This means that, typically, the United States has about twice as many SSNs at sea (about fourteen) as the Soviets have SSBNs (about seven).

It is difficult to determine whether or not this ratio of forces at sea poses a first strike threat to deployment Soviet SSBNs. Yankee and Hotel class SSBNs are certainly at risk because they must transit

the GIUK gap in the Atlantic or cross the bulk of the Pacific to get to their patrol areas. Thus they must use up substantial amounts of their patrol time getting to station (which is limited by the supplies on board not the range or the ship) meaning they would have less time actually on station. The intercepting SSN would have a shorter distance to travel, would use up less of its effective patrol endurance, and could thus outlast the SSBN it was trailing. In addition these submarines must cross sonar barriers which provide intelligence to the Americans on their movements, thus making it possible for SSNs to intercept them in the open ocean instead of near their home ports.

The ability of Delta-class SSBNs to patrol close to their home waters makes the logistics of trailing them more difficult. The American SSN must go farther to reach the SSBNs patrol area using up more of his patrol time in the process. These SSNs may also have less intelligence information to work with in locating the Delta SSBNs in waters close to the Soviet Union. However, American SSNs have demonstrated the ability to extend their patrol time and operate up to the coastal areas of the Soviet Union. The reported collisions involving the USS Gato and USS Pindato is evidence that trailing operations near the Soviet Union are at least possible if not regularly carried out. As long as the Soviets continue to deploy only 11% of their SSBN force at sea, the potential exists for the United States to achieve a first strike capability against the SSBNs at sea with its SSN force. One analyst has gone as far as to say that Soviet SSBNs "are ineluctably exposed to the threat of highly advanced American hunter/killer submarines, and hence permanently vulnerable."²¹

The Soviet Union has no broad ocean detection or tracking system

remotely comparable to the American network of sea-based sensors. The Soviet Navy operates with a number of profound disadvantages in this regard. The first problem is that neither the Soviet Union nor any of its allies are littoral to any of the major sea areas where American SSBNs are likely to patrol, with the exception of the Western Pacific. There is no place for the Soviets to place fixed underwater listening stations capable of monitoring the northern ocean basins.

Second, American SSBNs are extremely quiet. The SSBNs in the American fleet are reported to radiate less than one milliwatt of sound omni-directionally into the ocean when on patrol. This makes passive acoustic detection extraordinarily difficult.²²

A final problem which should not be overlooked is the history of the Soviet Navy. The primary role of the Soviet Navy has traditionally been the protection of the Soviet mainland against attack. Until the development of the Polaris A-3 and Poseidon C-3 SLBMs, the Soviet Navy had never needed to project forces more than 1500 miles from the Soviet coastline. Because there had never been a need for it, the Soviets had no "blue ocean" naval tradition or capability to which they could tie ASW efforts.

The Soviet Union has deployed acoustic sensors in their own coastal areas. A system was installed along the Pacific coast of the USSR at the end of World War II and has presumably been upgraded since then.²³ The Soviets have also deployed moored acoustic sensor arrays known as "spy bins" consisting of thirty-two hydrophones off of their northern coast, in the Norwegian Sea, and reportedly in the Arabian Sea. However, it seems clear that these acoustic detectors have limited capabilities, and are not used for broad ocean surveillance.²⁴ Instead the Soviets

seem to rely on surface intelligence gathering ships to keep track of American submarines in broad ocean areas.²⁵

Since 1965 the Soviets have also been investigating the use of orbiting satellites as broad ocean ASW detectors. Acoustic detection of submarines requires receptors be placed in the water, something a satellite obviously cannot do. Therefore, the Soviets have been concentrating on the ability to detect other phenomena caused by the passage of submerged submarines through seawater. Phenomena that the Soviets claim are detectable from satellites include changes in ocean surface temperature resulting from the displacement of cooler water by a submarine's propeller, alterations in wave patterns caused by submarine passage, biological tracks of dying microorganisms left in the wake of submarines, and modifications in the ultraviolet radiations of the seawater. These sea state changes create hydrodynamic signatures, some of which change "the radar reflective properties on the surface of the sea."²⁶ Detection of such changes would require the mounting of millimeter-band radar aboard satellites. The Soviets are currently launching a series of sea-surveillance satellites, but whether they mount such radar is unclear.²⁷

A system of sea surveillance satellites with this type of radar capability would result in a broad ocean surveillance capability, but the "false alarm" rate for such a system would certainly be extremely high. Constant changes in weather, sea temperature, currents and other oceanographic phenomena would certainly either create false submarine sightings or mask the presence of submarines that do exist. Further, such a system would not produce crucial data needed in distinguishing one type of submarine from another. Hydroacoustic sonar detection,

especially passive systems, can read a sound "signature" of a submarine which can often differentiate not only the nationality and class of submarine, but the actual individual ship. There is no indication that satellite-based sensors could develop this degree of discrimination as a broad ocean surveillance system, which would severely limit their ability to select out SSBNs for a first strike attack.

Such a system could be used in conjunction with other intelligence to indicate high-probability areas where American SSBNs are suspected to be hiding. These areas could then be searched by Soviet SSNs. However, Soviet dedication to using their SSNs to track American SSBNs is by no means clear. Soviet Admiral A. I. Sorokin has stated that "naval experts...are inclined to think that the most powerful enemy of an atomic submarine is another atomic submarine," and Soviet SSNs have deployed off of the American SSBN base at Holy Loch and attempted to follow SSBNs as they leave on patrol.²⁸

However, the Soviet SSN force remains relatively small. They only deploy about forty SSNs in their entire fleet. Of these forty SSNs, five are of the Echo I class which has been considered a failure by Western analysts, and thirteen are November class submarines which are considered very noisy and which are nearing the end of their hull life. The remaining SSNs are of the Victor- and Alpha-classes. There are three versions of the Victor class SSN. Victor I (16 deployed) is a very fast (33 knots, submerged) submarine which carries only torpedoes as armament. Victor II (six deployed) and Victor III (two deployed) are somewhat larger versions of Victor I believed to mount the new SS-N-15, an ASW missile with capabilities similar to Subroc. Victors have been delivered since 1968 at a rate of two per year, a rate which continues

today. This represents a relatively, and curiously, slow building program, particularly given the emphasis placed by the Soviet Navy on ASW and the "counter-Polaris task."

The building program of the new Alpha SSNs is similar to that of the Victor. The Alpha (four currently operational) is an advanced SSN with a deep diving capability, speeds reported in excess of forty knots, and the SS-N-15 missile system. However Alphas are being built at a rate described as "slow series production," which does not indicate that the Soviets feel an urgent need to put these submarine on the line.

The Soviets are also currently reinforcing their SSN fleet by removing the SLBM tubes from their Yankee class SSBNs and converting them to use as SSNs. At least three Yankees have undergone such a conversion. However, the Yankee series represents a relatively old submarine technology, and should be less effective in a counter-SSBN role than either the Victor or Alpha. Their operational lifetimes will also be lessened by time already spent in their SSBN incarnation.²⁹

The characteristics of the new Victor and Alpha class SSNs, and of the overall Soviet submarine building program, do not seem to indicate a purely, or even primarily, counter-SSBN role. American analysts have noted that in designing SSNs the Soviets have apparently sacrificed quietness and sensor capability in order to gain speed.³⁰ However, American SSBNs on patrol operate at very slow speeds in order to avoid detection. Although capable of speeds approaching 30 knots submerged, speeds above about 14 knots cause additional cooling machinery around the SSBNs reactor to activate significantly increasing the sound the submarine produces and thus its detectability. Trailing an SSBN requires

stealth so the SSBN does not detect its pursuer and take evasive action before the SSN comes within sensor range.

If intended primarily for the counter-SSBN task, the Soviet SSNs appear to be designed backwards. However, if designed to pursue ships of all types, surface and submarine, the Victor appears to represent an adequate compromise. As an SSN it retains its advantages as an ASW platform, both in terms of sensor capabilities and ASW weaponry. Its speed would make it a potent threat to convoys and naval task forces. They could also be used to chase down SSNs trying to penetrate into waters the Soviets wished to control. This is particularly true of the Alpha, its deep diving capability making it capable of pursuing the new American Los Angeles class SSNs.

Another curiosity which brings into question the dedication of the Soviet SSN as primarily a counter-SSBN weapon is the apparent pattern of deployment of the SS-N-15 Subroc-type missile. While there are indications that this system has been installed aboard Victor IIs, and Alphas, there is also evidence to indicate it is aboard an equal or greater number of new Tango-class diesel-powered submarines.

Western analysts believe that the Tango is designed as a patrol submarine for the defense of shallow waters off of the Soviet mainland where nuclear submarines would be less effective. The deployment of an advanced ASW weapon system on a new, advanced patrol-class submarine designed to operate closer to home indicates a high priority concern for ASW forces not designed for counter-SSBN tasks. The reason for such a concern will be discussed later.

The SS-N-15 is also apparently being deployed aboard new Charlie-class cruise missile attack submarines. This could either mean that

these Charlies will be used to supplement Soviet SSNs in an aggressive ASW mission. However, it seems more likely that this is simply adding a new capability in support of the sea-denial mission currently assigned to the Charlie force. It will now be able to practice sea-denial against both surface and submarine forces.³¹

In addition to technical problems, the Soviets have tremendous logistical problems in using SSNs as a counter-SSBN system. One is their lack of SSNs. They simply cannot keep enough SSNs at sea to trail all 17-20 American SSBNs at sea on patrol. Another is the distance between Soviet SSN bases and American SSBN bases. For example, a Soviet SSN would have to sail for 15 or more days out of Murmansk just to get into position to loiter off of the SSBN base at Kings Bay, Georgia, waiting for an SSBN to follow. The use of satellite or other intelligence data would probably not cut much off this time.

In 1969 the Soviets began and then aborted a project designed to establish a submarine base at Cienfuegos, Cuba. Establishment of such a base would have greatly upgraded Soviet SSN capabilities against the Poseidon fleet operating from South Carolina and Georgia. Transit time from port to station would be reduced to three to four days. However, this project was cancelled by the Soviets due to the American reaction to the building of this base.³²

It is reasonably clear that the Soviet SSN force alone will not pose a disarming first strike threat to the American SSBN force at sea in the near future. It is, however, the most potent current threat to deployed American SSBNs. Given the Soviet doctrinal commitment to damage limitation strategies, continued use of Soviet SSNs to attempt to track American Polaris/Poseidon/ Trident submarines must be expected as part

of a broader effort to try to neutralize the threat that they pose. However, unless supported by a breakthrough in broad ocean detection capabilities, this would not seem to pose an immediate threat to the American SSBN force.

There is one other broad ocean threat to American SSBNs hinted at in Soviet writings. This involves the possibility that submarine- or land-based ballistic missiles would be used to attack submarines in mid-ocean. Some Western analysts had thought that an SLBM being tested by the Soviets, the SS-NX-13, might be designed for such a mission. It had a range of about 300 miles, mid-course guidance correction capability, and could be launched from Yankee submarine SLBM tubes.³³

The SS-NX-13 was shelved by the Soviets in favor of the SS-N-6, but the principle behind the speculation is still sound. For example, a 200 kt warhead exploded in deep water would produce a peak overpressure in the sea of 500 pounds per square inch at a range of up to 6,000 yards. This could be expected to crush or severely damage the hull of a deeply submerged submarine. Even without actually sinking the submarine, a "cheap kill" could occur through shock damage to vital electronic or navigation systems, by buckling the covers to the missile tubes so they wouldn't open.³⁴ Either side could use existing missile systems to good effect in terms of area attack this way. However, as far as is known, neither side has attempted to modify any of their strategic systems to be used this way. Only the Soviets are seriously suspected of considering this strategy, generally by strategists who cite their lack of other options.

The problems in developing this kind of capability are enormous. In order to develop the real time response capability needed to make such a

strategy effective the following problems must be solved. First, the broad ocean ability to detect and discriminate between targets must exist. The false alarm and identification problems inherent in the types of satellite systems the Soviets are thought to be developing have already been cited.

Second, a system must be developed for a virtually instant translation of the sighting information into fire-control data for a large number of missiles. Such a system would have to sort and assign sighted targets to available missiles, and be linked into a missile retargeting system which could retarget in a very few minutes. The latest Minuteman retargeting process takes 30 minutes, even with the advantage of having fixed targets preprogrammed. Even assuming this retargeting time could be retained, a submarine moving at 10 knots would have changed position by up to five nautical miles between the time the reprogramming began and was finished.

Third there is the matter of flight time for the attacking missiles. Assuming it would take a missile 15 minutes to reach a target, the submarine still travelling at a modest ten knots, would have moved an additional 2.5 nautical miles. A submarine running for its life (30+ knots) would have gone 7.5 nautical miles while the missile was in flight. The simple expedient of periodically and randomly changing course and speed would reduce the probability that this movement could be compensated for by extrapolation of past maneuvers.

The scope of this problem in practical terms is mind-boggling. The alternative is to select high probability areas for SSBN patrols and launch massive barrages of nuclear warheads against them. However, this leaves the attacker without any real knowledge of how many SSBNs have

been attacked and killed, if any. Barrage attacks would provide a measure of preemptive damage limitation, but it seems inadequate to represent a realistic first strike threat.³⁵

In summary, broad ocean ASW requires an extensive ocean surveillance capability, coupled to a means of delivering ASW weapons against the target submarine if necessary. The most effective way to do so is to assign SSNs to trail patrolling SSBNs. Both superpowers utilize SSNs in a counter-SSBN role, but the United States has an enormous advantage because of its ability to deploy broad ocean surveillance sonar systems around the ocean basins of the Northern Hemisphere. These systems can provide valuable intelligence to SSNs on the location of SSBNs in transit and on patrol. Based on the size and capabilities of the American SSN fleet, the low percentage of the Soviet SSBN force at sea at any one time, noisy Soviet submarines, and recent developments in American ocean surveillance capabilities, it is not impossible that the Americans will have a first strike capability versus Soviet SSBNs at sea in the relatively near future. Soviet disadvantages in broad ocean sensor systems, the size of its SSN fleet, the logistics of SSBN trailing operations, and a lack of viable alternative options makes the reciprocal threat unlikely, but a degree of success with a damage limiting strategy is possible.

Area Search

The second type of ASW operation to be discussed will be referred to as area search. As the name implies, this involves the ability to localize and attack a submarine within a given area. This type of operation is the province of specially equipped ASW aircraft, both airplanes and helicopters. These are based either on land or on ships. Each of these aircraft is capable of acting as a self-contained ASW weapons system equipped with

both detection gear and weapons. The chief advantages of airborne ASW operations are the ability of these forces to react quickly to a target sighting and the inability of the hunted submarine to detect its pursuer. The drawbacks are the generally limited range of the sensors aboard these aircraft and their inability to stay on station for extended periods of time.

The best counter-SSBN area search system is the long-range patrol airplane, designated as VP. Both of the superpowers use this type of airplane for ASW operations. Figure III-5 describes a VP operating pattern. The VP currently deployed by the United States is known as the P-3C Orion. This is a propeller driven plane which has a flying range of 4800 miles and the ability to stay in the air for over 14 hours. As a result it can fly over 1000 miles to a patrol station and stay on patrol for seven hours before being forced to return to base. This time can be extended by allowing the VP to return to a different base if that base is closer to the patrol area.³⁷

The Orion carries a wide variety of detection equipment. Until recently the sonobuoy being carried was a basic hydrophone system known as LOFAR. This system has a theoretical passive range of two hundred miles, though it is reliable only to about one hundred miles. This system is in the process of being replaced by a much more sophisticated system known as DIFAR which has a longer range, a sophisticated direction finding capability, and variable depth deployment capability of up to 800 feet. Each Orion can carry at least 87 of these sonobuoys. These sonar devices are supplemented by variable depth bathythermograph recorder which feeds the Orion's computer information on sea conditions that effect sound propagation in that area. The Orion can currently

Figure III-5: Patrol airplane ASW search pattern

○ Sonobuoy

This figure describes a search pattern flown by patrol airplanes (VPs) on ASW missions. In this figure, the VP flies a clover-leaf pattern dropping sonobuoys at intervals of about two nautical miles apart. For the final run on an attack, active systems may be used to pinpoint the target. The clover-leaf pattern also allows the VP to make efficient use of its magnetic anomaly detection equipment to help in pinpointing the target submarine's position.

Other sonobuoy array patterns are also used. For longer range, purely passive detection, sonobuoys are often laid in simple linear arrays.

a) From Alfred Price, Aircraft vs. Submarines, p. 223.

monitor 31 sonobuoys simultaneously, and is undergoing an upgrading program that will allow it to monitor 99 sonobuoy channels. A system known as A-NEW has coordinated these new sensors with sophisticated signal processing equipment which digests all the incoming data and displays the target solutions to the crew.³⁸

The Orion's sonar capabilities are supplemented by other non-acoustic ASW sensors. One is a Magnetic Anomaly Detector (MAD) which detects distortions in the earth's magnetic field caused by the metal hull of a submarine at ranges of up to 1000 yards. Another includes either a Forward Looking Infrared (FLIR) detector or a low-light television system capable of detecting a "thermal scar" caused by the discharge of hot water from the cooling system of a nuclear submarine operating near the surface). Orions also carry sea-scanning radar capable of detecting exposed periscopes, snorkels (for diesel submarines), or radio antennae.³⁹

The P-3C is also capable of mounting a wide variety of weapons ranging from depth bombs (some nuclear) to torpedoes to mines. A typical weapon load would be eight Mark 46 torpedoes and eight Mark 57 or Mark 101 nuclear depth bombs. One of these weapons, the Mark 46 torpedo merits special attention because of its wide use in other ASW systems. The Mark 46 is a lightweight torpedo which carries a conventional warhead, has a range of about twenty miles, a speed of about fifty miles per hour, and a dive depth of 2500 feet. It carries a sophisticated active/passive sonar guidance package with a target acquisition range of about one kilometer. This torpedo also has a reattack capability. If it misses its target the first time it will circle back and try again.⁴⁰

The United States currently operates 260 P-3s in 24 squadrons from airfields near Soviet SSBN bases and the choke points Soviet SSBNs

and attack submarines must transit to reach patrol stations.⁴¹ This provides a significant supplement to American broad ocean ASW capabilities, further threatening Soviet SSBNs, particularly those that must venture far from home waters on patrol.

Aside from the ongoing improvements in sonobuoy capabilities being brought on line, the Americans are also continuing research and development in non-acoustic ASW sensors for aircraft. There are hints of advances in magnetic anomaly detection. There is also work being done on laser detection and communications equipment under the Optical Ranging, Identification, and Communications (ORICS) project. This system, which utilizes laser light in the blue-green spectrum, has reportedly been successful in detecting submarines from helicopters at the American ASW research station in the Florida Keys.⁴²

The Soviet Union currently operates three land-based patrol aircraft on ASW missions. The Tu-95F "Bear" is the longest-range, and thus most broad-ocean capable, of these aircraft. It is a four engine turbo-prop originally designed as an intercontinental bomber. It has an operational range of between 8-9,000 miles and carries a large number of sonobuoys and radar, but there is no evidence of any MAD capability. These planes operate round-trip patrols from the Soviet mainland though Bears of other types have operated between the USSR, Cuba, and Guinea. As of 1979, it was reported that the Soviets operated only thirty Bear-type aircraft in this "F" configuration.⁴³

The second area search airplane operated by the Soviets is the Be-12 Tchaika known to NATO as "Mail." This is a twin engine amphibious airplane first introduced in 1961 which still holds 17 records for flying boat performance. The Mail has a range of 2500 miles and an operating speed of

200 mph. Its ASW sensors include MAD and radar equipment. The Mail also carries various combinations of depth bombs, torpedoes, and mines internally and on the wings and operates with the North Sea, Baltic, and Black Sea fleets over the Atlantic and Mediterranean. It is believed that about 100 of these planes were built, and about 90 are still in service.⁴⁴

The Mail is gradually being replaced as a medium range ASW patrol plane by the Il-38 "May." This plane is very similar to the P-3 Orion. It is a four engine turboprop with a range of about 4500 miles, a maximum cruising speed of 400 mph and a flight endurance of 15 hours. The May carries radar, MAD, a large number of sonobuoys and "other sensors." It also reportedly carries an onboard computer to do tactical calculations. The weapons capability of the May is a matter of some dispute. No specifics are available on its weapons payload, and one source claims it does not carry any weapons (which seem highly unlikely, but would add fuel to the speculation the the Soviets intend to use ballistic missiles as ASW weapons). There are between fifty and sixty Il-38s believed to be operating with Soviet naval units. They primarily patrol the North Atlantic and Mediterranean, though some have been assigned to the Pacific fleet.⁴⁵

The Soviets are also developing a wing-in-ground (WIG) effect aircraft known as Ekranoplan (Western analysts have nicknamed it the Caspian Sea Monster) which could be developed as an ASW platform. The WIG effect would allow this plan to operate with enormous efficiency at altitudes of 30-50 feet. It could also reportedly carry a pay load of 250 tons for 5000 miles at speeds of 100 mph and up. It has been tested at speeds in excess of 300 mph. Reducing the payload could

increase time on station to periods on the order of days, which would greatly enhance the Ekranoplan's ASW capability.⁴⁶

Soviet literature also discusses a laser ASW sensor which sounds similar to the system being developed by the Americans under the ORICS project. This sensor can reportedly scan the ocean to depths of over 430 feet at a speed of 100 mph. There is no evidence that this system is currently deployed.⁴⁷

The patrol planes of the Soviet naval air arm are probably not much of a threat to American SSBNs for reasons relating to equipment, range and numbers. There is no evidence in the literature that either the Bear F or Mail ASW aircraft has an on-board computer for processing sensor data. The importance of such a system cannot be overestimated in developing an effective ASW patrol aircraft. Without it the tactical coordinator must personally process and interpret an bewildering array of data using only charts, graphs, and slide rules. This magnifies the chances of missing or losing a target enormously, particularly a fast, quiet nuclear submarine.⁴⁸ The Il-38 May is reported to carry a tactical computer, but the chances that it is at all comparable to the system aboard the P-3C Orion seem slight.

The May and Mail aircraft have a problem of range as well. For both of them, their operational radius from bases in the USSR is less than the range of the Poseidon missiles on the SSBNs they hunt. Not only would they lack time on station to locate and track and SSBN, but in many cases they are not even be able to reach the SSBN's patrol area at all.

Finally, logistically, there are not enough of them to track 20 SSBNs at sea. The time to patrol area is too long and the time on station

and sensor range too short and rotation of tracking planes too difficult for 85 long range and 100 short range planes to cover the ocean well enough to constantly find and track 20 SSBNs that are trying their best to hide. American land-based patrol planes are far more of a threat to Soviet SSBNs than vice versa.

Unlike the Americans, the Soviets also operate land-based helicopters in an ASW mode. Because of extreme limitations on range these helicopters are primarily used for coastal defense. Evidence that the Soviets consider this a high priority ASW capability can be found in the introduction of the new Mi-14 "Haze." These helicopters are equipped with radar, an advanced towed MAD detector, and has an amphibious capability. There are over seventy Haze helicopters now in service, and they are being introduced at a rate of twenty-five per year.⁴⁹

Barrier Operations

A "barrier" type of ASW operation involves cutting off the transit of enemy submarines through straits or other relatively narrow sea areas. ASW forces are concentrated on the constricted area of the strait in to ambush any enemy submarine that attempts to pass. Any type of ASW equipment can be adopted to serve in a barrier operation.⁵⁰ Submarines can be assigned limited areas in which to patrol, patrol aircraft can conduct area searches in portions of the narrows, and even surface ships can be assigned a patrol area. (e.g., see Maps III-3 and III-4). However, there is one sort of ASW weapon particularly suited for this task, the mine.

The United States is currently developing or deploying several types of ASW mine. Perhaps the most impressive is the deep water ASW

Map III-3: Possible barrier patrol stations in the GIUK gap

- Sonar listening posts
- Submarine barrier patrol areas
- Route of Soviet Northern Fleet submarines into the Atlantic Ocean and North Sea.

The figure above shows a possible barrier configuration combining SSN patrol areas with fixed undersea sonar stations designed to intercept Soviet submarines transiting the GIUK gap. This multiple barrier configuration allows for SSNs in zones to back up those in the five forward zones, while minimizing the risk of mutual interference by establishing relatively short common boundaries. The zones are numbered in the approximate order of their importance.

a) From Frank Leary, "The Anti-Sub submarine" Space/Aeronautics July 1966, p. 61.

Map III-4: Possible barrier patrol stations in the Pacific

Sonar listening posts

Submarine barrier patrol areas

Routes of Soviet submarines into the Pacific from bases in Vladivostok and Petropavlovsk.

The figure above describes a possible barrier configuration combining SSN patrol areas with fixed underwater sonar stations designed to intercept Soviet submarines in transit to the Pacific. The patrol zones are numbered in the approximate order of their importance.

- a) From Frank Leary, "The Anti-Sub Submarine" Space/Aeronautics July 1966, p. 62.

mine known as CAPTOR. CAPTOR consists of a Mark-46 torpedo encapsulated in a casing containing a small signal processing computer. This computer is capable of processing sounds from the mine's hydrophones, recognizing the particular sounds of Soviet submarines, and launching the torpedo, which then pursues and attacks the target. The sensor range of this system is reported to be up to one kilometer, and it can be moored to the bottom in up to 3000 feet of water. It has been estimated that 1000 CAPTOR mines placed in the GIUK gap could sink up to 50% of the Soviet submarine fleet trying to transit the gap. These mines can be deployed from aircraft, surface ships, or submarines. One thousand CAPTORs have been procured by the American navy.⁵²

Another mine being developed for use in intermediate depths is the propelled ascent mine (PRAM). This mine sits on the bottom until a submarine or surface ship passes over it. Then the mine's warhead is propelled to attack the ship above it by a rocket motor. It is expected that this mine will be particularly effective in narrow channels. PRAM is designed to be deployed by submarines.

The final type of ASW-capable mine is the submarine-launched mobile mine (SSLM) being developed in conjunction with a program known as Quickstrike. This is a shallow water mine capable of being deployed covertly by a submarine at stand-off distance. The project is essentially the conversion of old Mark 37 torpedoes into mines.

Finally the Americans are developing a system which can turn mine-fields on and off by remote control. This project, known as RECO, is apparently designed to operate primarily with the CAPTOR system.⁵³

The Soviets have traditionally had mines. They maintain what American analysts have termed "an almost mind-bogglingly high" number of mines

in their inventory.⁵⁴ Details of the actual characteristics of Soviet mines are hard to come by, but they are reported to have "a highly sophisticated mine capability" and are entering the "era of smart mines."⁵⁵ One type of Soviet mine, known as "Cluster Bay," is reported to be a passive listening mine presumably capable against ships and submarines. Another mine called "Cluster Gulf", is an ASW mine which may have a capability similar to CAPTOR in terms of being able to launch a warhead that pursues a submarine.

In the event of a war, both sides could be expected to deploy mine barriers in key passages (e.g., the GIUK gap, narrows in the Mediterranean, entrances to the Sea of Japan, etc.) and as close as possible to enemy naval bases and ports. Both sides could also be expected to use their attack submarines to lay minefields in forward areas.

Point Defense

The last type of ASW activity is known as point defense. It involves protecting high value targets at sea from attack by submarines. Traditionally, this has meant merchant shipping and naval warships, but other high value targets such as off-shore oil drilling equipment may require ASW protection in the event of a limited war.

To be effective, point defense ASW need only keep the area immediately around the target free of enemy submarines. The size of the area to be defended depends on the range of the weapons being carried by the enemy submarine. The Soviet submarine fleet has two types of anti-shiping submarines, one designed to carry cruise missiles (SSGN) and attack submarines (SS and SSNs) equipped only with torpedoes. The older Soviet SSCMs carry missiles with ranges of over 300 miles (the SS-N-3), however these missiles must be launched from the surface and have no

self-contained terminal guidance capability. They require the assistance of ships or aircraft in the area for midcourse guidance corrections. Besides being a cumbersome system this means that neutralizing the ship or airplane assisting the missile can significantly degrade the SS-N-3's performance. This system is now considered obsolete, and it is being replaced by the new SS-N-12, which has a similar range but which also has a more sophisticated internal guidance and target acquisition capability. Another new Soviet submarine-launched cruise missile, the SS-N-7, can be launched from a submerged submarine and has a significant internal terminal guidance capability, has a range of only about 30 miles. Soviet torpedoes have a range of about 20-25 miles.⁵⁶

American attack submarines are only now beginning to be fitted with the Harpoon anti-ship cruise missile. It has a range of about one hundred miles and full internal terminal guidance capability. The bulk of the American SSN anti-ship potential is in its torpedoes which have ranges of up to 25 miles at speeds of over 40 knots.

Thus, for the Americans, an ASW point defense effort would be considered effective if it could keep Soviet submarines more than three hundred miles from the target, and neutralize or destroy those that penetrate within that range. The Soviet problem is somewhat simpler because they need only protect an area one hundred miles in radius.⁵⁸

There are a multitude of ways to arrange point defense ASW efforts. The best technique is to arrange to stay hidden from the submarine. Speed is a big help here. A fast moving target is enormously more difficult for a submarine to intercept than a slow one. This is especially true where the submarine is only equipped with torpedoes. Cruise

missiles travel fast enough that the relative speed of the target becomes insignificant. The launching submarine can operate effectively anywhere within a roughly circular range. But torpedoes are much slower, and may have a speed only 5-10 knots greater than the target they are launched against. A torpedo launched from behind a fast fleeing target from long range may exhaust itself before it can close on its target. Thus, the faster the target the more important it is for the submarine to establish an attacking position in front of the ship. Speed complicates this process as well, because the submarine may be only a few knots faster than its target, and in some cases may even be slower.⁵⁹

Most of the ships capable of using speed to this kind of advantage are warships, which also have other ways of defending themselves which will be discussed later. But there are also techniques for hiding slower ships such as merchantmen. The chief adjustment in merchant shipping patterns for ASW purposes is the formation of convoys. Convoys not only make it easier to protect large numbers of ships with naval escorts, they also "empty the oceans" of targets. Instead of many targets there is only one. This means that fewer deployed enemy submarines are likely to encounter these ships and their ability to attack all of the targets in the convoy would be lessened. The increase in electronic underwater acoustic and satellite surveillance techniques makes it harder for convoys to hide, but these techniques can be countered to a degree by maintaining radio silence, and routing convoys to take advantage of water conditions that baffle the noise of the convoy, making use of weather fronts to hide the convoy from satellites, and utilizing intelligence information on the positions of Soviet forces reported by

SOSUS.⁶⁰ There has also been discussion of placing ASW helicopters on high-value merchant ships to provide them with a defensive capability.⁶¹

Merchant convoys could also be rerouted to travel as far from enemy submarine bases and as close to friendly shores as possible. (See Map III-5). However such rerouting can significantly increase the time it takes to cross the ocean. For example, for the route shown on Map III-5, the delay could be up to 10 days for an Atlantic crossing. This could be a critical delay in responding to a crisis situation (e.g. a Warsaw Pact attack on the NATO Central Front).

Modern weaponry has also created a significant drawback to the convoy system of protecting merchant ships. By concentrating these ships together to defend them against submarine attack, they become tempting targets for ICBM or intermediate range ballistic missile attacks. Further, all seaborne reinforcement and resupply efforts can be degraded by destroying the ports of destination.⁶²

ASW point defense for a target that has been located depends on a defense-in-depth principal. The single highest-value target on the seas is an American nuclear powered aircraft carrier (CVN). When accompanied by its escorts, it is also the best protected against attack by submarines. The CVN itself carries squadrons of ASW capable aircraft, both airplanes and helicopters. The airplanes, S-3A Vikings (replacing S-2 Tracker), provide the longest range protection. They have an operational range of about 2000 miles, have the same computer sonobuoy and weapons equipment as the P-3C Orion (though they carry fewer sonobuoys and weapons due to a smaller payload) and are capable of incorporating the latest signal processing advances under development. Each CVN carries about ten of these aircraft which fly sonobuoy patterns.

Map III-5: Convoy routes from the U.S. to Europe

This figure displays two possible convoy routes for merchant and naval ships attempting to reinforce NATO. Route A is the most direct and time-effective path (3500 nm.). However, it also passes close to the Greenland-Iceland-United Kingdom gap where Soviet submarine activity can be expected to be heavy. Route B avoids this area, but it is significantly longer (4300 nm.) and would require several extra days of sailing to reach the same destination. This could be a critical factor if prompt resupply of NATO was a critical need.

- a) From Lt. Cmdr. Shaar, "ASW and the Naval Officer Oceanographer"
U.S. Naval Institute Proceedings February, 1978, p.47.

much as the P-3C Orion aircraft do.⁶³

In addition, these CVNs also carry at least one squadron of ASW capable helicopters, usually composed of about eight SH-3 Sea Kings. These helicopters mount MAD detectors, depth bombs, and the Mark 46 light homing torpedoes in a variety of combinations. They also carry a "dunking sonar" which takes advantage of the helicopter's ability to hover in place. This is a variable depth sonar detector which is lowered into the water on a cable to the desired depth. The helicopter can then recover the hydrophone and fly off to another location. Helicopters will often work together in tracking a submarine or sweeping an area. (See Figure III-6). Helicopters can sweep an alley 6 miles wide and 60 miles long in about 2-3 hours. The operational range of the Sea King is just over 600 miles.⁶⁴

American destroyers, frigates and other escort vessels also have an airborne ASW capability provided by light multipurpose helicopters (LAMPS). The current LAMPS helicopter is the SH-2F Seasprite which carries radar, MAD, sonobuoys, and light torpedoes but which has a limited data link and navigation capability. A new LAMPS helicopter (LAMPS III) is in the early production stages with advanced detection and electronic capabilities and should begin deployment soon. One of the advances that was tested in the LAMPS III prototype was a towed array sonar system. The American Navy wants to deploy up to 300 LAMPS helicopters.⁶⁵

American escort vessels also have considerable shipboard ASW capabilities. There are about 160 ASW capable escort ships in the American navy (which could be supplemented by as many as 484 other ships from NATO allies in time of war). These ships mount a variety

Figure III-6: Dual helicopter ASW search pattern

This figure describes a search pattern by two helicopters on an ASW mission. In this search procedure, the helicopters "leap-frog" one another. Helicopter A will hover in position listening for submarine noises while helicopter B flies to a new position ahead of it. Then helicopter B will hover and listen as helicopter A moves forward. When a submarine is located, the helicopter that made contact remains in place until the other can swing around and make contact also. They would then close in to launch an attack.

a) Adapted from Alfred Price, Aircraft vs. Submarines, p. 244.

Text complete; leaf 136 omitted in numbering

of active and passive sonar. The active sonar has a limited range (between 8-12 miles) and is primarily used for fire control purposes because the sound pulse emitted by the sonar in its active phase could betray the ship to a submarine beyond the range of the sonar to detect the return pulse off of the submarine's hull.⁶⁶

Passive sonars deployed aboard surface ships include hull mounted, variable depth, and towed array systems. The hull mounted systems are poor in terms of long range detection due to the noise interference from the ship itself. The variable depth sonars avoid that problem and can boast of detection ranges as great as 35 miles. These sonars are currently being upgraded to this level throughout the American fleet. Further, a towed array system (TACTAS) is also being deployed which is said to significantly improve on this performance. The TACTAS/LAMPS combination will reportedly give American surface ships "an effective organic counter to advanced missile firing submarines."⁶⁷

The chief ASW weapon mounted on American naval escorts is known as ASROC. This is a missile with a range of 6-8 miles which carries a Mark 46 torpedo or a nuclear depth bomb to the target area and releases it. The ASROC system is one of the oldest ASW weapons in the American arsenal, but it is still considered highly effective close in.⁶⁸

The American navy is also working on improving the coordinated use of all of these systems in integrated operations. For example a recent exercise has demonstrated that combined operations between patrol aircraft and LAMPS helicopters resulted in detecting submarines before they reached firing stations 80% of the time.⁶⁹ On a larger scale, a great deal of effort is going into developing an ASW Center Command and Control System (ASWCCCS) to coordinate all the ASW operations of a

Figure III-7: American ASW defense-in depth structure for point defense operations.

T - Target.

Zone A - Terminal defenses (air defense against cruise missiles, sound decoys against homing torpedoes).

Zone B - Close escort defense (surface ships with hull-mounted and variable depth sonar, Asroc and other short range ASW weapons).

Zone C - Close airborne ASW defenses (helicopters, S-3A Viking airplanes for aircraft carriers).

Zone D - Forward defense (P-3C Orion patrols, SSN patrols, forward barrier defenses).

ships mount include the SSN-14 (from tubes rather than launchers), a variety of short-range rocket launchers, and 21-inch torpedoes.⁷³

All of these ships have been described as "large antisubmarine ships," but there is little evidence they are for the type of point defense use by the Americans in protecting convoys. Instead they seem to be dedicated to protecting the waters in which Soviets SSBNs operate. This would probably resemble area defense more than point defense. These ships may be used to support area operations. Their point defense role would probably arise only as a matter of self defense.

Threat Analysis

Based on the capabilities discussed above, the ASW deployments for the superpowers during a time of conflict would probably resemble the following. The United States would immediately take action to cut off the strategic choke points through which Soviet submarines must pass. Minefields would be established in the GIUK gap and around the entrances to the Sea of Japan. These would be supplemented with extensive VP and attack submarine barrier patrols at these points and off of the Kamchatka Peninsula. In addition, American aircraft carrier task forces in the Atlantic would attempt to penetrate into the Norwegian Sea to intercept Soviet naval units as far forward as possible and disrupt any attempt to surge through choke points.

American SSN sorties would attempt to penetrate as deep into the Barents Sea as possible to lay minefields and intercept Soviet submarines (and surface forces) as close to Soviet ports as possible. Similar operations would occur off of the Kamchatka Peninsula. A high priority targets for these forces would be surging Soviet SSBNs.

Finally, other American surface forces would, in conjunction with

NATO forces be forming and escorting convoys across the Atlantic, and possibly the Pacific as well. These forces would include helicopter-carrying frigates and destroyers, and possibly aircraft carrier support groups as well.

This distribution of forces has been described as the "gauntlet approach," and one analyst has claimed that it could cost the Soviets seventy to eighty percent of its submarine force in the first three weeks of a conflict. The Soviet submarines particularly at risk would be those attack submarines and Hotel and Yankee class SSBNs that must cross the American barriers to get to station. They would probably suffer severe attrition. A prompt positioning of American SSNs off of Soviet ports could also result in heavy losses to surging SSBNs. The security of the Soviet retaliatory threat could well rest on the few prepositioned SSBNs already on patrol. Their safety would depend on whether or not they had been previously detected and picked up by trailing American SSNs.

Soviet ASW activities would be focused on an intensive sea-denial effort against American SSNs. Close to Soviet ports there would be intensive ASW activity by coastal patrol craft and land-based helicopters. Beyond ranges of about 150 miles, VPs and major surface units of the Soviet navy would try to safeguard sanctuary areas for Delta (and Typhoon) class SSBNs. These forces would probably try to project these sanctuaries as far as Jan Mayen Island in the Norwegian Sea. These efforts would be supplemented by a massive surge of diesel-powered attack submarines who would establish patrols throughout the Barents, North, and Norwegian Seas, possibly as far forward as the GIUK gap to intercept infiltrating American SSNs and attack NATO naval forces in the area.

The Soviet nuclear-powered submarine fleet would probably have two missions. The first, with possible help from conventional submarines, would be to surpress the NATO barrier forces in the strategic choke points in order to support a surge by Yankee and Hotel class SSBNs. This would include operations against patrolling SSNs by Soviet SSNs, and operations against surface forces by Soviet cruise missile submarines. Having staged a massive breakout, the Soviet attack submarines would deploy to attack targets of opportunity (including naval forces, convoys, or patrolling SSBNs) while the SSBNs would continue on to their firing stations to await orders.

To each side, all of the above missions would be vital, and, although the Soviet forces would appear to be at a significantly higher risk, they provide a threat to the survivability of SSBN forces and thus to the stability of the strategic nuclear balance. The object of an arms control agreement would be to allow each side to pursue its legitimate ASW tasks while safeguarding each side's SSBN forces. It has been demonstrated that ASW is a highly diverse and complicated form of military activity, and this diversity allows considerable flexibility in generating means of tackling these problems. What is necessary is a model of acceptability linking arms control principles and discrete weapons systems before a realistic appraisal of the chances for such an agreement regarding ASW is feasible. The model to be used in this paper is developed in the next chapter.

NOTES: CHAPTER III

1. Testimony of Admiral Holloway, Senate Armed Services Committee, FY'78 Authorizations for Military Procurement, Research and Development, and Active Duty, Selected Reserve, and Civilian Personnel Strengths, p. 940.
2. The United States alone is reported to spend \$6.5 billion (15% of the entire Navy budget) on ASW activity annually. George C. Wilson, "U.S. Leads in Sub-Hunting" Washington Post, May 28, 1978, p. C2.
3. Information on the behavior of sound in water and the technical functioning of ASW sensors comes from SIPRI, Tactical and Strategic Antisubmarine Warfare; Richard L. Garwin, "Antisubmarine Warfare and National Security" in R. Garwin, Arms Control; Frank Leary, "Search for Subs" Space/Aeronautics September 1965; J.P. Craven, "Ocean Technology and Submarine Warfare" Adelphi Papers No. 46; Richard L. Garwin, "The Interaction of Antisubmarine Warfare with the Submarine-based Deterrent," and Kosta Tsipis, "Underwater Acoustic Detections" in Kosta Tsipis, et al. (eds.) The Future of the Undersea Deterrent. These sources are supplemented as noted below.
4. For example, the sound emission of American nuclear submarines increases significantly when they accelerate past 14 knots because additional cooling systems begin pumping in the nuclear reactor. (Confidential interview).
5. Interview with Donald Grant, Operational Research and Analysis, Canadian Department of National Defense. May 6, 1978.
6. E.W. Seabrook Hull, "Search and Destroy" National Defense, January/February 1977, p. 282; SIPRI Yearbook: 1975, p.111.
7. Data on SOSUS from SIPRI, Antisubmarine Warfare, pp. 29-30, p. 80; Robert C. Aldridge, The Counterforce Syndrome pp. 35-36; Kosta Tsipis "Antisubmarine Warfare - fact and fiction" New Scientist January 16, 1975, pp. 146-147; "Seventh Fleet's New Asian Role" Far Eastern Economic Review, p. 29; Leary "Search for Subs," Space/Aeronautics, September 1965, pp. 59-66.
8. Duncan Campbell "Sabotage, Submarines and the Secret Norwegian Connection" New Statesman June 2, 1978, pp. 730-731.
9. SIPRI Antisubmarine Warfare, pp. 30, 81.
10. E.W. Seabrook Hull "Hunter and Hunted" National Defense March-April 1977, p. 380; Aldridge, Counterforce p. 36; Senate Armed Services Committee, FY'78 Authorizations p. 5471; Tsipis, Anti-Submarine Warfare, pp. 30, 80.
11. SIPRI Antisubmarine Warfare, pp. 30, 81. Hull, "Hunter and Hunted," p. 380.

12. Secretary of Defense, Annual Defense Department Report, FY 1978, p. 200; Senate Armed Services Committee, FY'78 Authorizations, p. 5585; E.W. Seabrook Hull "The Surface Ship and ASW" National Defense, January-February 1977, p. 287.
13. Aldridge, Counterforce, pp. 36-37. Supporting evidence can be found in "Seventh Fleet" FEER, p. 29; Department of Defense, Program of Research, Development, Testing and Evaluation, pp. IV-73, 74. Senate Armed Services Committee, FY'78 Authorizations, pp. 5423-5608. Another analyst has maintained that Iliac-4 only identifies areas where submarines might hide rather than actually detecting them, Kosta Tsipis, "New Technologies and New Weapons Systems" in David Carlton and Carlo Schaerf, Arms Control and Technological Innovation.
14. These are the Soviet estimates of American DQQ-Z capabilities. Norman Polmar "Thinking About Soviet ASW" U.S. Naval Institute Proceedings May 1976, p. 124. Corroboration can be found in SIPRI Yearbook: 1975, p. 109.
15. Senate Armed Services Committee, FY'78 Authorizations p.5470; This system may be supplemented by a towed array system with countermeasure capabilities, SIPRI Antisubmarine Warfare, p. 70; Hull "Hunter and Hunted," p. 379.
16. SIPRI Yearbook, 1977, p. 76; Seymour Hersh "False Report Alleged in Sub Crash" New York Times July 6, 1975, p.1.
17. Hull, "Hunter and Hunted," p. 379; SIPRI Antisubmarine Warfare, p. 87; Aldridge, Counterforce, p. 41. Senate Armed Services Committee, FY '78 Authorization p. 5472.
18. Aldridge, Counterforce pp. 40-41; Hull "Hunter and Hunted," p. 379; Doug Richardson "World Missiles Directory" Flight International May 14, 1977, p. 1338. Jane's Weapons Systems, 1978, p. 839; Senate Armed Services Committee, FY'78 Authorizations, p. 5472.
19. See Polmar, "Thinking About Soviet ASW," pp. 122-123.
20. U.S. Navy, Nuclear Power: Challenge and Future 1980, p. 7.
21. Edward Wegener, The Soviet Naval Offensive, p. 66. It should also be noted that American warfighting doctrine involves engaging Soviet naval forces as far forward as possible, and are presumably developing this capability, Senate Armed Services Committee, FY'78 Authorizations, p. 1944.
22. SIPRI, Antisubmarine Warfare, p. 29.
23. SIPRI, Antisubmarine Warfare, p. 81. A Soviet writer claimed these are acoustic and magnetic sensors with a range of 100 miles (Polmar, "Thinking About Soviet ASW," p. 123). These are of a type that is clearly for near zone coastal defense (K.J. Moore "Antisubmarine Warfare," in Micheal McGwire and John McDonnell, Soviet Naval Influence:

Domestic and Foreign Dimensions, pp. 126-27.

24. Polmar, "Thinking About Soviet ASW," p. 124.
25. U.S. Admiral Rickover apparently thought these ships could jeopardize the security of the Polaris force, but his opinion is not widely shared. (Senate Armed Services Committee, FY'78 Authorizations, pp. 6616-6620. C.G. Jacobsen, Soviet Strategy - Soviet Foreign Policy, pp. 126-127).
26. Moore, "Antisubmarine Warfare," pp. 190-192; Polmar, "Thinking About Soviet ASW," p. 125.
27. "Soviets Launch Ocean Research Satellite" Aviation Week and Space Technology, February 25, 1979, p. 14.
28. Quoted in Polmar, "Thinking About Soviet ASW," p. 122. In Soviet Military Strategy, General Sokolovsky stated "effective weapons against missile-carrying nuclear submarines are hunter-killer submarines with homing missiles and torpedoes..." (quoted in Herrick, Soviet Naval Strategy, p. 116, note 24). Admiral Gorshkov has also written that "submarines are also becoming full fledged antisubmarine combatants, capable of detecting enemy missile-armed submarines, tracking them for a long period of time, and, when necessary, destroying them." (quoted in McGruther, Evolving Soviet Navy, p. 52). The tense of this quote is curious. It may indicate that the Soviets feel they are finally developing this capability with the introduction of Victor- and Alpha-class SSNs.
29. Janes Fighting Ships, 1980-81, p. 474; Senate Armed Services Committee, FY'78 Authorizations, p. 5614; McGwire "Soviet Naval Programs" pp. 338-340.
30. Testimony of Admiral Armstrong, Senate Armed Services Committee, FY'78 Authorizations, p. 5583.
31. Janes Fighting Ships, 1980-81, p. 478.
32. Micheal McGwire, "Soviet Naval Interests and Intentions in the Caribbean" in Micheal McGwire, Soviet Naval Developments; Barry Blechman and S.E. Levinson, "Soviet Submarine Visits to Cuba" in McGwire and McDonnell, Soviet Naval Influence: Domestic and Foreign Dimensions.
33. See Micheal McGwire "Current Soviet Warship Construction and Naval Weapons Development" in McGwire, Booth, and McDonnell, Soviet Naval Policy, p. 433; K.J. Moore, et.al. "Developments in Submarines," pp. 171-173.
34. See Harlan Ullman, "The Counter-Polaris Task," pp. 593-594. Apparently a submarine at shallower depths would stand a better chance of survival because it would be under less pressure from the sea, and the surface reflection of the pressure wave reduces the blast effect dramatically. Also blast effects in shallow water are far less than those in deep

- water. (S. Glasstone and P.J. Dolan, The Effects of Nuclear Weapons, pp. 246-273).
35. Part of this problem could be solved by using massive barrages of nuclear warheads. This possibility is discussed in Gerard Keith Burke, "The Need for Trident" US Naval Institute Proceedings, November 1978, p. 37, and in the SIPRI Yearbook: 1969/70, p. 117.
 36. A factor which might reduce the disadvantage of the size of the Soviet SSN fleet in escalation scenarios will be discussed in Chapter V.
 37. Jane's All the World's Aircraft 1979-80, pp. 312-314; Bill Guston, Modern Military Aircraft, p. 145.
 38. American sonobuoy capabilities are evolving rapidly. For details see E.W. Seabrook Hull, "Search and Destroy," p. 282; "Advanced Major Anti-Submarine Warfare Systems Sensors" Aviation Week and Space Technology, January 31, 1977, pp. 134-137; Aldridge, Counterforce, p. 39; SIPRI, Antisubmarine Warfare, pp. 21-23; and Frank Leary, "Search for Subs" Space/Aeronautics, pp. 60-67.
 39. Hull, "Search and Destroy," pp. 282-83; Guston, Modern Military Aircraft, p. 131; W.F. Biddle, Weapons Technology and Arms Control, p. 155.
 40. Aldridge, Counterforce, p. 40.
 41. This figure also includes some P-3Bs which have less sophisticated signal processing equipment. These are being phased out and put in reserve as new P-3Cs come into service. This process is expected to be completed by 1985. International Institute for Strategic Studies, The Military Balance: 1980-81, p. 7.
 42. For details on ORICS, see Aldridge, Counterforce, p. 38; "Advanced Sensors," Aviation Week and Space Technology, p. 139.
 43. Capabilities data from Jane's All the World's Aircraft 1979-80. Numerical data from International Institute for Strategic Studies, Military Balance: 1980-81, p. 11. Operational patterns from Robert G. Weinland, "The State and Future of the Soviet Navy in the North Atlantic" in McGwire and Booth, Soviet Naval Influence, p. 412; Polmar "Thinking About Soviet ASW," p. 123.
 44. Jane's Aircraft 1979-80, p. 408; International Institute for Strategic Studies, Military Balance: 1980-81, p. 11.
 45. Jane's Aircraft 1979-80, p. 413; Guston, Modern Military Aircraft p. 142; International Institute for Strategic Studies, Military Balance 1979-80, p. 11.
 46. Moore "Antisubmarine Warfare," p. 195; McGwire, "Soviet Naval Programs," p. 354.

47. The Soviets have claimed levels of effectiveness for systems such as this ranging from 300 to 2700 feet over time. Interestingly, the estimates seem to be decreasing rather than increasing (Moore, "Antisubmarine Warfare," p. 192).
48. See Senate Armed Services Committee, FY'78 Authorizations, p. 5507; Lt. W.G. Marshall "The Airborne Destroyer" US Naval Institute Proceedings March 1974, pp. 27-34; Lt. Cmdr. Shaar, "ASW and the Naval Officer Oceanographer," US Naval Institute Proceedings, February 1978, for discussions of the "human factors" in ASW detection systems.
49. Jane's Aircraft 1979-80, p. 201.
50. The American navy has justified the size of its SSN force largely on the basis of barrier operation requirements. Having reached that level (60 SSNs were deemed necessary), the navy is trying to justify more submarines by adding SSN missions. See Congressional Budget Office, The U.S. Sea Control Mission: Forces, Capabilities, and Requirements, pp. 40-48.
51. For data on Captor, see SIPRI, Antisubmarine Warfare, pp. 32-33, 94; Aldridge, Counterforce, p. 41; Garwin "Interaction," pp. 111-112. For information on the entire American ASW mine program see Hull, "Hunter and Hunted," pp. 380-381; Department of Defense, Annual Report, FY 1978, p. 201; Senate Armed Services Committee, FY'78 Authorizations, p. 5601; House Committee on Military Preparedness, Hearings on Military Posture and H.R. 5068, February 3, 1977, p. 221.
52. House Committee on Military Preparedness, Military Posture, p. 239. There also exists, in conjunction with the Joint Strategic Capabilities Plan, an agreement to use B-52D bombers to lay Captor mines if necessary. Senate Armed Services Committee, FY'78 Authorizations, p. 1002.
53. Hull, "Hunter and Hunter," p. 381.
54. Senate Armed Services Committee, FY'78 Authorizations, p. 6618.
55. Senate Armed Services Committee, FY'78 Authorizations, p. 5604.
56. House Committee on Military Preparedness, Military Posture, p. 226.
57. Jane's Fighting Ships 1979-80, p. 478.
58. See Senate Armed Services Committee, FY'78 Authorizations, p. 1945.
59. Senate Armed Services Committee, FY'78 Authorizations, pp. 1939-1954.
60. See Lt. Cmdr. W.R. Mellin, Jr., "ASW for the Amphibious Task Group" US Naval Institute Proceedings, March 1978, pp. 97-99; Shaar, "ASW and the Naval Officer Oceanographer," pp. 46-49; Chase and Galdorisi, "Tactical ASW and Ocean Acoustic Forecasting," US Naval Institute Proceedings, March 1978, pp. 146-147.

61. Senate Armed Services Committee, FY'78 Authorizations, p. 2101.
62. A drawback of the convoy system is that, in concentrating merchantmen together to hide and protect them from submarines, an ideal target for an ICBM or IRBM barrage is created. The Soviets are not reticent in claiming they will use ballistic missiles on naval targets. See Sokolovsky, Soviet Military Strategy, pp. 300-302; Herrick, Soviet Naval Strategy.
63. Jane's Aircraft 1979-80, pp. 314-316; Guston, Modern Military Aircraft, pp. 146-148.
64. Alfred Price, Aircraft vs. Submarine, p. 244; Jane's All the World's Aircraft 1979-80, Guston, Modern Military Aircraft, p. 205.
65. Jane's Aircraft 1979-80, pp. 309-310; Guston, Modern Military Aircraft, p. 207; Senate Armed Services Committee, FY'78 Authorizations, pp. 5594-5598.
66. Senate Armed Services Committee, FY'78 Authorizations, p. 1939; SIPRI, Antisubmarine Warfare, pp. 26-27; E.W. Seabrook Hull, "The Surface Ship and ASW," National Defense, pp. 284-287.
67. U.S. Department of Defense, Program for Research, Development, Testing and Evaluation, FY'78, pp. IV-62.
68. Richardson, "Missile Directory," p. 1338; SIPRI, Antisubmarine Warfare p. 95; Hull "Surface Ship," p. 286.
69. Marshall "Airborne Destroyer," pp. 27-34;
70. "Advanced Sensors," Aviation Week and Space Technology, p. 134.
71. Polmar "Soviet ASW" pp. 110-116; Moore, Soviet Navy Today, p. 247; Janes Aircraft 1979-80, p. 417; Guston, Modern Military Aircraft, p. 208.
72. McGwine, "Soviet Naval Programs," pp. 343-350.
73. Jane's Fighting Ships: 1980-81, pp. 489-495.

CHAPTER IV

CHARACTERISTICS OF ARMS CONTROL AGREEMENTS

The purpose of this chapter is to determine which modes of ASW activity might feasibly be included in a strategic arms control agreement. The discussions in the previous chapters have presented the factors that are important in determining the strategic balance and in understanding the operational missions and capabilities of the ASW forces of the superpowers. The only factors left to examine are those that deal with the arms control process itself.

As mentioned in the Introduction, this chapter will not adopt a theoretical approach in attempting to determine whether or not particular ASW systems are likely to be acceptable subject matter for an arms control agreement. Instead an empirical approach has been used to generate a set of principles against which the characteristics of ASW systems can be measured and compared. Borrowing from the behavioral psychologists, a "black box" has been placed around the motivations of the actors involved in negotiating arms control agreements. This analysis looks only at the characteristics of arms control proposals as they have emerged from the negotiation process. Taken together, the arms control principles that emerged from this examination provide the model against which ASW technologies will be judged in order to determine if reasonable grounds to pursue an agreement exist.

The analysis below takes two cuts at this issue. The first cut involves a simple description of the arms control treaties that were examined and their provisions, along with a basic categorization of the nature of these treaties. Four basic categories are used for this purpose. These categories are not intended as mutually exclusive sets.

Rather they are broad, and somewhat loose, descriptions of different orientations arms control agreements can take. Individual agreements often encompass provisions that cross from one category to another.

The second cut examines the common characteristics of these treaties that seem to apply to all arms control treaties as a class. Of course, some of these characteristics apply more to one category of agreement than others, and these anomalies are noted. These characteristics are discussed in terms of five fundamental principles of arms control.

ARMS CONTROL TYPOLOGY

The first observation to be made about arms control agreements is that they can be divided into four distinct types. The first type of agreement deals with the deployment and/or use of weapons and systems already possessed by the signatories, or readily available to them with no major investment in new technologies. The first modern agreement of this type was the Rush-Bagot Treaty of 1817, which limited the number of British, Canadian, and American warships on the Great Lakes.

A similar agreement was signed between Russia and Turkey in 1865, which attempted to limit both Russia and Turkey to ten warships in the Black Sea. The attempt failed. In 1931 the Soviet Union and Turkey tried again, signing a Protocol to the Russo-Turkish Treaty of Friendship which again limited the deployment of warships in the Black Sea. This attempt also failed when the events of World War II forced the Soviets to increase their naval presence there. However, one arms control agreement limiting the deployment of naval forces in that area has survived. The Montreux Convention of 1936 is still in force. This agreement limits the passage of warships between the Mediterranean and the Black Sea, and the deployment of such ships in the Black Sea.

A final naval treaty of this type was the Nyon Agreement of 1937. This agreement was initiated by Great Britain and France in response to the sinking of merchant ships headed to Spain by Italian submarines. The agreement banned submarines in the Mediterranean except in designated training zones or when in transit. Submarines in transit had to be escorted by surface vessels. Any submarine caught outside a training zone without an escort could be sunk. Initially nine nations signed this treaty, but Italy, which had been attacking merchantmen bringing supplies to the Republicans in the Spanish Civil War, did not sign the agreement until after that war had effectively been decided.¹

Three other general agreements on the deployment and use of naval forces and technologies were reached during the Hague Peace Conference of 1907. Convention #7 signed at the Hague governed the conversion of merchant ships into warships, and restricted the calibre of gun to be mounted on such ships to 6.1 inches. Convention #8 restricted the laying of submarine mines to the interdiction of warships as opposed to merchantmen whenever possible, and required signatories to construct mines and torpedoes so that they would become harmless after they had broken free of their moorings or missed their targets, respectively. Convention # 9 prohibited the naval bombardment of undefended ports and villages except those that contained military works.²

The previous Hague Peace Conferences of 1899 had produced three arms control declarations that forbade the military use of some readily available technologies in warfare. Declaration (IV, 1) prohibited for five years the launching of "projectiles and explosives from balloons, and other new methods of a similar nature." This declaration was renewed, though not by all of the original signatories, in 1907. Declaration (IV, 2)

confirmed the sentiments of the Declaration of St. Petersburg (1868) and banned the "use of projectiles the sole object of which is the diffusion of asphyxiating or deleterious gases." This declaration was signed or agreed to by all of the parties to World War I except the United States, though it did not stop the use of such gases in that war. (The use of poison gas was again banned in the Geneva Protocol of 1925). Declaration (IV, 3) of the 1899 Hague Peace Conference prohibited the use of bullets which "expanded or flatten easily in the human body."³

A modern series of agreements that limit the use of available technologies involve the nuclear test ban treaties. The first of these treaties was the Limited Test Ban Treaty signed by the United States, the Soviet Union, and Great Britain in 1963.⁴ This treaty prohibits the testing of nuclear weapons in the atmosphere, in outer space, and under water. In 1974 a new treaty and protocol (known as the Threshold Test Ban Treaty) was signed by the United States and the Soviet Union limiting the size of underground nuclear tests to a 150-kiloton explosive yield and pledging the powers to limit the number of such tests "to a minimum." An adjunct to Article III of the Threshold Test Ban Treaty is the treaty and protocol signed by the United States and Soviet Union in 1976 limiting the peaceful use of nuclear explosions to situations that meet the specifications of the above-mentioned test ban treaties.⁵

The second type of arms control agreement restricts the acquisition of a particular type of weapons system or technology that already exists or is readily available. The first major arms control agreement of this type came out of the Washington Naval Conference of 1922. Under the Treaty of Washington the United States, Great Britain, Japan, France, and Italy agreed to maintain a stable ratio of total tonnage of capital

warships between the signatories (5:5:3:1.67:1.67, respectively), and to limit the maximum tonnage of capital ships, aircraft carriers, and other warships. The effect of this treaty was to require the immediate scrapping of forty-four existing capital ships and twenty-one capital ships under construction. An additional eleven capital ships were to be scrapped without replacement between 1922 and 1931.⁶

In 1927 the United States, Great Britain, and Japan met in Geneva to attempt to expand the Treaty of Washington by including lighter categories of warship. The meeting failed due to an inability to define the type categories of warships to be limited and an inability to agree on an adequate definition of parity between the powers. However, in 1930 the London Naval Conference was held as a follow-up to the Washington Naval Conference and additional agreements were reached. The holiday on naval construction was extended from 1931 to 1936, the Ocean Powers (the United States, Great Britain, and Japan) agreed to accelerate the scrapping of capital ships to get down to the agreed levels sooner. Limitations on the tonnage and armament of the lighter classes of warships were also agreed upon, and the Ocean Powers agreed to a ratio of limits on the tonnage of these smaller classes of ships. An attempt in 1936 to extend these agreements failed, again over the question of parity between the Ocean Powers.⁷

The SALT I Treaty, signed in 1972, is also examples of this type of agreement. The agreement essentially holds the number of strategic ballistic missile launchers existing or under construction at their existing levels. An increase in SLBM launchers up to an agreed level is allowed under the agreement only if a corresponding number of older ICBM or SLBM launchers are dismantled. Further, the Soviet Union agreed not to

upgrade "light" ICBM silos to launch "heavy" ICBMs. The follow-on SALT II Treaty (signed but not ratified) extends SALT I by limiting the total number of strategic launchers each side may have, and the number of those launchers that can be MIRVed.⁸

Another example of an agreement limiting existing weapons systems is the Biological Weapons Convention signed in 1972 by 113 nations and acceded to by two others. This agreement forbids the possession and use of biological agents or toxins by any signatory. This agreement is an extension of the Geneva Protocol of 1925 which banned the use of chemical and biological weapons. Instead of just limiting the use of biological agents, Article I of this convention forbids the parties to "develop, produce, stockpile, or otherwise acquire or obtain" such weapons.⁹

The third type of arms control agreement restricts the development and subsequent deployment of weapons technologies that would not be available without significant technological development. This type of agreement is very similar to the first type of agreement discussed above. In some cases a single agreement may cross the line between the two. For example, the Hague Declaration (IV, I) of 1899 and the follow-on Hague Declaration of 1907 prohibiting the launching of projectiles from balloons also prohibited their launching by "other new methods of a similar nature." This is a clear attempt to prevent the deployment of a new weapons technology.¹⁰

The ABM Treaty, signed in 1972 with the SALT I Interim Agreement, is the most prominent recent example of this type of agreement. Both the United States and the Soviet Union were engaged in the development of anti-ballistic missile (ABM) missile systems. The ABM Treaty did not categorically cut off ABM research, but did forbid the development and

deployment of land-based ABM systems for national or regional defense, point defense of and categorically banned the development, testing, or deployment of sea-based, air-based, or space-based, and restricted the ABM missiles to one-per-launcher, with no rapid reload capability, and a single warhead per missile.¹¹

There are also three lesser-known arms control treaties that fit into this category. The first was the Outer Space Treaty signed in 1967 by 89 nations which forbids the basing of weapons of mass destruction in outer space or on any celestial bodies. The second is the Seabed Arms Control Treaty (1971) which forbids the basing of weapons of mass destruction on the ocean floor. The third is the Environmental Modification Ban (1977) which forbids the military use of any techniques designed to change "through the deliberate manipulation of natural processes - the dynamics, composition or structure of the earth, including its biota, lithosphere, hydrosphere, and atmosphere, or of outer space."¹²

The final type of arms control agreement is designed to prevent the introduction of one or several types of arms technology to a geographical area. The first treaty of this type was the Antarctic Treaty (1959). This treaty totally demilitarized the Antarctic Continent and provided that it would be used for only peaceful purposes. The second was the Treaty for the Prohibition of Nuclear Weapons in Latin America and its protocols (1967) which forbids the signatories to test, manufacture, store, deploy, or assist others in acquiring nuclear weapons. The final example of this type of agreement is the Nuclear Non-Proliferation Treaty (1968) which forbids the signatories from transferring or acquiring nuclear weapons technology if they did not already possess it.¹³

For the purposes of this analysis, two types of agreement commonly

considered arms control agreements have been left out. The first such are the crisis management treaties, such as the "Hot Line" agreements between the United States and the Soviet Union. The second such are peace treaties that have disarmed a defeated nation at the end of a war, such as the Treaty of Versailles. These have been left out of this analysis because they do not deal directly with arms technologies and they do not represent freely reached agreements between sovereign states, respectively.

ARMS CONTROL PRINCIPLES

Analysis of the arms control agreements reveals five principles which appear to apply to such agreements across the board. All five of these principles derive from the one overarching principle governing all international agreements. All such agreements are negotiated agreements between sovereign states which have their own best interests at heart. Each state is seeking to gain as much security or advantage for itself and its interests as possible. As mentioned in the Introduction, it is assumed that it is self-interest and not altruism that motivates states to enter into arms control agreements. The behavior of the states that negotiated the treaties mentioned above bears out this assumption remarkably well.

The Security Principle

The Security Principle provides that no nation will enter into an arms control agreement that jeopardizes its military ability to protect or promote its vital national interests. This principle is so nearly tautological, given voluntary nature of most arms control agreements, that it would be superfluous to include it except for the important corollaries that derive from it.

Corollary One provides that no nation will sign an arms control agreement that leaves it inequitably inferior to any of the other signatories. The

terms of most arms control treaties put equal restrictions on all parties. The Hague Conventions, the Biological Weapons Convention, the ABM Treaty, and the Antarctic Treaty represent examples of the arms control typologies discussed above where restrictions on all parties are equal. Both the Americans and the Soviets have made it clear that they will not accept any arms control agreement that leaves them inferior to the other in any regard.¹⁴

There have been arms control treaties that have allowed differential rights to the signatories, but only for specific reasons acceptable to all parties. The Montreux Convention allows Turkey special rights in determining the passage of ships through the Dardanelles to and from the Black Sea, but this is a special situation as the Dardanelles and Bosphorus are within Turkish territory. The Washington Naval Conference (1922) established a ratio of naval forces which left three of the signatories (Japan, France, and Italy) with smaller navies than the United States and Great Britain. France and Italy accepted this arrangement because they acknowledged that they were not, and did not intend to be major oceanic naval powers. Japan, considered an Ocean Power, initially accepted its inferior position because its sphere of interest was regional and not trans-oceanic. It should be noted that the attempt to extend this agreement between the Ocean Powers in the London Naval Conference of 1936 failed because Japan was no longer willing to accept a naval force less than equal to that of the United States and Great Britain.

Corollary Two is complementary to the first. It holds that a nation will not give up a technological advantage in an arms control agreement. The London Naval Conference of 1936 will also serve to illustrate this point. The United States and Britain had succeeded in fixing a

5:5:3 ratio of capital ship tonnage between themselves and Japan. In 1934 Japan began to insist on equality and carried this request to the London Naval Conference of 1936. The United States and Great Britain were unwilling to concede this point to Japan, and the talks collapsed over this issue.

A more recent example of this corollary appears during the initial rounds of talks for the Seabed Arms Control Treaty. On March 18, 1969 the Soviet Union tabled a draft treaty that called for the complete demilitarization of the seabed beyond territorial waters. This draft treaty would have banned all military use of the ocean floors, forcing the United States to remove its fixed underwater surveillance systems. The Soviets had no comparable open ocean systems to remove. The United States rejected the Soviet draft.¹⁵

There is some reason to believe that these two corollaries are not only characteristic of arms control agreements, but are actually preconditions to arms control negotiations. The chronology of the Soviet-American series of arms talks is particularly suggestive. Between the end of World War II and the late 1950s the United States was acknowledged to have strategic nuclear superiority. Then in 1957 the advent of Soviet rocketry demonstrated that the Soviets had the technology to deliver nuclear weapons to the American homeland. Americans started to worry and the Soviets gained confidence.

By 1961 arms control had been declared "a central goal of national policy" by President Kennedy, and American military strategists were rethinking the policy of massive retaliation in preparation for the Soviet achievement of strategic parity.¹⁶ However, no productive talks had yet been held on achieving arms limitation on actual weapons system.

By 1968 the Soviets had achieved strategic nuclear parity, and in 1968 serious talks on controlling deployed nuclear delivery systems began. One Soviet writer observed that the initiation of meaningful talks on strategic nuclear weapons after parity was achieved was "not accidental."¹⁷

It is also worth noting how well the attitudes which underlie these two corollaries follow from the discussion of Galtung's matrix in the Introduction. Corollary One follows from Theory I which maintains that a nation will feel that another nation with a military advantage will be tempted to be aggressive. Corollary Two follows from Theory II, under which a nation feels that a military advantage for itself will promote its security and will restrain any opponents. A nation would not be motivated to institutionalize its inferiority or to give up an advantage.

The Corollary Three to the Security Principle maintains that no nation will enter into an arms control agreement that would put it into an inferior position with a nonsignatory power. This is one of the most fundamental constraints on arms control agreements designed to limit the acquisition and use of weapon systems and technologies. Early illustration of this principle can be found in the Hague Conventions. The Hague Conventions only applied restrictions on actual warfare between signatory powers. Any war with a third party would not be restricted by the Conventions, and thus a signatory party could find itself threatened by one of the restricted technologies. For this reason the Conventions did not ban the development or deployment of such controlled weapons technologies as a deterrent, or their use against a third party. They only forbade their use against fellow signatories.

The explosion in nuclear weapons technology and the number nuclear weapon

delivery systems by the U.S. and the U.S.S.R. has left them largely in a class by themselves with regard to strategic nuclear weaponry. In the rest of the world, only Great Britain, France, and China have an acknowledged strategic nuclear capability, and their forces are far inferior in number to those of the superpowers. This makes strictly bilateral strategic negotiations between the superpowers possible. It does not, however, completely resolve the third power question. For example, both Great Britain and France deploy SSBNs similar to the American Polaris SSBNs. The Soviet Union considers these countries American allies, and considers their nuclear forces adjuncts to the American forces. As a result, the Soviets have claimed the right to exceed the limit on SSBNs set out in Article III of the SALT I agreement to an extent corresponding to any increase in the British or French SSBN fleet. The United States rejects this claim, but there is little it can do to alter the Soviet position.¹⁸

The Verification Principle.

The second outstanding principle of arms control agreements is the Verification Principle, which holds that no party will sign an arms control agreement unless it can obtain adequate continuing assurances that all parties are adhering to the terms of the agreement. This has emerged relatively recently as a major concern in arms control affairs. The reasons have to do with the types of violations that could be expected and the capabilities of the systems involved.

Arms control agreements that limit the deployment of military forces (usually naval forces) have almost invariably been designed to apply to very specific situations. For example, the Montreux Convention limits passage through a single narrow strait. Verification only requires observation of traffic through that strait. The most difficult of the

treaties of this type to verify was the Nyon Agreement of 1937 banning submarines in the Mediterranean Sea. The increased difficulty in verification was balanced by increasing the risk of violation. A submarine caught outside of a training area without an escort could legally be sunk. In other cases, the military advantages to be gained through a treaty violation were less than the diplomatic and/or military consequences of a violation. This appears to be the reason generally why such treaties are signed in the first place.

Prior to World War II, the situation regarding the acquisition and use of forbidden military technologies was somewhat similar. For example, there was never any question of any of the powers' ability to violate the Hague Conventions (or later the Geneva Protocol of 1925). Anyone with a pistol, a chemistry lab and munition works, or a pocket knife could violate the Conventions regarding projectiles from balloons, poison gas, and expanding bullets, respectively. Any of the powers could bombard defenseless coastal towns and lay illegal submarine minefields as well. However, there was little point in using these technologies because none of them were potent enough to be decisive, and their use only invited retaliation in kind. This retaliation could be made in relatively short order because of the low levels of technology involved.

The Washington Naval Treaty (1922) and the subsequent London Naval Treaty (1930) provided a somewhat different problem with respect to verification that the limits with regard to warship numbers, tonnage, and armaments were being met. These treaties did not establish an independent means of verifying the agreements. However each signatory was required to submit detailed notification of ship building plans annually which provided specifics on the characteristics of ships planned or

under construction.

In all of the above cases violations of the treaty in question would have provided only marginal advantages that could not be made decisive before the other parties could adequately adjust. However the post-World War II boom in strategic weapon capabilities provided weapons that could easily prove decisive in a major conflict. Furthermore, the shift from a reliance on armies for defense to a reliance on arms for deterrence forced the emphasis of military preparedness to the possession of forces-in-being. These forces were highly capable, but were also highly complex, requiring extensive research and development and consequently long lead times between the conceptualization of the system and its operational deployment. This made the prompt acquisition of military intelligence very important. A nation that discovered another nation deploying a sophisticated new strategic weapon system could be at a marked disadvantage for several years while a counter system was being planned, tested, and deployed.¹⁹

This has made verification a vital element of all of the strategic arms control agreements between the United States and the Soviet Union. Verification was a major obstacle in early negotiations for a Test Ban Treaty and during the Surprise Attack Talks in 1958. The two options available then were aircraft overflight (Eisenhower's "open skies" proposal) and on-site inspection. These relatively primitive approaches to verification were not acceptable to the superpowers for reasons that reflect the factors discussed under the Security principle.

By 1962 technologies existed that could detect nuclear blasts in the atmosphere, the oceans, and in outer space with confidence. Thus, with the United States, the Soviet Union, and Great Britain confident that they could

police a ban on nuclear explosions in these environments, they signed the Limited Test Ban Treaty. Underground nuclear explosions were not included in the ban because an agreeable means of verification could not be devised. By 1974 improvements in seismology made it possible to reliably detect underground nuclear explosion "signatures" without the need for on-site inspections given knowledge of geological formations in the test area. In 1974 the Threshold Test Ban Treaty was signed between the U.S. and U.S.S.R. which called for the exchange of the necessary geological information and limited the explosive yield of underground tests to 150 kilotons.²⁰

Verification is also an integral part of the SALT agreements. The SALT I agreement is verified by the superpowers through the use of satellite observation, electronic "eavesdropping", and other "national technical means" of verification. The SALT I agreement specifically forbids interference with these verification efforts. The American government has made it clear that adequate verifiability is a precondition to any strategic arms pact with the Soviet Union. The SALT II agreement, currently before the U.S. Senate, was believed by the Carter administration to be verifiable, but some Senators have serious doubts on this score. This agreement will probably not be ratified, and questions over verifiability will be a major factor.

The Comparability Principle

The Comparability Principle applies to arms control agreements that limit the quantity of a type of weapon system possessed by the signatories. It states that a type of weapon in one nation's arsenal will not be controlled unless another nation has a weapon that is comparable in both capability and mission. This principle presented itself as a major problem at the Washington Naval Conference in 1922. The parties there were

unable to reach an agreement on the limitation of cruisers, largely because the cruisers of the United States and Great Britain were different sizes, had different armament, and were designed to perform different missions. The problem was to find a ratio of these forces that satisfied the needs of both. A solution was found at the subsequent London Naval Conference of 1930 where the Ocean Powers agreed to create two separate categories of cruiser, and establish separate limitations for each.

The SALT talks have also produced an illustration of this principle. The Soviet Backfire bomber is a supersonic airplane that qualifies as a strategic system under both of the superpowers' preferred definition of "strategic," although few analysts contend that it is meant to fulfill a strategic mission. The Backfire is capable of flying unrefueled from the northwest coast of the Soviet Union, bombing targets along the eastern United States, with nuclear weapons and continuing on to land at airfields in Cuba. American efforts to include Backfire in the SALT limitations have failed because the Soviets insist that it is not intended as a strategic system, and because American negotiators have no American system comparable to Backfire to offer as an equitable trade-off.

To further illustrate the problem, the Americans do have a bomber, the FB-111, which has performance characteristics similar to the Backfire in terms of speed and payload. But the FB-111 has an unrefuelled combat radius 1000 miles less than the Backfire's, which means it could not fly from the northeast United States to the Northwest Soviet Union. Thus the Americans do not consider it "strategic." Further, the FB-111 is one of the "forward-based systems" used by the United States to support NATO and offset the Soviet superiority in intermediate range nuclear weapon systems in Europe.²³

Some commentators have suggested linking limitations on Backfire to limitations on the American's new cruise missiles, but it seems unlikely that grounds for a comparison which would allow for controls will be found. The American's interim solution to the issue of the Backfire has been to propose to "count or counter" Backfire with a similar system of their own. The Americans have apparently decided that the only way to get controls on Backfire is to develop a comparable airplane to "counter" it. They hope that limitations could then be developed for both aircraft. The probable "counter" would be a long-range version of the FB-111, known as the FB-111H. Two such aircraft have been built and flight tested.²⁴

The Protect-the-Best Principle

The Protect-the-Best principle maintains that arms control agreements will not be signed which require dismantling first-line operational weapons systems. Like the Comparability Principle, this applies to those agreements that limit the numbers of weapons of a particular type a signatory can possess. The typical method used to protect these newer systems is the establishment of force ceilings above the levels of these weapons systems in the arsenals of the signatories at the time of the agreement. Thus no forces would need to be cut. This approach was used with regard to small warships at the London Naval Conference of 1930, and in setting the force ceilings within which the SALT II limitations were negotiated at Vladivostok in 1974.

Those agreements that do contemplate scrapping weapons protect the front-line systems by allowing the signatories to dismantle their older, more obsolete systems to meet the treaty requirements. The SALT I accord even takes this principle a step farther, allowing the superpowers to continue their building programs for new SSBNs by replacing obsolete

heavy ICBMs and SSBNs deployed before 1964 period. If SALT II comes into force the Soviets would be required to dismantle 250 strategic delivery systems, and the treaty does allow these to be obsolete systems.

The two treaties that seem to violate this principle on their face really do not. The Biological Weapons Convention produced the blanket prohibition against the possession of biological agents for military purposes. This was a new military technology that was presumably scrapped by everyone who ratified the treaty, but it didn't really qualify as a first-line weapons technology. No nation has ever used biological weapons and they do not seem to be an integral part of any nation's arsenal.²⁵

The Washington Naval Treaty was also an apparent-but-not-real violation of this principle. Although 76 capital ships were to be scrapped under the agreement, none were modern, operational capital warships. The bulk of the ships removed from service were old ships that were retired early. The balance of these ships were not yet completed. They were destroyed in the yards before completion or commissioning. It should also be noted, as an analyst contemporary with the Treaty did, that "the Treaty of Washington was, in substance, the limitation of a ship not only extremely costly, but in respect of which certain technical experts entertained, and still entertain, grave doubts as to the real fighting value."²⁶ It was by no means clear that these ships would remain first line units in the face of the new submarines, aircraft carriers, and fast cruisers.

The Civilian Benefit Principle

The Civilian Benefit Principle applies to arms control measures across the board, and holds that an arms control agreement will not be reached that restricts the parties from reaping benefits in the civilian

(and particularly the commercial) arena from technologies that also have military uses. Virtually the entire body of international law relevant to commerce on the high seas displays a concern that commerce continue uninterrupted, even, if possible, in times of war.²⁷ Of the treaties discussed above, both the Hague Convention #8 regarding submarine mine warfare and the Montreux Convention are examples of agreements where benefits to civilian merchantmen are not only unrestricted, but actually explicitly protected by treaty.

Recently, this principle has surfaced in a different way, owing to the current technological revolution which is constantly creating new capabilities. Recent arms control agreements have specifically permitted civilian exploitation of technologies being banned militarily. The Biological Weapons Convention prohibits the development of biological agents for military purposes, but allows development of toxins for "prophylactic, protective or other peaceful purposes." The Threshold Test Ban Treaty spawned an entire new treaty outlining procedures for the peaceful uses of nuclear explosions. Most recently, Article III of the Environmental Modification Ban, in Article III, explicitly states that the ban "shall not hinder the use of environmental techniques for useful purposes...."²⁸

These five principles of arms control agreements describe a model against which the characteristics of the superpowers' ASW forces can be measured. This model is too loose to support any extravagant claims of predictive value. Indeed, there is no assumption that all arms control agreements of a given type must meet the appropriate principles described above to be agreeable to the parties involved. However, the inability of a particular weapons system to meet the criteria of one of the principles discussed above is held to significantly decrease the chances

of controlling that system. In the next chapter, ASW technologies will be measured against this model, and a prototype agreement will be discussed.

NOTES: CHAPTER IV

1. See Barry M. Blechman, The Control of Naval Armaments: Prospects and Possibilities, pp. 31-34; J.I. Knudson, A History of the League of Nations, p. 139, A.P. Higgins and C.J. Colombos, International Law of the Sea, pp. 137-140.
2. James B. Scott, The Hague Conventions and Declarations of 1899 and 1907, pp. 146-158.
3. Scott, Hague Conventions, p. 1899; Arms Control and Disarmament Agency (ACDA) Arms Control and Disarmament Agreements, pp. 9-17. The latter includes a discussion of recent interpretations of the 1925 Geneva Protocol.
4. Arms Control and Disarmament Agency, Arms Control and Disarmament Agreements, pp. 33-44.
5. Arms Control and Disarmament Agency, Arms Control and Disarmament Agreements, pp. 155-179.
6. Knudson, League of Nations, pp. 139-43; Giovanni Engley, The Politics of Naval Disarmament, pp. 4-10.
7. Engley, Naval Disarmament, pp. 37-46, 156-8; Knudson, League of Nations; James Ramsey McDonald, London Naval Conference, 1930, pp. 3-12; London Naval Conference 1935-36: Documents, J.H. Bouton and L.D. Weiler, International Arms Control: Issues and Agreements.
8. Arms Control and Disarmament Agency, Arms Control and Disarmament Agreements, pp. 136-147; Senate Committee on Foreign Relations, The SALT II Treaty: Report of the Committee on Foreign Relations, United States Senate, together with Supplemental and Minority Views, pp. 319-453. For an extraordinary account of the SALT II negotiations see Strobe Talbott, Endgame: The Inside Story of SALT II.
9. Arms Control and Disarmament Agency, Arms Control and Disarmament Agreements, pp. 113-123.
10. Scott, Hague Conventions, pp. 220, 1877.
11. Arms Control and Disarmament Agency, Arms Control and Disarmament Agreements, p. 177.
12. Arms Control and Disarmament Agency, Arms Control and Disarmament Agreements, pp. 45-54, 92-101, 181-187, respectively.
13. Arms Control and Disarmament Agency, Arms Control and Disarmament Agreements, pp. 18-26, 55-76, 77-91, respectively.

14. See "Strategic Arms Limitation: The Soviet View" Survival, May/June 1978, pp. 122-127. The Americans are required by law not to conclude any agreement that concedes inferiority under the so-called Jackson Amendment appended to the Senate ratification of the SALT I treaty.
15. ACDA, Arms Control and Disarmament Agreements, p. 93; Stockholm International Peace Research Institute (SIPRI) "Prospect for Arms control in the Ocean" SIPRI Research Report No. 7 (1972), p. 16.
16. Marie Levinson, Arms Control and International Politics, p. 33.
17. Cited in Douglas F. Garthoff, "The Soviet Military and Arms Control" Survival, November/December 1977, p. 244. This need for parity prior to arms control talks was predicted by Robert Herrick in Soviet Naval Strategy. See also Thomas L. Saaty, Mathematical Models of Arms Control and Disarmament, pp. 115-143; Jurgen Rohwer "Superpower Confrontation on the Seas" Washington Papers No. 26 (1975), p. 81; J.T. Westwood "Soviet Naval Strategy, 1968-78: A Reassessment" US Naval Institute Proceedings, May 1978, p. 121, for other perspectives on this point.
18. See the "Statement of the Soviet Side" and the American statement of rejection appended to the SALT I accord, Arms Control and Disarmament Agency, Arms Control Disarmament Agreements, pp. 146-147.
19. See Henry Kissinger, Nuclear Weapons and Foreign Policy, pp. 181-182. Adequate intelligence gathering capabilities can turn these long lead times into a stabilizing factor. If new weapons systems can be detected early in development, counter measures can get underway before the system is deployed. See W.F. Biddle, Arms Technology and Arms Control, p. 11; and Lawrence T. Caldwell "Adelphi Papers No. 75" (1971), p. 22.
20. Levinson, Arms Control and International Politics, pp. 28-32; ACDA, Arms Control and Disarmament Agreements, pp. 34-39, 155-158.
21. Arms Control and Disarmament Agency, Arms Control and Disarmament Agreements, p. 139.
22. The Senate committee looking into SALT II also concluded it was verifiable (Senate Foreign Relations Committee, The SALT II Treaty, pp. 227-228, see also pp. 189-227 and 484-486, 492-493). For an enlightening discussion of the interplay between verification issues and the SALT negotiations, see the discussions on encryption of missile telemetry in Talbott, Endgame, pp. 194-202, 221-225, 237-244, 256-259. For more on verification of arms control agreements, see David W. Wainhouse, Arms Control Agreements: Designs for Verification and Organization and W.F. Biddle Weapons Technology and Arms Control.
23. Data from John M. Collins, American and Soviet Military Trends Since the Cuban Missile Crisis, p. 107.

24. Talbott, Endgame, p. 213-214.
25. Some analysts think the Soviets have retained a significant biological warfare capability despite this treaty. They cite a recent anthrax outbreak in the Soviet Union as a probable biological weapons "spill." (confidential interviews). The Soviet military has made significant preparations to operate in chemical and biological warfare environments. Collins, Military Trends, p. 172.
26. Engley, The Politics of Naval Disarmament, p. 8.
27. For discussions of international law which support this point, see Sir Frederick Smith, The Destruction of Merchant Ships under International Law; Harold H. Martin and Joseph R. Baker, Laws of Maritime Warfare; and Kenkichi Mori, The Submarine in War: A Study of Relevant Rules and Problems.
28. Arms Control and Disarmament Agency, Arms Control and Disarmament Agreements, p. 185.

CHAPTER V

ARMS CONTROL AND ASW: SYNTHESIS AND PROPOSAL

In this chapter the threads of the analysis in the preceding chapters will be brought together to examine the potential for a viable arms control agreement regarding ASW. The initial chapters of the paper described the need to protect the SSBN forces from the possibility of a successful preemptive strike. With the increasing vulnerability of land-based ICBMs, and the somewhat confused and uncertain status of the future of manned strategic bomber forces, both superpowers agree that SSBNs are the most survivable and reliable retaliatory force in their arsenals. If a state of mutual deterrence is to be maintained between the superpowers the safety of SSBN forces must be assured.

However, the point was also developed that neither side could afford to sacrifice their ASW capability across the board to buy protection for their sea-based deterrent. The United States must maintain an ASW capability strong enough to protect the SLOCs between it and its allies in the face of a very large Soviet attack and cruise missile submarine fleet if deterrence is to be maintained on the theatre level in Europe and Asia. The Soviet Union needs to maintain an ASW capability because much of its ASW effort is intended to protect their SSBN forces at sea from the threat of American SSNs. Further, both sides need to maintain ASW capabilities to protect their high value naval forces from each other and from the large number of other navies that have submarines in their fleet. A balance needs to be struck between protecting the SSBN and safeguarding the superpowers' other interest on the high seas.

The paper then examined the current state-of-the-art in ASW capabilities. Because ASW is not a single-system military capability this analysis took in the full range of detectors, platforms, and weapons used by the superpowers, and their deployments. Four general categories of ASW activity were described, point defense, barrier defense, area search, and broad ocean interception. These were discussed in terms of their effectiveness against SSBNs.

Finally, the paper took an empirical look at major arms control agreements, particularly at those major agreements concluded during this century. This analysis identified four broad types of arms control agreement, and five principles of arms control which apply to such agreements. The discussion below synthesizes the analyses above by applying the five principles of arms control to the four types of ASW activity to determine the feasibility of an arms control agreement in this area.

The discussion below will examine the four types of ASW in the reverse order of their effectiveness against SSBNs (point defense, barrier defense, area search, and broad ocean interception). After it has been determined that a type of ASW activity is a likely candidate for arms control, a closer look at the individual systems used in that type of activity will be examined in the light of the arms control principles as well.

This analysis will establish that the only system amenable to arms control from the viewpoint of both superpowers is the SSN. Proposals made by others regarding the control of SSNs will be discussed and dismissed for their inability to meet the criteria dictated by the arms control principles. Finally, a proposal

will be presented that meets both the security needs of the SSBNs and the criteria of the arms control principles.

Analysis: Point Defense

The type of ASW operation that is least effective against SSBNs is point defense ASW. Its function is to protect high value targets at sea from attack submarines by either sinking them or by preventing them from penetrating close enough to its target to use its weapons. Any of the ASW technologies can be used to support such an operation, but the core of point defense operations are surface naval forces. All of the major surface warships of the superpowers have an ASW capability. The most effective of these ships are those that mount aircraft. Both sides have ships that mount helicopters, and the United States also deploys the fixed-wing S-3A Viking airplane from aircraft carriers.

The superpowers use their point defense ASW capability to serve different naval missions. The American navy uses their point defense capability for sea control. The United States needs to protect sea lines of communications between itself and its allies in Europe and Asia. As a result the Americans have structured their navy to be able to project an ASW screen of escorts along the path of a convoy or fleet. The most capable ASW surface platforms in the American navy are the large attack aircraft carriers which carry squadrons of ASW helicopters and airplanes along with their fighter, reconnaissance and attack aircraft.

The Soviet navy used its point defense ASW capability for sea denial. It appears that they are intending to deny attack submarines access to waters contiguous with the Soviet Union used by the newer Soviet SSBNs as patrol areas. In effect, they are providing

* their ballistic missile submarine force with sanctuary areas.

Their fleet is not structured for projecting an ASW screen as much as providing an ASW perimeter.

A strategic arms control agreement limiting this type of ASW activity is highly impractical for a number of reasons. The primary reason is that neither side would benefit strategically from a limitation on point defense capabilities. Point defense forces do not pose a credible threat to SSBNs. In the past when SLBMs had limited ranges both superpowers had considered this strategy. The United States formed "hunter-killer" naval squadrons specifically to hunt down submarines, and the Soviets initiated the Moskva-class ASW cruiser to prevent American Polaris submarines from closing within the limited range of the Polaris A1 missile. As SLBM ranges increased, both superpowers gave up on this idea. Surface ships are too limited in sensor capability, they are too slow, they require too much support, and have too many other missions to be sent out hunting SSBNs.¹

While there are no particular reasons for having an arms control agreement in this area, there are a number of reasons not to expect one. A limitation on point defense ASW would violate several elements of the Security Principle outlined in Chapter IV. Both of the superpowers would be hurting their ability to perform a vital naval mission by limiting their point defense ASW capability. The Americans would be reducing their control over SLOCs to their allies thus reducing the credibility of deterrence at the theatre level. The Soviets would be reducing their ability to keep their SSBN forces secure, thus reducing the credibility of their strategic retaliatory force.

In addition, the alliance relationships of the superpowers would make it extremely difficult to satisfy the Security Principle corollaries regarding attaining an equal balance of forces between the Americans and Soviets. The Soviets have made it clear that they consider NATO forces adjuncts to American naval forces, and they do not intend to allow a combination of American and other NATO forces to put them at a strategic disadvantage. America's NATO allies have nearly 500 ASW-capable warships which could be used to augment American forces in the Atlantic during a conflict.² Thus any agreement that the Soviets could even begin to consider equitable would require either that the limitations on point defense ASW forces would apply to all NATO navies, or the Soviets would have to be allowed to unilaterally compensate for any disadvantage they felt these other NATO forces caused them.

The Americans could not agree to a treaty which contained terms adequate to satisfy these Soviet concerns. Leaving aside the complications involved in inviting all of NATO into Soviet-American strategic arms control talks (including the French, whom the Soviet consider part of NATO though the French themselves do not), any such agreement would leave the Soviet navy with more capabilities than the American navy, measured bilaterally. Under the so-called Jackson Amendment, it would be illegal for the Americans to conclude such a treaty, and it would certainly not be ratified if signed.

Any arms control agreement limiting point defense ASW would also violate the Security Principle corollary forbidding weakening the parties to the treaty in relation to third parties. This is a particular problem for the Soviets, again, because of American

participation in NATO and the significant submarine forces of the other NATO navies. It would also be a concern to the United States because other countries maintain submarines in their navy which could be used against shipping lanes vital to the Americans, particularly those to the Persian Gulf. The United States would require an ASW force capable of meeting a threat in this area while maintaining the ability to protect SLOCs to NATO and Asia.

Finally, a point defense ASW agreement is unlikely because the naval forces of the superpowers are not comparable in either wartime mission or force structure. The distinction between the sea control mission of the American navy and the sea denial mission of the Soviet navy has already been drawn. These differing missions have resulted in navies equipped with warships with drastically different capabilities. The prime example is the difference between the highly-capable, multi-mission heavy aircraft carriers of the American navy and the more limited capabilities of the Soviet Kiev-class aircraft carriers. The American carriers are clearly superior in both numbers and capabilities.

The difficulty in drawing comparisons would extend down to the level of frigate and destroyer class ships. It would be hard to compare the ASW capabilities of the planned 300 LAMPS-equipped American escort vessels with either the two Soviet ASW helicopter cruisers or the bulk of the Soviet fleet which does not mount ASW helicopters. The current naval forces of the superpowers are simply not comparable. There are not enough similarities between these forces on which to base an agreement without forcing a radical change in the structure of one of these navies.

Analysis: Barrier Defense

Barrier defense ASW operations are designed to prevent the transit of submarines through straits or other "choke points" in the ocean. This is a particularly effective form of ASW against any type of submarine that must pass through a choke point on its way to a patrol station. Like point defense operations, any form of ASW technology may be used in a barrier defense operation.

Barrier defense ASW capabilities do impact on the survivability of SSBNs, and thus on the stability of the strategic balance. Owing to a significant quirk of geography, Soviet Golf, Hotel, and Yankee class SSBNs must transit choke points controlled by the United States or its allies before they can reach a patrol station where their SS-N-4, -5, or -6 SLBMs would be in range of targets in the continental United States (CONUS). Golf, Hotel and Yankee class submarines currently make up about two-thirds of the Soviet SSBN force. This vulnerability of the Soviet SSBN force is being reduced as newer Delta and Typhoon class SSBNs are introduced carrying SS-N-8 and SS-N-18 SLBMs capable of hitting the CONUS without transiting any choke points.

American SSBN forces do not have this problem. All of the American SSBN bases have immediate access to the open ocean and the routes from these bases to SSBN patrol areas is barrier free. An arms control agreement on barrier ASW operations would have no effect on the survivability of this force.

No arms control agreement is likely to be reached limiting barrier ASW operations, primarily because there is no reason for the United States to want one. Barrier operations provide a vital line of

defense for America's SLOCs with its allies. In order to attack these SLOCs, Soviet attack submarines must transit the same American controlled choke points as the older Soviet SSBNs. Because these SLOCs are so vital, the United States and its allies can be expected to focus enormous ASW resources on preventing the transit of the choke points in the event of war. This would include laying CAPTOR mines, establishing attack submarine patrols, and flying VP patrols from bases flanking the choke points.

The Soviet Union may use the same geographic choke points to prevent American SSNs and aircraft carrier task forces from intercepting Soviet naval units close to base. As seen in Chapter III, it is not difficult to imagine parallel ASW barriers going up along the GIUK gap and the entrances to the Sea of Japan. The Soviets would operate at a disadvantage even in this case. Because of the unfavorable geography they would not be able to deploy surface forces and VPs close to these gaps. These forces could not be protected from shore- or carrier-based air attacks. The Soviet barriers would probably consist of patrolling attack submarines and submarine-deployed mines.

Because a restriction on barrier operations would in no way promote the security of the American SSBN force, because barrier operations are a decreasing threat to the Soviet SSBN force, and because barrier ASW operations are otherwise useful to the superpowers in carrying out other naval missions, the Security Principle indicates that an arms control pact in this area is unlikely. In addition, the corollaries to the Security Principle also indicate against a barrier ASW arms control agreement. Except for the American concern

about third parties disrupting SLOCs, all of the same problems exist here that existed with regard to point defense capabilities (the status of NATO forces, etc.). In fact, more can be added. The geographic control of the flanks of these barriers is a tremendous logistical advantage that the United States will not give up. It provides bases for fixed undersea surveillance installations, VP overflights, and land-based combat air patrols insuring air superiority over the choke points, none of which the Soviets could match.

The Verification Principle would also be a problem in reaching a barrier ASW arms control agreement because the two most effective types of barrier forces, submarine patrols and ASW minefields, defy detection. This entire paper is a testimony to the difficulty of locating submerged submarines. Mines, particularly "smart" mines like CAPTOR, are nearly impossible to detect until a ship is attacked by one. However, even an attack by a submarine or an ASW minefield might not give away the nature or deployment of an ASW barrier because the whole operation takes place out of sight. The target submarine is already underwater when sunk, and the victim would not be missed until it was time to report in due to the limitations on submarine communications. This would provide at best a vague picture of the nature, extent, and deployment of the barrier force. An arms control agreement that attempted to restrict barrier ASW operations would not be verifiable, and would thus not be acceptable to either side.

Analysis: Area Search

No discussion of the arms control potential of area search ASW, per se, is needed at this point. This form of ASW operation was

discussed as a separate ASW type in Chapter IV because the characteristics of airborne ASW operations are clearly different than those of purely shipborne operations. However, except for the Soviet coastal defense helicopters, all ASW helicopters are deployed aboard ships and are used to assist in point defense operations. The role of (long-range maritime patrol aircraft (VPs) for barrier patrol operations was discussed above. Patrol aircraft can also pose a threat to deployed SSBNs as a part of a broad ocean interception capability, and the outlook for arms control in this area will be discussed below.

Analysis: Broad Ocean Interception

A broad ocean interception capability involves the ability to locate and destroy a submarine anywhere in the open ocean. This form of ASW is directed primarily at SSBNs. It poses the most serious threat to their survivability and thus their usefulness as a strategic deterrent. Both of the superpowers have a vested interest in insuring the continued security of their SSBNs, and so both should be willing to reach an arms control agreement if it meets the necessary conditions.

Successful broad ocean interception requires that two distinct types of capability exist in order to be effective. First, there must be a surveillance system operational that can locate the submarine in the open ocean. Second, a system must exist to deliver a weapon close enough to destroy the target submarine after it is found. These two different elements of broad ocean ASW will be discussed separately.

The single most vital element of a broad ocean ASW capability is

the ability to localize the target submarine to within a small area in the vast expanse of the ocean. The size of this area will vary with the capabilities of the system designed to destroy the target, but a system that could not locate a submarine to within thirty to forty miles would probably be ineffective. The superpowers are researching and developing both undersea and satellite-based sensors designed to perform this task.

The United States has a lead in the field of undersea surveillance sonars which even the Pentagon characterizes as "awesome." Again owing to geographic advantages, the United States has been able to ring the oceans of the Northern Hemisphere with fixed undersea sonar arrays which are being supplemented with the surveillance towed array sonar system (SURTASS). Improvements in signal processing capabilities and undersea sound path prediction indicate that the Americans are about to expand their lead in this field. The Soviets have no such capability in the Atlantic and only a limited fixed sonar system off of their Pacific and Arctic coastlines.

The American superiority in surveillance sonar technology makes it highly unlikely that they would agree to its limitation by treaty. Not only does this capability give the United States an advantage in hunting SSBNs, it also provides useful intelligence information which can be used to support barrier and point defense operations vital to the American Navy's other missions.

Both superpowers are also developing satellite-based technologies that have applications for broad ocean surveillance as well. The Americans are using satellites to collect sea state data which greatly increases their ability to predict the path of sound through

water and thus increases the capabilities of their undersea surveillance network. The Soviets are attempting to use satellites as a surrogate for the undersea network of sonar sensors they don't have. They are concentrating on detecting heat from the cooling systems of nuclear reactors, dead microorganisms in the wake of submerged submarines, or other physical phenomena caused by the presence of a nuclear-powered submarine.

The first two corollaries to the Security Principle again indicate that an arms control agreement here is unlikely. The United States is using satellite-based technology to augment a lead that already exists in broad ocean surveillance. It is not likely to unilaterally restrict its capabilities given its broad usefulness. On the other hand, the Soviets are far behind in broad ocean surveillance capabilities and are attempting to use satellite-based technology as a means of closing the gap. They cannot be expected to consider limitations on satellite-based ASW surveillance until some degree of parity is reached.

However, even reaching parity is unlikely to open the doors to an agreement limiting satellite surveillance for two reasons. The first deals with the Verification Principle. Many of the systems being developed for the satellite observation of the ocean are passive in nature. They do not give off any kind of observable radiation. With the large numbers and types of satellites put in orbit by the two powers it would be nearly impossible to verify that some of them didn't contain equipment with ASW surveillance capabilities.

The second, and in the long run the most serious, problem derives

from the Civilian Benefit Principle. Sea state data provided by satellites is enormously useful in efficiently tracking the resources of the sea. For example, this data can be used to predict likely feeding grounds for certain types of fish making fishing operations far more efficient. Further, this data can, by tracking currents and such, be used in the prediction of the weather, and potentially in its control. Neither superpower is likely to give up the civilian benefits this new technology promises to deliver.

Since limitations on ocean surveillance systems are unlikely, the only hope for limiting broad ocean interception ASW operations lies in controlling the means of attacking submarines in the open ocean. Three means of doing this were discussed in Chapter III. The most exotic possibility involves the use of land- or sea-based ballistic missiles to attack SSBNs on the basis of information provided by the broad ocean surveillance system. The United States is not pursuing this approach. Based on some statements by the military the Soviets may be, but difficulties in developing a surveillance system accurate enough to identify and pinpoint an SSBN, or in providing intelligence and ballistic missile reprogramming capabilities able to assure a real-time response fast enough to strike a moving SSBN are problematic enough to make this approach seem impractical.

Even if this approach was publicly adopted by the Soviets, such limitation would be improbable because of the Confidence and Comparability Principles. First, it would be impossible to verify which or how many Soviet ballistic missiles were dedicated to a counter-SSBN mission. Even if verification could be done, the Americans have no ballistic

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missiles with a comparable mission which could be used to trade off in reaching an agreement. As long as ballistic missiles exist, so will this option.

Long range VPs and nuclear-powered attack submarines are more effective broad ocean ASW attack platforms because they do not require the surveillance system to be as accurate to be effective. They can acquire and track an SSBN with onboard detectors at ranges of over thirty to forty miles.

Directed to the general area of an SSBN on patrol, the VPs of both the United States and Soviet Union are probably capable of acquiring and attacking it. The chief advantages of using VPs for this mission are their ability to deploy rapidly to the search area and their relative invulnerability from detection by the target submarine. The chief disadvantage is the VPs limited time-on-station capability. Because a VP can only stay on station a few hours it is not well suited for the continuous tracking of a submarine. It is better at the simpler task of finding and attacking it.

The United States has a clear lead in this capability based on its ability to base VPs along the exit paths of the older Soviet SSBNs, and within range of their patrol stations. The Soviets do not have bases for their VPs which would allow coverage of the patrol areas of the American SSBN force. Because of this advantage, and because of the usefulness of VPs for barrier ASW operations, the United States is unlikely to agree to limitations on the possession or deployment of VP forces.

However, the importance of the VP as a platform for attacking SSBNs

is decreasing. VPs have little or no self-defense capability. They are extremely vulnerable to attack from fighters or anti-aircraft weapons. The increased range of the newer SLBMs has allowed the superpowers to establish SSBN patrol areas that can be protected by land-based fighter patrols. This would make the use of VPs to attack SSBNs in these areas extremely difficult. Thus the lack of an arms control agreement in this area is unlikely to be critically destabilizing to the strategic balance.

Both superpowers agree that the most effective platform for acquiring, tracking, and attacking SSBNs is a nuclear-powered attack submarine. The SSN is an excellent sonar platform, allowing it to locate targets at relatively long ranges, it has speed and time-on-station capabilities equal to those of an SSBN, and it is well armed with ASW weaponry. An agreement putting limitations on SSNs would be the single most effective arms control action that could be taken to safeguard the SSBN forces of the superpowers. Because of this, the following discussion presents a detailed look at the issues involved in controlling the SSN forces of the superpowers.

However, before discussing arms control over SSNs as a means of safeguarding the SSBN fleets of the superpowers, it is necessary to review the environment in which an arms control agreement is expected to operate. To be effective, an ASW strategic arms control agreement must provide SSBNs with protection in both of the scenarios discussed in the Introduction. The SSBNs must be protected from a preemptive strike attack under a surprise attack scenario, and must also be protected against attack in the event of a limited naval conflict.

This scenario envisions a surprise first-strike counter-force attack being launched by one superpower against the other superpower's strategic nuclear forces in an attempt to disarm them. It envisions this attack as a simultaneous strike against all of the strategic forces of the other side, destroying them before they can be used for retaliation.

This would require that all of the SSBNs on station be destroyed within a very short time. One analyst has said it must be done within "a matter of minutes," but, the constrictions on communications with submarines would probably allow hours or perhaps even a day to locate and destroy these ships.⁴ Nonetheless, this is a relatively short amount of time in which to perform this task unless the SSBNs have already been located and are being tailed by SSNs. Any arms control agreement that interrupted the SSNs ability to tail SSBNs would probably suffice to safeguard SSBNs against a surprise attack.

It has been suggested that the practical difficulties inherent in a simultaneous strike against all SSBNs on patrol are sufficient protection in themselves for an SSBN force and that no arms control agreement is needed. However, this position fails to take into account the conditions that would exist under the escalation scenario, which is the scenario most likely to lead to a nuclear war. A number of escalation scenarios exist, but they all predict that the use of nuclear weapons will occur after, and as a result of, the outbreak of a conventional war between the United States, the Soviet Union, and their allies, probably in Europe.

Any large-scale conventional war in Europe is likely to ignite an

intense, large-scale naval conflict in the North Atlantic region as well.⁵ Because the Warsaw Pact's conventional forces outnumber NATO forces in Europe, NATO will be forced to rely on reinforcement and resupply from North America to put up an effective fight without resorting to the use of nuclear weapons. The Soviets can be expected to use at least some of their attack submarine fleet to interdict convoys from North America to Europe, and NATO will throw its ASW forces into high gear to protect them.

During the days or weeks this conflict stays below the nuclear or strategic nuclear threshold, SSBNs would be particularly at risk. Given that a war is already taking place, prudent military planning would require that the possibility of escalation into a strategic nuclear war be taken into account, and that action be taken to secure a military advantage if escalation should occur. The high-level of submarine, ASW, and other naval activity involved in the battle for control of strategic SLOCs could provide a cover for ASW operations against SSBNs. These operations would be designed to determine whether enough SSBNs could be located and trailed to make a first strike against the enemy's entire SSBN fleet feasible.

It is even possible that deliberate attacks would be carried out on one or two deployed SSBNs to determine whether ASW weapons are effective, to gather tactical intelligence on the evasive capabilities of the SSBNs to be used later by SSNs in a full-scale counter-SSBN attack as part of a broad preemptive strike, and to determine how long it takes the enemy headquarters to learn that one of their SSBNs has been lost. In the inevitable confusion that would surround the battle for the SLOCs, these attacks could

be characterized as regrettable "mistakes." Because such an attack would be nearly impossible to observe, there would be no evidence to establish for certain whether the SSBN had been attacked by an SSN or had been sunk by a mine laid by one side or the other. The attackers would be counting on the reluctance of the enemy to believe that the war had deliberately been escalated to degrade their nuclear strategic retaliatory force.

Such attacks would not necessarily escalate the war past the nuclear firebreak. They could be carried out using weapons with high explosive rather than nuclear warheads. The danger in such attacks lies in the possible belief of either power that the sea-based strategic deterrent of either side capability had been compromised. The power that perceives that it has compromised its opponent's SSBN force might begin to believe that a full-scale preemptive nuclear strike had become a viable option. The power that feels its SSBNs were at significant risk, recognizing that its other strategic forces had also been compromised by advances in weapons technology, would be pressed to adopt a launch-on-warning posture to offset the threat of being disarmed by a preemptive strike. This would greatly increase the risk of an accidental nuclear exchange. An effective ASW arms control agreement would prevent SSBNs from being at significant risk, even during a large scale conventional war between the superpowers.

Previous discussions have established that SSNs are the most effective weapons systems against SSBNs, and are the systems that are most likely to be controlled in an arms limitation agreement. Because SSNs are currently deployed weapons technology, an arms

control agreement would have to limit either the number of SSNs in the navies of the superpowers, or limit their deployment.

Some analysts believe that controlling the size of SSN forces would be the only effective way of structuring an ASW arms control agreement. For a number of reasons, a limitation on the number of SSNs in the superpowers' fleets is not a practical alternative. The primary obstacle is that the United States is not interested in reaching such an agreement.⁶ The United States currently holds a two-to-one edge over the Soviets in the number of SSNs currently operational. In fact, the United States has more SSNs operational than the Soviets have SSBNs by a ratio of seven to six. The Soviet SSN to American SSBN ratio is six to four.

The characteristics of the day-to-day deployment of these forces help create the American advantage. On a given day the United States has about twenty SSNs deployed at sea in forward areas. The Soviets typically have nine SSBNs on patrol. Conversely, the Soviets typically have only five SSNs at sea on patrol as opposed to twenty American SSBNs. The Americans, under the Corollary One of the Security Principle, cannot be expected to sign any agreement that would reduce any of these advantages.

Because SALT I effectively fixed the number of SSBNs that could be possessed by either superpower, the only way to change these ratios would be to decrease the numbers of SSNs in inventory. The Protect-the-Best principle of arms control would mitigate against this. In both the American and Soviet navies the SSN is considered the most effective ASW platform in the fleet. In addition, both American and Soviet SSNs can launch torpedo attacks against surface

targets, and American SSNs are being equipped with Harpoon anti-ship missiles and Tamahawk cruise missiles which give added capabilities against sea and land targets. Neither side, and particularly the Americans, would likely to be willing to reduce their inventory of such capable warships.

Even if the desire to reach a numerical limitation existed, the Comparability Principle suggests that reaching a formula for such a limitation would be impossible. The United States has given its SSNs weapons that allow them to carry out all of an attack submarine's missions. The Soviets have created a wide number of submarine classes designed to fulfill specific missions. A numerical limitation on SSNs alone would restrict American cruise missile capabilities without restricting similar Soviet capabilities. To compensate the Soviets would be required to submit to limitations on classes of attack submarines (especially SSCNs) that do not have ASW as a primary mission. In effect they would be restricting the possession of two submarines for every one American SSN. The Americans would not accept the first situation. The Soviet would not accept the second.

Finally there would be the problem of third party SSNs. Great Britain and China both operate SSNs in their navies. This problem parallels the problem of SSBN limitation encountered in SALT I. The Soviets can be expected to view British (and possibly Chinese) SSNs as adjuncts to the American SSN force and would insist that they be allowed to compensate for these "third party" SSNs. The Americans are bound to consider their bilateral status in relation to Soviets' capabilities alone. Their concept of equity in reaching

a formula would require that a balance be reached without counting third party forces.

The number and scope of the problems listed above rules out a numerical limitation on SSNs as a means of safeguarding SSBNs through arms control. The other option involves putting restrictions on the deployment of SSNs. Virtually all of the discussion on arms control of this type has involved providing sanctuaries for SSBNs. These sanctuaries would be designated areas of the ocean where SSBNs could patrol and where ASW forces, including SSNs, would be forbidden.⁷

The Soviet Union went as far as to table a proposal establishing SSBN sanctuaries during the SALT I negotiations.⁸ The United States rejected this idea on grounds relating to the Verification Principle. First, such an agreement could be instantly and massively violated by either party without prior warning. Second, because SSNs are as difficult to find and track as SSBNs, verification that SSNs were operating within the sanctuary areas would be difficult to establish and impossible to prove. There would be no hard, confirmable evidence to conclusively prove whether or not an SSN had been in a sanctuary area.

Sanctuary agreements could also interfere with other SSN missions considered vital to one side or the other. A prime example would be the declaration of the Barents Sea as a sanctuary for Soviet Delta and Typhoon class SSBNs. This would cut off access to the Barents by all American SSNs, including those SSNs assigned to intelligence gathering missions. The Americans would not agree to a sanctuary that restricted their SSNs' ability to carry out non-ASW

missions.

A sanctuary agreement would be unlikely to be of any use in the midst of one of the escalation scenarios and could actually be destabilizing. The problems mentioned above would intensify under the pressures of a wartime situation. Because verification of this agreement would be so chancy, each side would be suspicious that the other had violated the agreement, giving them a potentially decisive advantage if the war escalated into a nuclear exchange. This fear would be supplemented by the temptation provided by the possibility that a massive violation of the agreement might be undetected or misinterpreted in the confusion of a battle over SLOCs, and that a significant advantage could be seized should the war go nuclear.

Coupled to these fears and temptations would be pressing military contingencies that could, and probably would, arise as a result of the conventional war. For example, American SSNs would certainly violate a sanctuary in the Barents Sea to intercept a Soviet naval force supporting an invasion of Northern Norway. Conversely, the Soviets would certainly violate an Atlantic SSBN sanctuary if crossing through the sanctuary was the only, or even just the best, way of positioning SSNs to intercept a convoy threatening to break through to Europe with significant reinforcements and supplies.

It would be unreasonable to expect a formal sanctuary agreement to survive these pressures. Thus such an agreement would do little to improve the security of SSBNs during the period of their greatest vulnerability. It could even prove severely counterproductive in an

escalation scenario by adding to the suspicions and doubts of each side towards the other, thus contributing to an increase in tension.

For these reasons, a formal arms control agreement establishing sanctuaries for SSBNs is not feasible, and possibly not desirable. It is also probably unnecessary. The improved ranges of SLBMs has allowed the superpowers to withdraw their SSBN patrol areas to positions with support from friendly forces. This is a high priority mission for the Soviet Navy. The capability to establish de facto sanctuaries provides a margin of additional protection to SSBNs, especially during wartime when ASW forces could actually fire on SSNs. But it is not at all clear that even a heavy commitment of ASW forces could effectively screen out infiltrating SSNs.

This pretty much exhausts ideas presented in the literature concerning the protection of SSBNs from ASW forces, and particularly SSNs through arms control. As has been shown, all these ideas have significant shortcomings. The discussion below presents a new type of arms control agreement which meets both the need to protect SSBNs from SSNs and to keep SSNs free for other missions.

An ASW Arms Control Proposal

The proposal discussed below involves control over the deployment of SSNs on patrol. However, it does not attempt to set aside sanctuaries where SSNs could not enter. Instead, this proposal is intended to allow SSNs full freedom of the oceans while making it impractical for them to trail SSBNs. The proposal has two objectives. First, it is designed to prevent the constant trailing of SSBNs by SSNs. Second, it is designed to complicate the problem of acquisition of an SSBN by an SSN.

The method for achieving these objectives is simple. It involves establishing stations throughout the oceans where SSNs would periodically report when on patrol. Under this proposal, every time an SSN left port it would report to a ship stationed outside the port for positive identification. While at sea, the SSN must periodically surface and report to other ships stationed at positions scattered widely around the oceans within a given period of time.

The reporting stations would be positioned outside of the areas where SSBNs are likely to be patrolling and away from the probable transit paths of SSBNs from their bases to their patrol stations. A large number of these stations would be scattered throughout the Northern Atlantic and Pacific Oceans to allow SSNs to be able to cover these entire ocean areas and still be able to conveniently report to a station. SSNs could also report to any surface warship of the other superpower's navy. An SSN would be allowed to report to any station or warship it can reach within the given time frame.

Figures V-1 and V-2 profile SSN missions operating under this proposal demonstrating the difficulties of sustaining an operation designed to trail SSBNs, while allowing SSNs to continue to fulfill their other peacetime and wartime missions. These profiles assume that SSN patrols would last approximately 90 days, and that SSNs would be required to report to a station within twenty-five days of their last report.

These mission profiles clearly demonstrate the advantage of this proposal as a means of preventing the trailing of SSBNs. The need to periodically report to a station outside of an SSBN's patrol area means that an SSN would be forced to break off from this operation

Map V-1: Hypothetical Soviet SSN patrolling the Pacific during peacetime.

Day 1 - Reports out of port and proceeds to participate in Soviet fleet ASW exercise.

Day 15 - Exercise concluded, reports to nearest station and proceeds to Guam to attempt to trail American SSBN from port.

Day 19 - Arrives off Guam, establishes patrol.

Day 25 - Detects transiting SSBN and pursues.

Day 31 - Contact lost. Captain decides to continue search.

Day 33 - No contact. Captain breaks off search to report in.

Day 35 - SSN ordered to Petropavlovsk to screen SSBN exiting on patrol.

Days 39-45 - Takes part in screening Soviet SSBN from patrolling American SSNs.

Days 46-55 Breaks off patrol and returns to base.

Map V-2: Hypothetical American SSN patrol in the Atlantic during a limited war.

Day 1 - Reports out of port and proceeds towards GIUK gap

Day 6 - Reports in again (gaining a new 25 day grace period) and proceeds to take up a barrier patrol position.

Day 9 - Receives orders to intercept Soviet naval task force supporting operations in northern Norway.

Day 12 - Attacks Soviet task force; retires at high speed to resume barrier patrol.

Day 16 - Resumes barrier patrol.

Day 22 - Detects Soviet Yankee SSBN transiting gap and pursues.

Day 25 - Breaks off pursuit to report in.

Days 27-38 Attempts to reacquire Soviet SSBN without success.

Day 39 - Recalled to screen trans-Atlantic reinforcement convoy. Reports in and proceeds to new station.

Days 40-55 Remains on station until ordered back to base.

at least three times during a patrol. This would force any SSN dedicated to an SSBN trailing mission to go through the difficult procedure of reacquiring the target several times during each patrol. This process can be further complicated by providing SSBNs with the intelligence information regarding the number of SSNs at sea and the dates they reported to the various stations. The SSBN captain can use this information to position his ship where it would be the most difficult for the SSNs to find him.

As a practical matter, this proposal would also increase the amount of protection afforded to SSBNs in the event of a conventional conflict between the superpowers. Because of the potent capabilities of SSNs and their missions that could effect the outcome of a conventional struggle, they are likely to be high value targets for ASW forces during the conventional conflict. Neither power is likely to risk an attack on an SSN by having it report to a station that is within easy range of the enemy's ASW forces. Instead, they are likely to have their SSNs report to stations where the SSN is far from the bulk of enemy ASW forces and where it can be protected by friendly forces. This means that transit times to SSBN patrol stations would be increased, thus decreasing the amount of time the SSN could spend acquiring and trailing an SSBN.

The profiles above also indicate that this proposal would not interfere significantly with the other missions of the SSNs of either side. In the peacetime the wide number of stations available for reporting would allow SSNs free access to all areas of the ocean. In wartime, this proposal would restrict the amount of time an SSN could roam in enemy waters, but it would not impair the SSNs ability

to take part in barrier operations or to take part in sorties against particular targets deep in enemy waters.

There are also other advantages to this proposal besides those illustrated by the profiles above. One is the lack of restriction on SSN force required by this proposal. Because this proposal focuses on exacerbating the operational problems of the individual SSNs attempt to intercept and trail an SSBN rather than measuring the overall size and capability of the superpowers' SSN forces, this proposal can function effectively for any size SSN force. Under this proposal both superpowers would be free to construct and deploy any size SSN force they feel necessary to fulfill their other mission capabilities without significantly increasing the threat to the other side's SSBNs. This proposal can be effective for nearly any size SSN force.

Another positive feature of this proposal is its ease of verification. The agreement is actually self-verifying. Current surveillance capabilities can fairly easily determine whether or not a submarine is in port or not. If all of the SSNs known to be at sea are reporting to the ship just off of the port and to those on station at sea then it is clear that the agreement is being kept. If not, it becomes immediately obvious that the violation is occurring as it happens. This allows the other side to make a prompt response to the situation.

This voluntary self-verification feature could play a significant role in keeping a conventional war from escalating into a full scale nuclear exchange. By continuing to have their SSNs report to the stations at sea, the superpowers would be signalling each other that

they are not trying to attack each other's SSBN retaliatory force. This would constitute a significant signal that neither side is preparing a strategic counterforce strike as an escalation of the limited war.

There are some potential objections to this arms control approach, but most of them are not serious enough to make it impractical. The most obvious disadvantage of this proposal is the amount of information this proposal provides the other side about SSN deployments. In peacetime this would not present a significant problem because attack submarines are not important enough targets to justify using expensive and valuable naval resources chasing them around the oceans. Both of the superpowers' navies have other things to do. In any event, the information on peacetime SSN deployments would be unlikely to provide any valuable insights into their specific wartime missions, but this information would increase the SSBNs ability to avoid being tailed by an SSN.

In wartime, adhering to such a proposal might seem to expose SSNs to an unacceptable level of risk. However, there are reasons to believe that this might not be the case. First, although the verification of this agreement is virtually certain, the predictability of the SSNs future behavior is not. The enemy would have a general idea where and when the SSN will report, but they could not predict the next station where the SSN would choose to report or exactly when it would decide to show up. Because of this, in order to mount a significant threat to the SSN force, a power would have to keep a constant ASW presence around all of the reporting stations to intercept the incoming SSNs.

Mounting such an effort would require a significant investment in resources and would probably be counter-productive. No SSN would approach a reporting station without first checking to see whether it could detect enemy forces in the area. The reporting SSN would probably have an edge over the ASW ambush because it knows when and where it will arrive. Furthermore, as seen previously, the reporting stations could be positioned so that the SSN could receive help from friendly forces in keeping the area around some of the stations free from enemy ASW forces.

Second, an attempt to mount a counter-SSN ASW operation as the result of an SSN's report to a station would probably be impossible. The process of surfacing and being positively identified would not take more than about five minutes. After this had been done, the SSN would presumably retire from the scene at high speed. The problem of receiving the information on the SSN sighting, relaying it to an appropriate ASW unit, and getting that unit to the scene before the SSN had departed is probably impossible to overcome. It would be even more difficult if the SSN were being covered by friendly forces, and if the reporting station were required to hold the news of an SSN sighting until several hours after that sighting occurred.

Finally, the most powerful disincentive to mounting ASW operations against SSNs at their reporting stations would be the consequences if such operations were to succeed. At most no more than two or three SSNs could be expected to reporting stations on any one day. The rest of the force would be in port or at sea. If one side noticed that it had lost a couple of SSNs on or around the day

they were due to report to a station and had reason to suspect enemy action they would simply instruct the rest of their SSNs not to report to the stations. The other side would certainly reciprocate, if only to prevent retaliation against its SSNs.

The consequences of such an action would probably be severe. First, the act of continuing the SSN reporting during a limited conflict would be an act of faith on the part of the superpowers and a signal that neither side wanted an escalation of the conflict. Violating this faith by launching opportunistic attacks on SSNs would be seen as a massive, and probably unpardonable, breach of an agreement designed to keep the world from nuclear war. Worse, it could be seen as an act of escalation, and as a statement that the other side was willing to start up the escalation ladder. Additional anger, fear, and suspicion would be injected into an international environment that would probably be strained to the limit already.

Added to this would be the increased level of uncertainty caused by the loss of intelligence on the operations of SSNs made available by the operation of the agreement. One side could not be sure that the other had not decided to further the escalation of the conflict into counter-SSBN operations. This would increase the temptation to engage in such operations oneself, and would greatly increase the probability that a legitimately accidental attack against an SSBN on patrol would be interpreted as the initiation of a full scale attack on SSBNs in preparation for a massive first strike. The severely destabilizing nature of this scenario is obvious.

While the consequences of attacking an SSN at a reporting station

would be potentially disastrous, the decision not to risk exposing SSNs by ordering them not to report would be nearly as bad. This situation does not have quite the emotional component of betrayal contained in the previous scenario, but all the analytic uncertainties about the possibility of escalation into counter-SSBN ASW operations remain. The other side could not be sure that the withdrawal from adherence to the agreement was not done to enhance counter-SSBN capabilities, which would represent escalation across the threshold of strategic nuclear warfare.

A potentially major roadblock to the acceptance of an ASW arms control agreement of this type is the use of certain American SSNs as intelligence gathering ships. It is entirely possible that these ships could not carry out their intelligence mission under the constraints of such an agreement. An easy way to settle this problem would be to allow each power to exempt two or three SSNs at sea from the need to report in. These boats would be required to announce that they are exempt from the reporting requirement when they left base. They would only be required to report in and report out. Two, three, or even four SSNs would not pose a threat to the deployed SSBN forces of either side. The status of this exemption during a limited war would have to be negotiated.

The status of third party SSN forces could also pose a problem in this agreement, but it seems unlikely that this would be insurmountable. Even in combination, the SSN forces of the third parties are not big enough to be a major concern to the SSBN forces of either side. This proposal would allow either superpower to develop its force structure in any way it felt necessary to

counter the third-party threat. However, this is also the sort of agreement to which it would be easy for third parties to accede. These parties could join the agreement simply by agreeing to have their SSNs report just as the superpowers SSNs would. They could thus help to ease somewhat the pressure on the international strategic situation without making any changes in the force structures or deployments that suit their own national needs.

The only other potential roadblock to an agreement such as the one proposed above would be the American superiority in ASW capability. If the Americans believe they can pose a significant counterforce threat to Soviet SSBNs, and that the Soviets cannot mount a similar threat then the Americans are unlikely to opt for an agreement reducing their advantage. But even if the Soviets cannot mount such a threat today, they may be able to in the future as a result of the massive resources they are pouring into the effort today. This proposal should work as well in 1995 as it would today.

NOTES: CHAPTER V

1. K.J. Moore, "Antisubmarine Warfare" in Micheal McGwire, Ken Booth, and John Mc Donnell, Soviet Naval Policy: Objectives and Constraints p. 188.
2. House Committee on Military Preparedness, Hearings on Military Posture and H.R. 5068 and H.R. 1755, p. 1964.
3. See J. LaRogue, "The Nth Country Submarine Problem," in Tsipis, Cahn, and Feld (eds.), The Future of the Sea-Based Deterrent, pp. 244-258.
4. Kosta Tsipis, "Antisubmarine Warfare - fact and fiction," New Scientist, January 16, 1975, p. 146.
5. "...the oceanic spaces will become the arena of savage warfare between navies fighting to secure the maximum utilization of their naval power for the solution of crucial strategic tasks." Sergei G. Gorshkov, "The Sea Power of the State" Survival, January/February 1977, p. 26.
6. J.K. Davis, C.M. Lehman, and N.H. Wessell, "SALT II and the Search for Strategic Equivalence," Foreign Policy Research Institute Monograph Series No. 19 (1974), p. 52; William M. Rose, "Submarine vs. Anti-Submarine: The Billion-dollar Merry-Go-Round," Bulletin of the Atomic Scientist, April 1975, p. 29. However, in an interview, Dr. Victor Alessi of the U.S. Arms Control and Disarmament Agency told me flatly that the United States is not interested in such restrictions (May 28, 1978).
7. See SIPRI "Prospects for Arms Control in the Ocean" SIPRI Research Report No. 7, pp. 21-22; Rose, "Submarine vs. Anti-Submarine," pp. 28-29; Elizabeth Young "New Laws for Old Navies: Military Implications of the Law of the Sea," Survival, November/December 1974, pp. 262-267; Joseph Kruzel, "SALT II: The Search for a Follow-on Agreement," Orbis, Summer 1973, pp. 353-354; Richard L. Garwin, "The Interaction of Anti-submarine Warfare with the Submarine Based Deterrent," pp. 116-117, and B.T. Feld and G.W. Rathgens, "ASW, Arms Control, and the Sea Based Deterrent," pp. 136-40 in Tsipis, Cahn, and Feld, The Future of the Sea Based Deterrent.
8. The Soviets have consistently supported the concept of SSBN sanctuaries. They initially introduced the idea of a mare clausum for submarines in 1968 when they proposed that "submarines carrying nuclear missiles should be prohibited in areas from which the missiles can reach the frontiers of contracting parties" as a means of defense against American SSBNs. (E.D. Brown, "Arms Control in Hydrospace" Woodrow Wilson International Center for Scholars, Ocean Series No. 301, p. 48). The mare clausum concept changed as Soviet SSBN capabilities and naval strategy changed. They introduced the idea of SSBN sanctuaries during the SALT I negotiations but the Americans rejected their proposal as unworkable (Davis, Lehman, and Wessell,

"SALT II and the Search," p. 28). They tried again during SALT II negotiations, including the sanctuary concept in discussions on a ban on depressed trajectory SLBMs, but the Americans again refused to agree (Strobe Talbott, Endgame: The Inside Story of SALT II, pp. 208-209).

SUMMARY AND CONCLUSION

From its inception, this analysis has focused on the practical problems of a very specific policy issue. The subject matter, anti-submarine warfare and arms control, is a very small portion of a very large, highly complex subject area. This analysis began with a broad presentation of the factors that make the issue of the control of antisubmarine warfare of vital importance to strategic stability. From this point the focus of the analysis continually narrowed. First the technical capabilities of submarine and ASW forces were discussed in relationship to the effect they have on strategic stability. Then past arms control agreements were analysed to derive a model which could help determine which ASW technologies might be controllable. Finally, all of these factors were brought together to identify the SSN as the key ASW system, and to derive a means of limiting its strategically destabilizing potential while allowing it a full range of other capabilities.

The intentionally narrow focus of this analysis severely limits its general applicability. It provides an answer to only one specific, if vitally important, question: Can an acceptable means of controlling ASW forces be devised? The answer proposed above is not perfect, it may not even be good, but it is better than any of the other proposed solutions I have seen to date.

This paper itself does not open up broad new vistas for research. This was not its purpose. The only direct avenues for new research are 1) a further look into the principles of arms control devised in Chapter IV to refine them, assess the scope of their validity, and

to determine the scope of their applicability, and 2) to attempt to apply selective, voluntary control of the operational use of weapons systems in arms control agreements, especially to other "grey area" weapons systems that cross the line between strategic and tactical useage.

On a more general level, further analysis of specific strategic weapons systems, both current and projected, need to be done with an eye to their immediate control. Practical and equitable new means of defining military security must be devised which leaves neither of the superpowers with the slightest hint that they would benefit from the initiation of a war. At present, only the presence of secure strategic retaliatory forces provides this guarantee, and this must be preserved until something better can be found. Today, only arms control offers a means of protecting the security of these retaliatory forces because the emerging arms technologies only increase the vulnerability of these forces and destabilize the strategic balance.

The military strength of the superpowers has long since passed the point of diminishing returns. Between them the concept of "strategic superiority" is utterly devoid of meaning. This point must be driven home to policy-makers. They must be convinced that arms control is not only the cheapest way of achieving national security, but the only way any margin of security can be maintained at all.

Arms control is only a stop-gap measure. The real pressing need for researchers in strategic studies and international affairs is to devise new methods of avoiding and resolving conflicts.

Comprehensive work must be done into the fundamental nature of conflict, competition, cooperation, and peace. Concentration should be on fundamental concepts and basic theory. Analysis that takes new conceptual constructs to their logical extremes should be encouraged. Finally, and by far most important, these ideas must be translated into practical proposals based on a firm understanding of human nature and the realities of international politics, and sold to politicians and statesmen as reasonable alternatives to current practices.

Since Emeric Crucé proposed a plan for a congress of Europe in the 14th century, men have been trying to find a political alternative to the practice of states going to war. Never has the opportunity, or the need, to succeed been as great. Current weapons have made either warfare or civilization as we know it obsolete. If new ideas can be devised and developed, and if minds can be opened to the need for change, we may yet survive.

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APPENDIX

TABLE OF SELECTED ABBREVIATIONS

ACW	Anti-aircraft carrier warfare.
ALCM	Air launched cruise missile.
ASROC	* Antisubmarine rocket, used by American surface ships.
ASW	Antisubmarine warfare.
AWACS	Airborne Warning and Control System.
BMEWS	Ballistic Missile Early Warning System.
C ³	Communications, command, and control.
CAPTOR	enCAPsulated TORpedo, American deep water ASW mine.
CEP	Circular Error Probable, the radius from target within which a warhead will fall fifty percent of the time.
Cluster Bay	Soviet ASW mine.
Cluster Gulf	Soviet ASW mine.
ELF	Extremely low frequency sound.
FLIR	Forward-looking infrared detector, detects heat from submarines
ICBM	Intercontinental ballistic missile.
IOC	Initial operational capability, date a system comes into service.
IRBM	- Intermediate range ballistic missile.
LLTV	Low light level television, used on ASW patrol airplanes.
MAD	Mutually assured destruction.
MAD	Magnetic anomaly detection.
MIRV	Multiple, independently targeted reentry vehicles.
MRV	Multiple reentry vehicles, not independently targeted.
MX	New American ICBM, under development.
NAVSTAR	New American global navigation system, satellite based.

ORICS	Optical Ranging, Identification, and Communications System, American laser-based ASW and communications system.
PRAM	Propelled Rocket Ascent Mine, American medium depth ASW mine.
SLBM	Submarine-launched ballistic missile.
SLCM	Sea-launched cruise missile.
SLMM	Submarine-launched mobile mine, American shallow depth that can be delivered from stand-off distances.
SOSUS	Sound Surveillance System, American broad ocean ASW detection network.
SS	Designation for diesel-powered patrol submarines.
SS-	Prefix for Soviet ICBMs, higher numbers indicate more recent models.
SS-N-	Prefix for Soviet naval missiles.
SSBN	Nuclear powered submarine carrying SLBMs.
SSG	Diesel-powered, cruise missile carrying submarine.
SSGN	Nuclear-powered, cruise missile carrying submarine.
SSKP	Single-shot kill probability.
SSN	Nuclear powered attack submarine.
SRAM	Short-range attack missile, launched from bombers.
SUBROC	American, submarine-launched ASW rocket with a nuclear warhead.
SURTASS	Surveillance towed array sonar system.
TACTASS	Tactical towed array sonar system.
Tagos	Ships equipped with SURTASS
VDS	Variable depth sonar.
VP	ASW patrol airplane.

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