PRACTICAL PRESCRIPTIONS FOR DEEP CUTS

by

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ABSTRACT. Nuclear weapons are held from use by deterrence, and this will continue until someone identifies a path to the elimination of nuclear weapons, and persuades the nuclear powers to take that path. Nevertheless, there is an interim goal in which the 50,000 existing nuclear weapons are replaced by 1000 strategic nuclear weapons in the U.S. armory, a similar number for the Soviet Union, and perhaps 200 each for the U.K., France, and China. In order to ensure that such a regime be stable against first strike, the 1972 ABM Treaty must be respected and strengthened; there must be a ban on anti-satellite tests and deployment, and on space weapons. Furthermore, an increasingly effective and cooperative verification regime of the destruction of nuclear weapons and delivery vehicles and of those which remain must be brought into being. Proliferation of nuclear weapons to other nations would present an even greater threat than now, and must be opposed by a stringent anti-proliferation regime, augmented by an increasingly strict and eventually total ban on nuclear tests. One path toward the goal of 1000 weapons on either side is described, leading to that posture by 1997, from which it would be costly and time consuming to return to the present vastly excessive number of nuclear weapons.

At Reykjavik, October 1986, General Secretary Mikhail Gorbachev and President Ronald Reagan agreed on a number of far-reaching points, while others remained without agreement. Agreed, in particular, was the reduction by 50% within five years (end-1991) of the number of strategic weapons on either side, followed by further and correspondingly deeper cuts. It is the purpose of this paper to provide for a general audience the background and the motivation for deep cuts, to present a particular recommendation of the path, and to identify some accompanying or preconditions to ensure that such major reductions are in the interest of world security as well as of the Soviet Union and the United States.

At the present writing, there are some 50,000 nuclear weapons in the world, all but about 1000 of them in the armories of the United States and the Soviet Union.[1] As has been the case for the last 35 years, both superpowers are continuing a program of modernization and expansion of their nuclear forces. In the last decade, however, the nations and people of the world have taken a renewed interest in the existence and potential damage from these nuclear weapon stocks, and have emphasized their concern that any major use of these nuclear weapons could destroy not only the combatant nations and their societies, but would have similar effects on much of the rest of the world. Such damage would occur not only through the direct effects of the nuclear weapons-- blast, fire, and fallout of radioactive materials-- but also to some extent by "nuclear winter" effects, and by the disruption of world economy and trade involving the developed nations. Whether the great preponderance of people in the world would die as a result of the use of even 50% of the existing arsenals, or only 2000 million people, there is a strong motivation to reduce the number of nuclear weapons and the potential damage. In this attempt, however, one must weigh also the probability of such an exchange; it would be undesirable (to say the least) to reduce the potential damage by 50%, if (just for instance) the large-scale nuclear war would arise with 10 times the probability. Not to give unwarranted precision but simply to illustrate the proposition, if the likelihood of nuclear war under present circumstances were 1% per year (so an expected waiting time of about 100 years till it occurred), it would be highly undesirable to reduce the potential damage by 50% and to have the war arrive in ten years. Low likelihood of war is important not only in the calculation of "expected value" lost, but also because it gives time to think of something else and to reduce or even to eliminate the hazard.

History of defense against nuclear weapons.

Also proposed since the invention of nuclear weapons, as a means of reducing or eliminating potential damage, is the construction of a defense against nuclear weapons. But the nuclear weapon is very different from ordinary weapons. A nuclear weapon of 1-megaton explosive yield can destroy an entire city, killing 1 million people or more. A defense which destroyed 10% of the aircraft delivering high-explosive weapons directed against the populace would essentially eliminate the effectiveness of such an armory, in view of the high cost of an aircraft in comparison with the damage it could cause; but for the nuclear weapon of 1,000,000 times the explosive yield per ton, a defense of population would have to be near perfect. Indeed, it matters so little in the use of nuclear weapons whether the carrier vehicle is destroyed, that the majority of strategic nuclear weapons these days are planned for delivery by ballistic missile, which is totally destroyed during a single flight, even in the absence of defense. Although in the immediate decades following World War II both the Soviet Union and the United States made very intensive efforts to provide a system of defense against aircraft delivering either fission or thermonuclear weapons, those defenses at no time were effective enough to intercept the majority of delivery aircraft, as the offensive forces were adapted and planned for operation against the defense. Defense suppression (by attack on the defense), defense evasion, (by flying around or under the radar screen), and offensive multiplication have ensured that the offense could succeed in its attack. Indeed, in the 1960s the United States abandoned even an attempt at air defense against the nuclear threat, preferring to apply the resources to other military missions. Furthermore, the advent of the ICBM, against which there was no effective defense at that time, with its ability to deliver warheads over intercontinental ranges not only against cities and military targets, but in particular against air defense bases and radars, reduced even further the potential effectiveness of air defense.

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[1] SIPRI YEARBOOK 1987-- Table 1.7 lists some 487 French nuclear weapons in stockpile; Table 1.6 lists 536 British; Table 1.8 lists about 364 Chinese weapons. Natural Resources Defense Council estimates 25,000 U.S. nuclear bombs or warheads Bulletin of the Atomic Scientists, July 1987, page 56; NRDC Databook, Vol. IV: Soviet Forces and Capabilities (in draft), estimates Soviet warheads and bombs as 20,000 to 35,000 weapons.

In turn, the prospect of delivery of thermonuclear weapons by ICBM (or submarine-launched ballistic missile SLBM) spurred investigation of anti-ballistic missile (ABM) systems, also called "ballistic-missile defense" systems (BMD), even before ICBMs actually emerged on the scene. Such systems were investigated in great detail in the 1950s and 1960s, but the prospect for defense was so poor that the U.S. and the Soviet Union agreed in the 1972 ABM Treaty of permanent duration effectively to have no defense of the national territory, and to limit the defense of a single site to that which could be provided by a limited number of radars and no more than 100 interceptor missiles.

Indeed, in the 1950s, the United States considered the development and deployment of a system of orbiting rockets (BAMBI) to destroy enemy ballistic missiles in boost phase, but because of the poor prospects for survival of such a system (and perhaps because of the deleterious effects of putting weapons into space) did not proceed with such a system.

Following the 1972 ABM Treaty, the Soviet Union completed and has continued to modernize an ABM system around Moscow, which has never had the full complement of 100 interceptors, but is expected to acquire them within the next few years. In 1975 and 1976, the U.S. operated at Grand Forks, North Dakota, an ABM system for protection of a field of Minuteman missiles, deploying 20 exo-atmospheric SPARTAN missiles of multi-megaton yield, and 80 endo-atmospheric SPRINT missiles of low-kiloton yield. In 1976, the argument finally took effect in the U.S. that the cost of operation of the system was not repaid by any protection that it might offer (since it could be predictably eliminated by 100 Soviet warheads, and with high probability by far fewer) and the ABM system was destroyed.

In March, 1983, in his famous Star Wars speech, President Reagan called on the scientific community to give us the means "to render nuclear weapons impotent and obsolete" by intercepting "ballistic missiles before they reached our own soil or that of our allies," and for a year or so, the world press reported articles in which spokesmen for U.S. Government, industry, and some academic quarters considered as a serious prospect the development and deployment of defenses so good that (the President's purpose) the U.S. could eliminate its own nuclear weapons (and not be able to damage anyone), while living secure behind a total shield against adversary nuclear weapons. According to this dream, such a system would allow the United States (and its allies) to base their security not on the restraint of the leaders in the Kremlin, but on their own actions in designing, deploying, and operating a leak-proof defense against those weapons. But even the Strategic Defense Initiative Organization (SDIO, which is the mechanism created to pursue the dream of President Reagan) no longer suggests that a defense can replace deterrence by threat of retaliation, but only that it can bolster and supplement deterrence by threat of retaliation. And the United States continues to emphasize that it must modernize its ballistic missile force. "Plus c,a change ..."

Indeed, in February, 1985, the President's chief arms control advisor, Paul H. Nitze, announced two propositions (really three), stating that no defense against ballistic missiles could be considered for deployment unless it were

-- militarily effective,

-- adequately survivable,

-- cost-effective at the margin.

These criteria were signed into U.S. policy by President Reagan in Summer, 1985 in National Security Decision Directive (NSDD 172), and thus took on the force of law. A State Department document presenting the substance of NSDD 172 (Special Report Number 129, June 1985) emphasizes that a defense which is not adequately survivable could provoke attack rather than prevent it, and a defense which is not cost-effective at the margin could stimulate and arms race rather than quench one. Clearly, our inability to devise a defense meeting the criteria was at the base of the 1972 ABM Treaty agreement.

Against large number of ballistic missiles, boost-phase intercept is critical. Except in conjunction with a first strike on the retaliatory forces of the other side, such intercept can be done only from space-based systems, and those are vulnerable. Edward Teller has said in much testimony and many interviews that one cannot base a defense in space: "Lasers in space won't fill the bill-- they must be deployed in great numbers at terrible cost, and could be destroyed in advance of an attack."[2]

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[2] e.g., National Geographic, March 1984, page 363.

At present, the only operational ABM system in the world is that around Moscow. Even at 100% technical efficiency, the eventual 100 interceptors of the Moscow system could be predictably destroyed by 100 U.S. nuclear warheads of the existing 11,000 strategic nuclear weapons. The existence of the Moscow ABM system has simply increased the nuclear damage to Moscow if war comes, and will provide no protection.

Deterrence by promise of retaliation.

With no defense against nuclear weapons, how is it that nuclear weapons have not been used in war since 1945? The answer, of course, is that the use of nuclear weapons is deterred by the threat of nuclear response. In particular, both the U.S. and the Soviet Union have spent many tens of billions of dollars to base their nuclear forces in large part in survivable modes, so that they cannot be destroyed by a preemptive nuclear attack from the other side. Such survivable basing includes that on nuclear-powered submarines hidden in the oceans of the world (SLBM), in hardened silos in the vast interiors of the two countries, and (particularly in the United States) on long-range bombers which can take off from their airfields before they can be attacked even by ballistic missiles with 30-minute flight time (ICBMs) or 15-minute flight time (SLBM). Together with measures to ensure that political authority and military command and control remain after nuclear attack (adequate to launch the force to deal a crushingly destructive blow to the other side), a regime has been maintained in which no rational leader could judge the situation of his or her nation to be better as a consequence of its initiation of nuclear attack than in the absence of such an attack.

Note that the Soviet Union is deterred by the judgment that the Soviet Union is far healthier, wealthier, and more secure by not initiating a nuclear attack on the United States and it allies, than it would be after having initiated such an attack and received the nuclear response. The same is true for the United States. Such a security regime by deterrence if often characterized as one of "fear," of "mutual assured destruction," or as a "balance of terror." While far from ideal even from the point of view of citizens of the nuclear superpowers, the regime of mutual deterrence is neither so bad as it has been painted by some, nor so secure as it has been portrayed by some of its supporters. In particular, there is the prospect of nuclear war either by physical accident or by misjudgment. And there is the problem that if the nuclear weapons are indeed used, vast destruction will follow, and most of those destroyed will have had nothing to do with the decision to build or operate the nuclear forces. Measures taken "to strengthen deterrence" may well instead weaken security by doing little to strengthen an already-strong deterrence, but rather increase the probability of war by miscalculation, accident, or instability.

The questions of fear and morality may be illustrated, however, by a simplified example. Suppose there are not two nations but two individuals, with the same inability to devise defenses against nuclear weapons. Unwilling to surrender, they may agree, explicitly or tacitly, to accept and even to facilitate a regime in which there is mutual security or none at all. Each arranges an infernal machine to destroy the other, if the other has destroyed him. Once arranged, no further thought need be given to the fact that the other side has at all times the means to take one's life. But even in the case of individuals, a good deal of thought really ought to be given to the prospects of accident-- that the machine will operate when it is not wanted, thereby initiating the destruction of the other side and (just as certainly) the ending of one's own life. However, freely arrived at in a dangerous world, such a deterrent regime between individuals is entirely moral, and it eliminates the fear of intentional attack.

Aside from the prospect of accident, there is another hazard in the deterrent regime-- that the other side may find a way to disable the infernal machine. This could be done, in principle, by a preemptive strike or by a defense. In the one case, the retaliatory force could be disabled before launch, and in the other, it could be barred from reaching its target. Given other desirable prospects for the expenditure of resources, our two individuals could be depended upon to make reasoned judgments of the survivability and penetrativity of their own deterrent forces, and not to multiply them beyond all reason.

However, in the historical world of nations rather than individuals, of government bureaucracies and industry, of elections, alliances, and the Press, there is a strong incentive to worst-case analysis, and to building deterrent forces far beyond the level required at any time to deter the other side. Indeed, one has an example in the suggestion that the other side is deterred not by a comparison between the prospects before it initiates a strike and the prospects afterwards, but that the Soviet Union would not be deterred from a nuclear strike against the U.S. so long as the Soviet Union could look forward in the ashes of

nuclear war to somewhat better status than the United States in those ashes. Never mind that no individual has ever been identified on either side who would personally make that judgment. Furthermore, the intelligence of individuals in the world has long been insulted by invoking vulnerability of part of the strategic retaliatory force as a reason to install in that same vulnerable silo structure (the Minuteman missile silos) a system (the 10-warhead MX) for rendering both U.S. and Soviet retaliatory weapons even more vulnerable.

And there is the whole set of arguments which go far beyond deterrence (but use the same name) that the Soviet Union can only be deterred by "holding at risk its hardened and mobile military targets," especially ICBMs in their silos and mobile basing systems. Indeed, it has been explicitly proclaimed by some that the closed nature of Soviet society can be countered only by a "first-strike capability" on the part of the U.S., and that a retaliatory capability is insufficient to deter nuclear war.

In the few years between 1945 and acquisition of substantial numbers of nuclear weapons by the Soviet Union, there existed the possibility that nuclear weapons could be used on the battlefield to counter aggression waged by forces which did not possess nuclear weapons. Such "tactical nuclear weapons" (TNW) or "battlefield nuclear weapons," even in prospect would have the effect of forcing changes in organization and operation on the other side, in such a fashion that the other side did not mass its forces as is desirable to have local numerical superiority for attack, but would operate in a lower-density dispersed fashion. Even without use, TNW would thus give an advantage to the side that had them. Furthermore, strategic nuclear weapons could be used to deter conventional attack by the promise to inflict destruction of such a level that the aggressor would not benefit on balance from its initiative in attacking.

However, such a prospect is not encouraging to a potential adversary without nuclear weapons. Whether judging properly the other side, or taking the "prudent view," or fearful of how it might behave, itself, in the shoes of the other side, it might note that this deterrence (of conventional attack, since it has no nuclear weapons) by threat of nuclear attack has broader use-- that of "compellence." Not only can the nuclear nation prevent the non-nuclear nation from doing something, it can force the non-nuclear nation to do its bidding. In addition to national pride, and the desire to be in a similar position with respect to other non-nuclear nations, the acquisition of nuclear weapons by the Soviet Union may have been spurred by Soviet unwillingness to accept such a potential dominance by the United States.

When both parties have nuclear weapons, however, deterrence of nuclear attack by threat of retaliation remains feasible. The individuals of our prior example (perhaps absolute emperors) could also deter conventional attack. They need only promise to cause damage greater than the benefit which is achieved day by day by the conventional aggressor. And if the conventional aggressor responds in a proportionate manner with nuclear weapons, that does not really reduce the deterrent effect of the threat of nuclear retaliation, but only illustrates a form of blackmail which may be rejected by suitable will.

In similar fashion, the emperor could also deter conventional aggression against an ally, but the deterrence would depend upon the belief by the potential aggressor that the nuclear retaliation would in fact be carried out.

At present, NATO depends on nuclear weapons to supplement its conventional forces in deterrence of conventional attack, although many believe that NATO could readily achieve a posture in which NATO conventional forces were totally adequate to prevent potential attack by Warsaw Pact forces, and the NATO security would be improved by such a posture which did not require the "first use of nuclear weapons," but relied on the potential use of nuclear weapons only in retaliation, the prospect of such deterring nuclear attack.

Crisis stability and counterforce weapons.

Although it may be understandable that one side does not want to leave the other with a monopoly on first-strike counterforce capability, it is likely that its security is reduced by its acquisition of such a parallel capability. In the absence of significant defenses, even if one side could destroy all of the strategic retaliatory force of the other side (for instance, by the use of accurate warheads against silos), the prospect of such an attack would simply force the potential recipient to put its retaliatory forces on "launch on warning," or "launch under attack," so that the result of a strike intended to destroy the retaliatory force would result simply in its being launched and in the destruction of the aggressor. Readiness to launch

at any moment in response to indications from the early-warning satellites (LOW) or in response to such warning plus the detection of at least one nuclear explosion on one's territory (LUA) would certainly and properly enhance fear of accidental war, in contrast to a posture in which the retaliatory force was survivable and in which posture there would be no hurry to launch, even after a full-scale nuclear attack. However, the prospect of accidental war is increased, and not reduced, when both sides have the ability to destroy the silos of the other side.

It could be worse. Consider the (totally unacceptable) situation in which both the U.S. and the Soviet Union have precisely equal forces, consisting on each side of 100 missiles in silos, each with 10 multiple independently-targeted reentry vehicles (MIRVs). Assume these missiles are accurate and reliable. Assume also that they are fueled by inexpensive and efficient hydrocarbon jet fuel and ("cryogenic") liquid oxygen, rather than by the "storable liquid fuel" of the present day. Assume also that (as was the case with the early U.S. missiles) it takes an hour to fuel the missiles.

Assume that there are no other nuclear weapons. Under these conditions, there is absolute insecurity for the two sides, because there is absolute instability. If either side should decide to attack, it need only fuel ten of its missiles surreptitiously, and launch them against the 100 silos of the other side. Even if the other side has early-warning satellites, it will have only 30 minute warning of the destruction of its silos, by assumption not long enough to fuel and launch its missiles. Each side will understand that the other side could destroy it at any time, without the prospect for retaliation. Each side, would realize that it is only a matter of time until the other side would judge it too great a hazard in some future time of crisis. So even if one side has no suspicions at all about the ill will of the other side, if it suspects that the other side may at some time harbor suspicions about itself, it will feel driven to launch and thus to destroy the other side's retaliatory capability. Of course, even the early ICBMs came on the scene after bomber-delivered nuclear weapons were available, and so the preemptive destruction of these ICBMs would not have eliminated the overall retaliatory capability. In more recent years, the Scowcroft Commission appointed by President Reagan January, 1983 emphasized that the claimed vulnerability of the Minuteman silos did not constitute a "window of vulnerability" and a strategic hazard, because they housed only a portion of the retaliatory warheads. The warheads based on submarines and carried by bombers were not subject to preemptive strike by the Soviet Union. Nevertheless, the preservation of stability against first strike is an important criterion to consider as nuclear forces are reduced.

In the United States, some unfortunate dynamics of nuclear deterrence are clear. For instance, in 1962, Secretary of Defense Robert McNamara in a famous speech at the University of Michigan noted that the number of nuclear weapons to be acquired by the United States in its building of 1000 Minuteman silos and a fleet of SLBMs (together with the bomber-delivered weapons) was far in excess of the number required for deterrence by promise of retaliation. For this pure deterrence, he estimated that 400 one-megaton weapons would suffice. Thus, the additional weapons could not be said to strengthen deterrence, and McNamara's rational mind was looking for something for them to do.

DAMAGE LIMITATION. Ah-ha! If deterrence failed and nuclear war actually came, these "excess" weapons were to be used for damage limitation, targeted not against industry, population, conventional military forces ("counter-value") but against Soviet strategic forces which might damage the U.S. (counter-force). Although Secretary McNamara explained that strategic forces would not be purchased for this purpose, but only that forces in excess of those required for deterrence would be planned for use in this way, even this "secondary" mission for the U.S. retaliatory forces called forth a lot of enthusiasm among civilian and military staffs and industry, and legitimized interest in the counterforce role.

For counterforce application, good accuracy is particularly valuable; specific intelligence information is required, and the like. In any case, the mission of "damage limitation" ensured that no strategic force element remained unassigned in the event of war. This public announcement called attention to the potential for the use of these same forces in a first-strike role. Although almost immediately deemphasized by the Secretary of Defense, this "second-strike counterforce" application emerged again in the Nixon and Ford administrations, and was pursued with an enthusiasm more appropriate to first-strike counterforce. Indeed, second-strike counterforce is always a suspect goal, since one might expect that an aggressor who has used some nuclear weapons in a substantial attack would certainly put the remainder of the force on launch on warning status, so that it would specifically not be vulnerable to second-strike counterforce response. Given that likelihood, continued attention to second-strike counterforce capability and plans would seem rather to indicate the creation of a first-strike counterforce system, in the expectation of possible use.

Thus, any strategic ballistic missile system on either side with costly accuracy beyond that needed for ordinary targets (suitable for attack on hardened missile silos) arouses fear of a first-strike capability and intent.

Arms-race Instability.

In addition to the example of crisis instability provoked by accurate MIRV systems on both sides (which could be countered by LOW), the commitment not to launch on warning would compel a side to build additional (and perhaps different) strategic offensive force (retaliatory force) if counterforce capability were perceived on the other side. In fact, as soon as one side assesses it as feasible for the other side to deploy accurate counterforce weapons, unless the deployment time and the intelligence information is adequate to ensure that such cannot be done before a counter is available, the one side will build additional weapons to avoid destruction before launch.

Thus, those who want additional nuclear forces (and there are such in government, the military, and industry) will exaggerate the accuracy on the other side, will emphasize the unacceptability of launch on warning, will maintain some vulnerable forces, in order to motivate the acquisition of additional forces, whether or not the other side has capability or intention to attack the strategic retaliatory force.

While some would endorse the building of additional nuclear forces simply to threaten the other side beyond the level required for deterrence by threat of retaliation, many more will support the acquisition of additional nuclear forces in order to maintain minimum deterrent capability in the presence of both some potential future defensive system and the threat of destruction before launch. Thus, if 400 reliable weapons are assumed to constitute an effective deterrent capability, the fact that the United States has 11,000 and the Soviets 10,000 is not necessarily an indication of motives other than deterrence, since much of these increased numbers arose from the (perhaps inaccurately) perceived prospect of effective defenses and counterforce capability on the other side.

In addition to these strategic forces, many thousands of nuclear weapons are available as nuclear artillery shells, nuclear-armed counter-air weapons, torpedoes, battlefield bombs, and the like. Against an adversary armed with nuclear weapons, such tactical weapons do not help to win in armed conflict, but simply to ensure enormous destruction on both sides, and of the civilian population of the nations concerned.

The strategic nuclear offensive and defensive weapons of the Soviet Union are estimated by the Central Intelligence Agency as together costing some 20% of the Soviet military budget.[3] Non-strategic weapons add to this burden. In addition the the economic burden on both sides, we have already discussed the prospects for instability which arise as a result of nuclear weapons beyond those required for deterrence. In its most stark form, instability will bring about the war that neither side wants. The frankly unstable situation is exemplified by the accurate MIRVed forces which are fast to fly and slow to fuel. But there is also the possibility of a metastable situation, in which under normal circumstances there will be no unintended launch, but in the presence of a crisis or after the use of some small number of weapons, the margin of stability will have been exceeded, with the resultant launch of a large fraction of the weapons on both sides. Not so much the numbers of weapons, but the nature of nuclear weapons and their basing posture can lead to instability. Furthermore the number and nature of nations possessing nuclear weapons can contribute to instability, and a massive reduction in superpower nuclear arms should be accompanied by effective measures to deny the proliferation of nuclear arms.

The incentive to reductions in nuclear weapons is the reduction of the economic burden, but primarily the motivation is to improve security. One would wish to reduce in such a way as to reduce the likelihood of accidental launch, and to improve not only crisis stability as mentioned above, but also arms race stability. If nuclear weapons were reduced all the way to zero, there would be no prospect to deter nuclear or conventional attack, or to deter disruption of societies by other means such as biological warfare. The elimination of nuclear weapons is also impeded by the prospect that an individual nation could secrete a sufficient number of nuclear weapons and their delivery systems to rule the world as a monopolist of

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[3] R. Gates and L. Gershwin, "Soviet Strategic Force Developments" Testimony of June 26, 1985 before a joint session of the Subcommittee on Strategic and Theater Nuclear Forces of the Senate Armed Services Committee and the Defense Subcommittee of the Senate Committee on Appropriations.

nuclear weapons after the others reduce legitimately to zero. Or, there might be a stockpiling of rapid-production capability, so that in time of crisis there would be a race to produce large numbers of nuclear weapons and to suppress the production of nuclear weapons on the other side.

As weapons are reduced in number although not eliminated, the preservation of deterrence would be imperiled even by a defense (or prospect of a defense) which would be negligible against existing numbers of nuclear weapons. And a counterforce capability which is unimportant against present strategic forces would loom large against a much reduced strategic retaliatory force.

So secret stocks and the prospect of rebuilding nuclear weapons are concerns with the total elimination of nuclear weapons. In reducing to a "minimum deterrent," one encounters the definitional problem of exactly the level which can be counted upon to deter the other side. We have on the one hand the McNamara criterion of some 400 weapons, although much lower levels have also been advanced, even to deterrence by the prospect of even a single nuclear weapon exploding on a major city.

At greatly reduced numbers of weapons for deterrence, verification must be more rigorous, because one must establish with greater sensitivity the absence of defenses, of counterforce capability, and of hidden stocks which would be unimportant in comparison with the present large numbers of strategic weapons. And massive reductions must at least maintain and preferably improve first-strike stability. This would be ensured if each nation determined that it would be worse off by striking first than by waiting.

I shall discuss first in some detail what seems to me a highly desirable interim goal compared with the present situation. Naturally, the ultimate goal would be not only the elimination of weapons but the elimination of conflict, which would reduce not only the economic but also the psychological burden and fear of more conflict, either nuclear or conventional. I don't know how to achieve this ultimate goal, and there is certainly no consensus on how to go about it. I do propose that we can have a far more rational, less costly, and less threatening posture for the period until we learn how to go further in the reduction of nuclear weapons and the threat of war.

A Deep-Cut regime.

Over the last few years there has been considerable discussion of a regime comprising the following:

1. The 50,000 warheads total in U.S. plus Soviet inventories would be reduced to 1,000 on each side, which would be based on national territory or as SLBMs.

2. Both sides would respect the 1972 ABM Treaty, which would evolve to a total ban on defense against strategic ballistic missiles.

3. Anti-satellite tests would be banned, as would the test and deployment of space weapons of any kind.

4. The nuclear warheads of the United Kingdom, France, and China would be reduced to 200 each.

5. An extremely effective anti-proliferation regime would be mounted to ensure that additional countries do not acquire nuclear weapons. Part of this regime would be a total ban on nuclear explosion testing, which might be approached by a declining annual quota of low-yield tests.

6. Adequate verification, including cooperative means and on-site inspection as agreed and necessary, would be essential to achieve and maintain this regime.

7. Each side would deploy its permitted weapons in such a fashion as to strengthen stability against first strike. Although each side would explain and open for verification the basing of its 1,000 warheads, neither side could compel a particular basing on the other side. In my view, U.S. weapons should be based as follows:

--400 warheads in the form of single-warhead small ICBMs in soft silos.

--400 warheads divided among 50 small submarines, each carrying 8 small single-warhead SLBMs.

--200 warheads carried on 100 aircraft as air-launched cruise missiles, two to an aircraft.

Each warhead can weigh no more than 300 kg, including reentry vehicle for a strategic ballistic missile; the warhead maximum yield would be limited by the weight limit to about 0.5 megaton. It would be permitted to have any yield lower than that, including the possibility of variable yield weapons, such as exist at least in the U.S. inventory.

This is not the place to go into detail on the details of a total ban on ballistic missile defense or on anti-satellite and space weapons. In regard to the latter, the Soviet Union formally submitted to the U.N. General Assembly August 19, 1983 a draft treaty,[4] similar to one which I helped present 3 months earlier to the Senate Foreign Relations Committee.[5]

The reduction of U.K., French, and Chinese weapons (at least from the announced plans of the first two nations) is clearly necessary if the superpowers are to undertake the proposed 95% reductions. China has long ago committed itself to reductions as soon as the United States and the Soviet Union reduce by 50% or more, and appears willing to go to such a level. The same seems true of the United Kingdom, although there is as yet no public commitment on the part of France.

It should be emphasized that while France, the U.K., or China could not by its own behavior impel deep cuts in super power inventories, it has it within its power to prevent such deep cuts, by an unwillingness to return to the prescribed number of warheads.

Nor could such massive reductions take place without considerable confidence that additional nations would abstain from the development and acquisition of nuclear weapons. For this purpose, the ending of the existing regime of unlimited numbers of underground nuclear tests of 150 KT or less seems essential. Antipathy among the nuclear nations to nuclear tests by additional nations would seem greatly strengthened if there were no nuclear testing allowed at all, and this regime of a total ban on tests, if it cannot be achieved immediately, should at least be approached by a small and declining annual quota of tests of 1 KT or less.

Verification that numbers of nuclear weapons and delivery systems do not exceed the declared numbers and types will be achieved by national technical means, supplemented by cooperative measures (as in the SALT treaties), and by challenges and visits, as agreed and necessary. To remind the reader, the SALT I and SALT II agreements included commitments not to conceal the controlled activities (such as fitting out of submarines, maintenance of missile silos, and the like). They also included the preservation of functionally related observable differences (FRODs) to distinguish those aircraft capable of carrying ALCM from others. In this deep-cut regime, verification will be aided by the elimination on either side of all nuclear weapons aside from these strategic 1000. Presumably, all missiles of intermediate and short range will have been eliminated long before. Compliance with the nuclear test ban will be verified by many unmanned seismic stations.

Nuclear warheads convey the capability to destroy, whether delivered by ICBM or commercial aircraft. No one will be comfortable unless reassured that the side which has nominally reduced from 25,000 to 1,000 nuclear warheads has in fact none secretly retained or capable of fabrication. At this point, I can only sketch a control system for these warheads, which has been insufficiently worked out and which would be invoked in stages as warhead numbers

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[4] Reproduced in "Space Weapons," joint articles-- 'History and current debate,' by R.L. Garwin, and J.E. Pike and 'Effect on strategic stability,' by E.P. Velikhov in Bulletin of the Atomic Scientists May 1984, Volume 40, Number 5.

[5] ibid, presented in testimony May 18, 1983.

are reduced. Ultimately, each nuclear weapon will have an effective seal which, in principle, plays the same role as the replaceable seal on an electric power meter, bank vault, or the like. The seal must be so contrived that it cannot be counterfeited or removed without revealing that fact. In addition to the seal, there must be a tag, identifying the particular weapon.

The verification regime includes the ability to freeze on demand certain establishments or military vehicles or locations, and the right to search (unobtrusively) for nuclear materials or weapons. The host nation should reveal at the beginning of the search the location of any legitimate weapon within the defined area, and have its location and identity verified.

In addition, it might be agreed that weapons may be deployed only in defined areas and on specific launch vehicles. To verify the latter, a nation might have 1,000 envelopes in a particular (sealed and tagged) safe in its capital. Perhaps 10 times a year, the other nation could request to see an envelope at random, or to look at the envelope corresponding to a launcher identified precisely by position. The launcher would be frozen, the envelope produced, and agreement determined between the actual identity of the warhead on the launcher and that specified in the envelope.

For instance, if the 50 U.S. submarines were proscribed from operating within 2500 km of Moscow (and Soviet SLBM subs proscribed from 2500 km of Washington), compliance could be verified by an occasional random challenge to Submarine number 33, for instance. Within two hours, Sub 33 would have to surface, and identify itself in a fashion which could be unambiguously verified by encrypted tag within the submarine and on the missiles in warheads contained therein.[6] An actual visit to the spot by aircraft would be permitted, but unnecessary, in view of the capability of determining submarine position and identity from the cooperative verification system carried on board, and from time of arrival of the radio signal at the receiving satellites.

There is room for a lot more ingenuity in devising seals and tags capable of sustaining such a burden of security, but the more fundamental problem is to ensure the absence of illegitimate nuclear weapons. This would be done in large part by the identification and monitoring (as under IAEA safeguards) of all establishments with any fissile material, and the random, cooperative search to establish that no fissile material is anywhere else under the control of the nation.

Nothing is Forever.

What if a nation abruptly or after extensive planning abrogates the agreement and launches an all-out effort to build vast numbers of nuclear weapons and delivery systems? Fundamental to such an agreed security regime is the concept of "timely warning," which means that it would be incompatible with such security to allow the legitimate possession of plants capable of building (for instance) 10,000 nuclear warheads per year and the accompanying delivery means. But there would be no legitimate use for such plants, and they would be of substantial size if they were able to augment the permitted stockpile signficantly, given the very considerable number (1000) of warheads retained in this deep-cut regime. The question itself implies additional controls on facilities and readiness to build additional weapons of the permitted type or of a novel type.

Insofar as the stability of much reduced strategic forces depends on the absence of defense, the unconstrained evolution of air defense against the cruise missiles would stress the willingness of the other side to reduce to very small numbers. Similarly, unconstrained antisubmarine warfare practices in peacetime that imperiled the pre-launch survivability of the much-reduced number of sea-based missiles would threaten the stability of this regime of massive reductions.

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[6] T.M. Garwin, "Tagging Systems for Arms Control Verification," report for U.S. Arms Control and Disarmament Agency, February, 1980.

SILO-BASING OF ICBMS, OR MOBILE MISSILES? In a recent paper[7] a Soviet group analyzed stability in a regime of massive reductions, taking for their example 600 mobile ICBMs (single-warhead) for the USSR and for the U.S.. If the Soviet Union feels more comfortable with 600 mobiles than with 600 silo-based single-warhead small ICBMs, they should be encouraged to deploy their residual force in that way, but it should be recognized that the (well-warranted) aversion to silo-basing of MIRVed ICBMs as contributing to instability (unless contemplated for launch under attack, or unless supplemented by other survivable offensive force) does not apply to the single-warhead ICBM. It is generally accepted that to destroy a silo with high reliability, an attacker must provide two or more warheads, so that he disarms himself relatively and is worse off after the attack, provided that he does not have a very much larger force to begin with. There is no longer any reason to believe that mobile missiles need be less accurate than silo-based ICBMs, and those based in silos are far cheaper than ICBMs provided with survivability by mobility and concealment.

The Path to this Interim Goal.

Building on the commitment at Reykjavik to reduce strategic weapons by 50 percent in five years, and assuming that an INF agreement will be reached in 1987, which will result in the elimination of all INF and short-range nuclear missiles within the year, one recognizes that this INF-SRNF category is less than 2000 weapons on each side.

Nuclear weapons and their delivery vehicles would be destroyed in the following manner:

First, it is intended that not only the nuclear warhead but also the unmanned carrier (ICBM, SLBM, cruise missile) be destroyed. A particular missile selected for destruction by identification or location should be observed sufficiently closely as to determine that the nuclear weapons are disassembled from it and transported to the nuclear weapon destruction establishment. The carrier vehicle should in turn be taken to an appropriate destruction establishment, where dangerous materials are removed, and the structure and instrumentation crushed and scrapped. Alternatively, the missile can be destroyed by explosion.

The disassembly plant on national territory is operated entirely by nationals of the country concerned. Appropriate measures are taken to identify clearly the nuclear weapon as to identification and type, and to establish that it has the proper amount of fissile material as it is brought into the plant. All of that weapon must leave the plant, the fissile material in small protective containers, allowing it to be assayed as to mass and composition, and transferred to IAEA safeguarded stocks. U-235 should be denatured to 20 percent enrichment, and the plutonium must be carefully safeguarded. Safeguarded tritium can be withdrawn as necessary to compensate for tritium decay in the legitimately retained weapons. The question of destruction of weapons and the transfer of the fissile material to the civil and IAEA inventory has been considered by nuclear power experts in the referenced paper.[8]

In the case of nuclear bombs, it is only the bombs and their ballistic cases which will be destroyed, not the bombers.

First candidates for destruction are the INF and SRNF. In addition, over a 10-year period, all non-strategic nuclear weapons would be eliminated. This could be done by a declaration of numbers of weapons by types, and a mutually pleasing selection for destruction according to the techniques proposed by Calogero and by Salter.[9] For instance, the Soviet Union might

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[7] Soviet Committee of Scientists for Peace, Against the Nuclear Threat, "Strategic Stability Under the Conditions of Radical Nuclear Arms Reductions", (Moscow), April 1987.

[8] J. Taylor, R. Balent, J. Barton, and T. Shea "Converting nuclear weapons to peaceful use", Bulletin of the Atomic Scientists February 1985, pp. 35-38.

[9] F. Calogero, "Some Remarks, and a Proposal, Concerning the Limitation of Strategic Armaments", Proceedings of the 22nd Pugwash Conference, Oxford, September 1972, pp. 305-317.

assign "values" to the individual U.S. tactical weapons, adding to a total of 10,000. The U.S. could then choose which weapons totalling a value of 1000 it chooses to destroy. The next year, the Soviet Union could similarly assign values to the remaining U.S. tactical weapons, adding to 9000, and the U.S. would again choose which weapons totalling 1000 it wishes to destroy. If one assumes about 10,000 strategic weapons, 1000 INF and SRNF, and approximately 13,000 other weapons on each side, at the end of the first year there would remain approximately zero INF/SRNF, 11,700 TNF, and 9000 strategic weapons.

The U.S. and U.S.S.R. have negotiated at length about a 50 percent reduction in strategic weapons, and I will give here only a simple and independent example. First, it is warheads which each side wants to limit on the other side, not launchers. Nevertheless, launchers may well be important to limit, in order to avoid a capability for too rapid growth on abrogation of the treaty. There is an interesting waypoint on either side, which arises when one removes all but one warhead from each of the ICBMs and SLBMs. The U.S. would thus have 1000 warheads deployed in its Minuteman silos, and another 600 on SLBMs (each carrying a single warhead). The 100 B-1 bombers would carry 4 warheads each, for a total of 2000. Similarly, the Soviet Union would have 2000 warheads. Interestingly enough, the only construction that need be done in order to achieve this goal is the fabrication of a suitable number of aluminum, concrete, and steel dummy warheads, to occupy the positions on the MIRV bus from which real warheads are taken. In the anticipation that strategic warheads are reduced to 5000 in five years and to 1000 in ten years, and in view of the minimal changes in force structure and zero investment required to go to 2000 strategic weapons, this might be targeted for the seventh year (1993).

At this point, in principle, one could achieve the interim goal (to hold indefinitely until replaced by a further agreement on reductions or eliminations of nuclear weapons) simply by eliminating half of the launch vehicles. However, if one were to have in this way 20 warheads on each of 20 large submarines, and 1 warhead on each of 400 large missiles, and 2 ALCM on each of 100 large bombers, it would need only the production of warheads to increase the delivery capability tenfold. One would feel much more secure if the other side had delivery vehicles tailored to the single warhead, so that it would be a much longer and more costly effort to rebuild the force.

I have considered reducing the permitted number of warheads to 500 as a penalty, if a side insisted on keeping the oversize delivery vehicles, but no matter how much good faith was expressed and indeed inhered, I believe such an asymmetry would be untenable. The side that had 1000 warheads on 1000 tailor-made small delivery vehicles would be all the more convinced that the other side with massive delivery vehicles had accepted a limit of 500 warheads only because it valued the capability to break out of the limit. Thus I believe that one must plan by 1996 to have replaced the MX carrying one of its present 10 warheads by means of a small ICBM of perhaps 15,000 kg weight which carries a single RV. Similarly, the large submarine should be replaced with small ones carrying 8 or 10 single-RV missiles. It is not clear what to do about the bombers. It would be perfectly reasonable to make much smaller bombers capable of flying, unrefueled to the ALCM launch point, but unless the B-52 and the B-1 were destroyed, even though they were retired to conventional weapon carriage they would be available to carry a vast number of ALCM if such were ever produced in violation of or on abrogation of the agreement.

Perhaps this hazard would be compensated by the lack of restraint on air defense; because of the absence of U.S. air defense, the U.S. would be willing to give up B-52 and B-1 in order to have the Soviet Union give up its less capable large-bomber fleet. I think that should be left for negotiation.

Epilogue.

Nuclear weapons are held from use by deterrence, and this will continue until someone identifies a path to the elimination of nuclear weapons, and persuades the nuclear powers to take that path. Nevertheless, there is an interim goal in which the 50,000 existing nuclear weapons are replaced by 1000 strategic nuclear weapons in the U.S. armory, a similar number for the Soviet Union, and perhaps 200 each for the U.K., France, and China. In order to ensure that such a regime be stable against first strike, the 1972

F. Calogero, "A Novel Approach to Arms Control Negotiations", Proceedings of the 27th Pugwash Conference, Munich, August 1977, pp. 170-176.

S.H. Salter, "Stopping the Arms Race: A Modest Proposal," Issues in Science and Technology Winter, 1986.

ABM Treaty must be respected and strengthened; there must be a ban on anti-satellite tests and deployment, and on space weapons. Furthermore, an increasingly effective and cooperative verification regime of the destruction of nuclear weapons and delivery vehicles and of those which remain must be brought into being. Proliferation of nuclear weapons to other nations would present an even greater threat than now, and must be opposed by a stringent anti-proliferation regime, augmented by an increasingly strict and eventually total ban on nuclear tests. One path toward the goal of 1000 weapons on either side is described, leading to that posture by 1997, from which it would be costly and time consuming to return to the present vastly excessive number of nuclear weapons.