

STRATEGIC STABILITY:
THEORY AND MEASUREMENT FOR ARMS CONTROL

by

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Abstract

Analysis of strategic arms limitation proposals requires objective criteria by which to rank them. Toward this end, the purposes of strategic arms control are discussed, and "stability" chosen as the primary goal by which proposals should be judged. Several arguments against the use of stability as a criterion for arms control proposals are discussed, and qualifications of the stability idea are considered. Finally, a variety of criteria for judging the stability of alternative strategic balances are examined. The correct criteria are found to depend on doctrinal assumptions as to what factors would influence the course and outcome of a nuclear exchange; several doctrinal possibilities are considered, and a ranked set of criteria presented.

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Since it costs a lot to win
And even more to lose
You and me bound to spend some time
Wond'rin' what to choose.

---Robert Hunter and Jerry Garcia, "Deal"
Ice Nine Publishing, 1971

I. INTRODUCTION

General Edward Rowny, the former chief strategic arms negotiator for the Reagan Administration, has proposed an alternative acronym for the SALT process: "PEPPER," for "Poorly Evaluated Plans and Policies Executed Righteously." [1] Rowny's judgement is harsh, but it would be difficult to disagree completely. In the hectic battles over particular weapons and treaty proposals that consume so much of the arms control debate, discussions too rarely begin from the beginning, and ask: What precisely are the goals we are seeking to achieve through arms control? What is their relative importance? And what measures can we use to judge whether one proposal or another would bring us farther along the road to accomplishing those goals? These questions -- especially the last -- are what this thesis is intended to address. In essence, what I am attempting to do is to articulate a set of criteria by which the merits of different proposals for negotiations in the SALT forum can be objectively analyzed.

Any criterion for judging one proposal against another is simply an effort to quantify certain goals; the place to begin, therefore, is with an enumeration of the objectives of arms control. For the first part of the nuclear age, the goal most frequently put forward in discussions of "disarmament"

was simply reducing the number of nuclear weapons, with a view to eliminating such weapons entirely. By the end of the 1950s and the early 1960s, however, a number of writers had begun to argue that complete nuclear disarmament was impossible, and that discussion should therefore focus on the more limited idea of "arms control." [2] In a completely disarmed world, even a handful of nuclear weapons would be enough to achieve an overwhelming advantage in any conflict; as long as conflicts between nations continued, the incentives to produce a few weapons in secrecy -- and then to use them or threaten their use -- would be enormous. Thus, the nuclear dangers of a supposedly disarmed world might be even greater than those of the present one -- where a few weapons produced in secrecy would be insignificant by comparison to those that already exist. Nor was a perfect defense possible, in their view: and given the destructive power of each nuclear weapon, nothing significantly less than a perfect defense could provide cities with solid protection against attack. The only realistic means of preventing nuclear attack, therefore, was to dissuade prospective enemies by threatening a devastating retaliation to any nuclear attack -- nuclear deterrence. Despite the danger that nuclear deterrence might someday fail, unleashing a nuclear war, nuclear weapons were seen as the only available guarantors of peace.

The logical corollary of this conclusion is that any proposal for arms control should be judged not by whether it reduced the numbers of nuclear weapons, as a disarmament proposal would be, but rather by whether it helped reduce the dangers and difficulties of deterrence. Whether the number of nuclear weapons in the world is 2,000, 4,000, or 20,000 might be of relatively little importance in and of itself [3]. More specifically, the early arms control theorists identified three areas of possible benefit from arms control: reducing the risk of war, reducing the likely level of damage should war occur, and reducing the economic costs of defense. Despite their fundamental conflicts, the superpowers were judged to have identifiable mutual interests in accomplishing these goals, making negotiated agreement possible, at least in theory.

As arms control has been practiced over the intervening twenty years, however, it has become clear that it is an extremely complicated enterprise. Progress toward the original three goals has been difficult, and a number of other possible goals have manifested themselves -- not to mention undesirable side effects of the process [4]. First and foremost, arms control has played a multifaceted role as an instrument of political relations between the two superpowers; for better or for worse, progress in SALT has become both a measure and a determinant of the state of

relations between the United States and the Soviet Union. Indeed, SALT has traditionally carried the heavy burden of being the centerpiece of all political relations between the superpowers; a summit between the leaders of the two sides is thought to be meaningless unless it makes significant progress in arms control [5]. Second, many arms control proposals have been directed toward reinforcing the perception of "parity" in the nuclear arsenals of the two sides, and toward reducing or balancing any asymmetries between them. Third, arms control has enhanced the predictability of the arms race, and thereby simplified the task of defense planning. Even the loose upper limits that have so far been provided by the SALT agreements go a long way toward reducing the anxieties and uncertainties inherent in an unconstrained arms race -- where physical capability sets the only upper limit on the weapons one might expect the other side to build. Along these same lines, the SALT agreements have eased the process of monitoring Soviet forces -- by outlawing interference with national technical means of verification (NTM), and intentional measures to confuse those means. Lastly, arms control has been a powerful instrument of propaganda and manipulation of public opinion -- on both sides, and for a variety of ends.

Which of these is the most important consideration? Given the destructiveness of current nuclear arsenals (which I need

not belabor here), the intuitive answer is that the overriding goal of any SALT proposal should be to reduce the risk of nuclear war; other goals pale by comparison. But it should be remembered that this is true only if the risk of nuclear war is judged to be a significant one, and if arms control can have a significant effect on that risk [6]. If we have faith that the probability of nuclear war is negligibly small, or if we lack faith in our ability to invent and negotiate arms control agreements that would reduce that probability, then we should turn our attention to some other area, where the effects of arms control might be swifter and surer -- perhaps to saving money [7].

There have always been those who argued that weapons themselves were merely a symptom of international conflict, not the cause, and therefore disarmament or arms control could have no effect on the risk of nuclear war. But a fundamental part of ^{the} credo of arms control is that, as Thomas Schelling and Morton Halperin wrote in their seminal 1961 book, Strategy and Arms Control [8]: "some of the danger of war resides in the very character of modern weapons." Given the awesome scope of the destruction that a nuclear war might bring, the burden of proof would seem to be on those who would disagree, and argue that the effect that negotiated limitations on strategic weapons could have on the risk of war is negligibly small; even a tiny reduction in such a huge

danger would be sufficient to override most other goals. In this thesis, therefore, I will assume that the primary goal by which proposals for SALT negotiations should be judged is the reduction of the risk of nuclear war, and it is on this that the specific criteria I will develop will be based.

Not only will I concentrate on only one of the possible goals of arms control, but I will concentrate on only one aspect of that goal: the issues that I will concern myself with in this thesis are only those concerning the technical specifics of arms control proposals, and only those that would arise in a negotiating forum similar to SALT. This thesis is not about the immensely broad topic of measures to reduce the risk of nuclear war. Rather, it is about the narrower (though still broad) topic of how specific limitations on the characteristics of strategic weapons themselves might influence those goals. The focus on technical issues, and on the SALT forum, constrains the scope of the discussion in several important ways. First, I will consider only nuclear weapons, and only those considered strategic; the probably more important issues arising from conventional forces or even tactical nuclear weapons will not be explored [9]. Second, I will assume throughout that the Anti-Ballistic Missile Treaty of 1972 remains in place, meaning that no significant defenses against ballistic missiles are deployed by either side [10]; I will be concerned

only with offensive strategic nuclear weapons. Third, I will consider only technical limitations on the strategic balance, leaving aside all of the other important possibilities that could be placed under the rubric of arms control, from hotlines and crisis control centers to broad political agreements. Moreover, I will not discuss the political effects which even agreements conceived of as purely "technical" would surely have, but only their technical impact on the strategic balance. Lastly, the criteria for judging differing proposals that I will develop can suggest only whether a given proposal is "desirable," in the narrow sense of contributing to the fulfillment of a specific goal. But whether a given agreement would be desirable is a moot point unless it is both negotiable and verifiable.

It is by no means obvious, of course, that this emphasis on the technical aspects of strategic nuclear weapons addresses the most important aspect of the nuclear problem; if anything, it seems obvious that it does not. The history of the nuclear age seems more a matter of global power politics, of bureaucracy and economics, of international crises and the men who played them out, than of weaponry. In the end, it seems likely that such issues as the Arab-Israeli conflict have much more impact on the risk of nuclear war than do the numbers and types of nuclear missiles. Indeed, if nuclear

negotiations help relax political tensions between the United States and the Soviet Union -- or if they exacerbate them -- the fact that we are talking at all may in the end be more important than what we are talking about.

But given that the SALT negotiations are almost certain to continue (if sporadically), it is by no means irrelevant to ask what benefits we hope to achieve from the specific technical limitations to be negotiated, and how those benefits might be measured and quantified. These are the questions that I will attempt to address in the coming pages.

The idea of reducing the risk of nuclear war through limitations on the numbers and types of strategic nuclear weapons requires, of course, a clear idea of exactly what "character" of those weapons it is that contributes to the risk of war. The most common such conceptualization is the theory of "stability" -- the idea of minimizing the pressure to strike first, should war seem likely. The next section will be devoted to a basic description of stability theory, as it relates to the specific characteristics of strategic weapons. Before stability theory can be applied, however, its weaknesses must be either acknowledged or defended: the third section, therefore, will examine a broad range of criticisms and qualifications of the theory described in Section Two. The fourth section will be devoted to the surprisingly difficult question of exactly how to apply the simple theory

of stability to the development of specific criteria for analysis.

Before beginning, however, there remains a final qualification: this thesis is largely about nuclear theory -- and therefore the bulk of the questions it addresses simply cannot be definitively answered. The most important conclusion is merely a recognition of the enormous uncertainty surrounding all aspects of nuclear weapons. A nuclear war has never been fought, so there can be no hard and fast knowledge as to how the weapons would actually work, how a nuclear war might begin, or what might happen then; here, there are no true experts. No matter how great the length at which one expounds one's theory of the nuclear danger, no matter how well grounded it might seem to be in logic and analogy, it remains speculation.

Nevertheless, one cannot allow oneself to be disabled by doubt; that a question has no incontrovertible answer by no means implies that it can be safely ignored. One must keep in mind not only the magnitude of the uncertainty but the magnitude of the problem. Decisions concerning nuclear weapons must be made, and so theoretical judgements must be made as well. Policy-oriented readers may argue that such theories rarely have much relevance to actual governmental debates over nuclear policy, and may be dismayed at the prospect of such a long discussion of stability theory; but as

Keynes once observed, theoretical ideas have power that is not often recognized: even "practical men," who "believe themselves to be quite exempt from any intellectual influences," are usually the unconscious slaves of long-defunct theorists [11]. Theory provides a basis for deciding what is important and what is not; that it should be the basis of any criteria for judging arms control proposals is inevitable. And when setting down to the practical matter of SALT negotiations, having such criteria embodying one's goals can hardly be considered a matter of complete irrelevance.

III. The Idea of Stability

For both the United States and the Soviet Union, the primary purpose of procuring strategic nuclear weapons is to reduce the probability of a nuclear attack on their homelands -- by means of deterrence, posing the threat that any nuclear attack would be met by a devastating retaliation in kind. "Extended deterrence" -- the effort to extend protection to allies -- is also of crucial importance, but is not as immediately a matter of survival; I will be discussing primarily the issue of deterrence of strategic nuclear attacks on the homelands of the two powers.

Maintaining deterrence is in its essence a matter of psychology: the task is to influence the beliefs of the decision-makers on the opposing side, to insure that they are convinced that one has both the means and the will to respond to any attack, raising the costs of an attack beyond the worth of any possible gain from the attack. It is a matter of fear.

This fear is presumably based, at least in part, on judgements as to technical facts. Specifically, the threat of retaliation requires that the retaliatory weapons themselves not be vulnerable to attack: if either side could gain complete confidence that a strategic surprise attack would wipe out the other's nuclear forces, leaving it unable to retaliate in kind, those forces would cease to have much

deterrent effect. Fortunately, however, such a completely disarming attack is simply not a technical possibility, for the foreseeable future: and as long as each side maintains a significant number of survivable nuclear weapons with which to retaliate for a nuclear attack, neither side seems likely to attack the other in peacetime.

Imagine, however, a severe crisis -- so severe that all-out nuclear war seemed very likely. Each side, believing attack by the other to be a significant possibility, would have to reconsider the question of whether to attack in the light of the significant possibility that not doing so would simply mean allowing the other to get in the first blow. If a large proportion of one side's weapons were vulnerable to attack, the other side might feel impelled to strike them, in order to limit the damage those weapons might inflict. The side whose weapons were vulnerable, realizing what the other might be thinking, would have its own incentive to get its weapons off early, while it still could. In this case, the thought that war was likely would create enormous pressures to be the one to begin it, changing a mere possibility of war to a near certainty of war. This danger does not depend on the idea that one side could disarm the other completely; it depends only on the perception that war is very likely, and that should war come, it would be significantly better to strike first than to strike second. In Richard Betts' words: "the choice of

Pyrrhic victory becomes less appalling when the only alternative is Pyrrhic defeat." [1]

The outbreak of World War I provides a slow-motion example of a similar phenomenon. The organizations and technology of the time made it possible to mobilize vast armies of reserves in time of war, armies far greater than could be kept constantly ready in peacetime. What this meant, of course, was that if one country mobilized before its neighbors, it would have an enormously larger army available in the first days of a war, and might gain an overwhelming advantage. As a result, when one country began to mobilize, all the others were forced to follow suit, in a grim cascade of cause and effect. Once the mobilized troops reached the frontiers, the slide toward war proved impossible to stop, in part because the military leaders on all sides believed that the side which seized the initiative and attacked would have an enormous, perhaps decisive advantage over the defender, and had drawn up the war plans with an immediate offensive in mind [2].

The danger, in the simplest terms, arose from forces that were thought to give an important advantage to the first blow: as soon as war seemed likely, there was enormous pressure to hurry to begin it, seizing the advantage of the initiative. Such a situation is referred to as "unstable." (Part of the tragedy, of course, is that the "advantage of the offensive" turned out to be a chimera; as the years of bloody trench

warfare showed, the technology of the time -- particularly the machine gun -- actually gave an enormous advantage to the defense, rather than the offense.) This idea of the special dangers of a situation that requires haste, that gives an enormous advantage, in the event of war, to the side that starts it, is the core of "stability theory" -- the hypothesized link between the "character of modern weapons" and the risk of nuclear war. As Thomas Schelling, perhaps the greatest exponent of stability theory, has written [3]:

Military technology that puts a premium on haste in a crisis puts a premium on war itself. . . . The premium on haste . . . is undoubtedly the greatest piece of mischief that can be introduced into military forces, and the greatest source of danger that peace will explode into all-out war.

In the nuclear age, the advantage of the initiative, if there is one, lies in the vulnerability of the strategic nuclear weapons and command facilities on each side. If both side's strategic nuclear forces were completely invulnerable, so that the damage they could inflict by striking first was no different from the damage they could inflict by striking second -- and this technical fact was sufficiently evident to be perceived by the leaders on both sides -- then any crisis would be "stable." Neither side, in theory, would have any incentive toward precipitate action: even in the most severe crisis, each side could afford to wait, and see if the crisis could be resolved. But if the

forces were so vulnerable as to make a major difference between striking first and striking second, then a severe crisis would give each side two reinforcing reasons to strike: the temptation of the advantage to be gained by going first, and the fear of the disadvantage to be suffered by waiting.

A useful analogy is that of two gunmen sitting across a table from each other, each with his pistol out and pointed at the other. If we suppose that each gunman knows that neither can kill the other fast enough to prevent a deadly return shot, then neither will be likely to shoot: deterrence prevails.

But what if we suppose, alternatively, that each gunman believes it possible to shoot the gun out of the other's hand -- if he fires first? He could then finish the other gunman off at his leisure, with no fear of reprisal. Each gunman ponders this possibility, and realizes that the other is both thinking the same thing, and realizing that he is also thinking it; from either gunman's point of view, it is necessary to shoot first, to forestall the other's doing so. Shooting ensues, unless the gunmen trust each other almost completely, in which case it is hard to see why they would have been sitting with their pistols pointed at each other in the first place. Schelling, using a similar example, imagined one gunman explaining himself by saying: "He, thinking I was

about to kill him in self-defense, was about to kill me in self-defense, so I had to to kill him in self-defense."[4]

What of a less symmetrical situation? Let us suppose, for example, that one of the gunmen is a poor shot; at such close range, he could kill the other gunman, but he wouldn't have a very good chance of shooting the gun out of his hand. The other gunman is still capable of shooting the other's gun out of his hand -- probably. But he now realizes that the other isn't likely to shoot unless he believes that shooting is about to break out anyway -- since for the less able gunman, shooting would only bring instant retaliation. So if the more able gunman is less than 100% certain of being able to shoot the gun out of the other's hand, he might now decline to risk it -- having no fear of being disarmed if he waits. Much of the incentive to go first in the previous situation came from the reciprocal nature of the fear: each gunman not only knew that he might be able to disarm the other by going first, but that he might be doomed if he didn't, and that the other was thinking the very same thing and heading toward the very same conclusion. Thus, increasing the safety of one man's pistol can make both men a good deal safer, though not symmetrically so.

How might the gunman with poor aim want the situation changed? He would wish, of course, that the other's aim were equally poor; then there would be little possibility of his

being disarmed. The two men would be back to a situation of stable deterrence, with no advantage in going first for either side, and any shooting at all would be unlikely. Failing that, would he wish his own aim were improved, to "equalize" the balance? Not necessarily; while this would give him a chance to disarm his opponent, it would also increase his opponent's fear of exactly that result, making his opponent more likely to shoot first. Paradoxically, improving his aim would undermine his own security, as well as that of his opponent. Shooting is least likely when both are poor shots; both men are less safe if one might be able to shoot the gun out of the other's hand; if either could shoot the gun out of the other's hand, and both know it, an immediate outbreak of shooting is nearly inevitable. Each improvement in aim by either gunman increases the likelihood of an outbreak of shooting -- and hence decreases each gunman's security -- even if it is only "catching up" to equalize an improvement by the other [5].

So far we have been imagining the possibility of a clean win, with one gunman disarming his opponent completely. But such a disarming blow is a technical impossibility, both for the moment and for as much of the future as can be foreseen. Suppose, then, that a first shot couldn't be expected to knock the gun out of the other's hand, but would badly affect the aim of the return shot, so that the gunman who shot first could be

sure of killing his opponent, and in return would expect a shot that could conceivably miss entirely, but would be most likely to wound him, either lightly or severely -- and might still kill him. Clearly for either gunman to go first in this case would be a risky proposition; but if it seemed very likely that the other would shoot, then it would be much better to beat him to the punch. The net result is uncertain; perhaps the two would simply eye each other warily, but any suspicion that either was thinking of shooting could lead to a shoot-out.

It would be impossible, of course, to find a real situation as simple and as totally dependent on the specific "technological" situation as this analogy. Nevertheless, the example of World War I provides sobering evidence that when the military balance seems to offer the best prospect of victory to whichever side mobilizes first, or strikes first, the character of the balance itself can contribute to the outbreak of all-out war.

A point of signal importance is that the stability or instability of a balance is a shared commodity: the Senator who asked "Why don't we destabilize them for a change?" was missing the point. If stability theory is correct, U.S. security depends not only on the survivability of U.S. weapons, but on the survivability of Soviet weapons as well -- for the vulnerability of their own strategic forces to

preemptive attack would increase the incentive to launch those weapons in a first strike, if a U.S. attack seemed likely. Moreover, in a severe crisis, U.S. counterforce capabilities might also increase the Soviet estimate of the likelihood of a U.S. attack, further increasing their incentive to launch. As with the gunmen, increasing the vulnerability of either side's deterrent decreases the security of both.

The recommendations of stability theory, in simplest terms, are that both superpowers should deploy invulnerable nuclear forces (to the extent possible), and should refrain from deploying weapons that increase the vulnerability of the other side's nuclear forces. Arms control should be directed toward reducing force vulnerabilities on each side, reducing the advantages of the first blow. To quote Schelling and Halperin again [6]:

There are several ways that arms control might possibly help. One is to alter the character of the weapons themselves, especially their vulnerability to each other -- their potency in foreclosing return attack. Whatever reduces the ability of weapons to achieve advantage by going quickly, and to suffer a great disadvantage by responding slowly, may reduce the likelihood of war.

This vision of the dangers of vulnerable strategic forces has led to a widespread classification of "good" and "bad" strategic nuclear weapons: "good" weapons are those that are both invulnerable to attack and pose little threat of

no yet de' is!
preemptive attack on the weapons of the opposite side, while "bad" weapons are those that are both vulnerable and threatening. Intermediate are weapons which are vulnerable but not threatening, or which pose a threat of preemptive attack but are themselves secure. Since the underground concrete "silos" which house intercontinental ballistic missiles (ICBMs) can only be destroyed by extremely accurate missiles, such missiles are regarded as particularly destabilizing. Accurate ICBMs carrying multiple warheads -- MIRVs, for Multiple Independently-targetable Reentry Vehicles -- are considered the most destabilizing weapons, for MIRVs allow one missile to strike several of the ICBMs on the opposing side, each of which might itself contain several warheads, giving the attacker a double advantage. Single-warhead ICBMs, by contrast, are not considered to be destabilizing, for even a completely successful attack on them could only destroy one warhead for every warhead expended, disarming the attacker as rapidly as the defender. Submarine-launched ballistic missiles (SLBMs) have long been judged to be the most stabilizing strategic weapons, since the submarines which carry them spend much of their time invulnerably hidden in the ocean depths, and SLBMs have traditionally been too inaccurate to strike the ICBM silos of the opposing side. But this inaccuracy is now disappearing; the U.S. Trident I SLBM now being deployed is already far more

accurate than its predecessors, and the Trident II will be more accurate still, giving it the ability to attack Soviet ICBMs. Bombers are also considered, on balance, to be stabilizing; while they must be launched immediately on the receipt of warning of an attack, they can be recalled if launched in error, and their long flight times make them incapable of surprise attack [7].

However, while these are currently the accepted judgements as to what is destabilizing and what is not, they cannot be considered absolute. They rely primarily on the threat to ICBMs, and concentrating on the threats to other strategic forces would give different results. In a more complete account, air defenses against bombers, and attacks on bombers by rapid-flight-time SLBMs would be included, as would strategic anti-submarine warfare efforts against ballistic missile submarines [8]. In recent years, it has also become clear that concentrating on the vulnerability of the forces themselves misses an important part of even the purely technical aspect of stability: the command facilities necessary to retaliate against an attack are actually more vulnerable to preemptive attack than are the strategic forces themselves [9].

Moreover, as Schelling pointed out, concentrating on weaponry alone is not a complete description of stability [10]:

To impute this influence to "weaponry" is to focus too narrowly on technology. It is weapons, organization, plans, geography, communications, warning systems, intelligence, and even beliefs and doctrines about the conduct of war that together have this influence. The point is that this complex of military factors is not neutral in the process by which war may come about.

Nevertheless, as was stated at the outset, this thesis is concerned only with limitations on strategic weapons that might be embodied in an arms control agreement; hence, the discussion here will focus largely on weapons, their vulnerability to attack, and ^{the} threat they pose to the opposing side. Issues of doctrine, intelligence, warning, and organization are more susceptible to unilateral improvement than to bilateral control, and about geography there is little one can do.

Before going any further, it may be useful to clarify some jargon. While I have referred to these ideas broadly as "stability theory," there are a variety of other kinds of "stability" that are commonly referred to. What I have described is often called "crisis stability," since it is in part the presence of a severe crisis, raising a plausible fear that the other side will attack, that creates the incentive to strike first; referring to these concerns simply as "stability" or as "strategic stability," as I have done, is also common. Some writers, however, make a distinction between "crisis stability" and "strategic stability" or

"deterrent stability": in this usage, that^A situation suffers from "strategic instability" or "deterrent instability" means that the weapons of one side are so inadequate that the other might be tempted to strike even if war did not otherwise seem imminent [11]. I have not bothered to make this distinction; force postures sufficiently robust to moderate the incentive to attack even when nuclear war seems very probable should be sufficiently robust to deter attack when such an attack would mean trading peace for thermonuclear war -- although it is true, as we shall see in the next section, that many nuclear forces would be significantly less vulnerable to attack in a crisis than they would in calmer times. Thus, if the conditions of crisis stability are fulfilled, the conditions of "strategic" or "deterrent" stability will almost certainly be fulfilled as well, and need not be considered separately.

Another common usage is the idea of "arms race stability," which refers to the degree of incentive for each side to build more weapons;) this may be related to the risk of war, but indirectly so at most [12];) it is more directly related to the costs of defense, and the predictability of the arms race, two other, probably lesser concerns of arms control. A much more general use of the words "stability" or "strategic stability" can be found in general writing on international relations (as distinct from specific discussions of arms control).

Here, it is common to find these words used to mean simply a state of relative order and calm in international relations: as, for example, "the Congress of Vienna was a stabilizing influence and contributed to world order." Lastly, in current rhetoric, this latter concept of stability seems in some sense to have been applied to arms control, so the statement that something is "stabilizing" often means no more than that the particular development in question pleases the speaker.

More jargon: the sort of attack that stability theory fears, carried out in an effort to forestall an attack by the other side, is referred to as a "preemptive" attack. An attack limited to the strategic forces of the other side is usually referred to as a "counterforce" attack, although "counterforce" is sometimes used to refer to attacks on other military forces as well; I will use it exclusively in the former sense in this paper. An attack on population and industry, by contrast, is referred to as a "countervalue" attack (the jargon appears to be from economists: the labor force and industry of a society are its "value", so destroying them is a "countervalue" attack.) Lastly, the side which strikes first will be referred to throughout as "the attacker," and the other side as the "defender," even if it is the defender's second-strike attack which is under discussion.

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From the discussion so far, it might seem that the basic idea of stability had been adequately defined, and one could apply it immediately to arms control: one need only create limitations that decrease the vulnerability of both side's strategic forces. The more the vulnerability is decreased, the better the limitation. But it is not so simple: two separable, but interconnected areas remain to be discussed. First, significant objections to stability theory have been raised, on a variety of fronts: stability can be argued to be immoral, militarily impractical, technologically irrelevant, based on unsound theories of governmental action, or untenable as a basis for negotiation with the Soviet Union. These objections must be addressed, and possible qualifications to stability theory explored; that is the purpose of the next section.

Second, in order to really compare the strategic future that one arms control proposal might bring with the strategic consequences of another proposal, one must have a precise idea of how to measure the first-strike advantage inherent in a particular strategic balance: as it turns out, that measurement is much more difficult than it might seem. Is it a greater first strike advantage when one side can destroy nine-tenths of the other's force, but would disarm itself in the process; or when one side can destroy only three-quarters of the other's force, but need expend only one-tenth of its

own force to do so? Does the answer to this question depend on whether the number of weapons held by each side before the exchange is 100 or 10,000? These judgements, as we shall see, depend on one's views of nuclear doctrine. If one believes that a strategic nuclear war would inevitably escalate to all-out, apocalyptic destruction, then the situation is captured by the gunman analogy: whatever the defender has left with which to retaliate after an attack, it will use, probably in the most deadly manner available. In this case, stability would only be threatened if a preemptive attack could significantly reduce the damage that the defender's weapons were capable of inflicting in response: this would be rather difficult to do, since even a few hundred weapons -- a tiny fraction of current arsenals -- could essentially obliterate a modern society as such. If one believes, on the other hand, that achieving a decisive military advantage in a first strike might allow the attacker to intimidate the defender from striking back, then the maintenance of stability becomes considerably more difficult and complex. It is these issues of measuring and defining the idea of "first strike advantage" that will be addressed in the last section, leading to the development of a ranked set of criteria for comparing the stability of different strategic balances.

III. Stability Reconsidered

Judging from the discussions of arms control objectives that appear in the U.S. political debate, one could easily conclude that unanimity had been achieved on the basic ideas of nuclear policy: stability is first on almost everyone's list of the goals of arms control. But if one examines the specific proposals put forward in stability's name, it becomes clear that this rhetorical agreement is almost wholly illusory: everyone can favor stability only because there is no precise and agreed-upon definition of what stability entails. Indeed, the rhetorical agreement obscures a variety of fundamental disagreements over the most basic ideas of stability theory.

On one of the tenets of stability theory discussed in the last section -- that it is better for one's own forces to be survivable than vulnerable -- there is no serious disagreement. However, the idea that serious threats to the enemy's forces might also pose a danger -- not because the U.S. would actually be tempted to launch a preemptive attack, but because the vulnerability of their own forces would increase the Soviets' incentive to do so -- has met with greater resistance. It is an extremely strange idea, from a traditional military point of view, to avoid acquiring the

weapons necessary to destroy the most threatening part of the opponent's military forces; moreover, arguing in terms of a "need" to threaten Soviet strategic forces offers an excellent justification for maintaining and increasing the strategic weapons budget, which might otherwise be difficult to rationalize.

Stability in U.S. Policy

Until the mid-1960's, the idea that Soviet forces should not be threatened did not even appear in official U.S. policy, which was explicitly directed along relatively traditional military lines. "Damage-limitation" -- the ability to destroy enough of the Soviet strategic force to significantly reduce its capability to destroy U.S. society -- was one of the primary goals of U.S. strategic planning. By the second half of Robert McNamara's tenure as Secretary of Defense, however, there was an increasingly widespread realization that the Soviets were improving their strategic forces to a point at which damage-limitation was simply no longer feasible: no matter what programs the United States undertook, the Soviet Union could maintain the capability to annihilate the U.S. as a functioning society in a retaliatory blow. Moreover, the dangers inherent in threatening Soviet forces were beginning to be realized; such a threat, it was

thought, not only exacerbated crisis instability, but might create an "arms race instability," provoking the Soviet Union into building even more nuclear forces, forcing the United States to build more as well, and so on. This idea came to be called the "action-reaction" model of the arms race.

Since then, official U.S. policy with regard to the desirability of threatening Soviet strategic forces has been quite schizophrenic, often upholding stability concepts rhetorically, while undermining them in actual weapons deployments. In my view, for example, Colin Gray was correct to point out that "to deploy a hard-target killing force of MX ICBM . . . would constitute a direct repudiation of Western stability theory"[1]. Nevertheless, the "dovish" Carter Administration decided in favor of just such a deployment, while then-Secretary of Defense Harold Brown continued to strongly support the goal of crisis stability in his annual reports to Congress. On occasion such schizophrenia is so pronounced that both points of view will be defended within a few paragraphs in a single statement: for example, Richard Delauer, then Undersecretary of Defense for Research and Engineering, argued in 1982 Congressional testimony that the capability to destroy Soviet ICBMs was absolutely essential to deterrence, and that "if [Soviet] forces are not vulnerable, they will have less incentive to use them in a crisis." [2] Similarly, the recent report of the Scowcroft

Commission on Strategic Forces argued strenuously in favor of the acquisition of a capability to threaten Soviet ICBMs, the bulwark of the Soviet strategic force, while defining stability as "the condition which exists when no strategic power believes it can significantly improve its situation by attacking first in a crisis or when it does not feel compelled to launch its strategic weapons in order to avoid losing them"[3].

With respect to the implementation of stability ideas in arms control proposals, the kindest adjective one could honestly use is "spotty". The failure to seriously pursue a ban on MIRVs in SALT I, in particular, is widely recognized as an error of the most serious kind; indeed, arguments about troublesome new technologies are constantly phrased in terms of "not repeating the MIRV mistake." In retrospect, the destabilizing nature of MIRVs seems painfully obvious: giving each weapon the ability to destroy several on the other side in a first strike, MIRVs seem almost the archetype of instability. It also seems obvious, in retrospect, that MIRVs would eventually give a greater advantage to the Soviet Union than to the United States: while the U.S. had a short-term monopoly on the technology, the Soviets had a long-term advantage in the large, heavy missiles needed to carry large numbers of warheads. Now, more than a decade later, there is serious interest in arms control circles in undoing the

mistake, negotiating an agreement to return, over time, to single-warhead missiles. Whether this will prove to be a negotiable idea, either within the U.S. government or with the Soviet Union, remains to be seen.

The failure to ban MIRVed missiles stands out, from the point of view of stability theory, as the greatest single error of arms control policy. But it hardly stands alone as an example of the failure to mesh stability ideas with arms control negotiations. Indeed, as Raymond Garthoff has written, though stability has almost universally been put forward as the justification of U.S. proposals in SALT, the criteria used to judge it "depended above all on perceived advantages for one's own side, not on scientifically determinable technical criteria." For example, the U.S. position on the question of whether mobile ICBMs are stabilizing or destabilizing changed four times during the course of the SALT negotiations [4]. Perhaps the most shocking example was the Reagan Administration's first START proposal: while touted as the answer to instability, the proposal was explicitly designed to maintain and increase the vulnerability of Soviet strategic forces to attack by the United States [5]. Nevertheless, there have been some successes: the ABM Treaty of 1972 is perhaps the finest example of the meshing of theory and practical politics to result in an agreement that increased the security of both

sides. Limitations such as the limits on heavy missiles in SALT I, and SALT II's limitations on the number of MIRVs ICBMs could carry and on the total number of MIRVed ICBMs allowed have also arguably had a stabilizing effect -- though certainly of a much more limited kind [6].

Second Thoughts on Stability Theory

The spottiness of its implementation in U.S. force deployments and arms control policy is not the only difficulty facing stability theory. There are several important arguments against the whole idea of basing arms control proposals on the concept of strategic stability; before proceeding further, therefore, we must see whether these arguments are sufficient to tumble the edifice. The most fundamental of these arguments is the moral one: stability theory offers no road past relying forever on the threat of nuclear incineration, a posture whose morality is self-evidently open to question. Second is the military argument that the ability to destroy Soviet strategic forces is militarily necessary, not something to be avoided: if this argument cannot be answered, then arms control cannot be based on improving the survivability of both sides' nuclear forces. The third important issue is the relation of stability theory to the technological changes of the last

twenty years; with the growth in the size and security of the nuclear arsenals on both sides, is stability still the most important issue? Related to this question is a conceptual error in many formulations of stability theory: the emphasis placed on the "attack/no-attack" decision obscures the other possible actions that a nation which feared attack could take in a crisis. What does this imply for the theory? As we shall see, considering these issues raises the salience of another: how can arms control help to reduce the danger of a nuclear war that is not the result of a deliberate preemptive attack -- that arises from accident or inadvertence? A sixth, related issue is the implicit reliance of stability theory on a "rational actor" model of governmental decision-making. Is such a model adequate for considering the problem of nuclear deterrence? If not, how should stability theory be modified? Seventh, what does the emphasis on counterforce and preemption in Soviet strategic doctrine imply for efforts to achieve a more stable balance through arms control? Last, what conclusions -- however tentative -- can we draw from examining the empirical evidence offered by past nuclear crises?

The Moral Problems of Deterrence

Not to feel unease at relying on the threat of nuclear retaliation would be to deny the most basic of human values: that "safety" should rely on the ever-present danger of incineration is, in the famous acronym, MAD. Deterrence is a human construct, and as such it may someday fail, unleashing the horrible power of thermonuclear weapons. It is therefore a practical and moral imperative to find some way past reliance on this apocalyptic threat, before disaster strikes. Stability theory is concerned only with strengthening deterrence and is therefore tainted; it can provide no guidance as to how deterrence might be abolished.

It should be noted, however, that while the idea of "stable deterrence" is often equated specifically with the threat to attack civilians and destroy cities, this is by no means required by stability theory: stability requires only that neither side be able to destroy the other's forces in a first blow -- which would eliminate strategic nuclear forces themselves as possible targets, but nothing else. Retaliation need not be directed at cities. It is true, however, that if the stability of the balance were at all in question -- if the number of survivable nuclear weapons held by either side were small -- then plans for retaliation would probably be based on using those weapons to maximum effect,

destroying those targets where what the opponent valued was most concentrated -- which would, in most cases, mean major cities.

Whether deterrence relies on attacking civilians or not, the power of the argument against it -- and therefore against stability ideas -- is undeniable. The only reply is a practical one: the implausibility of the available alternatives. On the left, the belief in the immorality of deterrence manifests itself in the desire for complete nuclear disarmament. But as I argued at the outset, complete disarmament is hardly possible in a world of nation-states as we know them: as nuclear weapons cannot be disinvented, it would be impossible to prevent any major power from manufacturing a few weapons in secret. And the temptation to do so would be enormous, given the advantages that even a few nuclear weapons might give in a disarmed world. Indeed, stability theory, in focusing on strengthening deterrence, would sometimes argue against reducing the size of nuclear forces. With only 100 weapons on each side, stability might be threatened by the ability to destroy 80 or 80% of the opponent's forces in a first strike, whereas with 100,000 weapons on each side, an attack of the same percentage effectiveness would be meaningless [7]. (This argument is only a strong one for relatively small number of nuclear weapons, of course; it provides little justification for the

massive current arsenals of the U.S. and the U.S.S.R.)

On the right, the argument leads to a desire for defensive weapons, leading to "deterrence by denial" -- denying potential enemies the possibility of attacking U.S. society -- rather than "deterrence by punishment." In Donald Brennan's famous words: "we should rather prefer live Americans to dead Russians." [8] But this phrase, while wonderfully apt as a debating point, misses the point. Everyone would prefer live Americans to dead Russians; the question at issue is how best to insure that those Americans remain alive. To offer such insurance, a defense would have to be essentially perfect, for if even one large nuclear weapon got through the defense of a particular city, the city would be destroyed. Even if the vast technical difficulties of constructing a near-perfect defense against ballistic missiles, cruise missiles, and bombers could be solved -- which they cannot [9] -- nuclear weapons could still be smuggled into any major city by a determined adversary, whether by plane, suitcase, boat, truck, or some other, more ingenious device. The same argument holds for the recently popular idea of combining disarmament with a strong defense, thereby reducing the requirements facing either.

In short, nuclear deterrence cannot be eliminated by either defense or disarmament. In the long run, it may be possible to make more fundamental changes -- in the

government of the Soviet Union and other nuclear powers, or in the very nature of sovereign nation-states -- that will reduce the need to rely on nuclear weapons and the threat of retaliation. But such changes will come slowly, if they come at all. In the meantime, in the absence of any realistic alternative, deterrence will continue to be necessary; the question is how it can most safely be maintained until a practical alternative is found. If stability theory provides the best way of thinking about strengthening deterrence, and thereby lessening the chance of nuclear incineration, it can hardly be dismissed as immoral.

The "Requirement" for Counterforce Weapons

It is this question -- how best to maintain deterrence -- that has been the focus of another line of thought that challenges the very basis of stability theory. The argument, in a nutshell, is that the ability to attack Soviet ICBMs in their hardened silos, far from undermining deterrence, is a requirement for deterrence to be maintained [10].

The argument begins from the premise that a nuclear war need not be all-out. If a nuclear war began with a limited Soviet attack, seeking limited objectives, a reflexive response against Soviet cities would be unwise, for that would only lead to an all-out retaliation against U.S.

cities. In short, a kind of deterrence, might continue even after the bombs had begun to fall: as long as each side held some of its forces in reserve, each would have a strong incentive to refrain from escalating to attacks on the other's cities. As a result, the threat to retaliate against Soviet cities in response to a limited attack might not be "credible" -- if that were the only option available, the Soviets might not believe it would be exercised, and so might not be deterred from a limited attack. (These ideas of limited nuclear war will be treated in much more detail in the next section -- for it will become clear that they make an enormous difference in assessing exactly what would constitute a first-strike advantage.)

A common variant of such limited war theories in the late 1970s was the "window of vulnerability" scenario, which provided the primary justification for the MX missile for many years. The argument, in essence, was that the Soviets could attack U.S. ICBMs without destroying U.S. cities, and holding thousands of weapons in reserve. Without the accurate ICBMs, the U.S. could not launch a rapid "mirror-image" response against the remaining Soviet ICBMs in their hardened silos; and the U.S. would be deterred from retaliating against Soviet cities with its remaining bomber and submarine forces, as that would only invite an instant retaliation in kind. Hence, it was argued, such an attack might be tempting

to Soviet leaders, who might reason that faced with the alternative of "suicide or surrender," the U.S. would choose surrender. Even if the Soviets were not tempted to attack, their capability to do so would bolster an aggressive Soviet foreign policy and weaken U.S. resolve [11].

In order to deter such an attack, the argument continued, the United States must have the ability to threaten Soviet ICBMs, even after absorbing a Soviet first strike. By this logic, negotiating arms control agreements that prevented the United States from threatening Soviet strategic forces would prevent the U.S. from solving this problem, undermining deterrence rather than reinforcing it: the recommendations of stability theory, in short, are simply dead wrong.

The heart of this argument is its weakest point: the idea that the only credible response to such a limited attack would be to retaliate against the remaining Soviet ICBMs. In fact, such a response would be among the worst available options: after having initiated a limited attack, the remaining Soviet ICBMs would certainly be on alert, and any vulnerable ICBMs would simply be launched when warning of an attack on them is received. As a result, a counterforce second-strike would probably encounter only empty silos, having forced a large Soviet third strike against the United States; such a result would render the U.S. attack not only useless, but suicidal. One could imagine, of course, that the U.S. might destroy

Soviet warning systems before the attack on Soviet ICBMs began, but that would only provide warning that an attack of some sort was underway, creating enormous pressure to launch any vulnerable ICBMs. It is therefore difficult to imagine any situation in which a counterforce second-strike -- as opposed to a first-strike -- would be effective.

Moreover, as Soviet ICBMs are deployed not only along the Trans-Siberian Railway, but also throughout European Russia, an attack on them might not be as clearly different from an attack on cities as it is in strategic theory: for example, there are hundreds of ICBM silos in the immediate vicinity of Moscow. Any attack on Soviet ICBMs would spread lethal radioactivity over much of the Russian heartland [12]. Escalation to attacks on cities would then be almost impossible to avoid.

One could argue that the destruction of even empty ICBM silos might be worthwhile -- in order to prevent them from being reloaded. The design of some Soviet ICBM silos does make it at least theoretically possible to reload them. However, testing the ability to reload rapidly, and the storage of missiles in the silo fields for that purpose, have both been forbidden by SALT II. In any case, destroying each empty silo would be a wasteful way to prevent such reloads; this could be done by using a much smaller number of warheads to destroy both the transportation networks leading to the Soviet ICBM

fields, and any known storage sites of excess missiles.

There are two other classes of targets that are often sufficiently hardened to require an accurate missile to destroy them: these are command and control bunkers, and nuclear weapon storage bunkers. The number of storage sites is small; even if it were judged important to destroy them, they could be destroyed by larger numbers of less accurate weapons, which could not seriously threaten the bulk of Soviet strategic forces. Attacking the Soviet leadership and its command and control facilities would also be a poor option in the event of a limited attack. In all likelihood, such a retaliation would make it impossible to keep the war "limited," even if a "limited" strategic nuclear war is conceivable at all; with the central leadership destroyed or no longer able to control its forces, there would be no one left with whom to negotiate, and no one to stop the carnage. Moreover, most Soviet command and control centers are in or near major cities, making a retaliation against command and control little different from a full-scale retaliation against cities; there are reported to be some 75 hardened command posts in the Moscow area [13].

The argument for counterforce weapons as the only means to deter limited attacks is based, in large part, on the implicit idea that only pure "counterforce" and "countervalue" targets exist: one can only retaliate against ICBM silos or

cities. Most of any nation, however, is neither a city nor an ICBM silo; there are thousands of other possible targets, including railway yards, bridges, dams, power plants, refineries, factories, surface-to-air missile sites, airbases, ports, troop concentrations, ammunition and supply depots, and tank and vehicle storage yards. Any of these could be attacked in a "limited" response to any Soviet attack, even without the accurate missiles necessary to attack Soviet ICBMs.

In short, missiles designed to attack hardened targets such as ICBM silos and command and control are not required to deter limited Soviet attacks; attacking ICBM silos would only force the Soviets to launch their remaining ICBMs, and attacking command and control might end whatever meagre possibility there had been for preventing the war from escalating to an all-out exchange. Indeed, because a counterforce second-strike would probably destroy only empty silos, it may be that weapons designed to attack hard targets such as ICBM silos would convey an advantage only in a preemptive first strike -- further evidence, from the point of view of stability theory, that such weapons should be avoided, if deterrence is to be maintained.

Stability and Technology: Strategic Force Survivability

Another fundamental criticism of relying on stability as the criterion for arms control is that stability ideas have become technologically irrelevant. Improving stability may have been an urgent concern in the 1950s and early 1960s, when stability theory was developed; that was a time of small and vulnerable nuclear forces, a time when both the U.S. and the U.S.S.R. did in fact rely on preemption as a central part of their strategic nuclear policies [14]. But the balance has changed: each side now has robust nuclear forces, carrying many thousands of nuclear weapons. Whether a deliberate preemptive attack is still among the important roads to nuclear war is very much an open question -- and an important one to ask.

The first question is whether the nuclear forces of either side could, in the foreseeable future, become so vulnerable that a "bolt-from-the-blue" attack might be a serious possibility. What is needed here is not a detailed technical accounting of the current and projected survivability of the strategic forces on each side; that is beyond the scope of a paper such as this one, largely concerned with the theories behind arms control. Rather, a qualitative judgement is necessary: will there continue to be at least a few hundred survivable weapons on each side? There is little room for

doubt on this score: for the present and as much of the future as can be projected, the answer will be yes. In the case of the United States, the more than 50% of the ballistic missile submarines which are at sea at any given time, which carry more than 2,500 warheads, are "invulnerable today and will remain so for the foreseeable future," according to recent Senate testimony by Navy experts. The CIA, the Defense Intelligence Agency, and the Office of Technology Assessment all concur in this judgement [15]. This alone would constitute an extremely substantial deterrent to any "bolt-from-the-blue"; but the U.S. also has a substantial bomber force, and the ICBMs, while vulnerable, could by no means be completely eliminated in a surprise attack.

In the case of a "bolt-from-the-blue" attack, Soviet forces would be substantially more vulnerable than those of the United States. None of the small Soviet strategic bomber force is kept on alert, meaning that the entire force might be destroyed if there were no prior warning of an attack; similarly, only 15-20% of the Soviet submarine force, carrying perhaps 300-400 nuclear warheads, is kept at sea [16]. Moreover, the Soviet submarines at sea are noisier than U.S. submarines, and face U.S. anti-submarine warfare capabilities which are more sophisticated and more global than their Soviet counterparts. Unlike the United States, which has approximately one-quarter of its strategic nuclear

warheads in land-based ICBMs, the Soviet Union has maintained an ICBM force comprising more than 70% of its total arsenal. For the moment, less than half of this force could probably be destroyed by U.S. ballistic missiles; but with the deployment of the MX and the Trident II missiles by the U.S. in the late 1980s and early 1990s, the vulnerability of Soviet ICBMs will increase drastically. Despite these vulnerabilities, however, any U.S. surprise attack in the foreseeable future would leave the Soviet Union with several hundreds of surviving nuclear weapons.

In short, any prospective attacker would have to face the fact that several hundred, if not several thousand, thermonuclear weapons would survive any attack. Under these circumstances, a "bolt-from-the-blue" attack -- a deliberate decision to trade peace for strategic nuclear war -- is an almost negligible possibility [17].

Nuclear Alerts and Preemption in Crisis

But what of a severe crisis? If one side believed the other was likely to attack, then the choice, in Schelling and Halperin's words, might seem to be not "between initiating war and no war at all, but between initiating war and waiting for the other to initiate it." [18] The key questions would then center around how likely an attack by the opponent seemed

to be, and how much different the destruction to be suffered in a first strike would be from that which might result from a weakened second-strike. But these formulations -- which are central to many commonly-held concepts of stability -- contain the kernel of a central conceptual problem. They imply that a severe crisis would offer each superpower only two choices: to preempt, or to wait, and possibly be preempted. But any real crisis would proceed in stages, and would provide a variety of intermediate choices between preemption and doing nothing -- the most obvious possibility being to place one's strategic nuclear forces on alert, thereby reducing their vulnerability.

If attack was feared, the strategic bombers could be dispersed to a large number of bases (making a barrage of the areas around those bases to catch escaping bombers more difficult), the number of bombers prepared to launch at a moment's notice could increase to nearly 100%, and more submarines could be moved out to the invulnerability of the sea. Arrangements to predelegate authority to use nuclear weapons would almost surely be made, to hedge against the possibility of a "decapitation" attack on the central command authorities. In an especially severe crisis, bombers could be placed on airborne alert, and in a worst case, ICBMs could be prepared to launch immediately after satellite warning of an enemy attack underway. Thus, by the time a crisis became

sufficiently severe to lead to real consideration of a preemptive blow, such a blow would have become much more difficult to execute, for much of the alerted nuclear forces might be essentially invulnerable to attack.

This increased survivability gained by alerting one's nuclear forces would drastically reduce both one's own incentive to get one's weapons off while they could still be used, and the opponent's incentive to destroy them while they were still vulnerable. But some of these measures -- such as placing bombers on airborne alert -- would be more ambiguous: they are the same as the preparations for an attack. Such moves, then, would decrease the opponent's perception of the gains to be had from striking, but increase the estimate of the likelihood of attack. If one side took such moves, the other would probably be forced to alert its own nuclear forces, if it had not done so already, ratcheting upward the tension of the crisis.

A situation in which both side's nuclear forces were at peak alert, poised for immediate action, would be extremely tense and extremely dangerous. But the danger would not come from the vulnerability of either side's nuclear forces; a preemptive attack on strategic forces in such a situation would have almost no prospect of success. Launching a massive counterforce attack against a force on maximum alert -- which might well have escaped before one's attack arrived -- could

hardly be considered an attractive proposition. The deterrent capability of current nuclear forces may therefore be greatest at those moments when it is most needed -- in severe crises, which might otherwise be the most plausible antecedents of a counterforce attack.

The Vulnerability of Command and Control

The strategic forces of the two superpowers, then, are reasonably survivable in peacetime, and would become much more survivable when alerted in a severe crisis. This is not true of the command and control systems needed to use those weapons; these are far more vulnerable than the strategic forces themselves. Enormous disruption could be caused by allocating a few hundred weapons to direct attacks on command centers, and a half-dozen more to high-altitude detonations intended to create electro-magnetic pulses (EMP); the latter might disrupt computer electronics and communications over the entire territory of either superpower. Such a first strike might well render a carefully coordinated retaliation impossible [19].

The destruction of command and control facilities could not, however, preclude retaliation entirely; as one analyst of the situation concluded, "basic retaliatory commands would always get to the forces eventually." [20] Thus, in

response to a first strike on command and control, an attacker would have to expect that the defender would launch as many of its remaining forces as possible, in a retaliation which would be ragged, uncoordinated -- but which might well include most of the attacker's major cities.

Nevertheless, the damage from such a retaliation would probably be considerably less severe than the damage that could be inflicted with an intact command system; if all-out nuclear war seemed nearly certain in any case, therefore, the vulnerability of the opponent's command and control system might create some incentive to strike first [21]. Should a decision be made to launch such a strike, it is unlikely it would be limited to command and control: at a minimum, it would probably include attacks on whatever strategic forces could still be destroyed, and probably attacks on a broad range of other targets as well.

More important, perhaps, than this damage-limiting incentive would be an organizational factor [22]. If war seemed likely, military organizations on each side would probably realize that detailed pre-arranged procedures and war plans could only be successfully carried out by the side that struck first. These organizations are likely to be both institutionally convinced that the success of such plans is crucial for national survival, and extremely influential in decisions on military questions -- meaning that they might

exert powerful pressures to go first [23]. Considered in this light, the fear of an attack on one's own command and control system might be a much more powerful incentive to strike first than the temptation offered by the vulnerability of the opponent's system.

Because of these factors, command and control vulnerability may well be one of the more important aspects of the overall stability problem [24]. But this thesis is about criteria for limitations on strategic nuclear weapons; could such limitations have any effect on the vulnerability of command control? In recent years, there have been a variety of arms control proposals intended to improve command survivability. Chief among them have been a ban on anti-satellite weapons, capable of destroying satellites used for warning and for command of nuclear weapons; and a ban on "short flight-time" missiles, to increase the amount of time available for decisions before the command facilities of either country could be destroyed. The argument for anti-satellite arms control is a strong one, but it is largely outside the scope of a paper concerned with limits on strategic nuclear weapons, such as this one. The argument for a ban on "short flight-time" missiles would be a strong one -- if such missiles were the only way to launch an attack with little warning. But either Washington or Moscow could be destroyed with no warning whatsoever if a thermonuclear

weapon had been brought into the city beforehand; and to smuggle one such weapon into a large, bustling city would not be a difficult task. Similarly, an EMP attack on command and control could be carried out with zero warning time, by means of nuclear weapons on seemingly-innocuous satellites orbiting the earth. While the Outer Space Treaty bans the placement of nuclear weapons in space, it would be difficult to verify whether, in fact, a large satellite had a nuclear weapon on board. For these reasons, one cannot count on any warning time at all before a "decapitation" attack, regardless of whether missiles with short flight-times are banned or not.

It is true, however, that these possibilities are not widely perceived. If a ban on short flight-time missiles gave national leaders the perception of greater command security, it might contribute something to calming 'the pace of decision, thereby perhaps reducing the risk of war.

But overall, the vulnerability of command and control has relatively little to do with the numbers and types of weapons held by the opposing side, and a great deal to do with the specifics of how one designs one's own command system -- and hence, there is little that a negotiation such as SALT can do about it. Since the subject of this thesis is the theory behind technical limitations on strategic weapons, the preemptive incentives arising from the vulnerability of

command and control systems fall largely outside its scope. Such instabilities can best be addressed by unilateral actions, rather than agreed limitations on strategic arms.

To summarize these technological arguments, it appears that in the current and foreseeable strategic situation, the strategic forces themselves are sufficiently survivable to make a deliberate "bolt-from-the-blue" attack on them extremely unlikely -- and would be much more difficult to attack in a severe crisis. If there are incentives to launch a deliberate preemptive attack, they are likely to arise more from the vulnerability of the command and control systems on each side than from the vulnerability of the strategic forces themselves -- but this vulnerability cannot be significantly alleviated by technical limitations on strategic weapons.

This technological argument against applying stability theory to arms control, then, is perhaps the strongest criticism raised so far; the classical problem of stability -- the incentives to launch a deliberate, calculated preemptive attack on strategic forces -- may have been largely ameliorated, not so much by arms control as by the sheer size and robustness of current (and prospective) nuclear arsenals.

Arms Limitation and the Danger of Inadvertent War

The incentive to launch a deliberate attack on strategic forces themselves may therefore be extremely small; more important dangers of nuclear war may have nothing to do with "rational" decision, but rather with the possibilities of accident, madness, or miscalculation [25] If this judgement is accepted, then the question becomes: could limitations on strategic nuclear weapons significantly reduce the risk of such an "unintended" nuclear war, and if so, how?

To even begin to answer this question, we must consider how such a war might arise. One can imagine a variety of scenarios:

- 1) Escalation from a smaller nuclear or non-nuclear war.
- 2) Use of nuclear weapons by field commanders after authority had been delegated in a nuclear crisis, or after communication with central authorities had failed.
- 3) "Irrational" preemption. One side launches a first strike in a crisis, despite the survivability of the other's nuclear forces -- perhaps as the result of a rigid preemptive doctrine, or of a "clever briefer" convincing the national leadership that the prospects for success were much better than they were.
- 4) A madman -- both suicidal and homicidal -- gains

absolute power in one of the major nuclear powers, and unleashes total war.

- 5) A missile is launched by accident, or an insane military officer manages to launch one or more weapons without authorization, setting off an all-out war.
- 6) An electronic or human failure results in a convincing false warning of an attack under way -- and the missiles are launched in reply.
- 7) A terrorist group or "crazy state" gains access to one or several nuclear weapons, and uses it in an attempt to provoke a major war.

This is hardly an exhaustive list, of course; the human mind is simply not adequate to the task of imagining all the things that might go disastrously wrong in international affairs. Nevertheless, some important judgements can be made.

First of all, none of these events is likely. It is simply not possible, for example, for a single insane launch officer to launch a U.S. nuclear weapon; this requires, at a minimum, the concerted action of at least two individuals, who often must also have an authorization code from the central command authorities. Nor does an act of sheer lunacy seem probable. The example of Hitler does throw considerable doubt on the argument that a lunatic could not gain absolute power in a modern state; but perhaps even a Hitler would shrink from

launching a nuclear war if it meant that both he and all the pillars of his power would inevitably be obliterated in return. Even were such an order to be issued, it is far from clear that it would be obeyed, if its consequences were clear. Much more plausible, perhaps, than these scenarios is a nuclear war developing from some lower-level confrontation, through a loss of control, or through the unpredictable "friction" of war.

This is a rather comforting conclusion: a "rational" decision to launch a nuclear war seems implausible, if not a contradiction in terms; and an inadvertent nuclear war seems unlikely. It is not a conclusion of which one can be very certain, however, especially as it is not widely held. It remains important, therefore, to ask how the probability of these "inadvertent" roads to strategic nuclear war could be reduced.

There are many factors which would crucially affect that probability which are not strictly within the purview of this thesis -- the state of political relations between the superpowers, the personalities of their political leaders, the frequency and intensity of their involvements in foreign crises, the details of nuclear command and control and nuclear safety arrangements, the spread of nuclear weapons to other nations (and possibly to terrorists), and the mechanisms available for crisis management and

communication, to name a few. All of these have a central affect on the danger of nuclear war -- and most are the subject of continuous efforts at improvement [26]. None of these factors, however, gives much guidance on the question of what types of limits on the numbers and types of strategic weapons arms negotiators might usefully seek -- the central concern of this thesis. Could such limitations on the characteristics of strategic weapons themselves affect the risk of any of these "inadvertent" roads to nuclear war?

For some, the answer is clearly no. No arms control treaty would much affect the chance that an utterly mad leader would come to power -- although, as argued above, facing a large force of survivable weapons on the other side would deter all but the most extreme madmen, and would greatly increase the likelihood that an order to launch would be circumvented.

Other possibilities for an unintended war, however, seem intimately related to the numbers and types of weapons. It seems likely, for example, that the probability of a missile being launched by accident or mischief increases with the number of missiles (though safety arrangements and so on are more important factors). Indeed, it is common to hear the argument that there is a direct one-for-one relationship between the number of strategic nuclear weapons and the total risk of nuclear war; hence any agreed decrease in the number of number of nuclear weapons would decrease the risk of war.

It hardly seems likely, however, that the relation between the number of launchers and the risk of accident is sufficiently strong to make the sheer number of weapons the primary measure of the risk of war; moreover, as we have seen already, stability theory would argue that up to a point, larger arsenals might reduce the risk of war.

One could conceive that there might be some types of weapons that were more prone to accidental launch than others, and that one might therefore negotiate agreements designed to eliminate these types. It is clear, however, that such a weapon is as much a threat to its possessor as to the opposing side; hence, one would hope that each side would attempt to improve the safety of its weapons without a treaty requiring it to do so. Moreover, any such treaty would be rather difficult to negotiate and verify, since it would be difficult to determine which weapons were most dangerous in this respect. It is possible, however, that certain broad classes of weapons would be considered safer than others, and that both sides could agree on which these were and seek to eliminate them. For example, it might be agreed to eliminate ballistic missiles, which cannot be recalled if launched accidentally, while maintaining bomber forces, which can. Such an agreement, however, does not appear likely for the foreseeable future.

From Accident to General War

In any case, it may be more important (and more feasible) for arms control to help reduce the risk that a single accident would explode into all-out war, than to reduce the risk of that accident itself -- though the latter is certainly a worthwhile goal. Accidental launches share a common characteristic with many other possible routes to inadvertent war: the method by which they might start a war is by convincing one side that the war is already on, and that therefore it is necessary to get one's weapons off as soon as possible. No matter what scenario one imagines, whether it be an accidental launch of a few weapons, an unauthorized use by commanders in a regional conflict, an attack by a terrorist or third country in an effort to provoke a war, or a convincing false alarm in the midst of an international crisis, some person or small group of people would still have to decide whether the situation justified an immediate launch of the strategic forces -- or whether it would be better to wait and see.

This brings us back to the question of stability -- for if each side were secure against preemptive attack, it would be possible to wait, in the event of an alarm, to see whether the alarm was false. Indeed, it may be in this link between some inadvertent act and escalation to all-out war that stability

is most important. The greater the vulnerability of the strategic forces and command and control, and the less the time available for decision, the greater the possibility that an accident or false alarm would trigger a mistaken decision to launch a major war. To quote Schelling again [27]:

The whole idea of accidental or inadvertent war, of a war that is not entirely intended or premeditated, rests on a crucial premise -- that there is an advantage, in the event of war, in being the one to start it and that each side will be not only conscious of this but conscious of the other's preoccupation with it. . . . It is hard to imagine how anybody would be precipitated into full-scale war by accident, false alarm, mischief, or momentary panic, if it were not for such urgency to get in quick. If there is no decisive advantage in striking an hour sooner than the enemy and no disadvantage in striking an hour later, one can wait for better evidence of whether the war is on. But when speed is critical the victim of an accident or a false alarm is under terrible pressure to get on with the war if in fact it is war. . . . It is not accidents themselves -- mechanical, electronic, or human -- that could cause a war, but their effect on decisions.

Thus, even if one moves away from considering supposedly "rational" motives to attack, and concentrates instead on the dangers of accidents, false alarms, or provocations by third parties, one comes back in the end to the idea that the need to get one's forces off quickly to prevent their destruction is a central component of the danger. Almost certainly the vulnerability of strategic forces is not the most important factor in determining the likelihood of an inadvertent war. But it may well be the area in which the characteristics of the

weapons themselves have the most influence on that likelihood -- and therefore the area in which arms control limitations might do the most good.

The Danger of Launch on Warning

The influence of force vulnerability on the likelihood of accidental war is the incentive it creates to move quickly -- to rely on responding immediately to warning or provocation, before the situation unfolds in its entirety. The archetypal quick-response strategy is launch on warning (LOW) [28]. As has been discussed already, a policy of launching vulnerable weapons on warning of attack would greatly reduce the incentives for a deliberate preemptive blow -- for the weapons under attack would simply not be there when the attack arrived. But any such policy also carries with it the inherent possibility of an inadvertent armageddon.

This danger can be more or less. One can imagine, for example, two fundamentally different types of LOW policies that the possessor of a force of vulnerable ICBMs might take (and, of course, many variations between the two extremes). One could put one's forces in a LOW posture only in severe crises, when attack seemed possible. Such a "crisis-LOW" policy would raise the spectre of false alarm only during those rare crises which might create a credible fear of

preemptive attack. Alternatively, if the threat of a "bolt-from-the-blue" attack were taken seriously, one might rely on launch-on-warning continuously, 365 days of the year. This would in theory deter even surprise attacks on the ICBMs -- but it would also raise the danger of inadvertent war day-in and day-out, increasing the danger manyfold. Paul Bracken, an optimist on this issue if not on others, has argued that "No political leader in the Soviet Union (or the United States, for that matter) is going to allow nuclear forces to be operated in a launch-on-warning mode in peacetime. It is too dangerous, and literally begs for accidental war." [29]

No matter what the specific degree of reliance on LOW, the magnitude of the danger would depend, among other things, on the quality of the strategic warning and command and control systems. But the designers of a warning and command system for LOW would always confront a fundamental barrier: the time available for warning, decision, and action would be extremely short. While the flight time of the ICBMs that would probably be used to attack hardened missile silos is approximately 30 minutes, submarine-launched weapons might arrive within 10 minutes, possibly disrupting command and control or detonating in space over the ICBM fields in an attempt to prevent the ICBMs from being launched. Moreover, once a decision had been made, it would take several minutes for the ICBM commanders to receive and confirm it, launch

their weapons, and get the weapons safely away from their silos before the attack arrived [30]. Hence, there might be no more than five minutes in which to search out possible errors, clear up uncertainties, and make one of the most fateful decisions in human history -- and indeed, in so short a time, those who in theory carry the responsibility of decision might not be available for consultation. No matter how redundant and ingenious the warning systems, the possibility of error in such a situation -- of a decision to launch based on a false alarm -- could never be ruled out [31]. Nevertheless, Soviet and U.S. military leaders have made statements indicating that reliance on LOW, at least in some situations, is under serious consideration by both countries [32].

At first glance, then, it might seem desirable for arms control agreements to prohibit strategies such as launch-on-warning. But such agreements would be as impossible to enforce as agreements prohibiting surprise attack itself; the best that arms control can do is to seek to reduce the incentives to rely on such strategies. In addition, of course, we can forego LOW and preemption unilaterally ourselves, as we apparently have in the past.

How might one measure the incentive toward LOW? The most important part of the incentive to rely on LOW is the vulnerability of the ICBMs to which the policy would apply

[33]; however, the vulnerability of the rest of the strategic force would also be important, as relatively secure bomber and submarine forces might make the vulnerability of the ICBM force seem a less crucial issue, and LOW therefore less necessary. Thus, when considering the vulnerability of the overall force, special consideration should be given to the vulnerability of forces that could be launched on warning, such as ICBMs; the more vulnerable the ICBMs on each side become, the greater the incentive to rely on launching them on warning of attack, and the greater the risk of accidental war [34].

The "Rational Actor" and Crisis Escalation

The essence of stability theory is to analyze the risk of war by asking: what are the incentives to attack? Thus, stability ideas implicitly -- and sometimes explicitly -- rely on a "rational actor" model of governmental actions. Deterrence will be maintained, the argument runs, if the leader (or a small group of leaders) makes a rational calculation that the costs of attack would outweigh the gains.

But anyone with any familiarity with the actual behavior of governments realizes that such a model is fundamentally flawed; while most governments do have a single central

figure, that figure is enmeshed in constant bureaucratic politics, and presides over a government composed of many large organizations, each with its own considerable inertia. A rational calculation of costs and benefits is rarely the basis of any action of a large government; rather, as the result of pulling and hauling by the various individuals involved, and the standard preferences and procedures of the various organizations involved, the final action taken is likely to be an amalgam of possibly contradictory pieces, not what any specific individual would have intended. Stability theory, therefore, deserves to be criticized for relying on an incomplete model of governmental action [35]. In particular, to say that there is no situation in which a decision to begin a strategic nuclear war could be "rational" is by no means equivalent to saying that the risk of such a war is negligible.

If it is true, as argued above, that the "rational" incentives for preemptive attacks on strategic forces would be small, then the additional dangers highlighted by bureaucratic or organizational models of government may be of central importance. In particular, the inevitable "friction" of government in a crisis -- the gap between what the leadership decides and what actually occurs -- is almost certain to be a major contributor to the probability that a regional conflict or crisis would escalate. And such

escalation may be the most likely path to all-out war.

Paul Bracken, among others, has argued that the alert measures taken on each side in any major nuclear crisis are likely to be reinforcing; alert measures taken defensively on one side would be seen as threatening by the other, requiring a higher alert on the other side, ratcheting the crisis to higher and higher levels of alert and tension. In this process, an enormous web of military standard operating procedures, all designed in peacetime, largely without the benefit of real crisis experience, would interact in unpredictable and uncontrollable ways. Given the sheer size and complexity of current military organizations in both superpowers, unintended incidents in such crises are simply to be expected; it is clearly impossible, even if it were judged desirable, for a small group of policy-makers to control every detail of a far-flung military operation. In Europe, a major nuclear alert would result in the wide dispersal of nuclear weapons and at least the physical ability -- if not the theoretical authority -- to use them. The dangers are manifest, though the specific course of events that would lead to all-out war cannot be specified. Indeed, Bracken has argued that "intead of asking whether nuclear war can be controlled, it is more relevant to ask whether nuclear alerts can be controlled." [36]

Can the probability of such events leading to war be reduced by limitations on strategic arms? Perhaps so. John Steinbruner has also addressed the issue of how governmental "friction" can be factored in to theories of deterrence, and has made a (somewhat implicit) argument for a sweeping revision of "the concept of strategic stability." [37]. Steinbruner argues, in essence, that wherever opposing forces interact in a crisis, the unexpected should be expected, and dangers will arise. It may be, then, that forces which are incapable of interacting with enemy forces without a political command -- such as ICBMs in their hardened North Dakota shelters -- pose a lower risk of war, even if they are theoretically vulnerable, than do submarine-based forces, which must inevitably interact with the enemy Navy, and will do so in ways that cannot be completely controlled by the political leadership. Vulnerability, in short, is not the issue; rather, the issue is the likelihood that a particular type of strategic force could make -- or be subject to -- unauthorized provocative actions, posing a greater risk of unintentional escalation from crisis to war. If so, then rather than basing arms control on classical stability ideas, one should base it on reducing the frequency and intensity of the interactions of the strategic nuclear forces on the two sides.

These ideas could be taken as direct contradictions of stability theory -- and as such, they would be among the most telling to date. Certainly the dangers of a crisis escalating to all-out war as the result of unforeseen incidents cannot be ignored; these dangers are an humbling reminder of how little of what will be important in a crisis can be foreseen and calculated beforehand. But it may be that these ideas should in some sense be regarded as additions to, not contradictions of, stability theory; for provocative incidents would be much less likely to lead to all-out war if there were no compelling reason to rush to strike the first blow, should all-out war appear to be coming. It would seem wise, therefore, to take both vulnerability and "controllability" into account in procurement decisions and in arms control policy. But it is extremely difficult to say precisely how to do so -- especially where the two conflict, as in the case of a decision whether to emphasize vulnerable land-based ICBMs or invulnerable but less controllable submarines.

Another important organizational factor is that alluded to in the discussion of the vulnerability of command and control: the unique pressures toward preemption that might be exerted by military organizations, reacting institutional concerns. Even in the deepest crisis, most national leaders, left to themselves, are likely to be more concerned with the horrific consequences of even a weakened retaliatory strike

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by the enemy, and with whatever possibility remains for averting such a war, than with the difference between the damage from a first strike and that from a second strike. For the central leader, having pursued a policy that led to any strategic nuclear war would probably be seen as a monumental personal failure. But military leaders and organizations, while equally concerned for the safety of their country and of the world, are likely for institutional reasons to be much more aware of any vulnerabilities in their own forces and those of the enemy. And representatives of military organizations (especially, in the United States, civilian military experts) will be much more familiar with the results of various different war scenarios, including the various measures of first-strike advantage to be discussed in the next section -- although they may also be more aware of the weakness of many of the assumptions in such scenarios, and the immense uncertainty any attack would face. In decisions on the use of nuclear weapons, the advice of such experts will probably carry significant weight -- and that advice is likely to be heavily colored by concerns relating to the vulnerability of the forces and command systems in the event of an attack. It is at least conceivable, then, that there would be internal pressures to preempt, even in situations -- such as the current one -- where a "rational actor" model would rate preemption as a very unlikely prospect [38].

Despite all these qualifications to the "rational actor" model of stability, it retains a key core of validity. For no matter how intense the crisis or regional war, political leaders are likely to make it their business to keep tight control over at least the central strategic forces -- if not tactical forces in the theatre of conflict, which must be dispersed to survive -- at least until the command and control system is disrupted by strategic nuclear attacks, which would in any case signal the onset of total war. Whatever bureaucratic or organizational pressures there may be in one direction or another, the final decision to move from crisis or limited war to strategic nuclear war would probably be taken by a small group of political leaders, resembling, one hopes, the "rational actor" of theory. And the vulnerability of their forces and command and control, and those of their opponent, is unlikely to be a matter of complete irrelevance to them in making that fateful decision.

Stability and Soviet Strategic Doctrine

Yet another important line of criticism of stability theory focuses on its conflict with Soviet strategic doctrine. The central thrust of the idea of applying stability to arms control is to reduce the incentives to rely on particularly dangerous strategies such as preemption or

launch-on-warning -- which assumes that the incentives the Soviets perceive will be similar to those our own logic would predict. But even the briefest look at Soviet strategic doctrine makes it disturbingly clear that their nuclear logic is not the same as that of either hawks or doves in the United States [39]. This raises difficult questions as to the ultimate relevance of stability theory, and its applicability to arms control.

It is important to begin by saying that to imply, as some do, that the Soviet Union is actively preparing to launch a nuclear war is simply nonsense; the Soviets are no more interested in fomenting such a conflict than is the United States. Soviet leaders regularly reiterate that nuclear war would bring unimaginably disastrous consequences to all concerned, and beginning such a war under present circumstances would be insane. Indeed, while it is commonly argued that Soviet propaganda minimizes the consequences of nuclear war, a recent study suggests that this is far from the case; indeed, it appears that if anything, the Soviet media exaggerate the devastation that nuclear war would bring [40]. Preventing war by means of deterrence is the central goal of Soviet nuclear policy, just as it is the central goal of U.S. policy.

But the Soviets have a very different idea of what makes deterrence work. In Soviet writings, it is usually assumed

that war will be preceded by crisis, and the onset of war will in most cases be reliably foreseen. A "bolt-from-the-blue" attack does not appear to be the primary scenario considered, which may help to explain the relatively low peacetime alert rates of Soviet forces [41]. The Soviets do believe, however, that the enormous destructive power of nuclear weapons makes the initial strike a crucial element in determining the outcome of a war.

Given the importance of the initial strike, if strategic nuclear war becomes certain the only logical thing to do is to hasten to get in the first blow --- and damage and disrupt the opponent's strategic forces (and the rest of the opponent's military machine) as much as possible, thereby reducing the damage those forces can inflict. In this view, the best outcome can be achieved if it is possible to preempt the opponent's attack; second, if one launches on warning of an attack already underway; and launching only after absorbing a first strike, while a necessary capability, would be a distant third best as a wartime strategy. In short, Soviet doctrine appears to emphasize precisely the strategies we would prefer them to avoid. Indeed, Soviet writings explicitly rank strategic forces and command and control as the most important targets to be attacked, and their forces appear to be designed with these goals very much in mind [42]. In some sense, of course, the identical statement could be

made with respect to the United States; despite rhetoric to the contrary, and the theories of arms controllers, the U.S. has for many years been consistently emphasizing weapons capable of attacks on Soviet strategic forces [43]. Nevertheless, the emphasis on preemption appears to be greater in Soviet strategic writings than it is in the U.S. The Soviets simply do not make the Western distinction between stabilizing and destabilizing weapons and doctrines; to them, counterforce is the backbone of deterrence, not its antithesis [44].

On the other hand, the Soviets do not appear to give any credence whatsoever to the idea of "limited" strategic nuclear war -- the idea which has provided the strongest public justifications for counterforce weapons in the U.S. political debate. In their virtually unanimous view, the way to fight a nuclear war is to destroy all of the important targets (including nuclear forces, command and control, other military targets, political and leadership centers, and war-supporting industry) as rapidly as possible, in massive strikes [45]. This raises a serious difficulty for proponents of limited nuclear options in the United States. As Lawrence Freedman has described the problem [46]:

If the U.S. [limited war] policy was designed only as a reaction to plausible opening nuclear shots from the USSR, then a Soviet proclivity for large strikes rendered it futile; if it was designed for

opening shots for the US then it could be folly, for it would invite a massive Soviet response. . . .

Thus, the Soviets seem to emphasize preemption even though hundreds or thousands of nuclear weapons would surely survive any attack, and even though the expected response would not be a "limited" one --- in short, even though preemption would not be "rational" as seen from the American perspective. Nothing could demonstrate more clearly that Soviet nuclear logic does not proceed along the same lines as that of the United States [47]. To say that this reasoning is "less logical" than that of stability theory, however, would explain little; rather than simply expressing frustration, it is important to make some attempt to understand the Soviet logic.

If one assumes, as Soviet writings seem to, that the onset of strategic nuclear war will in some cases be foreseen with certainty, then one loses nothing by preempting; thermonuclear war was coming in any case. Moreover, the idea that preemption is not worthwhile if thousands of nuclear weapons would still survive -- unless the war could somehow be kept limited -- depends on the notion of diminishing returns: after suffering a certain level of attack, a larger attack ceases to be much different. This is a notion the Soviets do not seem to think much of when the subject is defending the homeland. In their eyes, preventing nuclear weapons from detonating over the Soviet Union is a crucial wartime task,

regardless of whether 4000 other weapons have already done so or not. That the Soviets continue to devote many billions of dollars a year to the world's most extensive air defense system, for example, despite the fact that no significant defenses are available against the thousands of missile-carried weapons that could devastate the Soviet Union in the event of war, may be a reflection of this philosophy -- although much of the explanation of this fact may be bureaucratic inertia, in the form of the struggle of the Soviet air defense forces to maintain their budget [48]. The U.S., in a similar situation, has chosen to have only token air defenses, realizing the futility of bothering to defend against one fraction of the threat while defenseless against the rest [49].

The fact that Soviet doctrine seems to emphasize preemption and launch-on-warning, despite the apparent robustness of the forces on each side, raises the original question of whether attempts to reduce the incentives to rely on such strategies through arms control would have any effect. If the Soviets already rely on such strategies, and always have to some extent, then one could argue that technical judgements as to the stability of the balance may be largely irrelevant. New threats to Soviet ICBMs could not destabilize the balance further, since the Soviets already rely on preemption; nor would new protection for these

weapons offer much hope of a safer situation [50].

In my view, this argument misses important parts of the problem. The question is not whether one would preempt or launch on warning if one knew for an absolute certainty that all-out war was coming; anyone would. The questions, in a more realistic world of uncertainty, are how likely strategic war must seem before that likelihood would provoke a decision to preempt, and how conclusive must the evidence of warning systems be before the forces are launched on warning? The mere fact that preemption and launch on warning are discussed at length (and favorably) in Soviet military journals does not imply that the nuclear balance cannot become more dangerous than it is [51].

The key question, which cannot be definitively answered one way or another, is whether the specific level of vulnerability of U.S. and Soviet strategic forces would have an important impact on the thinking of Soviet leaders in a severe crisis. To what degree would the decision to accept the necessity of preemptive attack, or of launching the forces on possibly ambiguous warning, be affected by the vulnerability of Soviet and U.S. nuclear weapons? Logically, there ought to be some connection, just as there ought to be a connection between the probability of an act and its consequences; but of course this is impossible to prove. If such decisions would not be affected by strategic vulnerability, then any arms

control proposal aimed at improving the technical stability of the balance is chasing an irrelevant will-o-the-wisp; but if they would be, at least to some degree, then the fundamental tenets of stability theory remain valid, and technical arms control limitations may have an important role to play in reducing the risk of nuclear war.

Soviet Doctrine and Stability Theory: Some Other Issues

However, Soviet doctrine may make stabilizing arms control agreements more difficult to achieve. If the Soviets really regard their counterforce capabilities as the backbone of their deterrent, would any stabilizing agreement --- which would have to put significant restraints on those capabilities --- be negotiable [52]? Indeed, is any major agreement possible between two adversaries with such fundamentally different visions of what is desirable? These are questions of crucial importance.

It seems clear that the path to stability through arms control would be much easier if each side agreed on the goal of assuring the survivability of each side's strategic forces; sadly, however, the Soviets do not. Moreover, as we have seen already, the U.S. government itself remains in conflict over this idea. Nevertheless, the record of SALT so far, while revealing that truly stabilizing agreements are difficult to

achieve, also indicates that limited but important progress can be made. Not only have the U.S. and the U.S.S.R. concluded several agreements limiting their strategic nuclear arms, but some of these have made notable contributions to stability. The most impressive example is the ABM Treaty of 1972, which forbid the deployment of significant anti-missile defenses on each side, helping to assure that each side could retaliate against any attack. Limitations on offensive forces, have been more limited and less successful, but they may have had some stabilizing effect [53]. Moreover, the record indicates that some of the most important failures of arms control have been the result more of historical accident than of predetermination; the failure to achieve a MIRV ban in SALT I, for example, occurred despite the fact that each side had proposed such a ban, at different times during the negotiations.

More fundamentally, the argument that two sides with profoundly differing goals cannot reach mutually acceptable agreements rests on the most dubious logical ground; by the same reasoning, agreements between the management and the labor force of any firm are impossible, since any increase in wages or benefits ceded to the union is taken away from the firm's profits. The essence of adversarial bargaining is the creation of a compromise between such conflicting goals, fulfilling some of the hopes of one side, and some of the hopes

of the other; this is possible as long as each side has a strong interest in the completion of an agreement. The presence of conflicting goals undeniably complicates negotiations, making them more difficult and grueling; but it does not preclude any meaningful result.

A last, gut-level point raised by Soviet doctrine and programs is "if the Soviets have these counterforce capabilities, shouldn't we have them too?" Crisis stability, however, is not something one side can have, and the other not; it is a shared commodity, and the question is whether, given the Soviet emphasis on preemptive doctrine and capabilities, development of similar capabilities by the United States would increase or decrease the supply of that commodity [54]. As was argued at the outset, if the gunman analogy has any validity the answer is clear: improving the aim of either gunman, even if only to catch up to an improvement on the other side, decreased the security of both, by increasing the danger of a shoot-out.

The Risks of Nuclear War: Some Lessons of Past Crises

Faced with so many varied challenges to a theory, it would be logical to turn to historical evidence. Up to this point, both the basic tenets of stability theory described in Section Two and the second thoughts about that theory

described in this section have been developed through a process that amounts to arm-chair speculation -- drawing out the salient points of a situation by means of logic and analogy. By their very nature, such speculations cannot be a complete model of the world we live in, and the risks we face; real situations are simply too complex to be so boiled down. Indeed, it is quite possible that the discussion so far has missed the most important factors determining the risk of war; what may appear logical from one point of view could easily be nonsensical when viewed within a larger framework. For most purposes, therefore, an ounce of empirical evidence is worth a pound of logical disquisition.

For analyzing how nuclear wars begin, however, we are immensely fortunate to be without historical data. There does exist a great and growing body of knowledge (and controversy) on the causes of conventional wars; but strategic nuclear war would be qualitatively different, and cannot necessarily be analyzed within the same framework. How, then, to proceed?

One possible avenue of inquiry is to examine those crises of the last forty years which, in retrospect, might have led to a nuclear war, had the situation played out differently. To speculate on what might have been, of course, is always a dangerous historical enterprise; moreover, the choice of which past crises were especially dangerous is itself inevitably biased by one's theoretical preconceptions as to

the likely causes of war. Nevertheless, it may be worthwhile to tentatively examine a small sampling of these nuclear crises, in an effort to uncover strengths and weaknesses of deterrence theory that may not be evident from logic alone.

While the post-war period has seen a good deal of nuclear sabre-rattling for diplomatic purposes, especially in the early post-war years [55], there are only a few crises which seem to have raised a real risk of nuclear war, and it is only the latter that are of interest, for the present purposes. I will examine certain aspects of three of these crises: the Suez crisis of 1956, the Berlin crisis of 1961, and the Cuban missile crisis of 1962. This is by no means intended as a comprehensive list of the dangerous crises of the nuclear age; indeed, other crises may have been more dangerous than these. I have chosen these three for two reasons: first, in each of these crises some of the major players on the U.S. side appeared to believe that nuclear war was at least a possibility; second, aspects of each of these crises raise interesting points about stability theory. I will treat them in chronological order, rather than ranking them by order of importance or by the number of lessons to be drawn; as a result, the first two discussions will each be a good deal shorter than the third.

Ambiguous Warnings in the Suez Crisis

A series of coincidences during the course of the Suez crisis of 1956 points up the danger of combining frayed nerves and ambiguous warnings [56]. At the end of October of that year, the Israelis attacked Egypt, in a collaborative effort with Britain and France, after a prolonged dispute over ownership of the Suez canal. British and French troops began bombing Egyptian targets on November 1, and despite an already well-developed world outcry, including warnings from the U.S., their troops landed at dawn on the 5th. On the 4th, in Hungary, Soviet troops had intervened decisively to crush a domestic rebellion. The world situation, needless to say, was tense. Then, on the fifth, the Soviets sent letters to the leaders of Israel, Britain, France, and the United States. The letters to the first three conveyed veiled threats of "rocket missile" attack, and stated that Moscow was "fully resolved to use force to crush the aggressors . . ."[57] The letter to the United States suggested a joint U.S.-Soviet military intervention.

In retrospect, it is widely believed that the Soviet action was calculated as a propaganda move to show support for the Arabs, without actually taking any significant risk; it was already clear that the U.S. would not back up the Franco-British-Israeli adventure, and that therefore there was

little chance that the bluff would be called. Nevertheless, one can imagine the feelings in the allied capitals upon the receipt of these Soviet letters; one report (admittedly from an author prone to hyperbole) claims that Eisenhower was "terrified," and "expected an attack." [58] The U.S. felt called upon to issue a statement that it would retaliate for any attack on London or Paris.

The following morning, November 6, it appeared that a Soviet intervention might indeed be underway. NATO Supreme Command received a message that unidentified jets were flying over Turkey, and that the Turkish Air Force had been put on alert. A British Canberra bomber, flying too high to be attacked by any plane other than a Soviet MIG, went down over Syria. One hundred MIGs were reported flying in Syrian airspace. A Soviet fleet was reported moving toward the Dardanelles. As a result of these signals, a hurried meeting was called of the U.S. National Security Council and Joint Chiefs of Staff, after which U.S. strategic forces were placed on alert, and aircraft carriers with nuclear-equipped aircraft moved closer to the Soviet Union. Eisenhower's Special Assistant for Defense, General Goodpaster, was reportedly worried that these events "might trigger off all the NATO operations plan" -- which called for all-out nuclear strikes [59].

As it turned out, the jets over Turkey were a flock of swans, mistaken by radar; the Canberra bomber had been downed by mechanical trouble; the 100 MIGs over Syria were a much smaller number escorting the Syrian president home from a visit to Moscow; and the fleet movement was a long-scheduled exercise [60]. This chain of coincidences, coming at a time when nuclear threats were already being exchanged, provides a rather dramatic illustration of the dangers inherent in relying on initiating nuclear war on the basis of possibly misleading evidence of attack. One can easily imagine that if the United States had at the time possessed a force of vulnerable ICBMs, and even one more coincidence had occurred -- the Soviets testing a group of ICBMs all at once, for example, or a convincing false alarm like that recently caused by a technician running a training tape in the warning system's computer -- the pressures to launch might have been very great.

This is an extremely unusual example, in that the danger arose almost entirely by accident and coincidence: with respect to the fundamental issue involved in the crisis -- the sovereignty of Egypt over the Suez canal -- the two superpowers were largely in accord. Yet these false warnings and coincidences, when combined with the enormous tension of the moment, led to a strategic nuclear alert, and significant fears of attack.

The Berlin Crisis and the First-Strike Plan

The Berlin crisis of 1961 posed an entirely different situation. Far from being in accord, the basic goals of the superpowers in Berlin were in direct conflict -- and indeed, Berlin had for many years been a symbol of superpower tension, a lightning rod for the fiercest emotions of the cold war. The 1961 crisis was essentially a continuation of past crises over the status of West Berlin; Khrushchev was demanding an immediate "resolution of the problem" -- meaning that West Berlin should be handed over to East Germany -- and a military threat to the city could not be ruled out. The Kennedy Administration was well aware that if the Soviets attempted to take the isolated city by force, they would have an overwhelming advantage in any conventional battle, deep within East Germany as it would be; Kennedy therefore ordered a study of what options he might have to stop such an attack [61].

Coincidentally, the intelligence photographs obtained by the first reconnaissance satellites were just then being analyzed. They revealed that the Soviet strategic nuclear forces were much fewer in number and more vulnerable than had been thought; the missiles were totally unhardened, would take hours to fuel, and weren't even stored with their warheads. A number of top-level aides discussed this

information and decided that a disarming first-strike might be feasible. One of them, Henry Rowen, set up a study group at the Pentagon, which came up with a detailed plan for such a strike, including even the appropriate evasion tactics for attacking U.S. bombers. The report was sent to the President and other top security officials of the U.S. government, among whom the search for credible options in the event of a Soviet conventional attack was still an urgent matter.

There was one crucial flaw in the plan, however. Even in 1961, with the Soviet force in its infancy, it was thought that a handful of Soviet strategic weapons might survive, along with many of their shorter-range weapons in Europe; hence, if the Soviets chose to retaliate, between 2 and 15 million Americans might be killed, as well as tens of millions of Europeans. This hardly seemed a plausible option, and the plan was utterly rejected.

Nevertheless, this history would seem to indicate that force vulnerability can very directly increase the risk that nuclear weapons will be used; the vulnerability of Soviet forces was the direct cause of serious consideration of a strategic attack on the Soviet Union at the highest levels of the U.S. government. But the incident also seems to indicate that the risk is large only if the attacker can have high confidence in disarming the defender completely; it lends some credence to the idea that a very few nuclear weapons may

be enough to deter. Certainly it was enough to deter the particular U.S. leaders involved at the time -- given the particular situation and the available alternatives. Of course, it is open to dispute whether the outcome would have been the same if the Soviets had been in a similar position, but it does not seem unlikely that it would. If, in fact, such a small number of survivable weapons was sufficient for basic deterrence, this would lend considerable strength to the argument that stability concerns have become largely irrelevant, given the enormous size and relative robustness of current strategic arsenals.

But part of the deterrent effect of those weapons undoubtedly arose from the fact that there did not appear to be an immediate need to take any step even remotely as drastic as a nuclear first strike. In the end, the Soviets never did make any effort to take the city by force; instead, they forfeited the ultimate goal of controlling West Berlin, and solved the most immediate problem -- the flood of refugees from East Germany into West Berlin -- by erecting the Berlin Wall. What might have happened if the Soviets had attempted to take the city by military action? What if events had developed in such a way that U.S. leaders saw no alternatives between a strategic strike and simply acquiescing to the Soviet grab -- which might have thrown doubt on all U.S. commitments, and severely damaged the NATO alliance? (Certainly there would

have been other alternatives, but equally certainly, not all of them would have been perceived in the heat of the moment.) We can never know. Similarly, we can never know what the outcome would have been had the U.S. force been as vulnerable to attack as the Soviet force -- and had the Soviets begun, say, to fuel their missiles in preparation for launch, an act which might well have been taken as a defensive precaution. What pressures to strike might then have been felt? Since the U.S. has never been in the position of being vulnerable to a nearly disarming first strike by the Soviet Union, we cannot historically assess the probably much larger impact of reciprocal vulnerability, and reciprocal fears of surprise attack -- the central problem emphasized by Schelling, and brought out by the analogy of the gunmen.

The Cuban Missile Crisis

The Cuban missile crisis is in some sense the archetypal crisis of the nuclear age. As such, it has been studied, restudied, and studied again; an enormous wealth of material has been published, much of it relevant to the question of what factors most importantly affected the risk of nuclear war [62]. Only a shallow skimming of a few salient points is possible here.

In brief, the crisis was precipitated by the discovery that the Soviet Union was emplacing nuclear missiles in Cuba capable of striking the United States; the U.S. responded with a naval "quarantine" of the island (a blockade in all but name), and a demand that the missiles be withdrawn; after an enormously tense several days, the Soviets withdrew their missiles from Cuba, and the United States promised never to invade the island [63].

While the Berlin case offers evidence that the vulnerability of strategic forces can in fact increase the risk of strategic war, the Cuban missile crisis does not; indeed, quite the contrary. It is clear that though a year had passed since the Berlin crisis, the fundamental strategic situation was much the same: the U.S. enjoyed a striking preponderance of nuclear force over the Soviet Union, and a U.S. preemptive strike could have enormously reduced the damage that Soviet forces could have inflicted on the United States, if war did in fact occur. Moreover, in the Cuban crisis, President Kennedy and several of his closest advisers believed nuclear war to be an immediate possibility; Kennedy is often quoted as putting the odds at "between one out of three and even." [64] But despite these two facts -- that the possibility of nuclear war was salient, and that there would be an enormous advantage in getting in the first blow -- the idea of a preemptive attack does not seem to have even been

mentioned within the ad hoc Executive Committee considering U.S. strategy, and the major surviving participants report that the specific state of the strategic balance was never examined as a relevant factor [65].

There are two explanations of this. First, while Kennedy and his advisers believed that nuclear war was a serious possibility, no one believed that a Soviet preemptive attack was likely; pronounced Soviet nuclear inferiority seemed to rule out that possibility. Nuclear war, if it came, would be the result of escalation from lower-level actions: one scenario that worried Kennedy proceeded from an American air strike on the Cuban missiles to a Soviet strike on U.S. missiles in Turkey, to a U.S. retaliation against the bases from which this attack on the territory of our NATO ally had been launched, and from there to strategic nuclear war. As avoiding such a sequence was foremost in Kennedy's mind, to consider launching a strategic nuclear war by a preemptive attack -- when a Soviet attack was unlikely -- would be to consider jumping into the ocean for fear of getting wet. That no such attack was even contemplated lends credence to the idea that the vulnerability of the opponent's force is unlikely to be relevant unless an imminent attack is feared -- unless the vulnerability of that force is essentially total. A second, possibly complementary explanation is simply that a preemptive attack had already been considered and rejected

the year before, in the Berlin crisis.

The Cuban crisis also presents a wealth of material on the question of the relative importance of "rational" decisions by a single actor, bureaucratic politics, and organizational factors [66]. It is clear that in crises such as this one, a greater proportion of governmental action can be attributed to deliberate decisions by central leaders than at any other time; after the discovery of the Cuban missiles, Kennedy and his chosen advisers on the Executive Committee attempted to regulate every aspect of the government's behavior and communication with the Soviet Union. In implementing the blockade, the Executive Committee inquired even into such details as whether there were Russian-speaking officers on board the blockading ships; Kennedy forced the Navy to allow several ships through the blockade, and personally selected the first ship to be stopped [67].

Despite these efforts, however, several of the most dangerous actions of the crisis (on the U.S. side, at least) were undertaken not as a result of deliberate decision on the part of high-level policy-makers, but rather as unforeseen consequences of standard military procedures. The most important example, emphasized by John Steinbruner, is provided by the Navy's anti-submarine warfare operation in the Atlantic [68]. The Executive Committee was determined to postpone any confrontation between the U.S. blockading fleet

and Soviet ships for as long as possible, to give the Soviets time to consider; Soviet submarines were considered especially sensitive. Indeed, when Kennedy was informed that a Soviet sub had taken up position between the first two Soviet ships approaching the quarantine boundary, he replied: "Isn't there some way we can avoid having our first exchange with a Soviet submarine -- almost anything but that?"[69] By this time, however, the Navy had been aggressively pursuing Soviet submarines for two days, unbeknownst to the Executive Committee, apparently succeeding in detecting and trailing every Soviet submarine within striking range (then about 600 miles) of the U.S. coasts. Indeed, the Navy had gone so far as to force several Soviet subs to the surface [70].

The Soviet missile submarines under trail would have been unable to launch their weapons, since Soviet technology of the time required surfacing to prepare the missile launchers, an operation which could easily have been stopped by the trailing vessels. As the Soviet ICBM and intercontinental bomber forces were still rather small and extremely vulnerable, this ASW campaign threatened a very significant fraction of the Soviet strategic deterrent. This threat may well have been the single strongest military "signal" sent during the crisis; moreover, one can easily imagine how a precipitous action by the commanders of one of the submarines

involved could have had disastrous results. Yet this campaign was undertaken without the knowledge of any of the political leaders involved in the crisis.

This particular incident has two implications: it certainly demonstrates how important unauthorized -- but standard and long-planned -- military activities might be in determining whether a crisis would escalate to all-out war. But at the same time, it is clear that part of what made this event so important was the fact that it threatened the Soviet strategic deterrent -- that is, it threatened to undermine stability. Again, as argued earlier, both the controllability and the vulnerability of strategic forces have important implications for the risk of war.

Another important point is illustrated by the Navy's reaction to the Executive Committee's efforts to moderate the implementation of the blockade, to make it as unprovocative as possible, and to increase the amount of time the Soviets would have available to reconsider before the military forces confronted each other on the seas. The Navy resisted every such effort as interference with its institutional prerogatives; for the Executive Committee to demand that the first ships to reach the line be shadowed, and then allowed through, rather than stopped, was "a hell of a way run a blockade," in the words of one Naval officer [71]. Similarly, the Air Force resisted all efforts to change its prearranged

plan for an air strike on Cuba -- which involved massive bombing of all significant military targets -- to a plan for a "surgical strike" attacking only the nuclear missiles. In each case, the military services minimized the possibility that the actions they recommended might have far-reaching effects; President Kennedy later complained that the military leaders, by and large, seemed to give "little consideration to the implications of steps they suggested." [72].

The most telling incident of this kind, and the most important for stability theory, is the Navy's furious reaction to the idea of pulling the blockade line back, closer to Cuban shores. To Kennedy, such a pull-back meant giving the Soviets more time for decision, before their ships reached the blockade line. To the Navy, it meant operating the blockade within the range of Cuban jets, making their vessels far more vulnerable. It is hardly surprising that Kennedy's order to pull the line back drew agitated protests from the Navy; indeed, Graham Allison persuasively argues that the line may never, in fact, have been pulled back as Kennedy ordered [73]. This points up the importance that military officers will inevitably attach to the vulnerability of the forces under their command, and the degree to which broader considerations may be played down. It lends credence to the idea that in some future crisis, the commander of a vulnerable

strategic force may see strong reasons for getting those forces off as rapidly as possible, and may argue strongly for such a course.

Summary

From this long and broad-ranging reexamination, stability theory has emerged severely battered -- but perhaps broadened as well. While the moral arguments against deterrence are compelling, the alternatives that can be offered are not. By contrast, the military argument in favor of counterforce weapons offers a clear alternative to stability theory -- but the arguments in its favor are much less than compelling. Moreover, the Soviet emphasis on preemption and counterforce, while making stability more difficult to achieve, especially through negotiated agreement, does not undermine the fundamental basis of stability theory, unless strategic vulnerability would be unrelated to the decisions of Soviet leaders on the question of whether to launch their strategic forces.

The technological argument is much stronger. It does not throw doubt on the basic ideas of stability theory, but only on their relevance to the current nuclear balance. The size and survivability of current nuclear arsenals, combined with the possibility of placing the strategic forces on alert if an

attack is feared, may make the incentives to launch a deliberate nuclear attack on the strategic forces themselves negligible. Greater incentives to preempt might arise from the vulnerability of command and control systems, but this does little to rescue the idea of applying stability criteria to arms control, for arms control could have but little effect on that vulnerability.

The danger that an accident, provocation, or false alarm could result in all-out strategic nuclear war is also strongly related to the vulnerability of the strategic forces and command and control, for that vulnerability increases the pressure, in Schelling's words, to "get on with the war if in fact it is war." Specifically, the possibility that ICBMs might be placed in a launch-on-warning posture raises the possibility of war arising through a false alarm. But the fact that roads to war other than that of a cold, calculated decision to preempt may also depend on the vulnerability of strategic forces does not answer the question of whether the current large and robust nuclear forces -- combined with the possibility of making those forces much more robust by alerting them in a crisis -- might make the concerns of stability theory irrelevant.

Examination of the effect of organizational and bureaucratic factors raises two issues. First, it is clear that many of the events of any real crisis will not be the

result of deliberate decisions by governmental leaders; unforeseen incidents and provocations will inevitably play a key role in any major nuclear crisis. This raises the issue of the "controllability" of nuclear forces -- possibly a competing paradigm to "stability" in assessing the link between the characteristics of strategic forces and the risk of nuclear war. But despite the fact that these first steps along the road to strategic war may be taken through foul-ups or inadvertence, the central leadership is likely to maintain the tightest possible control over the central strategic forces: it seems likely that the final step to all-out war will be taken deliberately, if it is taken at all. Second, responses to a crisis will be in part the result of conflicting advice and pressures exerted by different players within the governments of the nations involved, and the players are likely to give advice that reflects their institutional concerns. Specifically, those entrusted with the command of strategic forces, whose job is to ensure that those forces can perform their assigned missions are likely to be acutely aware of whatever vulnerabilities those forces may suffer from, and to see good reasons for haste, should it seem likely that an enemy attack was underway. And in deciding whether to launch the strategic forces, the advice of those commanders of those forces may carry considerable weight.

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Lastly, there is the evidence of the three nuclear crises -- ambiguous, tentative, but no less important for that. The three are hardly a definitive set of cases; there may indeed be others in which the world came closer to the brink. Moreover, any lessons drawn from them must of necessity be very tentative. As John Steinbruner wrote in concluding a similar exercise [74]:

Uncomfortable as the fact may be the most important lesson that can be derived from experience with nuclear weapons in crisis concerns what is not and cannot be known.... One may develop theories, beliefs, hopes, and firm convictions, and one may appeal to events of the past thirty years for support, but one cannot objectively determine by inference from the historical record just what it is that has preserved peace in the face of enormous destructive capabilities. Nor can one establish where the most serious threats of war are to be found.

Nevertheless, a few tentative judgements can be made -- and must be, if we are to gain anything from the experiences of the past. First, the Suez incident points up as no analogy possibly could the dangers of a policy of responding at once to warning of attack -- for no matter how convincing that warning, no matter how many different indications there may be, it is at least conceivable that all the indications are merely a string of grim coincidences, as they were then. The development of the first-strike plan in the Berlin crisis lends credence to the idea that force vulnerability can increase the risk of war -- but also to the idea that the

effect may only be significant when considering very small and vulnerable nuclear forces. But on the latter point, the evidence is by no means conclusive, for push never came to shove. The Cuban crisis makes it clear, if it was not already, that unauthorized interactions of the military organizations on each side can be of crucial importance. It also shows the importance of institutional concerns in the recommendations made by Kennedy's advisers: the State Department feared for the NATO alliance, the military forces resisted politicians' efforts to change their plans, and the Navy may have disobeyed the President on an order that would have increased the vulnerability of their ships -- but might also have decreased the risk of nuclear war. All of these illustrate the importance of including factors other than the purely "rational" in estimates of the likelihood of war.

It is impossible, considering all of these factors together, along with the historical evidence, to reach any incontrovertible conclusion as to how the numbers and types of strategic nuclear weapons relate to the risk of war. It may be that stability theory has been rendered irrelevant by the growth and increasing sophistication of nuclear arsenals. If so, perhaps "controllability," would be a better criterion for judging the effect of strategic weapons on the risk of war. Or perhaps the characteristics of those weapons are simply no longer of much importance to the risk of war; if so,

then negotiations on those weapons should turn to some other goal instead.

But consideration of institutional and organizational factors, far from undermining the most basic stability ideas, may provide a small counterargument to the view that changes in strategic vulnerability would no longer affect the risk of war: increasing the survivability of even quite large and fairly robust forces might help to alleviate the concerns of those entrusted with the command of those forces, and hence perhaps reduce the likelihood that they would counsel in favor of immediate action in the event of alarm. Moreover, as was argued at the outset, even small changes in the risk of strategic nuclear war would overwhelm other possible goals of arms control -- and it seems likely that the vulnerability of strategic forces still has at least some impact on the risk of war. If so, then arms control based on stability criteria might still have some role to play, even given the current state of the nuclear balance. While it is possible that "controllability" of nuclear forces has a greater impact on the threat of war, it is by no means certain, and issue of "controllability" is not yet well enough defined theoretically to be used as a criterion for judging arms control proposals; it is deserving of further study, which is unfortunately beyond the scope of this thesis.

Stability, therefore, will still be the basis of the criteria for judging arms control proposals that I will finally develop in the next section. The task of that section is to determine how the concept of stability can be made into a precise set of criteria for judging possible strategic balances. But in reviewing the various proposals that have been made in this regard, some of which assume extremely precise calculations of costs and benefits, one must keep in mind that "rational" decision is likely to be only one part of the broader stability problem; overly rationalistic models of governments in crisis should therefore be approached with caution.

IV. Measuring Stability

If the concept of strategic stability is to be used as an analytical tool for judging and comparing arms control proposals, the question of what constitutes a "first-strike advantage" must be more precisely answered. Armed with a set of criteria for judging the degree of first-strike advantage inherent in a strategic balance, one could then compare the future balances envisioned by differing arms control proposals, and judge which proposal would lead to the greatest degree of stability [1]. The development of such criteria is the purpose of this section.

There is considerable dispute over how a first-strike advantage should be defined; situations that some analysts would call stable, others would refer to as delicate. Although there are some technical disagreements as to the vulnerability of the forces on each side, the primary sources of disagreement are divergent definitions of stability itself -- that is, of what circumstances would significantly increase each side's propensity to strike first. In the example of the gunmen, or in the conventional wars of the past, the question of what constituted an advantage was clear-cut, as was the concept of victory. But in a world of thousands of thermonuclear weapons, what might constitute a real advantage, and how could it be measured?

Two Views of Nuclear War

This question is a fundamental one; it is asking, in essence, what is necessary to deter strategic nuclear attack. The answer therefore depends deeply on one's view of the purpose of strategic weapons and the likely course of a strategic nuclear war; hence, as Colin Gray has written, "definitions of stability tend to betray the political preferences and doctrinal assumptions of their authors." [2] In particular, one can identify a great schism in nuclear thought: on the one hand are those who believe that any strategic nuclear war would almost certainly escalate to all-out, apocalyptic destruction; on the other are those who believe that it might be possible to limit the scope of an exchange after it had begun, and that one side might be able to exercise coercion over the other, thus possibly "prevailing" in the conflict [3].

These ideas have far-reaching implications for judgements of stability. If one believes that any use of strategic nuclear weapons would escalate to all-out war -- and that the other side thinks along the same lines -- then stability is relatively easy to maintain. It would only be threatened if one side believed that by striking first it could greatly reduce the damage the other side's forces were capable of inflicting, and only then if that side also believed that the

other was imminently about to attack -- or, in a more extreme case, that the gains to be had from getting in the first blow justified trading peace for thermonuclear war. Since the first few nuclear weapons do much of the damage, this would require an ability to launch an almost totally disarming attack.

If one believes, on the other hand, that it might be possible to limit a nuclear war, stability might be more difficult to maintain. Limited war scenarios cover a broad spectrum, from very small "demonstration" strikes to prolonged counterforce or countervalue exchanges involving thousands of weapons over a period of weeks. It is hardly necessary to consider the entire field of such theories here, however; since the present purpose is to consider how a first-strike advantage might be defined and measured, only those scenarios that affect the advantages of going first rather than second need to be addressed. The only situation in which the side striking second would be at a disadvantage remains the contingency of a large-scale preemptive attack on strategic nuclear forces or their command and control.

The danger is of a limited counterforce attack, designed to achieve a decisive advantage in remaining nuclear capabilities, while sparing the defender's cities, holding them hostage to deter retaliation. The objective would be to gain a military advantage so decisive as to allow one to coerce

the other side into foregoing retaliation, or at least limiting its scope. The question for stability theory, in this case, is how to assess the likelihood that such a limited attack would be successful -- both in achieving the desired military advantage and in keeping the war limited.

This distinction between stability concepts that address only the damage that could be done by the defender in retaliation for an attack, as opposed to concepts that consider the question of relative military advantage, has also been made by Glenn Snyder [4]:

Whether there is an advantage in getting in the first blow depends on a combination of strategic and intrinsic considerations. In strategic terms, there is a strike-first advantage when the side striking first can destroy more of the opponent's strategic nuclear capability in doing so than it loses of its own. In intrinsic terms, a strike-first advantage exists when the destruction to one's population and economy which would be suffered in the opponent's first strike is greater than the destruction which the opponent could inflict in a retaliatory blow.

The fundamental opposition between these two schools of nuclear thought underlies many, if not most, intellectual disagreements over stability -- and over many other aspects of nuclear policy as well. I do not claim to be able to reconcile these views; I propose only to discuss in more detail their implications for attempts to measure strategic stability.

Measuring the Strategic Balance

Before we can begin to discuss measures of the first-strike advantage, however, it is necessary to describe the measures used to tally up strategic nuclear weapons themselves. Measures of the day-to-day peacetime balance are called "static" measures, as they change only slowly. Such measures of who's ahead in peacetime have great political significance: witness, for example, the Senate's overwhelming passage of the Jackson Amendment after SALT I, which specified that no future agreement could limit the United States to strategic force levels lower than those allowed the Soviet Union. Similarly, the constant Soviet refrain in arms talks is the idea of "equality and equal security."

But if one takes stability ideas seriously, these static measures may have little relevance to the probability of nuclear war: the question is not how many bullets each gunman has in his gun, but whether his gun can be shot out of his hand. If our forces were vulnerable, they could be twice as many as Soviet forces and still not be enough, while if they were survivable, they might be half Soviet forces and still be sufficient to deter a strategic nuclear attack. The key strategic balance, then, is not that which might exist before an attack, but that which might exist after one. By combining

estimates of the performance of the various offensive and defensive strategic forces in attacking each other, and making a host of simplifying assumptions, one can estimate what the post-attack balance might look like; such estimates are referred to as "dynamic" measures. Dynamic measures are always highly uncertain -- though they are rarely presented so -- as they rely on dozens of fundamentally untestable assumptions as to strategies, technical parameters, and the like. Nevertheless, these dynamic measures address the question of the vulnerability of strategic forces, and how much of a retaliation could be expected after an attack, which static measures cannot. As a result, it is in the context of these dynamic measures that differing ideas of how to measure stability must be examined.

The question, then, is how best to measure the power of each side's remaining arsenal after a first-strike has occurred. The specific categories most often measured and compared are: number of launchers, "megatonnage", "equivalent megatonnage", "throw-weight", "lethality", and number of warheads.

Tallies of the number of launchers -- missile launchers and bombers -- are by far the most primitive; such counts really don't say much of anything about the military power of the respective forces, since a missile carrying ten warheads is obviously very different from a missile carrying only one.

Nevertheless, the number of launchers has traditionally been the "unit of account" in SALT, for reasons having to do primarily with verification -- it is easier to count how many missiles the opposing side has, than to judge what those missiles can carry. (The SALT II negotiations broke the back of this problem, through the development of "counting rules" for estimating the number of warheads particular missiles carry.)

More useful measures are generally based on the numbers and power of the nuclear warheads themselves. Megatonnage is a measure of the total explosive yield of a collection of nuclear weapons; the name refers to the number of millions of tons of conventional explosives that would be required to provide an equally big bang. The area destroyed by a weapon does not increase proportionally with its megatonnage, however, so sheer megatonnage is no longer often used; instead, many analysts use "equivalent megatonnage", or EMT, which measures the yield of each weapon taken to the two-thirds power. The total area that a weapon can destroy is proportional to its EMT. The yield of a given weapon is impossible to verify directly, however. Hence, for the purposes of arms control, throw-weight -- the weight of everything a missile carries from its launch site to its target -- is often used as a surrogate for destructive power, since larger yields require heavier warheads; unfortunately,

since many things other than the warheads themselves are included in a missile's throw-weight, throw-weight is a woefully inaccurate measure of destructive power.

Megatonnage, EMT, and throw-weight are all essentially measures of the sheer amount of territory nuclear weapons could obliterate. "Lethality," by contrast, measures the ability to destroy small but hardened targets, such as missile silos, command and control bunkers, and nuclear weapon storage sites; a weapon's lethality is related to both its yield and its accuracy, with accuracy being substantially more important [5]. A last measure often used is a simple count of the number of warheads; such a count is important because the number of separate warheads determines how many different targets could be attacked, something the other measures obscure.

Which of these measures is best depends on the targets that would be attacked in a war, which is to say, on strategic doctrine. If the weapons are intended to destroy hardened missile silos, as they might well be in an initial strike, lethality is crucial. If they are intended to destroy an extremely large area (such as large cities or bomber bases), total EMT is the best measure. By far the majority of possible targets, however, including small cities and towns, and most industrial and military targets, don't require a weapon with high lethality, since they are unhardened; and they are

simply too small to require a large-EMT warhead. (The weapon that obliterated Hiroshima, after all, was several times smaller than the smallest bomb in current strategic arsenals.) Thus, for these targets, the only thing that counts is whether there are enough weapons to target on them.

For most purposes, then, the sheer number of warheads is probably the best measure for judging both the retaliatory power of a strategic force after a first strike, and the coercive power of the attacker's remaining force -- despite its tendency to obscure real differences in yield, accuracy, and the like [6]. In this thesis, the discussion will usually be framed in terms of numbers of weapons, although occasional reference will be made to the equivalent megatonnage available to each side.

One last point is necessary before proceeding to consider specific measures of stability. As was described in the last section, in the event of a severe crisis, both superpowers may increase the survivability of their nuclear forces by placing more of their bombers on alert, and increasing the number of submarines at sea. As a result, no matter what specific measure of the first-strike advantage one is using, there will be at least two possible answers: the advantage in striking first if the opponent has not yet alerted its forces, and the much smaller advantage to be had once the opponent has prepared for possible attack.

Absolute Numbers and Countervalue Damage

For those who believe that any nuclear war would inevitably escalate to all-out war, the question of measuring stability is a relatively simple one: each side need only maintain an adequate absolute number of survivable weapons, and stability is insured. As long as each side is convinced that any conceivable attack would leave enough weapons to inflict "unacceptable damage" in retaliation, deterrence should prevail. Building more weapons beyond that point is held to be utterly fruitless, at least with respect to the risk of strategic war, regardless of how many weapons the opponent may have. The number of weapons held by the prospective attacker in peacetime is relevant only insofar as it affects the survivability of one's own weapons. The number an attacker might have left over after launching an attack is wholly irrelevant [7].

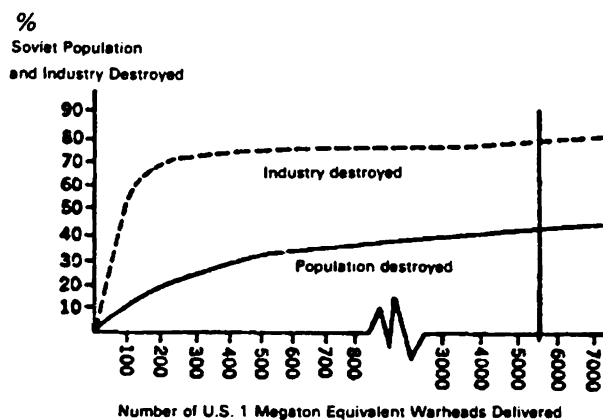
The chief question that this line of reasoning raises with respect to measuring stability is how many surviving weapons, specifically, are necessary to insure stable deterrence. There are two ways of thinking about this question: a technical approach, and a psychological approach.

For those who rely on the technical approach, Figure 1 and the reasoning that follows from it are essentially the entire answer. It shows the percentage of civilian population and

industry that could be destroyed, as a function of the equivalent megatonnage used in the attack [8]. As can be seen, the curve begins going upward steeply, and then levels off; the fourth hundred weapons is nothing like as important as the first hundred, and the tenth thousand may, in Winston Churchill's words, "only make the rubble bounce." Thus, even a 90% successful first strike might not decisively reduce the amount of destruction that could be wreaked in retaliation, if the original force was sufficiently large.

Figure 1

"Soviet Population and Industry Destroyed by Megatons"*



*Not including deaths caused by radiation, fallout or firestorm.

This emphasizes the point made earlier, that up to a point, large forces may be safer than small forces. With only 100 weapons on each side, the possibility of a 90% effective first strike would mean a significant reduction in the damage that

could be done in retaliation, and stability might be threatened; with 10,000 weapons on each side, an attack of the same percentage effectiveness would be meaningless. Moreover, it might be more difficult to destroy as much as 90% of a large force. Again, however, this does not do a great deal to justify the extremely large forces currently maintained by the U.S. and the U.S.S.R.; stability could be maintained with much smaller forces, especially if they were more survivable.

Several possible measures of stability could be defined from this technical approach to the problem. One might, for example, say that the larger the equivalent megatonnage each side would hold after a nuclear attack, the more stable the balance. This would essentially be a recipe for an unending arms race, however, as larger forces would always provide greater surviving EMT than would smaller forces, if survivability remains constant; we need a measure that takes into account the diminishing utility of additional nuclear weapons. Another possibility would be a simple stable/unstable assessment, whereby any situation where more than 400 EMT -- or some similar number -- would survive was considered stable, and any situation where less would survive was considered unstable [9]. This is rather unsatisfactory, as there are clearly more distinctions to be made than can be summed up in such an on/off formulation; the idea that 390 EMT would not deter, while 400 would, is clearly untenable.

Perhaps the most sensible measure, from this point of view, would be a calculation of the difference between the damage either side might suffer if they allowed the other side to strike first, and the damage they might suffer in a second-strike after a preemptive first strike of their own. The difference could be calculated in either population or industry destroyed, and as either an absolute difference (i.e. 80% destroyed in a first strike minus 75% destroyed in a second-strike, for a difference of 5%) or as a ratio (i.e., 80% over 75%, for an advantage of 1.07 to 1 in going first). This comparison -- of what Herman Kahn called "horrible but distinguishable" war outcomes -- would provide a measure of how likely one must consider an opponent's first-strike to be before going first to forestall it becomes the best available option.

One should avoid thinking about such a measure in simplistic terms, however, as there are a variety of complicating factors. Most important, perhaps, are the damages ignored by the calculation (some of which are explicitly mentioned on the bottom of the graph). Inevitably, the number of people that would be killed in any attack is immensely uncertain; it might be that two levels of attack which seemed to be quite different in such simple-minded calculations would not be much different in practice. Moreover, discussing economic destruction in terms of the

percentage of industrial floor-space destroyed is extremely misleading; even a small attack, if it is targeted on select "bottle-neck" industries, might cause the economy to collapse completely, making further destruction relevant only for long-term rebuilding. Nor can the immense social and psychological effects of nuclear war be ignored; it may be that even a "small" nuclear war would create such profound trauma as to functionally destroy the participants as modern societies and great powers [10].

A Psychological Approach

All of these are purely technical formulations, however; calculating how many tens of millions would be killed before the "point of diminishing returns" was reached has little to do with the fundamentally psychological and political bases of deterrence. Another possible approach would be to take the opposite tack and emphasize the psychological -- to consider what would be uppermost in the mind of a leader or group of leaders confronted with the awful choice of whether or not to launch a preemptive attack, given evidence that the enemy might be about to strike first. Most of those who take this tack reach a much smaller answer on the number of weapons required for deterrence; they argue that even a few survivable thermonuclear weapons -- and the visions of ruined

cites they would carry with them -- would weigh enormously heavily in the mind of any reasonably balanced national leader. In McGeorge Bundy's famous words [11]:

There is an enormous gulf between what political leaders really think about nuclear weapons and what is assumed in complex calculations of relative "advantage" in simulated strategic warfare. Think Tank analysts can set levels of "acceptable" damage well up in the tens of millions of lives. They can assume that the loss of dozens of great cities is somehow a real choice for sane men. They are in an unreal world. In the real world of real political leaders -- whether here or in the Soviet Union -- a decision that would bring even one hydrogen bomb on one city of one's own country would be recognized in advance as a catastrophic blunder; ten bombs on ten cities would be a disaster beyond history, and a hundred bombs on a hundred cities are unthinkable. Yet this unthinkable level of human incineration is the least that could be expected by either side in response to any first strike in the next ten years, no matter what happens to weapons systems in the meantime.

To phrase this argument in rationalist terms, there would be a vast gap between the "utilities" that national leaders would assign to the outcome of zero nuclear weapons dropped on their country, and to the outcome of ten nuclear weapons being dropped on ten major cities. This qualitative chasm would be so immense as to overshadow the purely quantitative gap between that "disaster beyond history" and some greater disaster. In short, these outcomes may be "distinguishable" to Herman Kahn, but the distinction would not be great in the minds of leaders facing the situation. If the result of any war would be ten nuclear weapons being dropped on their

country, then the overwhelming focus of national leaders will be on avoiding that war, not on considering whether to initiate it, with the hope of forestalling an outcome yet more horrible to contemplate. As Snyder has written [12]:

It is very hard to believe that any country would deliberately accept the certainly of severe retaliatory damage in preference to the uncertain prospect of being the recipient of a first strike. As long as there existed any significant chance of avoiding war altogether, inaction would be preferred to striking first.

Thus, if one believes that that any nuclear war would almost surely escalate to an all-out, apocalyptic exchange, either the technical or the psychological approach would indicate that a preemptive attack on strategic forces is unlikely, under most circumstances; stability should be relatively easy to maintain. Indeed, from this perspective, the technological argument of the last section -- that strategic forces are now so large and robust that changes in their vulnerability no longer have much effect on the risk of war, and should therefore not be the focus of arms control -- is compelling. From this perspective, arms control might best be directed toward saving money.

Limited War and Strategic Advantage

For those who believe that a strategic nuclear war might remain limited, however, stability is considerably more

complex [13]. The key conception of this school of thought is the idea of "intra-war deterrence": even once a strategic nuclear war had begun, some degree of rationality would remain, and as long as each side retained some nuclear weapons, each would be deterred from beginning large-scale annihilation of cities. A series of limited strikes and counterstrikes might ensue, essentially a "contest of resolve," in Klaus Knorr's words, with the loser being whichever side first judged the pain or the risk of a larger war to be more than it could bear [14].

What determines the outcome of such an exchange? Some believe that the contest would be entirely political and psychological, a contest of will. Winning would involve convincing the opponent of one's unalterable determination not to back down, or better yet, of one's utter madness or physical inability to back down; the opponent would then have no way to avert catastrophe except to give in [15]. Since the determining factor in deciding such a war of resolve would be determination, not the number or capabilities of the nuclear weapons held by either side, such a war might begin even if the strategic balance were stable; indeed, some limited war theorists have argued that limited war requires a stable balance, as any instabilities would result in unlimited escalation, with each side attempting to get its weapons off the ground and into action as fast as possible [16].

Other limited war analysts, however, put less emphasis on the issue of will in the abstract, arguing that each side's will to continue might well be determined largely by the number and capabilities of the weapons held by the other; the stronger side would have a greater threat available with which to coerce the other [17]. In this case, stability might be more easily endangered, for a first strike need not be completely disarming, or even nearly so, to be worthwhile.

By striking first in a limited counterforce attack, while sparing the defender's cities and so holding them hostage, one might gain a large enough advantage to coerce the defender into forgoing retaliation, or at least limiting its scale and targets [18]; in the early McNamara era, such "counterforce-no-cities" attacks were the keystone of the declared U.S. strategy for nuclear war [19]. From this point of view, the incentive to strike first would depend not only on the number of weapons the defender might have left after a preemptive attack, but on the number and capabilities of the weapons remaining to the attacker as well. The relative balance would be the crucial point: who has the biggest stick now? Moreover, in pondering such a limited preemptive attack, each side would have to consider the possibility that the other might be thinking the same thing, just as with completely disarming attacks; as a result, any situation in which the relative balance would be better if one went first than if one went

second could be a threat to stability.

Suppose, for example, that by striking first, an attacker could hope to reduce the victim's forces to perhaps 20 weapons, while the attacker would still have more than 1000. As Bundy argued, the obliteration of 20 major cities would probably be "unacceptable" to any sane decision-maker; but would the prospective attacker believe such a threat would be carried out, given the much larger 1000-weapon counterthreat held by the attacker? This is what worried Paul Nitze, as early as 1956 [20]:

The side which has lost effective control of the intercontinental air spaces will face a truly agonizing decision. It may still have the capability of destroying a few of the enemy's cities. But the damage it could inflict would be indecisive and out of all proportion to the annihilation which its own cities could expect to receive in return.

If either side believed that faced with such circumstances the other side might not retaliate, then the temptation to attack might be increased, and stability undermined. To reiterate the basic idea, the objective of a first strike in this case would be to create a sufficient asymmetry in nuclear capabilities so that the partially-disarmed defender could be deterred from a full retaliatory response. The question for stability theory is how to measure the incentives for such an attack in different strategic situations, so that those situations can be compared.

The most obvious possibility for creating a decisive advantage in remaining nuclear capabilities is to attack the enemy's most vulnerable point: the command and control system. But to attack the central leadership and command and control of the other side would make it impossible to exert coercive leverage, or to bargain: the assumption of the limited-war school of thought is that there remains some one on the other side who can be convinced to see reason, and who can keep control over the remaining nuclear forces. Attacking the leaders of the opposite side and their command and control would probably end any possibility of keeping the exchange limited, and would therefore not be a very attractive option for an attack launched in the hope of fighting only a "limited" nuclear war.

Another possibility that has frequently been suggested is that if the Soviet Union could destroy U.S. ICBMs, thereby making it impossible for the U.S. to retaliate rapidly against the remaining Soviet ICBMs, this might carry with it the necessary coercive leverage. But as we saw in the last section, this is not the case: there are many targets other than ICBMs and cities that could be attacked in retaliation by the remaining strategic forces, even if the ICBMs were destroyed. And to launch a second-strike against the remaining ICBMs of a nation that has already initiated a nuclear war -- and is therefore on the lookout for some

retaliation -- would, in all likelihood, only force the launching of those ICBMs, further escalating the exchange. As then-Secretary of Defense Harold Brown wrote in his 1981 report [21]:

the hypothetical ability of the Soviets to destroy over 90% of our ICBM force cannot be equated with any of the following: a disarming first strike; a Soviet advantage that could be made meaningful in an all-out nuclear exchange; a significant contribution to a damage-limiting objective; or increased probability of a Soviet surprise attack. It would amount to none of these.

Numerical Advantages

If, as it seems, one cannot gain a coercive advantage either by attacking command and control or by eliminating the specific capability to retaliate against ICBM silos, a decisive numerical advantage is the primary remaining possibility for achieving coercive dominance over the other side with a first strike. Any situation in which either side could increase its numerical advantage (or decrease its disadvantage) by striking first could be considered less stable than one in which this was not possible. Such an advantage might be measured in several ways.

Exchange Ratios

One possible basis for measuring such a "strategic advantage," in Snyder's terms, is the use of exchange ratios. The exchange ratio is the ratio of the forces that could be destroyed in a first strike to those the attacker would expend in launching the strike; it can be calculated in warheads, EMT, throw-weight, or any other similar measure. If the ratio is greater than one, then the victim is being disarmed more rapidly than the attacker, and the exchange ratio is said to be "favorable" for the attacker. If we postulate, for example, that one side's land-based missiles each carried 10 warheads, and that an attack by the other side involving two warheads on each of those silos could destroy 80% of them, then the exchange ratio would be 4-1, as it would on the average require two warheads to destroy eight.

Some analysts see the stability problem largely as one of insuring that any attack would face an unfavorable exchange ratio. An Air Force general, for example, describing the proposed multiple-shelter basing scheme for the MX, pointed out that [22]:

The Soviets would have to attack each of the 23 shelters to destroy one 10-warhead missile because they would not know in which shelter the missile is located. That concept provides what is known as an adverse exchange ratio. What this means is that if we start from a position of near parity, the Soviets use 23 of their warheads to destroy 10 of

ours, the more they strike our system, the more they fall behind in warheads. This is significant because remaining warheads is considered by most military experts to determine the final outcome of this kind of an exchange.

This exchange ratio concept would be extremely useful if the only nuclear forces available were ICBMs, and each superpower had a roughly equal number. In that case, if it required more than one ICBM to destroy each ICBM on the opposing side, a disarming attack would be quite impossible, as would either side gaining any advantage by going first. When bombers and SLBMs are included, however, the situation changes: the destruction of SLBMs in port and bombers at their bases would always carry with it a favorable exchange ratio, much larger than is ever likely in attacks on ICBMs. In such real-world situations, exchange ratios by themselves can be quite misleading measures of stability; indeed, one can imagine both stable situations in which the exchange ratio for any attacker would be enormously favorable, and unstable situations in which any attack would face a decisively unfavorable exchange ratio.

Let us suppose, for example, that the entire arsenal of each of the two superpowers consisted of a force of 4000 submarine-based missile warheads. The submarines operate from two ports on each side, and are at sea perhaps 50% of the time. By using two detonations to destroy the opponent's submarine ports, with the submarines they contain, an

attacker could achieve an exchange ratio of something like 1000-1, transforming a situation of parity into one of 2-1 superiority in total weapons available. Few would argue that this situation is drastically unstable, however; the severely provoked defender would still have 50% of his force, some 2000 weapons, with which to retaliate. Given that the 50% at-sea rate would have been known when the submarines were procured, it is fair to assume that each side in this hypothetical situation had previously decided that a survivable force of 2000 weapons was sufficient for deterrence, even allowing for the possibility of limited wars and counterforce attacks such as the one just described. No real instability exists, despite the favorable exchange ratio.

Alternatively, one can imagine a balance in which the Soviet Union has several thousand ICBM warheads, and the U.S. has 1000, each carried by a separate ICBM. To make up for the asymmetry in ICBMs, the U.S. has much larger SLBM and bomber forces than does the Soviet Union, much as in the real situation. Let us assume for the sake of argument that by targeting four warheads on each U.S. silo, the Soviets could have high confidence of destroying them all: but the exchange ratio would be 1-4, the Soviets being disarmed four times as rapidly by their own attack as the U.S. For this reason, some might assume the ICBM balance to be a stable one. But if Soviet

anti-submarine warfare (ASW) and air defenses had improved to the point where they felt confident of blunting the other two legs of the U.S. strategic triad, then an attack on the ICBM force might be a serious possibility despite the unfavorable exchange ratio, and an unstable situation could arise. Thus, if a large part of the point of maintaining three separate forces is for each to provide a hedge against possible vulnerabilities of the others, the requirement is not simply that each part of the force be costly to attack, but rather that the force as a whole be so costly as to be impossible to attack [23].

Overall Post-Attack Balances: Differences and Ratios

These examples indicate that considering the exchange ratio involved in a single part of an attack is simply too limited an approach, revealing little about the overall stability of the balance. Instead, a better measure of the incentive to strike first might be the overall change in the relative balance as a result of a counterforce strike. In the last example, while the Soviet Union faced an unfavorable exchange ratio in attacking the ICBMs, that attack, when combined with that on the bombers and SLBMs, allowed it to drastically increase both the difference in numbers between its total strategic forces and those of the United States, and

the ratio of the two forces, if not to disarm the U.S. entirely.

The most explicit and influential recent proponent of measuring stability by such calculations of relative numerical advantage has been Paul Nitze; he uses both the difference and ratio measures, apparently giving the ratios slightly greater weight [24]. He has argued, for example, that any situation in which "the Soviet side could . . . hope by initiating a counterforce exchange to improve . . . the absolute excess in pounds of its throw-weight over ours" -- i.e., in which, an attack would destroy more U.S. throw-weight than the Soviets would expend in launching it -- might be dangerous [25]; similarly, in his view, as of 1976 the strategic balance was "becoming unstable; the Soviets in coming years will be able to increase their ratio of advantage by attacking U.S. forces." [26]

A suprisingly important question with respect to such numerical advantage models is exactly when in the sequence of a possible exchange the ratio or the difference should be measured. Nitze has listed three different ways of measuring the forces held by each side, in "increasing order of depth and sophistication" [27]:

1. That which each side has before a strike;
2. That surviving to the United States after an initial counterforce strike by the Soviet side;
3. That remaining to each side after an exchange in

which the Soviet side attacks U.S. forces and the U.S. responds by reducing the Soviet side's reserved forces to the greatest useful extent.

This framework is the quintessential example of Gray's dictum that definitions of stability reflect primarily the doctrinal assumptions of their authors. The first method, of course, is simply the "static" measures discussed previously; the second is also straightforward enough; but Nitze's preferred third method, of measuring the balance after a counterforce first strike and a counterforce retaliatory strike approaches the problem in a profoundly different way. Using Nitze's third method, U.S. threats to Soviet strategic forces actually reinforce stability, as they allow the U.S. to reduce any advantage the Soviets might gain in a first strike by launching a counterforce second-strike, "reducing the Soviet side's reserved forces." Indeed, Nitze's first recommendation for "assuring stability," before even improving the survivability of U.S. forces, is to increase their accuracy, giving them the capability to attack Soviet ICBMs [28]. Such a retaliatory capability, of course, is also a preemptive capability; Nitze is arguing that the more vulnerable Soviet forces become, the less incentive they will have to get in the first blow in a crisis. The gunman is less likely to fire if he thinks the other gunman could shoot the gun out of his hand. Nitze's definition of stability is for all intents and purposes the

opposite of the common usage of the word; it stands stability theory on its head [29].

The implicit assumption in Nitze's third method appears to be that the Soviets have no fears of the United States, and that they are firmly convinced that the U.S. would never strike first under any circumstances; in that case, U.S. preemptive capabilities could not increase Soviet incentives to attack. Alternatively, one might imagine a world where a disarming capability could be purely retaliatory, and not pose any threat of striking first; in such a world, Nitze's third method would be entirely appropriate. But the real situation is nearly the opposite. A counterforce capability would create the possibility of a preemptive attack, but could not, in all likelihood, successfully attack ICBMs in a retaliatory blow. As I have pointed out already, the attacker, having initiated a nuclear war, would surely have his remaining ICBMs on alert, pending possible responses; one can only assume that these ICBMs would be launched before any retaliatory blow arrived, making the retaliation useless. Moreover, if we use Nitze's third method, it is clear that any increase in the size, survivability, or accuracy of U.S. forces is always stabilizing; identical changes in Soviet forces would be destabilizing.

For these reasons, the method of measuring both counterforce first strike and counterforce second-strike

cannot serve as a useful measure of strategic stability. Where measurements of numerical advantages are concerned, this thesis will rely instead on the second method -- measuring the balance of forces after an attack by one side, but before any retaliation. This does not mean that I am assuming there will be no retaliation; rather, this method addresses the question of what forces the defender would have left with which to retaliate. And, under limited-war assumption, it gives some guidance as to what the prospects for post-attack coercion might be.

How, more specifically, should the incentive to strike first be measured, in this case? One approach would be to calculate the relative balance after an attack by either side (rather than only by the Soviet Union, as Nitze does), and compare that balance to the pre-war balance. Suppose, for example, that "Side A" was armed with 1000 ICBMs, each carrying two warheads, and "Side B" was armed with 500 ICBMs, each carrying five warheads; further, suppose that each warhead would have an 80% chance of destroying a single ICBM. Before any attack, Side A has 2000 warheads, and Side B 2500, making the "absolute difference" 500 warheads, and the ratio 1.25-1, in favor of Side B -- though the ratio of launchers is 2-1 in the opposite direction. Were Side B to use 1000 warheads to attack each of Side A's missile silos, Side A's force would be reduced to 400 warheads, while side B would

still have 1500 warheads remaining; by striking first, therefore, Side B could increase the difference in warheads from 500 to 1100, and increase its "ratio of advantage," in Nitze's terms, from from 1.25-1 to 3.75-1. Side A, in a similar first strike, would only expend 500 warheads, changing Side B's 500 warhead lead into a 1000 warhead lead for Side A, and shifting the ratio from 1.2-1 against it to 3-1 in its favor. In theory, such calculations provide a measure of the military advantage to be gained by striking first; hence, using such a measure, any balance offering either side a less favorable shift in the strategic ratio as a result of a first strike would be considered more stable than the balance in this example.

But such a measure would not adequately reveal whatever mutually reinforcing aspects the reciprocal fear of surprise attack might have. If war seemed likely, the relevant questions would include not only the degree of advantage to be gained by going first, but the degree of disadvantage to be suffered by leaving open the possibility of being second. Thus, another possible method of measuring one side's incentive to preempt would be to compare not the prewar balance and the post-preemption balance, but the balance after a first strike by one side, versus the balance after a first strike by the other. In considering Soviet temptation to launch, for example, one might take a ratio of ratios: the

ratio of Soviet forces to U.S. forces after a Soviet first strike, compared to the Soviet-U.S. ratio after a U.S. first strike. In the previous example, this ratio of ratios would be $3.75-1$, divided by $1-3$, or 11.25 to one in favor of the side striking first. Such a comparison would highlight the difference between striking first and allowing the other side to do so -- in theory, the essence of the stability problem.

Difficulties with Numerical Advantage Models

These precise numerical calculations of the "balance of remaining forces" all have a certain air of unreality about them. The theoretical temptation to attack offered by the opportunity to gain some numerical advantage cannot by any means be compared with that which would exist if the defender could actually be disarmed; reliance on the mere possibility of coercing an opponent still armed with thermonuclear weapons would involve almost incomprehensible risks.

Indeed, it is extremely doubtful that any exchange involving large counterforce attacks could in fact be kept "limited." In the horror and chaos of even a "small" nuclear conflict, misperception, anger and irrationality would be almost inevitable. Bringing the war to an end would be likely to require communication, and the continued existence of tight central control over nuclear forces on both sides; but

these communication and control capabilities might well be rapidly destroyed, even if this were not intended [30]. Moreover, if the conflict concerns a truly mortal issue, neither side may be willing to accept defeat without using the most extreme means at its disposal to avert it, despite calculations of relative advantage or disadvantage. If the conflict is over a less than mortal issue, it is hard to imagine why nuclear weapons would have been called into play at all.

It is difficult to imagine real political leaders, in the heat of a crisis, making a decision to launch a preemptive attack based solely on the idea that such an attack would improve the "ratio of forces," and possibly intimidate the other side. To assume such a scenario is to presume that those leaders would be unaware of the manifest possibilities for escalation and loss of control; that they would have confidence in the calculations of experts as to the outcome of the exchange; that they would assume that each side would have good information, after an attack, as to how many weapons each had left, and would base its policy on that calculation; and lastly, that the defender would respond as predicted, that everyone would remain "rational" -- as defined, of course, by those speculating about such scenarios.

The Importance of Absolute Numbers

Even within the framework of limited nuclear war theory, there are a number of caveats that must be made about the use of numerical advantage models. Among the most important matters left out when considering only the ratio or the difference between the two forces is the mitigating effect of absolute numbers. If every possibility of a limited attack improving the attacker's "ratio of advantage" were destabilizing, then no balance would be stable; there will always be a few submarines in port, or a few bombers not on alert, whose destruction would shift the balance somewhat in favor of the attacker. The example of the two submarine forces described above is just as relevant to the discussion of overall advantage as it is to the discussion of exchange ratios: despite the fact that either side could gain a 2-1 advantage by means of a rather small attack, it would be difficult to argue that either side would feel any significant pressure to strike first -- because each side maintained a large enough absolute number of survivable weapons to make an attack pointless. Even using the phrase "ten-to-one advantage" would be nonsensical if the numbers were 10 million megatons to 1 million [31].

This is true even if the targets to be attacked are military ones, for attacks on these also encounter rapidly diminishing

returns, though the effect does not set in as rapidly as it does in the case of attacks on cities [32]. The first hundred airbases, troop concentrations, or oil refineries destroyed are likely to be much more important than the tenth or eleventh. With each side having the ability to destroy all of the other's major cities and primary military installations, it is hard to imagine either side getting much coercive leverage out of having the additional ability to destroy the other's villages and secondary military bases. Even in limited-war scenarios, it is crucial to keep in mind the sheer numbers of weapons being considered, in relation to the possible targets. Once the surviving weapons mount into the thousands, it is difficult to take even the theoretical possibility of coercion very seriously.

Collateral Damage and Limited War

Crucial to any assessment of the possibility of limited nuclear war, and hence to any realistic judgement as to the incentive to begin such a war by a first strike, is the fact of collateral damage -- the unintended damage to civilian populations from an attack directed against military targets. The more casualties a "limited" preemptive attack would cause, the more the already hazy line between limited and unlimited war would be eroded, and the higher would be the

likelihood of rapid escalation [33]. Even without escalation, the attacker could have little confidence that the victim would not exact a price in retaliation at least equal to that of the initial attack. If a preemptive attack would inevitably cause millions of casualties, the incentive to launch such an attack in hopes of keeping the exchange limited would be rather low, regardless of how large the "ratio of advantage" that might be obtained thereby might be.

The collateral damage from a preemptive attack would arise from a variety of factors. The destruction of hardened ICBM silos requires that weapons be burst on or near the ground. With current accuracies and yields, this would create clouds of lethal radioactive fallout, which would then be spread over surrounding areas by the wind. Attacks on bomber bases with current forces would probably involve large airburst nuclear weapons, creating little fallout but maximizing the blast damage to nearby cities. To destroy submarines in port would require destroying the port itself, with the attendant casualties. Attacks on command and control would be particularly destructive, since the most important command targets would be those in major cities, especially Washington and Moscow.

The collateral damage to be expected from a given attack cannot be calculated with any certainty; experience with nuclear weapons is too slim, and too much depends on

unpredictable factors. The speed and direction of the wind, for example, will determine whether the fallout from a nuclear attack is carried over cities, resulting in millions of casualties, or dispersed comparatively harmlessly over uninhabited areas. As a result, estimates of collateral damage often vary by a factor of a hundred or even more. In the specific case of an attack on U.S. strategic forces with weapons resembling current Soviet forces, one recent report estimated the resulting civilian deaths at between 20 and 40 million [34]; other estimates, however, have ranged from below one million to fifty million. Even the high end of such estimates usually includes only short-term physical damage (such as deaths and injuries), ignoring both long-term hazards and the truly incalculable -- but nonetheless overwhelming -- economic, social, psychological and environmental devastation that would accompany a large-scale nuclear war. In sum, a prospective attacker would have little idea how many people would be killed in the attack, and still less of what response might be provoked.

It is possible, of course, that in the future weapons might be designed with the idea of minimizing collateral damage explicitly in mind. One could imagine, for example, ICBM silos attacked by precision-guided reentry vehicles, able to home in on the silo and destroy it with small, "clean" weapons, creating little radioactive fallout. Similarly, one could

imagine bomber bases being attacked by a large number of tiny nuclear weapons, or even conventional bomblets, greatly reducing the damage to the surrounding area. Indeed, the United States has had a program to develop such precision-guided weapons underway since 1974, when then-Secretary of Defense James Schlesinger began to emphasize the importance of "limited nuclear options." [35]

Would such precise new weapons be desirable? Given that attacks on strategic forces are possible, would we prefer a world in which such attacks could not be undertaken without massive accompanying fatalities, or one in which the collateral damage were low, and controllable? If a nuclear war were already underway, the answer would be obvious: we would fervently hope that the human catastrophe accompanying a military strike could be as limited as possible. But collateral damage could also affect the probability of facing that situation in the first place; the possibility of "surgical" nuclear strikes might lower the nuclear threshold, making nuclear weapons seem less different from conventional weapons. In a severe crisis, offering few other options, leaders who believed their weapons capable of a "surgical" strategic strike, offering the possibility of a limited, controllable war, might be more likely to order a nuclear attack. Once the nuclear threshold had been crossed, there would be no guarantee against apocalyptic escalation.

In this view, then, the likelihood of major collateral damage is a sobering factor, tending to stabilize the balance; if we are really concerned about the possibility of limited attacks, undertaken with the idea of carefully controlling the exchange, then paradoxical as it might seem, arms control measures might be directed toward maintaining the current grim balance, where no counterforce attack could be undertaken without millions of accompanying fatalities [36]. Hence, if any of the numerical advantage models of stability are being considered in measuring the incentive to strike first, the degree of collateral damage facing such a strike should be considered as well.

Another important issue which has been raised in the last two years is the problem of "nuclear winter." Several studies have indicated at least the possibility that a large nuclear war would create enough smoke and dust to obscure the sun over much of the globe, cooling the earth and creating almost unimaginable ecological consequences. This raises the possibility that a large-scale counterforce strike might result in immense damage not only to the defender but to the attacker, as a result of the global darkness and cooling. If so, this would greatly reduce the incentive to strike first, even if the defender could be almost completely disarmed. Several points need to be made, however. There is enormous uncertainty on almost every technical aspect of such

estimates of climatic catastrophe: how much smoke and dust would be raised by given attacks, how long those particles would remain in the atmosphere, how the atmosphere would respond, and so on. It seems clear that if one continually increased the size of the attack under consideration, one could eventually create a nuclear winter; but whether the minimum number of weapons needed to do so is ten times or one-tenth the number in current arsenals remains open to considerable question. Indeed, the question can never be answered definitively, for there is simply too little experience to go by: no one has ever collected data on how much smoke a modern city makes when destroyed by a one-megaton weapon, or how the atmosphere would respond to a perturbation far greater than has ever been experienced in historical times. It seems clear, however, that attacks on such targets as missile silos are not the most important contributor to the cooling effect; the studies done to date indicate that the dust created by such attacks would have much less effect than the smoke from burning cities. Hence, the possibility of global cooling might be less of a deterrent to a counterforce first-strike than to an attack on cities. Moreover, if precision-guided weapons were developed in the future, the amount of dust raised into the atmosphere by attacks on strategic forces could be reduced to very low levels. The effect of nuclear winter, therefore, is simply to introduce

one more element of uncertainty into the calculations of a prospective attacker; and that uncertainty will probably decrease as weapons become more accurate in the future.

Uncertainties

The extent of collateral damage is only one of the crucial uncertainties facing any prospective attacker. Whether one is considering the perspective of those who believe that any strategic nuclear war would be all-out, or those who leave open the possibility of a limited strategic war, the uncertainty in any calculation of the success of a first strike is of immense importance. Unfortunately, it is often ignored. Especially when post-attack "ratios of advantage" are under discussion, the impression is often given that such things can be perfectly predicted beforehand; the forces that would remain after a hypothetical first strike are often given to two or even three significant figures. This sort of artificial precision is grotesquely misleading.

The number and variety of possible uncertainties and complications facing any counterforce attack is staggering; hundreds of people must fire hundreds of missiles to thousands of separate targets, and the slightest mix-up in timing, for example, could cause the whole attack to go awry. The largest uncertainties are imponderables -- the

confidence that political leaders have in their technical experts, the thousands of seemingly minor human errors that might wreck the operation, and most importantly, what the other side will do -- whether they will launch their missiles on warning of the attack, preventing them from being destroyed, or perhaps mount a devastating retaliation in response, despite all calculations of advantage or disadvantage. These uncertainties will always be present, and arms control can have little effect on them.

In addition to these fundamental uncertainties, however, there is a more limited class of purely technical uncertainties relevant to a counterforce attack. Most of these have to do with the fact that nuclear weapons and their delivery systems have undergone only the most limited peacetime testing; fortunately, we have almost no "combat experience" with nuclear weapons. As a result, estimates of the accuracy, reliability, destructiveness, or survivability of nuclear weapons are all inherently speculative. Former Secretary of Defense James Schlesinger pointed to the importance of such uncertainties in recent Senate testimony [37]:

perhaps the dominant element in measuring nuclear forces against each other is the unknown and immeasurable element of the probability of major technical failure. It would tend to dominate any outcome. Given the rather spotty Soviet history in dealing with modern technologies, one would hypothesize that this must be a constant worry of

the Soviet leaders regardless of what others abroad may say about the supposed superiority of their forces. We ourselves know a great deal more about helicopter operations and maintenance than we do about actual missile operations. Yet, if we recall the abortive rescue operation in Iran in 1980, even we, with a far more impressive history of technical success, should bear in mind this salient element.

I stress this matter because there has been some tendency of late to overdramatize speculations about hypothetical exchanges . . .

When the technical uncertainties inherent in strategic attacks are taken together, it becomes clear that the uncertainties inherent in such an attack would often be so large as to dominate the difference between striking first and striking second. In the case of an attack on U.S. ICBMs with current Soviet strategic forces, for example, even conservative estimates of the uncertainty in each of the various technical parameters involved leads to the conclusion that anywhere from 50% to 100% of the silos might be destroyed (provided that publicly available estimates of the technical characteristics of Soviet weapons are correct); given current weapons technology, it is unrealistic to specify the outcome of such a strike with any greater precision [38].

In contrast to the question of collateral damage, there can be little doubt that such uncertainties are desirable: the greater the doubt in the mind of a prospective attacker as to the outcome of an attack, the less the chance that attack will

seem a plausible option. If there were any possibility that war could still be avoided, then the manifest possibility of a preemptive attack going badly wrong would weigh heavily against a decision to strike. The crucial point, in this context, is that an attack which did go wrong would very likely mean the obliteration of the attacker's civilization; and any attack would have to work the first time, with no room for learning from experience. Such gambles are not made by sane people without extremely high confidence in the outcome [39]. Only if an attack by the opponent seemed essentially certain in any case would the uncertainty cease to be a deterrent: then, the fact that it might just work could seem as important as the fact that it might very well not. In almost every case, then, the uncertainties facing an attacker would be of enormous significance in mitigating the incentive to strike; the attacker's uncertainty is a highly stabilizing factor.

While the set of purely technical unknowns (such as uncertainty in missile accuracy) is probably of lesser importance than the political and human uncertainties, the technical matters in themselves can be large enough to significantly effect judgements of stability; moreover, such technical uncertainties are at least partly a function of the properties of the weapons themselves, and thus might conceivably be enlarged or reduced by arms control. One can

imagine, for example, that a ban on testing of weapons might increase the uncertainty in judgements of their accuracy or reliability, eroding the confidence necessary for a first strike. Such increases in the magnitude of even these more limited, technical uncertainties could be an important goal of arms control -- and whatever the size of these uncertainties, they must be taken into account in assessing other measures of stability, if those measures are to have any realistic meaning.

A Last Point on Numerical Advantages

These qualifications and additional factors throw great doubt on the use of models of numerical advantage for measuring the incentive to strike first. But even if one ignored these qualifications, and accepted that a the prospects for gaining a decisive advantage could be predicted precisely beforehand, and the collateral damage kept minimal, and the war carefully controlled, it might still not be possible to translate a numerical advantage into political gains; one must keep in mind the arguments of those limited nuclear war theorists who believe that such a war would be primarily a contest of political and psychological will, not numbers of weapons. As Schelling once wrote [40]:

There is no guarantee that the terms would reflect

the arithmetic of potential violence. If one side can destroy two thirds of the other, and only be destroyed one third itself, this does not guarantee that it wins the bargaining hands down, having its own way altogether just because it is decisively superior. Nor does it mean that it has about "two thirds" of the bargaining power and should expect an outcome with which it is twice as pleased (or half as displeased) as its adversary. There is no simple mathematics of bargaining . . .

Nevertheless, comparisons of numerical advantage cannot be discounted entirely: it is difficult to deny that a balance in which the attacker could destroy all but 100 of the defender's weapons, but would expend essentially his entire force in the process, would offer less incentive to attack than a balance in which an attack of similar effectiveness could be carried out while holding thousands of weapons in reserve. But one must be extremely careful, in discussing such measures, not to forget the important caveats, or to get lost in a myth of precision -- a precision which such calculations can never truly offer.

A Soviet Model for Measuring the Balance

In judging how stability can best be maintained, it is of crucial interest to ask how the party to be deterred thinks about the question. It is for this reason that the only available Soviet model for measuring the strategic balance is of great interest; indeed, since that model is based on

precisely the sort of numerical advantages that have been discussed here, it may do a great deal to rescue such measures from the obscurity they might otherwise deserve.

The "correlation of nuclear forces" model was published by Major-General I. Anureyev in 1967, in the authoritative journal of the Soviet General Staff, Military Thought [41]. The advantages to be gained by a preemptive attack are the fundamental basis of the model; the author points out the "sharp changes" in the "correlation of nuclear forces" which would occur during a nuclear exchange, and emphasizes that "maximum efforts must be directed against the nuclear means of the enemy."

Specifically, the "correlation of nuclear forces" is a dynamic model, measuring the ratio of the attacker's remaining equivalent megatonnage to that of the defender after a nuclear exchange -- and maximizing that first-strike advantage for a Soviet attack is the explicit goal. It is interesting to note the similarities between this "correlation of forces" model and Nitze's model. Both measure the ratio of the remaining forces on each side after a nuclear attack; both largely ignore the absolute numbers of weapons left on each side; both use "area destruction" measures for their final tallies, though Nitze uses throw-weight, and the correlation model uses EMT. On the issue of when to measure the correlation, Anureyev's paper gives support to both

Nitze's "strike and counterstrike" method and the arguments against it. Anureyev explicitly describes performing the calculation with both a counterforce first strike and a counterforce second-strike, as in Nitze's third method. But Anureyev also hints at the problem of launch on warning, pointing out "a sharp improvement in the combat readiness of primarily the strategic nuclear forces as a consequence of which the struggle against them at the time of launching becomes even more difficult." More explicitly, Anureyev gives a hypothetical case in which an American attack destroys a large percentage of the Soviet force, and then reassures his readers that this could only happen in "a sufficiently unexpected enemy attack" -- meaning, clearly, that an expected attack, such as a U.S. response to an initial Soviet strike, would not find Soviet missiles in their silos waiting to be destroyed.

Anureyev does not necessarily use a ratio model because he shares Nitze's limited, controlled, "counterforce plus coercion" image of a nuclear war, however; as discussed in Section Three, the idea of limited strategic nuclear war plays little role in Soviet strategic thought. Rather, it seems likely that he uses a ratio because "correlations" expressed as ratios are so fundamental a part of Soviet military thinking: almost any Soviet military analysis problem includes calculating the ratio of tanks on one side to

tanks on the other, aircraft to aircraft, and so on. Indeed, Anureyev defines the very concept of correlation as meaning a ratio: "the correlation of potentials . . . is expressed by a definite number which indicates how many times greater are the forces or means of one side as compared with the other."

Whatever the reasons for emphasizing the ratio of forces, the possible Soviet use of this model gives somewhat greater credence to such numerical ratio measures as indicators of strategic stability. If the Soviet military does in fact use a model of this type, then the opportunity to achieve a decisive "correlation of nuclear forces" might be a contributing factor affecting the danger of a Soviet attack; indeed, one Soviet commentator on the model indicated that its greatest usefulness would come in "planning a first nuclear strike." [42]

The Importance of Strategic Diversity

No matter what model of first-strike incentives one uses, one must consider the problem not only in the present, but in the future, given possible changes in technology. It is necessary to avoid any situation in which a single technological change could greatly increase the vulnerability of either side's strategic forces.

Achieving such robustness in the face of uncertain technological change usually means spreading one's eggs over several baskets, by maintaining a variety of different types of nuclear forces, with differing vulnerabilities. If the entire U.S. strategic nuclear force were concentrated in one type of weapon, and the Soviet Union developed a means of countering that weapon, then stability could be undermined rather rapidly. But since the United States maintains a "triad" of different types of strategic forces (ICBMs, SLBMs, and bombers), no one technological breakthrough could seriously threaten the stability of the nuclear balance, in theory. Hence, in addition to measurements involving the total number of weapons that would survive an attack, a complete assessment of stability should include the number of weapons that would survive from each leg of the triad; a situation where all three legs are survivable is at least somewhat preferable to one in which only one or two are.

Stability Beyond the "Rational Actor"

Up to this point, all the measures of stability that have been considered have been based on the idea of a deliberate decision to preempt, in an effort to disarm the opponent or achieve some substantial advantage in nuclear forces. But as was discussed in the last section, such calculations may be

only one part of the broader stability problem: even disregarding the possibility of an accidental launch or an unauthorized use of nuclear weapons, the decision to launch the strategic forces is likely to have a great deal to do with organizational and bureaucratic factors which a purely "rational" approach might not reveal.

It is extremely difficult, however, to judge how the vulnerability of strategic forces might affect these factors. One important possibility raised by the discussion in the last section is the concern of military commanders for the safety of their forces: if the strategic forces are vulnerable to preemptive attack, the advice of military commanders as to the most appropriate line of action will surely be colored by that fact.

From this point of view, one important question in considering the effect of any particular type of strategic weapon on the risk of nuclear war might be to ask what specific actions would be required, in a crisis, to render that weapon invulnerable. In the case of SSBN's and bombers, the weapons can be made much more survivable simply by placing them on full alert, and this is the action that the commanders of such forces would be most likely to recommend. In the case of ICBMs, however, there is little means of guaranteeing their survival short of preparing to launch them on warning of attack; if there was considerable doubt as to whether it would

be possible to launch them on the short warning that might be available in a real attack, then in an extreme crisis might even turn in the direction of a preemptive launch.

What specific measure of strategic force survivability might best measure the likelihood that such advice would be offered? It is difficult to say. The most obvious approximation is to consider the percentage vulnerability of each of the three types of strategic forces: if only 20% of a force could be destroyed in a first strike, its commander is less likely to feel duty-bound to recommend immediate action than if 80% of the force could be destroyed. Other, more complicated factors might also be important, however: in making any judgements of this sort, it would be wise to attempt to learn as much as possible about the organizational structure and decision-making process on the opposite side. It may be, for example, that threatening the weapons controlled by a service that traditionally has great political influence would be a greater risk than threatening those of another service whose views tend to carry less weight. These are uncertain matters -- but they may be of some importance; certainly such organizational questions deserve further study, in formulating a more complete theory of strategic stability.

Summary

For those who believe that any strategic nuclear war would inevitably escalate to all-out destruction, strategic stability is achieved when each side has an adequate number of weapons that would survive an attack to launch a devastating retaliation. There might be some disagreement over exactly what the "adequate" number might be, with those taking what I have called the technical approach suggesting something in the 200-1000 realm, and those taking the psychological approach suggesting that a much smaller number might be sufficient. But it is agreed that beyond assuring this basic requirement, further weapons deployments are largely unnecessary, except perhaps for the sake of political perceptions. There is no need to worry over whether the opponent's force is larger or more capable, as long as it cannot threaten the basic retaliatory mission.

For those who believe that a nuclear war might be limited, however, the situation is more complex. They would agree that a basic retaliatory capability is the first requirement. But in addition, some would argue that stability might be threatened if either side could gain a significant advantage -- or forestall a significant disadvantage -- by striking first; the advantage might allow the attacker to deter the defender from retaliation.

While the command and control networks are the most vulnerable link in the strategic forces, targeting these would make limited war impossible. Eliminating the opponent's counterforce capabilities would carry little coercive advantage, since counterforce capabilities could not be used effectively in a second strike in any case, and there are a variety of other targets available. Establishing a dominant numerical advantage -- measured by the difference in numbers of the two forces, or the ratio of the two -- might offer some coercive power, but only if the absolute number of weapons remaining to the defender were small. Enormous uncertainties would face any prospective attacker, in estimating both the military performance of the attack, and the likely extent of civilian damage it would cause. These uncertainties, on balance, are likely to be stabilizing.

Regardless of which of these schools of thought one adheres to, the problem of ensuring that stability is not abruptly threatened by technological change is an important one; this consideration indicates that having several different survivable forces, with different potential vulnerabilities, is preferable to having only one such force. Lastly, the percentage vulnerability of strategic forces -- especially of forces which cannot achieve survivability short of being launched on warning of attack -- may be important in considering the internal pressures to launch

that national leaders might feel in an extreme crisis.

Based on these judgements, I would offer the following rough criteria for comparing the stability of possible strategic balances, ranked in rough order of importance:

- 1) It must be clear that some minimum number of weapons -- perhaps 200 -- would survive any conceivable attack. Any balance which meets this criterion is preferable to any balance which does not.
- 2) If the situations being compared both meet the first criterion, that which assures the broadest mix of different survivable strategic forces is the best of the two, since such a mix helps to insure against technological surprise.
- 3) If both strategic balances offer a reasonable minimum number of survivable weapons, spread across several types of strategic forces, then the balance in which the percentage vulnerability of the forces on each side is lower is preferable, as this might reduce the possibility of internal pressures to launch, in the face of ambiguous warning of attack; the vulnerability of forces such as ICBMs, which cannot be made invulnerable except by launching on warning, would be especially important in this regard.
- 4) If the two situations cannot be decisively differentiated by the first three criteria, then a balance in which

neither side can gain a large numerical advantage -- probably best measured by a ratio, in deference to the Soviet "correlation of forces" model -- by launching a first strike is preferable to one in which one side could. Worse yet would be a balance in which both sides could gain such an advantage, creating a reciprocal fear.

- 5) If the two balances both offer some of a successful preemptive attack, then the balance which confronts the attacker with more fundamental and irreducible uncertainty is preferable to the other.
- 6) If an attacker in both of the situations being compared could have reasonable certainty of gaining a substantial advantage in a first strike, then the balance in such a first strike would cause greater collateral damage -- and thus offer the attacker a greater risk of a wider war -- is probably the more stable of the two.

These, then, are the long-promised criteria for arms control: when confronted with differing arms control proposals, these criteria can be used to judge whether the strategic balance that one proposal might lead to would be more or less stable than that which would be the probable result of the other. The ranking of the criteria that I have given here is by no means absolute; one can certainly imagine situations where the degree of uncertainty facing a preemptive attack would be more important than the best

estimate of the percentage vulnerability of the strategic forces, for example. But as all of the criteria point in the same general direction, the effect of such qualifications will only rarely be important in judging one arms control proposal against another. Given the enormous differences of opinion as to the likely course of a strategic war, it is hardly to be expected that any particular set of criteria will be absolute; there will always be a necessity for judgement. But the criteria I have outlined above can provide a strong basis for making that judgement, in attempting to analyze the effects of proposals for limitations on strategic nuclear weapons.

V. Conclusions

In an enterprise of this kind, it may be presumptuous even to label a section "conclusions." Too little is known about the risks of nuclear war, and how arms control might best contribute to controlling them; too many questions remain murky. The most important conclusion is simply an acceptance of how little can ever be known. Despite all efforts to analyze and quantify, nuclear weapons and nuclear war will remain the most terrifying of enigmas; to consider them seriously is to delve into a realm of chaos. But if we take seriously only those things that can be known with certainty, it is very likely that we will miss much of what is most important; the crucial issues in the world are rarely simple ones. In the face of the perplexities posed by the existence of nuclear weapons, we must be humble, but we must not be paralyzed.

It can only be assumed, never proved, that the risk of nuclear war, and the effect of the technological balance on that risk, are significant enough to justify making the reduction of that risk the preeminent goal of arms control. It can only be assumed, never proved, that stability is the most important link between strategic nuclear weapons and the probability of nuclear war. But the alternative to making such assumptions is to give up on any attempt to analyze arms

control seriously, pending the arrival of more convincing evidence, or more powerful reasoning; given the importance of nuclear weapons, such a course would be irresponsible.

I believe that the analysis so far gives strong reasons for believing in the importance of stability: whether one considers the most likely scenario to be a deliberate preemptive attack, or a mistaken decision to launch resulting from some accident or provocation, the vulnerability of the forces on each side seems likely to play an important role. The greater the opportunity to disarm the other side, and the greater the fear of being disarmed oneself, the greater the pressure to make the fateful decision to launch. While the reexamination of this idea and the exploration of the historical record in these pages has raised important qualifications, and pointed out the salience of many other factors beyond the numbers and types of strategic weapons on each side, the core of stability theory remains valid.

Moving from that conceptual understanding to precise measures for comparing the danger of different strategic balances has proved to be a difficult task. No definition of stability, or set of criteria based on it, can be completely separated from the preconceptions of its author. Nevertheless, in order to move forward, it is again necessary to assert: the rough criteria developed in Section Four are my particular contribution to the task of systematizing

judgements of stability. Possible strategic balances can be compared on the basis of whether they insure that at least a small number of weapons would survive any attack; whether this surviving force is distributed over several types of weapons, making it more impervious to technological change; whether the percentage of each force -- especially of those forces that might be launched on warning -- that is vulnerable is high or low; whether it is possible for either side to gain an important numerical advantage by striking first; and by the degree of uncertainty facing an attacker, both as to the likely success of the attack, and as to the collateral damage it would inflict.

Once again, these conclusions are tentative. Nevertheless, they provide a basis on which to proceed. Such criteria can provide a knife with which to cut away the murky rhetoric surrounding arms control debates; they form a consistent set of ideas within which any proposal can be analyzed, evaluated, and compared to any other.

ENDNOTES

Notes to Section One

1 Informal talk on the START negotiations, Center for Science and International Affairs, Harvard University, Spring 1984. Though the formal strategic arms negotiations are now referred to as START, I will refer to all such negotiations simply as SALT, as that is much more harmonious than SALT/START, and more historical than simply START.

2 The fundamental ideas of arms control are spelled out, among other places, in three influential works which all appeared in 1961: T. Schelling and M. Halperin, Strategy and Arms Control; H. Bull: The Control of the Arms Race; and D. Brennan (ed.): Arms Control, Disarmament, and National Security. Lawrence Freedman argues that much of what he calls "the strategy of stable conflict" that was so central to these early works arose from the work of Warren Amster, reported in the May 1956 issue of The Bulletin of the Atomic Scientists. See Freedman: The Evolution of Nuclear Strategy, 1981, p. 191-193.

It should be noted that the ideas of "disarmament" and "arms control" have been hopelessly mixed together in the rhetoric of nearly all parties in the nuclear debate, so that the distinction between the two that I am drawing -- and that was drawn by early arms controllers such as Schelling -- often appears less salient than it is.

3 The idea that the sheer number of nuclear weapons is not the crucial point has now been challenged, primarily by those scientists who have revealed the possibility of a catastrophic "nuclear winter." Carl Sagan, for example, has argued that the need to reduce the world arsenal of nuclear weapons to below the "threshold" for nuclear winter -- which he argues exists, and is at about 500 weapons -- is a matter of "elementary planetary hygiene." See "Nuclear War and Climatic Catastrophe," Foreign Policy, Winter 83/84. The nuclear winter hypothesis will be discussed in more detail later.

4 What exactly falls into the category of undesirable effects of arms control depends on one's position in the political spectrum: on the right, arms control is seen as constraining U.S. programs while the Soviets surge ahead, exploiting loopholes and committing outright violations of past agreements. Moreover, the process is charged with creating a dangerous euphoria which undermines support for necessary defense programs. On the left, arms control has been accused

Notes to Section One (cont.)

of providing justifications for new weapons more often than it constrains them, through the "bargaining chip" effect, and through efforts to garner conservative support for arms control by promising more weapons. Moreover, arms control has created an unwarranted focus on the details of small asymmetries in the nuclear balance. For two intriguing reviews of such issues from supporters of the arms control idea, see J. Sharp: "Restructuring the SALT Dialogue," International Security, Winter 1981/82, and G. Rathjens: "Are Arms Control Negotiations Worthwhile?" in P. Abrecht and N. Koshy, eds: Before It's Too Late, 1983. Another interesting exchange on the subject is that between L. Gelb and R. Burt: "The Future of Arms Control: A Glass Half Full," and "The Future of Arms Control: Or Half Empty," Foreign Policy, Fall 1979.

5 A subset of arms control's political role, which has been crucial for the arms control process itself, is the US-Soviet Standing Consultative Commission, created by the ABM Treaty of 1972 for secret (and therefore frank) discussions of compliance with agreed limitations.

6 Moreover, it must be possible to have some understanding of how that effect might operate, for the technical limitations to be directed appropriately. Ingrained though they are in the U.S. nuclear debate, it is important to recognize that these ideas -- that we face a major risk of nuclear war, and that changing the numbers or types of strategic weapons might reduce or increase that risk, in a significant and calculable way -- are not facts, subject to proof or refutation, but merely assumptions. Both may be true, but neither is by any means obvious.

7 This argument is made forcefully in B. Brodie: "On the Objectives of Arms Control," International Security, Summer 1976.

8 p. 10.

9 Nearly everyone agrees that a strategic nuclear war is unlikely to spring out of nowhere; rather, such a war would most probably develop out of a conventional or tactical nuclear war. The inference is manifest that the specific characteristics of the conventional and tactical nuclear forces of the world have a much larger effect on the risk of war than do the characteristics of strategic nuclear forces. These other forces also consume a much larger part of the

Notes to Section One (cont.)

defense budget than do strategic nuclear forces, and might therefore be a more important target of measures to reduce the cost of the arms competition.

10 This assumption, of course, is becoming more doubtful day by day; the U.S. is now conducting a massive research program on missile defenses, with the apparent intention of abrogating the ABM treaty in the late 1980's or 1990's. Both sides have already committed what may be significant violations of the treaty; for example, the Soviets are building a large radar at Krasnoyarsk, and the U.S. has tested a Minuteman I ICBM booster as an ABM in the Homing Overlay Experiment. See T. Longstreth, J. Pike, and J. Rhineland: The Impact of U.S. and Soviet Ballistic Missile Defense Programs on the ABM Treaty, Third Edition, National Campaign to Save the ABM Treaty, Washington DC, March 1985.

11 The General Theory of Employment, Interest, and Money, 1936.

Notes to Section Two

1 "Nuclear Surprise Attack: Deterrence, Defense and Conceptual Contradictions in American Policy," Jerusalem Journal of International Relations, Vol. 5, No. 3, 1981, p. 81.

2 Most of the Summer 1984 issue of International Security is devoted to discussions of the factors contributing to the outbreak of World War I, emphasizing the importance of offensive doctrines and the belief in the benefits of preemption, including articles by P. Kennedy, M. Howard, S. Van Evera, J. Snyder, and R. Lebow.

3 "The Dynamics of Mutual Alarm," in Arms and Influence, 1966, p. 227. This chapter is perhaps the clearest, most beautifully written description of the stability idea ever to appear. Other major Schelling essays on stability include: Schelling and Halperin, Strategy and Arms Control; "Surprise Attack and Disarmament," and "The Reciprocal Fear of Surprise Attack," in Schelling: The Strategy of Conflict, 1960; and "Reciprocal Measures for Arms Stabilization," in Brennan, ed., Arms Control, Disarmament and National Security.

4 Schelling, "Surprise Attack and Disarmament," p. 232. Earlier in the book Schelling uses a similar example, where the danger, as he describes it, is that what might seem a small temptation to attack is compounded by the fear of the other's doing so: "He thinks we think he thinks we think . . . he thinks we think he'll attack; so he thinks we shall; so he will; so we must." See "The Reciprocal Fear of Surprise Attack," p. 209.

5 From this discussion, it should be clear that I am a convinced partisan in the debate over counterforce weapons such as the MX and the Trident II; I believe that stability could be undermined by the acquisition of serious counterforce capabilities by either the Soviet Union or the United States. Readers should bear this in mind, keeping an open eye for possible bias. Some discussion of the details of the argument against U.S. deployment of counterforce weapons is given in the next section; for a more complete discussion, see M. Bunn and J. Romm: "Is a Counterforce Capability Desirable?" unpublished manuscript.

6 Strategy and Arms Control, p. 10.

7 The argument that long flight-time systems such as bombers and cruise missiles cannot be used in a surprise attack depends on the idea that the attack would be detected; in the

Notes to Section Two (cont.)

future, with the advent of such weapons as stealth cruise missiles, this assumption should perhaps be reexamined.

8 For several more detailed discussion of the characteristics and vulnerabilities of the various types of strategic forces, see K. Tsipis: Arsenal, 1983; D. Schroeder: Science, Technology, and the Nuclear Arms Race, 1984; and R. Speed: Strategic Deterrence in the 1980s, 1979.

9 For discussions of this point see D. Ball: Can Nuclear War Be Controlled?, Adelphi Paper #169, 1981; B. Blair: Headless Horseman of the Apocalypse: Command and Control of U.S. Strategic Nuclear Forces, Ph.D. dissertation, Yale University, 1983; J. Steinbruner: "Nuclear Decapitation," Foreign Policy, Winter 1981-82; and P. Bracken: The Command and Control of Nuclear Forces, 1983.

10 Schelling, "The Dynamics of Mutual Alarm," p. 234.

11 For the use of the strategic stability term, see, for example, L. Sigal: "Warming to the Freeze," Foreign Policy, Fall 1982. For "deterrent stability," see The Harvard Nuclear Study Group: Living With Nuclear Weapons, 1983. It is a weakness of the social sciences that everybody makes up their own jargon, so that, as in this case, a phrase like "strategic stability" may end up meaning several slightly different things.

12 There is some evidence that arms races contribute to the outbreak of wars, though this point is somewhat controversial, and there is of course no evidence as to whether it remains true for nuclear wars, as there has never been a nuclear war. It does seem clear that if weapons technologies are constantly changing, rather than remaining in a single stable state, there is a greater chance that at some moment in time the particular balance will be crisis-unstable. In addition, it would seem intuitively probable that arms races contribute to tension between nations, and hence to the probability of war.

Notes to Section Three

1 The Future of Land-Based Missile Forces, Adelphi Paper 140, International Institute for Strategic Studies, Winter 1977-78, p. 7.

2 Department of Defense Authorizations for Appropriations for Fiscal Year 1983, Senate Armed Services Committee, pt. 7, p. 4196.

3 Report of the President's Commission on Strategic Forces, (Scowcroft Commission), April 1983, p. 29, emphasis added. Given that this definition appears only in the glossary of a report by a rather large number of individuals, it remains conceivable that its wording amounts to a conscious effort by a dissenting member or staffer to insert an alternative view.

4 See R. Garthoff: "Letter to the Editor," Comparative Strategy, Vol. 4, #3, 1984.

5 For a discussion of how this came about, see S. Talbott: Deadly Gambits, 1984, p. 253-262.

6 While neither of these limits was sufficient to prevent the ICBM vulnerability problem from arising and continuing, an analysis of a Soviet model of the strategic balance indicates that by this measure, the Soviets could have achieved a greater first-strike advantage in the absence of SALT limits than they in fact achieved -- even remaining within the same estimated cost constraints. See P. Almquist and S. Meyer: Mathematical Modeling of the Correlation of Nuclear Forces, report prepared for the Defense Advanced Research Projects Agency, 1984.

7 See the discussion in Schelling, "The Dynamics of Mutual Alarm." It is on this issue, needless to say, that the ideas of the early "arms controllers" contrasted most sharply with those of "disarmers."

8 "The Case for Population Defense," in Johan Holst and William Schneider, eds., Why ABM?, 1969.

9 For a sampling of the recent technical literature supporting this view, see: A. Carter and D. Schwartz, eds: Ballistic Missile Defense, Brookings, 1984; Directed Energy Missile Defense in Space, Office of Technology Assessment, 1984; S. Drell, P. Farley and D. Holloway: The Reagan Strategic Defense Initiative: A Technical, Political and Arms Control Assessment, Stanford, 1984; and H. Bethe et.

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al.: "Space-Based Ballistic-Missile Defense," Scientific American, October 1984.

10 For a more detailed treatment of these issues than is provided here, see Bunn and Romm.

11 The best expositions of this view are probably the various pamphlets of the Committee on the Present Danger, an organization founded by opponents of SALT II. For an especially detailed official statement of this scenario, see the testimony of Gen. Alton Slay, USAF, before the House Armed Services Committee, March 6, 1978. For a recent restatement, see R. Jastrow: "Why Strategic Superiority Matters," Commentary, March 1983.

12 See discussion in Ball. Also Gary Guertner: "Carter's SALT: MAD or SAFE?" Bulletin of the Atomic Scientists, October 1979.

13 Ball, p. 44.

14 For Soviet reliance on preemption, see R. Garthoff: Soviet Strategy in the Nuclear Age, 1958; for the U.S., see D. Rosenberg: "The Origins of Overkill: Nuclear Weapons and American Strategy, 1945-1960," International Security, Spring 1983.

15 Number of warheads on Soviet submarines is taken from Scowcroft Commission Report, p. 4. Quote is contained in Department of Defense Authorization for Appropriations, FY1985, Senate Armed Services Committee, part 7, p. 3402. The agreement of the other agencies was attested to in Strategic Force Modernization Programs, Senate Armed Services Committee, 1981, p. 194.

16 For discussion of these points, see V. Van Diepen: Strategic Force Survivability and the Soviet Union, MS thesis in Political Science, MIT, 1983.

17 The nuclear command and control facilities on each side are considerably more vulnerable than the forces themselves, but not sufficiently vulnerable so that an attack could be expected to preclude all retaliation. This will be discussed at more length in a moment.

18 p. 10.

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19 See references in note 9, Section Two.

20 Ball, p. 37.

21 This would not be a good option if the side facing the decision had any hope that a nuclear war, should it come, might remain limited; as argued above, such a limited war would require the maintenance, not the destruction, of the central leadership on both sides, and their control over their nuclear forces.

22 The general idea that organizational and bureaucratic factors may have as much relevance as stability theory's concentration on a "rational actor" deciding whether it is better to attack or to wait will be discussed in later in this section.

23 This issue is discussed in Steinbruner: "Nuclear Decapitation," and "Launch Under Attack," Scientific American, January 1984, by the same author.

24 This is cogently argued by Steinbruner: "National Security and the Concept of Strategic Stability," Journal of Conflict Resolution, September 1978.

25 A cogent argument that the danger of "accident or miscalculation" is "the only real risk of nuclear war in the foreseeable future" is given in W. Perry: "Reducing the Risk of Nuclear War," Orbis, Winter 1984. Perry also briefly considers several measures to reduce this risk.

26 The scale of the effort devoted to superpower political relations, as just one example, dwarfs that devoted to most other foreign policy problems. Indeed, the specific issue of measures to improve superpower crisis management and communication procedures has become a central focus of arms control research over the past several years. See, for example, W. Ury and R. Smoke: Beyond the Hotline: Controlling a Nuclear Crisis, 1984; and the September/October 1984 issue of Survival, which contains articles on the subject by D. Landall et. al., D. Hart, and A. George.

27 "The Dynamics of Mutual Alarm," p. 227-228.

28 LOW is sometimes referred to as "launch under attack," (LUA). Sometimes LUA is used differently, to mean launch after the attack has been confirmed beyond any reasonable

Notes to Section Three (cont.)

doubt, for example after nuclear weapons have begun detonating on the United States. A discussion of the various different possibilities of this sort can be found in R. Garwin: "Launch Under Attack to Redress Minuteman Vulnerability?" International Security, Winter 1979/80. An early, but definitive argument against LOW is given by P. Wolfowitz: "The Proposal to Launch on Warning," in Department of Defense Authorization for Procurement, Research and Development, and Reserves for FY 1971, Senate Armed Services Committee, pt. 3, p. 2278-2282.

29 Bracken, p.43-44.

30 An excellent technical discussion of LOW, giving some of these timelines, can be found in MX Missile Basing, Office of Technology Assessment, 1981. See also Steinbruner, "Launch Under Attack"; because of the shortness of time before command functions might be disrupted, Steinbruner is skeptical about whether LOW is even physically possible.

31 As the OTA concluded in MX Missile Basing, "despite all safeguards, there would always remain the possibility of error . . ." p. 148. A contrary view is offered by Garwin.

32 For Soviet consideration of LOW, see Van Diepen; and R. Garthoff: "Mutual Deterrence and Strategic Arms Limitation in Soviet Policy," International Security, Summer 1978. For the U.S., see Senate testimony of Secretary of Defense Caspar Weinberger, and John Vessey, Chairman of the Joint Chiefs of Staff, quoted in the New York Times, May 6, 1983.

33 With the development of intercontinental-range SLBMs, one could conceive of a LOW policy for SLBMs in port as well.

34 This is not meant to imply that the U.S. should dismantle its ICBM force to reduce the danger that the U.S. might itself rely on LOW; that would be nonsensical, since the U.S. can unilaterally decide not to rely on LOW much more easily than it could make any major change in its triad. Moreover, the ICBM force, even if theoretically vulnerable, provides a valuable extra complication to any attacker's plans. It does suggest, however, that each side would be better off if it presented less threat to the ICBMs on the opposing side.

35 For an excellent description of varying models of government behavior in the national security arena, see G. Allison: Essence of Decision, 1971. Allison also briefly

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discusses the implications for deterrence of each of the three models he examines.

36 Bracken, p. 242.

37 Steinbruner: "National Security and the Concept of Strategic Stability." I say somewhat implicit because what I am about to describe is not in fact the point point Steinbruner emphasizes most heavily, in arguing for a revision of stability theory. Indeed, a surprisingly small portion of this article is devoted to exploration of this idea of the importance of minimizing uncontrollable interactions between one's forces and those of the enemy; most of the article is devoted to a discussion of the vulnerability of command and control, as being a more important determinant of stability than the vulnerability of the forces themselves. The two ideas are blended together somewhat in a concept Steinbruner refers to as "command stability."

38 As will be discussed later in this section, the military in the Cuban missile crisis pushed constantly for stronger action to be taken, and consistently minimized the implications of the acts under discussion. However, in many subsequent crises, especially in the post-Vietnam period, top military officers have been the chief proponents of caution in the use of military forces.

39 U.S. information on Soviet strategy is pieced together from public statements of Soviet leaders, and from translations of Soviet journals; the most authoritative statements (at least of the military point of view, not necessarily identical to that of Soviet political leaders) are generally those found in the secret journal of the Soviet General Staff, Military Thought, which is obtained by the U.S. government and released several years later. The U.S. literature on Soviet doctrine is vast, though perhaps not as vast as it ought to be. A classic early description is to be found in Garthoff: Soviet Strategy in the Nuclear Age; more recently, see Garthoff's "Mutual Deterrence." Garthoff's implications in the latter are possibly more comforting than is justified; see the critique by Donald Brennan in the following issue of International Security. A brief but useful summation of Soviet views on deterrence can be found in Freedman, chapters 10 and 17. Much of the following discussion of Soviet thoughts on force vulnerability and preemption is based on three sources: S. Meyer: "Soviet Perspectives on the Paths to Nuclear War," in G. Allison, A.

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Carnesale, and J. Nye, eds., Hawks, Doves, and Owls, forthcoming; Van Diepen; and Almquist and Meyer.

40 "What Soviet Children Are Saying About Nuclear War," videotape produced by International Physicians for the Prevention of Nuclear War, and the Harvard Medical School. Indeed, roughly twice as many Soviet as American children believed they personally would die if a nuclear war occurred.

41 No Soviet strategic bombers are kept on alert, and only 15% of Soviet submarines are at sea at any given time; until the mid-1970s, even the ICBM force was kept at a low alert rate of perhaps 30-40%. See Van Diepen. For discussion of Soviet scenarios for how a war might start, see Meyer.

42 See Almquist and Meyer.

43 R. Pipes and T. Downey had an interesting exchange on this point some years ago; see Pipes: "Why the Soviet Think They Can Fight and Win a Nuclear War," Commentary, July 1977, with letters (including Downey's), September 1977. Downey argues that "should Mr. Pipes's counterpart in the Soviet Union wish to argue, 'Comrades, we must understand the Americans don't think as we do; they have not experienced the ravages of war as we have; their every action demonstrates a willingness to use force at any time to achieve their ends,' he will have better basic material on which to build his case than does Mr. Pipes."

44 This point is emphasized in Van Diepen.

45 Indeed, their primary interest in reducing collateral damage arises in the European theater, in the context of protecting their own advancing troops, rather than from the possibility of limiting a war to low levels of violence. See S. Meyer: Soviet Theatre Nuclear Forces: Part I: Development of Doctrine and Objectives, and Part II: Capabilities and Implications, Adelphi Papers #187 and #188, 1983. A concise description of these Soviet views and their implications for the prospects of keeping a war limited can be found in Ball.

46 p. 381.

47 Part of the reason for this divergence of strategic logics may be the complete absence of civilian strategists and defense analysts in the Soviet Union; the ideas of both stability theory (which suggests that one ought to eschew the

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capability to attack the opponent's strategic forces) and limited war theory (which suggests that certain kinds of war should be thought of as influencing the opponent's behavior through the infliction of pain, rather than overcoming the opponent by force) were developed entirely by civilian strategists in the United States, and are intrinsically unlikely to appeal very strongly to men trained in traditional military thinking. In the United States, it required enormous effort by civilians to get any acceptance of these ideas whatsoever from the military services.

48 For a description of Soviet air defenses (and a very brief speculation as to why they have received so much emphasis), see G. MacDonald, J. Ruina, and M. Balaschak: "Soviet Strategic Air Defense," in R. Betts, ed.: Cruise Missiles: Technology, Strategy, Politics, Brookings, 1981. Almquist and Meyer argue that after a Soviet preemptive attack, U.S. bombers would carry most of the remaining U.S. equivalent megatonnage, possibly justifying a serious investment in defenses against them.

49 The Reagan Administration has altered this policy somewhat by initiating a major modernization of existing U.S. air defenses.

50 This argument is made by Van Diepen; he chastises opponents of the MX for saying that MX deployment might lead to Soviet adoption of LOW, arguing that the Soviets rely on LOW already. Of course, if the Soviets rely on LOW already, then the MX cannot perform its principal mission of destroying Soviet ICBMs in their silos, so its proponents, one would imagine, are equally to be criticized.

51 Though Garthoff, like Van Diepen, highlights Soviet references to launch-on-warning, he does not take the fatalistic view that Soviet reliance on LOW is absolute and cannot be changed; rather, he argues that "U.S. pursuit of such a [hard-target] capability with the MK 12A warhead for Minuteman III, the MX missile, and Trident II may serve only to increase Soviet reliance on a launch-on-warning concept." "Mutual Deterrence," emphasis added. It seems clear, given the low alert rates of Soviet forces, that the Soviet Union does not have a day-to-day policy of launch-on-warning; rather, LOW would probably only be a possibility in an intense crisis, which would lend credibility to the warning of attack that satellites could provide. Regardless of any discussions of LOW in Soviet military journals, it is certainly possible

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for the degree of Soviet reliance on LOW to increase or decrease, depending, perhaps, on the perceived threat to their strategic forces.

52 Van Diepen argues that the answer is no.

53 See note 6, Section Three.

54 The phrasing of this question is perhaps misleading, as it implies that the Soviet Union has the capability to threaten U.S. strategic forces, and the U.S. poses no similar threat to the Soviet Union; in fact, as was described earlier, the percentage of Soviet forces that might be destroyed in a "bolt-from-the-blue" attack is higher than the percentage of vulnerable U.S. forces. The Soviets do have an advantage in the number of missile warheads capable of attacking hard targets such as ICBM silos, but ICBMs constitute only 25% of the U.S. strategic force.

55 An extremely interesting short discussion of the record of such incidents is given by M. Bundy: "The Dubious Record of Nuclear Diplomacy," in G. Prins, ed.: The Nuclear Crisis Reader, 1984.

56 This description is primarily based on that in Bracken, p. 65-66. See also H. Finer: Dulles Over Suez, 1964, (cited as Bracken's source), and O. Smolansky: "Moscow and the Suez Crisis, 1956: A Reappraisal," Political Science Quarterly, December 1965.

57 Smolansky, p. 589

58 Finer, p. 417-18.

59 Ibid., p. 421.

60 Ibid., and Bracken.

61 The following discussion of particular secret events during the Berlin crisis is taken entirely from F. Kaplan: The Wizards of Armageddon, 1983, p. 291-301, which is the only detailed, publicly available account.

62 Of the dozens of studies of this crisis, the classic is still Allison's Essence of Decision, 1971.

63 The U.S. also privately told the Soviet Union it would

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remove its missiles from Turkey. This move had been decided upon long before the crisis, however, because the Turkish missiles were extremely vulnerable, and the U.S. expressly stated that it was in no sense a quid pro quo. But the Soviets may still have regarded it as such -- and in some sense they may have been intended to do so.

64 Allison, p. 1, (all citations from paperback edition), citing T. Sorensen: Kennedy, 1965, p. 705.

65 The statement that the strategic balance was never considered was made by McGeorge Bundy, National Security Adviser to Kennedy at the time, in a speech at Harvard University on the occasion of the 20th anniversary of the crisis, in October 1982. See also Time, September 27, 1982, in which six of Kennedy's key advisers wrote: "No one of us ever reviewed the strategic nuclear balance for comfort in those hard weeks. The Cuban missile crisis illustrates not the significance but the insignificance of nuclear superiority . . ."

It is frequently asserted that the same was not true on the Soviet side, and indeed, that most of the Soviet strategic missile program of the 1960's and 1970's can be explained as a reaction to the "lesson" that U.S. strategic superiority carried with it enormous political power. Despite the fact that such assertions are repeated absolutely everywhere, they are merely guesses, with no particular basis in evidence. It seems likely that the determining factor on both sides was the overwhelming U.S. conventional superiority in the Caribbean, which offered the Soviets few realistic options.

66 This question is the theme of Allison's book.

67 Allison, p. 216.

68 See "An Assessment of Nuclear Crises," in F. Griffiths and J. Polanyi, eds.: The Dangers of Nuclear War, 1979. The events in question are also described in Allison, p. 136-139.

69 R. Kennedy: Thirteen Days: A Memoir of the Cuban Missile Crisis, 1969, quoted in Allison, p. 137.

70 Allison, p. 138.

71 Ibid., p. 129

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72 Ibid., p.206

73 Ibid., 129-130.

74 "An Assessment of Nuclear Crises."

Notes to Section Four

1 The method envisioned is approximately as follows: given two arms control proposals to choose between, make a projection of the forces that would be likely to exist on each side at some specified time in the future, for each proposal. Then estimate the vulnerability of those forces to various types of attack. Then apply the criteria to judge which balance offered less of a "first-strike advantage"; the proposal leading to the more stable balance (as judged by the criteria to be developed at the end of this section) would then be considered preferable to the other. Since there would be substantial uncertainty in both the force projection and the estimates of vulnerability, analyzing the sensitivity of the result to important assumptions would be critical. A recent example of something approximating this approach can be found in Modernizing U.S. Strategic Offensive Forces: The Administration's Program and Alternatives, U.S. Congressional Budget Office, May 1983.

2 The Future of Land-Based Missile Forces, Adelphi Paper 140, International Institute for Strategic Studies, Winter 1977-78, p. iv.

3 Those with an eye for the whimsical have invented acronyms for these two ways of thinking: MAD, for Mutual Assured Destruction, a concept first used during Robert McNamara's tenure as Secretary of Defense, and NUTS, for Nuclear Utilization Target Selection, pointing up that school's emphasis on the specifics of nuclear targeting. The MAD acronym is generally attributed to Donald Brennan; NUTS is from S. Keeny and W. Panofsky: "MAD vs. NUTS," Foreign Affairs, Winter 1981-82. A. Wohlstetter has pointed out that although the criterion for designing U.S. forces in the McNamara era was that they be capable of assured destruction of cities, this was never the actual war plan; he therefore refers to McNamara's policy as MADCAP, for Mutual Assured Destruction Capability. See "Bishops, Statesmen, and Other Strategists On the Bombing of Innocents," Commentary, June 1983. Even more exotic acronyms can be thought of if there seems a reason to do so; W. Schilling, for example, has proposed COFFIN, for Capability of Firing First if Necessary. See Freedman, p. 422.

4 G. Snyder: Deterrence and Defence, 1961, p. 105.

5 Lethality, sometimes also called "countermilitary potential" (CMP), or "hard-target kill potential" (HTKP), is given by the yield of the weapon to the two-thirds power,

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divided by the square of its CEP, a measure of accuracy. Thus, increasing the accuracy by a factor of two has the same effect as increasing the yield by a factor of eight.

6 See discussion in A. Enthoven and K. Smith: How Much is Enough? Shaping the Defense Program, 1961-1969, 1971, p. 172-196.

7 If one assumes that a nuclear exchange would certainly escalate to all-out war, then the attacker's nuclear weapons could serve only two purposes: to prevent a nuclear war (which they have already failed to do, once his attack has been launched), or to reduce the damage the enemy could do in such a war (which they will have already done or failed to do, once the initial attack has been carried out). Hence, these weapons are no longer of any use; logically, once war has broken out, the attacker should have no qualms about disarming himself entirely in the process of attempting to disarm his opponent.

8 Figure is taken from F. Kaplan: Dubious Specter, Institute for Policy Studies, 1977, citing "U.S. Strategic Offensive Forces in the 1960's," in Commission on the Organization of the Government for the Conduct of Foreign Policies, Appendices, Vol. 4, p. 139. Even such seemingly straightforward calculations, however, are very much open to dispute. From this chart, the standard McNamara-era estimate was that the leveling off point was at roughly 400 equivalent megatons, and this has become the accepted number. But from examining later graphs (such as those given in An Analysis of Civil Defense in Nuclear War, U.S. Arms Control and Disarmament Agency, 1978) one might draw the conclusion that nothing beyond 200 megatons would really make much difference, at least for an attack on the Soviet Union, whose population is more concentrated than that of the U.S.

Moreover, Joseph Romm has argued that all traditional calculations of nuclear weapons fatalities drastically underestimate their effects. For example, such calculations usually use the 5 psi overpressure contour as the lethal radius of a nuclear blast; this is based on the data from the 14 kiloton bomb that destroyed Hiroshima, where most people within the 5 psi contour were killed and most of those outside were not. Romm points out that since the bulk of the casualties at Hiroshima appear to have been the result of thermal effects, rather than overpressure, and thermal effects increase much more rapidly with increasing yield, the use of lethal radii based on overpressure seriously

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underestimates the probable destructive effects of large nuclear weapons, such as those in the current arsenals of both sides. (Conversations with the author.)

On the other side of the argument, Paul Nitze has argued that Soviet civil defense is so effective that "something of the order of 3,000 deliverable megatons" would be required to "keep the Soviet population hostage." See "Deterring our Deterrent." For a thorough debunking of such claims for Soviet civil defenses, see F. Kaplan: "The Soviet Civil Defense Myth," Bulletin of the Atomic Scientists, March and April, 1978.

9 See, for example, T. Downey: "How to Avoid Monad -- And Disaster," Congressional Record, September 20, 1976, beginning at S16210. Downey defines more than 400 surviving EMT as "hypersufficient," while 400 is "sufficient," and less than 400 is "insufficient."

10 An additional point has been raised by Glenn Snyder. If stability theory is correct, then much of the brunt of a first strike would probably fall on the strategic forces; if their destruction required a significant proportion of the attacker's weapons, then these weapons could not be used for maximum effect against cities and industry. In a second strike, however, many of the remaining weapons might be reassigned to retaliatory attacks on cities. This has the effect of reducing the difference in civilian damage between a first strike and a second strike, reinforcing stability. See Deterrence and Defense.

11 M. Bundy: "To Cap the Volcano," Foreign Affairs, October 1969.

12 p. 108

13 The relation between concepts of limited nuclear war and strategic stability is ably discussed in R. Siegel: Strategic Targeting Options, MS Thesis in Political Science, Massachusetts Institute of Technology, June 1981.

14 K. Knorr and T. Read, eds.: Limited Strategic War, 1962. This is one of the earlier unclassified works on the subject of limited strategic nuclear war; note especially the "Comment" in that volume by Schelling. Schelling was one of the foremost exponents of this "bargaining through the infliction of pain" idea; see both The Strategy of Conflict, and Arms and Influence, especially the rather shocking

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chapter "The Diplomacy of Ultimate Survival," in the latter. Herman Kahn, however, remains the classically outrageous exponent of limited war ideas; see especially his On Escalation: Metaphors and Scenarios, 1965, which identifies 44 "rungs" of the "escalation ladder," of which 30 lie beyond the nuclear threshold!

15 Such a contest is identical, in the game-theory terms often used to analyze it, to the game of "Chicken," in which two people drive toward each other in cars at high speed, watched by their peers. Each wants to avoid a collision, but the first to swerve away loses face. The key is then to make a "credible" commitment not to swerve, leaving the opponent with no choice but to swerve himself. The commitment is inherently incredible, however, since one is saying that one would rather die than lose face; one possibility is to throw the steering wheel out the window, in order to make it physically impossible to swerve. Even such a commitment might not be credible however; the opponent might think you had a spare steering wheel hidden away in case of disaster. The only thing to do at that point would be to hack off all of your arms and legs . . .

16 See discussion in Freedman, p. 214.

17 See Kahn, for example.

18 See Paul Nitze's influential articles: "Assuring Strategic Stability in an Era of Detente," and "Deterring Our Deterrent."

19 Freedman's chapter 15 contains an excellent discussion of such city-avoidance strategies.

20 "Atoms, Strategy and Policy," Foreign Affairs, January 1956, cited by Nitze in "Deterring our Deterrent."

21 Department of Defense Annual Report, FY 1981, p. 86. More recently, the Scowcroft Commission Report came to a similar conclusion: "to deter such surprise attacks [on U.S. ICBMs] we can reasonably rely both on our other strategic forces and on the range of operational uncertainties that the Soviets would have to consider. . . ." For a discussion of the technical aspect of the ICBM vulnerability problem, see M. Bunn and K. Tsipis: "The Uncertainties of a Preemptive Nuclear Attack," Scientific American, November 1983, and Ballistic Missile Guidance and Technical Uncertainties of

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Countersilo Attacks, MIT Program in Science and Technology for International Security, Report #9, August 1983. The most extensive critique known to the author of the idea that destroying the ICBMs alone would give the Soviets a coercive advantage over the United States is contained in Appendix A of the latter Bunn and Tsipis paper.

22 Gen. McCarthy, USAF, in The MX Missile System, hearings before the House Subcommittee on Public Lands, March 1981, p. 89.

23 This is the chief problem with the more extreme exchange ratio arguments sometimes offered in discussions of the proposed Midgetman missile. Some analysts have argued that since the Midgetman would carry only one warhead, and therefore any possible attack on it would face an unfavorable exchange ratio, a Midgetman deployment would be reasonably "secure" even in a vulnerable basing mode, such as traditional ICBM silos. See, for example, comments of K. Tsipis, in W. Biddle: "Time, Cost and Base For Smaller Missiles Under Vital Debate," New York Times, September 7, 1983, with similar views attributed to Rep. Albert Gore. Tsipis' views on the subject have been spelled out in more detail in conversations with the author.

It is interesting to note in this respect that if unfavorable exchange ratios were the sole determinant of stability, Midgetman would be unnecessary; an attack on the current U.S. ICBMs would already face an unfavorable exchange ratio. It is usually postulated that two warheads would be used against each of the U.S. Minuteman missiles, which themselves carry 2100 warheads; if such an attack were 90% successful, the 2000 warheads expended in the attack would destroy only 1890 warheads. The exchange ratio would be more unfavorable still if measured in throw-weight, or equivalent megatonnage.

24 See "Assuring Strategic Stability," and "Deterring Our Deterrent." The criticisms of Mr. Nitze that I am about to raise are not intended to imply any disrespect for his considerable talents; but having written the definitive expressions of a certain point of view makes him perforce the definitive target in discussions of that view.

25 "Deterring Our Deterrent," p. 208, emphasis added.

26 Ibid., p. 203, emphasis added. On that page there appears a graph showing, over time, the trends in the ratio of Soviet to

Notes to Section Four (cont.)

U.S. throw-weight before an attack and after a counterforce exchange; Nitze highlights "the point at which the curves cross [which] indicates that point at which the Soviets could, by initiating such an exchange as postulated here, increase the ratio of advantage they held before the exchange."

27 P. Nitze: "Comment and Correspondence: Strategic Stability," Foreign Affairs, July 1976. This is his most succinct summary of the three methods, but the same three appear in both the Nitze articles cited above.

As an aside, Nitze's exchange scenarios, by having the U.S. target on the basis of absolute differences, tend to exaggerate the resulting post-exchange ratios. As Nitze put it: "the Soviets were assumed to attack U.S. forces in a manner which would give them the greatest net advantage at the end of an exchange, including U.S. retaliation against the Soviet reserve forces. U.S. retaliation was in the analysis limited so that a pound of U.S. missile throw weight knocks out more than a pound of Soviet reserve force throw-weight." It is not clear from the context whether Nitze used a ratio or difference approach as the "net advantage" goal for the Soviet half of the targeting; having the Soviets target on the basis of ratios, and the U.S. on the basis of differences, would clearly be misleading. In any case, if the Soviets are ahead after their initial strike (which they are in almost all of Nitze's calculations) then the U.S., by continuing to target as long as each pound of throw-weight destroys at least one on the opposing side, will shift the overall ratio against itself; for example, if the Soviets had 8 weapons to 2 for the U.S. (a 4-1 advantage), and the U.S. used one of its weapons to destroy 2 on the Soviet side, this would shift the ratio adversely, to 6-1. The targeting method thus minimizes the absolute differences between the two forces, but exaggerates the Soviets' post-attack "ratio of advantage."

28 "Assuring Strategic Stability," p. 227.

29 Remarkably, neither of the major criticisms of Nitze's articles have seriously addressed this central point. See J. Lodal: "Assuring Stability: An Alternative View," Foreign Affairs, April 1976; and A. Tonelson: "Nitze's World," Foreign Policy, Summer 1979.

30 These reasons why a nuclear war could probably not remain limited are discussed in D. Ball: Can Nuclear War Be Controlled?, Adelphi Paper #169, 1981.

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31 Nitze acknowledges the importance of absolute numbers, at least rhetorically, pointing out that if the absolute number of surviving weapons is adequate to "threaten a major portion of the other side's military and urban/industrial targets, this will be conducive to continued effective deterrence even if the ratios are unfavorable." ("Assuring Strategic Stability," p. 226.) However, since he believes that at least 3000 EMT are required just for urban-industrial attacks ("Deterring Our Deterrent," p. 209), neglecting the more numerous military targets, he does not give much attention to the possibility that the absolute numbers might already be high enough to make the ratios and absolute differences he is discussing irrelevant.

32 This may not be the case with respect to attacks on strategic forces, for the following reason: while the first few weapons in an attack on strategic forces would destroy more of the opponent's forces than subsequent weapons would, the utility of destroying only half the opponent's force may be small, while if all of the opponent's force could be destroyed, the utility of destroying the last few weapons would be very great indeed. (I am grateful to George Rathjens for pointing this out.) However, as I have argued already, retaliation against strategic forces is unlikely to be successful, as those forces will certainly be on alert once a war has begun.

33 This point is discussed in several critiques of limited nuclear war theory. See, for example, Ball; and S. Drell and F. von Hippel: "Limited Nuclear War," Scientific American, November 1976. Kahn also discusses the importance of collateral damage.

34 MX Missile Basing, U.S. Office of Technology Assessment, 1981, p. 105-106. Note that this estimate includes only short-term fatalities, and only those in the urban population, neglecting rural deaths; actual fatalities are incalculable.

35 For a discussion of such precision-guided ballistic missiles, see M. Bunn: "Technology of Ballistic Missile Reentry Vehicles," in P. Janeway and K. Tsipis, eds.: Review of U.S. Military Research and Development, 1984.

36 For a brief discussion of this dilemma, see M. Bunn: "Les Missiles Nucleaires Ultraprecis," Le Temps Strategique, (Geneva), Spring 1985. The obvious parallel of such ideas is

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the holding of hostages by military forces to prevent attack on them, the most recent example being the PLO retreat into Beirut during the Lebanon war. This analogy makes the idea of maintaining collateral damage seem extremely immoral, or at best, Machiavellian. A somewhat different perspective on the question can be gained by considering NATO theatre nuclear forces in Europe. Most defense analysts agree that at a minimum, such forces should not be vulnerable to attack by conventional weaponry; they should be sufficiently survivable, it is argued, to make them impossible to attack without the use of nuclear weapons, which would drastically up the ante. Such invulnerability to any but nuclear attack would probably reduce the likelihood of attack; but should attack come, it would certainly be undertaken with nuclear weapons, making it all the more devastating. These are dilemmas which would arise quite often if they were recognized for what they are, rather than being glossed over.

37 Nuclear Arms Reductions Proposals, hearings before the Senate Foreign Relations Committee, April 30, 1982, p. 71-72. For similar earlier comments by Schlesinger, see his testimony in U.S.-U.S.S.R. Strategic Policies, hearings before the Arms Control Subcommittee of the Senate Foreign Relations Committee, March 4, 1974, p. 15-17.

38 See Bunn and Tsipis: "Uncertainties of a Preemptive Nuclear Attack," and Ballistic Missile Guidance and Technical Uncertainties of Countersilo Attacks.

39 For discussions of the importance of uncertainty, and of some of the uncertainties involved in a counterforce attack, see: the two Bunn and Tsipis papers; S. Sienkiewicz: "Observations on the Impact of Uncertainty in Strategic Analysis," World Politics, October 1979; J. Steinbruner and T. Garwin: "Strategic Vulnerability: The Balance Between Prudence and Paranoia," International Security, Summer 1976; H. Estes: "On Strategic Uncertainty," Strategic Review, Winter 1983; and B. Bennett: Assessing the Survivability of U.S. ICBMs, RAND Corporation, R-2577-FF, with Appendices, R-2578-FF, June 1980.

40 "The Dynamics of Mutual Alarm," p. 202-204.

41 "Determining the Correlation of Forces in Terms of Nuclear Weapons," Military Thought, No. 6, 1967. This model is discussed in detail in Almquist and Meyer. While it is impossible to know for certain whether the model was ever

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widely used by Soviet planners, Almquist and Meyer make three points in its favor: it corresponds well to the basic ideas of most Soviet nuclear strategy discussed in Section Three, its author has since received important promotions, and the subsequent Soviet deployments of ICBMs appear to have been close to the optimal ones under the assumptions of the model.

42 Quoted in Almquist and Meyer.