Nuclear Weapons Databook
Working Paper 90-1

Making A Virtue of Necessity: START and Strategic Modernization

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May 15, 1990

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After nearly eight years the United States and the Soviet Union are close to concluding a START treaty. Though it will not be finished in time for the May 30-June 3 Washington summit, it is sufficiently defined to analyze its central military, technological, political and economic implications. This report discusses some of those implications and comments on the treaty's shortcomings. Among the paper's major findings and recommendations are:

FINDINGS

* The START treaty has the character of making a virtue of necessity. As with many past treaties this will be arms control without pain or sacrifice. To a public that believes the problem of the nuclear arms race is being addressed the recognition of the true nature of the treaty with its limited cuts, "fine print" and "loopholes" could lead to disillusionment and anger.

* Actual reductions of U.S. and Soviet strategic offensive nuclear warheads will be about one-third rather than the 50 percent often advertised. The reduction will be from combined warhead levels of 23,300 warheads in 1990 to 16,000 in 1998. The U.S. portion (9000) is approximately the number of strategic weapons it had in 1973. The Soviet portion (7000) is approximately the number it had in 1980.

* Almost two dozen U.S. and Soviet strategic nuclear weapon systems would be permitted under the terms of the current proposals, though perhaps not in as large numbers as originally planned.

* Retirements will be of systems scheduled to be retired in any case. The lower military budgets forecast for the future would not support the current strategic forces for either nation.

* START will result in little economic savings in the short term.

* Under a START treaty the nature of the arms race will further shift from quantitative to qualitative competition.

* The retirement of large numbers of warheads ensures that no additional plutonium or highly enriched uranium (HEU) need be produced for weapons in the U.S. or the Soviet Union. A fissile material cutoff may occur by default.

RECOMMENDATIONS

* START II talks should begin immediately upon entry into force of START I. A START II treaty should aim for deep reductions of launchers and warheads so that arsenals are cut by significant percentages. All weapon types should be counted, including bombs, air-to-surface missiles (ASM), and air-launched cruise missiles (ALCM), with no "discounting."

* Additional measures should be added to START II to strengthen the treaty and curb modernization. These could include bans or limits on future missile types and restrictions on ballistic missile flight testing.

* Success in other arms negotiations, such as a nuclear test ban or naval arms control, would further assist in constraining the arms race.

* A comprehensive arms control and disarmament agenda should be developed along the lines of Soviet President Gorbachev's January 1986 fifteen year plan, to eliminate all types of nuclear weapons.

* The most significant act that the U.S. could take to slow the pace and change the character of the strategic nuclear arms race would be to radically revise its Single Integrated Operational Plan (SIOP). Just as there will be a wide-ranging review of NATO's mission and strategy so too should there be an in depth examination of U.S. strategic nuclear war plans. Deep reductions in U.S. strategic forces will be impossible without major changes in the SIOP.

The conclusions in this report are illustrated by seven Tables. Tables 1 and 2 present estimates of current U.S. and Soviet strategic forces as of mid-1990. Table 3 outlines the current START negotiating proposals, showing common positions and remaining differences. Tables 4 and 5 are projections of nominal U.S. and Soviet strategic forces after a START treaty (circa 1998). Table 6 lists current and future weapon programs that would be allowed in part or in full under START. Table 7 details the retirements that would have to take place to comply with the START limits, assuming the forces presented in Tables 4 and 5.

As a timetable we have assumed that a treaty will be signed by the end of 1990. U.S. Senate and Supreme Soviet hearings could then take place from February-May 1991, with ratification in June and entry into force on July 1, 1991.[1] The two sides have agreed that reductions would occur over seven years, and the treaty would have a duration of 15 years.

The SALT treaties provided a measure of predictability about strategic force trends even while warhead numbers grew significantly. The two sides added over 13,000 warheads to their respective strategic arsenals since SALT I was signed eighteen years ago.[2] Launcher limits were set largely to accommodate future programs and did not radically alter the relationship of the different "legs" of the strategic triads of each nation. During the Reagan Administration (1981-1989) the Soviet Union added 3400 strategic warheads to its arsenal while the U.S. added 2100. A START treaty will not allow such growth in strategic forces. It will essentially reduce U.S. and Soviet nuclear forces back to the numerical levels of the late 1970s, before the recent buildups began, but with more capable weapons.

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[1] The SALT II Treaty was signed on 18 June 1979. The Senate Foreign Relations Committee held 28 days of hearings over a four month period during July-October. Markup was held between October 15 and November 9 with its report issued on November 19. The Senate Armed Services Committee held sixteen days of hearings between July 23 and October 24. The INF Treaty was signed on December 7, 1987. The SFRC held 20 days of hearings between January 25 and March 22, 1988. The SASC held 13 days of hearings between January 25 and February 23. Their reports were issued April 13 and April 1 respectively. On May 15 the INF Treaty was brought to the floor of the Senate. After floor debate the Senate voted 93 to 5 on May 27 to approve the INF Treaty. The treaty entered into force on June 1.

[2] See Robert S. Norris and Thomas B. Cochran, "US-USSR Strategic Offensive Nuclear Forces 1946-1989," Nuclear Weapons Databook Working Paper 90-2, May 1990.

Advertised Versus Real Reductions

The Reagan Administration, the Bush Administration, as well as many in the media, routinely report that the START Treaty "calls for 50% reductions to equal levels in strategic offensive arms."[3] This is a common misperception about what will actually happen under START. In fact 50 percent reductions will not occur in Strategic Nuclear Delivery Vehicles (SNDVs), in total warheads, or in ballistic missiles:

1) The U.S. currently has 1847 SNDVs and the Soviet Union 2448. The agreed limit of 1600 would mean a 15 percent reduction for the U.S. and a 35 percent reduction for the Soviet Union.

2) Comparing warheads before and after an agreement reveals that there would be a reduction of approximately 25 per cent for the U.S. (from 12,000 warheads to some 9000) and a reduction of about 35 per cent for the Soviet Union (from 11,300 warheads to some 7000). The combined strategic arsenals would drop from 23,300 to 16,000, or 30 percent.

3) In ballistic missile warheads the U.S. would reduce from 7500 to 4900, a 35 per cent drop. The only area where there is a 50 per cent reduction is in Soviet ballistic missile warheads. Specifically the number of SS-18s will be halved. Overall Soviet forces would be reduced from approximately 10,100 to 4900 warheads and as a consequence so would the throwweight.

Negotiators on both sides have adopted a variety of tactics, no doubt under pressure from their respective civilian bureaucracies and military services, to exempt, or "discount" certain weapons from counting towards the ceilings or subceilings.

One major way has to do with the way bomber weapons are counted. Modern strategic bombers carry three different types of weapons; gravity bombs, ASMs,[4] and ALCMs. Both sides have agreed, primarily because of alleged verification difficulties, that all bombs and ASMs together on one bomber will count as only one warhead under the 6000 warhead ceiling. Thus a bomber carrying 24 bombs/ASMs will be counted as one warhead, not 24. The actual number of bombs currently deployed with each nation's strategic bomber force is difficult to gauge and will remain so after a START agreement. The U.S. currently has a larger bomber force and would presumably retain a warhead advantage after the treaty is implemented.

A second way to undercount has to do with the counting rules for ALCMs. For the U.S., B-52G and H models will be declared ALCM carriers, initially. For purposes of the warhead ceiling, each B-52 will count as 10 yet they have a maximum capability of carrying

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[3] Though this is beginning to change as more journalists examine the details. See, e.g.: R. Jeffery Smith, "Treaty Would Cut Few U.S. Warheads," Washington Post, April 3, 1990, p. A1; David Evans, "Nuclear Arsenals May Not Shrink Much," Chicago Tribune, February 21, 1990, p. A1.

[4] The U.S. has the Short Range Attack Missile (SRAM) on its strategic bomber force. The Soviet Union has the AS-3, AS-4, and AS-16 air-to-surface missiles on its strategic bomber force.

between 12 and 20. Thus 1000 or so deployed ALCMs will be part of U.S. nuclear forces but will not be counted.

Two particularly egregious examples of "discounting" have been proposed by the U.S. Navy. The Navy has proposed that up to 72 SLBM launchers be excluded from being counted in the aggregate since at any given time several submarines are in overhaul. For the 24 tube Tridents this would mean three submarines would be exempt. The Soviets have reportedly agreed to between 48 and 72, with the exact number yet to be announced. If the number is between 64 and 72 up to four Soviet submarines could be exempt. The second example has to do with changing the warhead counting rule on Trident II SLBMs, agreed to in December 1987, from eight to six.[5] If the Soviets agree it would allow a force of 21 Trident SSBNs to each have 24 launchers with roughly 3000 accountable warheads. If the counting rule remains the same, then the Navy will either have to operate with a smaller fleet of 24-tube SSBNs or fill six launchers per submarine with concrete on the 21 boat fleet (see Table 4).

The recent idea of deep reductions can be traced to George Kennan, who in May 1981 called for "an immediate across-the boards reduction by 50 percent" of all types of nuclear weapons in both nations arsenals.[6] On May 9, 1982 President Reagan called for a one-third cut in each nation's strategic ballistic missile warheads, from about 7500 to 5000. Had these plans been implemented quickly the reduction of the then smaller arsenals might have been significant. As it turned out during the eight years of negotiations each side's arsenals have grown. The principle of "50 percent reductions in nuclear arms" was articulated during the first Reagan-Gorbachev summit in Geneva in November 1985. As the negotiations proceeded the principle has been whittled away. Administration spokesmen no longer bother to use 50 percent reductions as a goal of START, the new buzzword is "stability."[7]

The efforts to exempt certain weapons from counting toward the ceilings have protected certain military programs. But it has also resulted in watered down and ineffective arms control and disarmament. A key goal for a START II treaty must be the inclusion of all types of strategic weapons. Verification difficulties should not be used as an excuse to exempt bomber weapons, or any other types, from deep reductions.

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[5] "U.S. Proposes to Reduce the Number of Trident D-5 Warheads Under START Treaty," Inside the Pentagon, April 27, 1990.

[6] George F. Kennan, The Nuclear Delusion: Soviet-American Relations in the Atomic Age (New York: Pantheon Books, 1983), p. 180.

[7] Richard Burt, "The Strategic Arms Reduction Talks - President Bush Proposes Verification Measures," NATO Review, August 1989, pp. 6-10; Richard R. Burt, "Status of the Strategic Arms Reduction Talks, Department of State Bulletin, October 1989, pp. 17-19; Richard Burt, "The State of START," Arms Control Today, February 1990, pp. 3-8. "In START, our goals are not merely to reduce forces but to reduce the risk of nuclear war and create a more stable nuclear balance"; The White House, National Security Strategy of the United States, March 1990, p. 16.

New Weapons

Under current proposals all U.S. weapon systems now being deployed or in research and development would be allowed to proceed. These include: the SRAM II, the B-2, Trident II Submarine-launched Ballistic Missile (SLBM), and the Advanced Cruise Missile (ACM). Given congressional support for funding, the two mobile ICBM programs, the Small ICBM ("Midgetman") and MX rail garrison would be permitted as well.

Programs now in production and currently being deployed would be allowed in their entirety or only be slightly curtailed. In the latter category fewer numbers of SLBMs would be needed if the Navy chooses to put 18 SLBMs per sub instead of 24 to keep within the warhead ceiling. If the counting rule is changed to six warheads per missile, then the original number could be deployed.

Under the current draft START treaty, virtually all Soviet weapon systems under development or being deployed could proceed. These include: the SS-24 and SS-25 ICBMs, the Typhoon and Delta IV submarines, the SS-N-20 and SS-N-23 SLBMs, the Bear H and Blackjack bombers, the AS-15 ALCM, AS-16 SRAM, AS-X-19 ASM, and new gravity bombs for the bombers.[8]

START allows for open-ended modernization; weapon systems currently in research and development can proceed, and as yet unthought of weapon systems are not prohibited. Allowing open-ended modernization will no doubt assist in gaining support for the treaty from the respective military establishments. Following the SALT II and INF precedents a START II Treaty should ban certain types of new missiles.[9]

One of the presumed purposes for the U.S. and the Soviet Union to engage in arms control or disarmament is to alleviate some of the economic burden of the arms race. The enormous U.S. deficit has accrued partially as a result of large military budgets, and Soviet President Gorbachev has repeatedly stated that more resources must be directed to the civilian economy. It is difficult at this time to calculate exactly what effect these reductions would have on the military budgets of both countries. As a rule of thumb strategic nuclear forces constitute about 15 to 20 percent of the annual U.S. military budget. While reductions in the conventional forces, that make up 80 to 85 percent of the budget, can save the most money cutting nuclear weapons programs can marginally reduce the military budget. But allowing a host of very expensive weapon systems to proceed, albeit on a somewhat reduced scale, will probably cost about the same or more than is being spent today.[10] The reductions will no

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[8] The U.S. has proposed a ban on production, flight testing or modernization of new or existing heavy missiles, which the Soviets have rejected. Since the U.S. neither has or intends to develop a "heavy" missile this only applies to the Soviet SS-18 or its follow on. The Soviet have reportedly stopped their Typhoon submarine program at six.

[9] The SALT II Treaty banned flight testing and deployment of new types of ICBMs except for one new type of light ICBM. The INF Treaty specifies the elimination of all current types of U.S. and Soviet land-based ballistic missiles between 500 and 5500 kilometers and prohibits future development or deployment.

[10] A Congressional Budget Office report estimates that, depending upon the options chosen for new systems, the annual long-run cost savings range between $3 and $12 billion; CBO, "Budgetary and Military Effects of the Strategic Arms Reduction Talks

(continued...)

doubt stimulate a natural military reaction to compensate with more capable weapons to replace those just removed, and to try to solve a host of new military problems created by limitations in the number of warheads allowed in strategic forces.

Retirements

Under a START Treaty, retirements on both sides would be substantial, but the vast majority of what would be withdrawn is old and obsolete and was scheduled for retirement anyway.

For the U.S. retirements would include:

- 350 Minuteman II ICBMs and silos[11]
- 350 W56 warheads for the Minuteman II
- 200 W62 warheads for the Minuteman III
- 300 W78 warheads for the Minuteman III
- 23 Lafayette/Franklin class SSBNs
- 368 Poseidon and Trident I SLBMs
- 3300 W68 and W76 SLBM warheads
- 98 B-52G bombers

For the Soviet Union retirements would include:

- 914 SS-11, SS-13, SS-17, SS-18, and SS-19 ICBMs
- 708 SS-N-6, SS-N-8, SS-N-17, and SS-N-18 SLBMs
- 6500 ballistic missile warheads
- 45-51 Hotel, Yankee, and Delta class SSBNs
- 20 Bear B/C bombers

Retirements could begin with the entry into force of the Treaty, (possibly July 1991), and would be accomplished in a phased manner (U.S. position) or in two phases (Soviet position) during the seven year period, until mid-1998. A review of the status of each weapon intended for retirement shows that, in most cases, it was scheduled for retirement anyway.

U.S. Retirements

* The Minuteman II force was deployed between 1966 and 1969. Assuming a thirty-year life span, retirement by 1998 would be exactly on time.

* The Minuteman III force was deployed between 1970 and 1975. Three hundred missiles were fitted with new reentry vehicles between late 1979 and early 1983. Removing one warhead (of three) from each of 500 missiles would not interfere with retirement plans. It has undergone numerous upgrades over the years. Presumably, the Minuteman III will be in

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[10](...continued)
(START) Treaty," Staff Memorandum, February 1990. See also Stephen Alexis Cain, The START Agreement: Strategic Options and Budgetary Savings, Defense Budget Project, July 1988.

[11] If the SICBM program is funded it could be deployed in current Minuteman II silos.

service until about 2005 or later. No missiles need be retired in the force structure assumed in Table 4.

* The remaining 23 (of the original 31) Lafayette/Franklin class SSBNs were commissioned between 1963 and 1967. Eight have been withdrawn from service between 1985 and 1990. Under current plans all were scheduled for decommissioning between 1994 and 1999 as Ohio class submarines are deployed.[12]

* Poseidon (C3) SLBMs were deployed between 1971 and 1978 and Trident I (C4) SLBMs (aboard 12 Lafayette/Franklin class SSBNs) were deployed between 1979 and 1983. Retirement of Trident I missiles on the 12 Lafayette/Franklin submarines by the end of 1998 would be about 10-15 years early for the missiles. Trident I SLBMs are also deployed on the first eight Ohio class SSBNs. Those missiles will be removed at the rate of about one SSBN per year during the period 1993-2000 and replaced with Trident II SLBMs.

* The B-52G bombers were built from 1958 to 1960 and the B-52 H models between 1960 and 1962. Earlier B-52 A/B/C/D/E and F models have already been retired. The original air force plan was to retire B-52s as B-2s were introduced. Now apparently the two programs are not so intertwined. The B-2 may be cancelled or bought in much reduced numbers for budgetary reasons. And some, or all of the remaining B-52Hs may be retained well into the twenty-first century. The U.S. position is to allow 115 B-52 for conventional missions.

* ALCM deployments began in 1982 and were completed in 1987 at B-52 bases. Because of the way that ALCMs are being counted all 1600 operational ALCMs (AGM-86B) may be retained with only 95 bombers counting toward the SNDV limit and only 950 counting toward the warhead limit.

* The Advanced Cruise Missile (AGM-129A) program has experienced considerable difficulty during its development, but in mid-1990 it looks as though it will soon begin limited production. Shrouded in secrecy, it has been difficult to determine what the Air Force's plans are for this weapon. Before the START constraints on cruise missiles the Air Force had planned to deploy approximately 3000 of both types on B-52s and B-1Bs. This would mean about 1400 operational ACM. Since the original plans of the early 1980s many changes have occurred. The B-1B is not now slated to be a cruise missile carrier. Over 30 B-52Gs have been retired. Several dozen other B-52Gs have been transferred to conventional missions with more likely to follow. With this smaller force and with the START "penalty" for cruise missile bombers there are not enough spaces on the B-52H force to accommodate 3000 cruise missiles. The upper limit is approximately 1900 cruise missiles. One report indicates a planned ACM purchase of 1461 missiles.[13] What are the Air Force's plans for the ACM?

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[12] "The Poseidon SSBN fleet constructed in the 1960s will reach the end of its 30 year life by the late 1990s. Because these submarines require costly overhauls to continue in service, five of the original 31 Poseidon submarines have been, or will soon be, retired. The remaining 26 Poseidons will leave service between 1994 and 1999. Independent of a START agreement, the Navy will need to retire the Poseidon force, although START could potentially accelerate the pace depending upon when the Treaty enters into force and the resulting draw-down schedule. In short, START would be entirely consistent with our plans for the Poseidon force"; HASC, FY 1990 DOD, No. 101-9, p. 874.

[13] "Full-Rate Production of ACM to Begin in 1992," Aviation Week & Space Technology, 29 January 1990, p. 32.

Also deserving consideration is the impact at the local level that retirements may have on possible base closures or cutbacks in support functions and manpower levels.

If funding is maintained for the mobile SICBM then possibly 350 Minuteman II missiles would have to be withdrawn and their silos destroyed at three bases in South Dakota, Montana, and Missouri. If funding is not maintained then only 100 Minuteman IIs may be withdrawn at one or more of the three bases. A third possibility is that the SICBM may be purchased and put in Minuteman II silos, reducing the high cost of the program. What ever happens the bases do perform other functions. Whiteman AFB, MO is scheduled to be the first base for the B-2 bomber. Ellsworth AFB, SD has a B-1B wing, and Malmstrom AFB, MT has Minuteman IIIs.

Two SAC bases are being closed as a result of the Base Realignment and Closure Commission and others may close as a result of reduced budgets. If the rail garrison program moves forward the fifty MX missiles removed from F.E. Warren AFB would operate from Warren and from six other SAC bases. The plan for the SICBM is to use existing SAC bases as well. In sum, a portion of the ICBM silo infrastructure, some old (MMII), some new (MX), which cost billions to create, would be dismantled and replaced by a new mobile infrastructure.

The retirement of the remaining 23 SSBNs would have an impact on the ports of Charleston, South Carolina, Groton, Connecticut and Holy Loch, Scotland.[14] While attack submarines would continue to be based at Charleston and Groton there may be decreases in the number of personnel and support services at each base. The first eight Trident submarines operate out of Bangor, Washington. Beginning with the ninth Trident, the *USS Tennessee*, which first deployed at the end of March, the base at Kings Bay, Georgia will be used.

Soviet Retirements

The Soviet Union would have to retire greater numbers of weapons and greater numbers of newer weapons than the U.S.

* SS-11 ICBMs were first operational in 1966. At the peak in 1973 there were over 1000. They have been steadily reduced to the current number of 360.

* The SS-13s date from 1969. Only 60 were ever deployed.

* The three other Soviet ICBMs that would have to be retired, in part or in whole, the SS-17, SS-18 and SS-19, were deployed between 1975 and 1980 and have been undergoing modification and upgrading programs until very recently. SS-17s have been withdrawn to keep within SALT ceilings. SS-19s are being withdrawn as new SS-24s are deployed, and SS-11s are withdrawn as SS-25s are deployed.

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[14] Sixteen SSBNs use Charleston, SC and Kings Bay, GA as bases. The other seven use Groton, CT as a homeport though the submarines deploy from Holy Loch, Scotland. The crews fly to and from Scotland before and after their patrols. Charleston is also the central support point for all of the Navy's Poseidon submarines.

* Somewhere between 45 and 51 SSBNs would have to be retired. These include Yankee submarines deployed in the early 1970s and Delta I, II, and III submarines which date from 1973 to 1978.

* Older Bear A/B/C bombers date from the mid-1950s. Many will surely be retired or converted into tankers or reconnaissance aircraft.

Implications of START for Fissile Material Production

With the retirement of thousands of warheads associated with the above weapons, neither the U.S. nor the Soviet Union would need to produce any further plutonium or highly enriched uranium (HEU) for weapons.

For the U.S., approximately 4200 ballistic missile warheads may be retired. Assuming four kilograms of plutonium per warhead this would result in 17 metric tons available for new warheads. This is estimated to be almost 20 percent of the stockpile of plutonium. At recent peak production during 1984-1985 the U.S. was producing about 2.5 metric tons of plutonium per year. Combined with the already large stocks that exist from many other retirements this amount should ensure that no new plutonium need ever be produced.

Assuming 20 kilograms of HEU per warhead, the retirement of 4200 warheads would result in about 85 metric tons of HEU. This represents about 17 percent of the estimated U.S. stockpile of 500 metric tons of HEU for weapons. No newly produced HEU would be required for weapons.

For the Soviet Union over 6000 ballistic missile warheads may be retired. Using similar calculations to those for the U.S. about amounts of plutonium and HEU per warhead the Soviets would have at least as much of both materials and probably a great deal more. It would seem unlikely that they would need to continue to produce either material in the future. A fissile material cutoff may occur by default.

The Continuing Technological Arms Race

While one of the stated purposes of START is to reduce the number of strategic weapons, the treaty does not address the qualitative competition for technological breakthroughs in future weapons systems. This important feature of the arms race will continue, probably at an accelerated pace, if nothing is done to constrain it. Four key areas are at the forefront of the technological arms race with regard to strategic weapons: Zero or near zero Circular Error Probable (CEP)[15] weapons, Maneuvering reentry vehicles (MaRVs), Earth penetrator warheads, and "third generation" warheads. A START treaty may encourage accelerated research into all of these areas.

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[15] The standard way in which missile accuracy is measured. CEP is the radius of a circle within which half of the missile's reentry vehicles are expected to fall.

Nuclear war planners normally allocate two warheads for certain kinds of targets to be sure it is destroyed. With fewer warheads to allocate under START, it would become more important to nuclear planners to achieve high single-shot kill probabilities.[16]

* *Zero/Near zero CEP RVs* - The most important trend over the past two decades in strategic weapons has been increasingly accurate ballistic missiles. Early ballistic missiles had CEPs of 3000 to 5000 feet or more. The recently deployed MX has a CEP in the 300 to 400 foot range and the Trident II 400 to 500 feet. It is theoretically possible to design a guidance system that would approach or attain a zero CEP, and U.S. and Soviet scientists and engineers are busily at work on terminal guidance and sensor systems for ever greater accuracy. We can expect that any future ballistic missile deployed will be more accurate than the one it replaces or supplements.

* *MaRVs* - Unlike normal reentry vehicles which follow a ballistic trajectory to their targets after being released from the "bus," a MaRV can change its direction in flight. This would be useful to evade and dodge a ballistic missile defense system, improve accuracy, or with the proper sensors track and attack mobile targets. Currently neither the U.S. nor the Soviet Union has MaRVs on their strategic ballistic missiles. The U.S. has conducted successful ballistic missile flight tests using MaRVs and has an ongoing research program. It is likely the Soviets have done the same.

* *Earth penetrator warheads* - In response to the widespread hardening of Soviet missile silos and the building of deep underground command posts, U.S. warhead designers are busily at work trying to perfect a strategic warhead that would burrow underground before exploding. Another use for such a warhead is to penetrate the Arctic icecap to destroy Soviet SSBNs. The warhead could be on ballistic missile reentry vehicles or cruise missiles. Reentry vehicles travel at enormous speeds. While the higher the speed the greater the penetration, if it travels too fast the force of impact will break apart the warhead before it can penetrate. Subsonic cruise missiles may not attain sufficient speed for warhead penetration, but future supersonic versions could be likely candidates.

Research into combining MaRV and penetrator technologies is underway as well. Air Force Ballistic Missile Office contracts to General Electric and Lockheed call for developing operational prototypes of earth-penetrating maneuverable re-entry vehicles. After dodging interceptor missiles the warhead would penetrate into the earth and explode presumably to destroy hardened underground missile silos or command bunkers.

* *Third Generation Concepts* - The U.S. is attempting to develop a new class of nuclear-driven directed-energy weapons as part of its Strategic Defense Initiative program and for other applications. Three basic concepts are being investigated though none appear promising at this stage.

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[16] Single shot kill probability (SSKP) is expressed as a mathematical formula (made up of the variables of yield, CEP and hardness) which war planners use to attempt to measure the probability that a single reliable warhead can be expected to destroy a given target.

The x-ray laser program has received the most attention. Here laser rods are energized by the radiation of a nuclear explosion. The strong burst of x-ray laser energy would be aimed in a certain direction to destroy a target. The technical difficulties in achieving a nuclear pumped x-ray laser weapon now appear insurmountable and funding for this program has been reduced.[17]

A second concept is a hypervelocity pellet weapon, a kind of "nuclear shotgun," where thousands or perhaps millions of pellets channeled and driven by a nuclear explosion would presumably destroy incoming reentry vehicles or other targets. Still farther down the technological road are optical frequency lasers intended for similar application. All of these third generation weapons could have missions to attack mobile missiles. Under a START treaty attempts to perfect them would be encouraged.

Effects of START on Strategic Stability

According to the Bush Administration a primary goal of START is to improve stability, that is, to lessen the temptation to strike first out of fear that if weapons are not launched they will be destroyed. A situation where each side's forces are less vulnerable to the other is highly desirable; it would increase stability and should be reflected in START. Ideally, strategists on both sides could construct a stable and invulnerable nuclear force of many missiles which each carry few warheads and are therefore more survivable.

Because of the seven-year implementation period, the U.S. and Soviet Union will only be able to field the nuclear weapons that are currently in the pipeline. Many of these weapons have been designed to maximize their warhead carrying capability, that is, to place as many launch tubes on submarines or as many warheads on ballistic missiles as is possible. Under START numerical limits, nuclear planners will want to spread the number of launch tubes on submarines and reduce the number of warheads on missiles as much as possible, rather than having them concentrated in a few delivery vehicles. Unfortunately the goal of redesigning nuclear forces to make them more stable will not be possible in a seven year period, and may not be possible in the long-term given economic constraints on military spending.

In other ways, START does not improve stability to any significant degree. The current ratio of Soviet "heavy" ICBMs (SS-18 Mod 4/5/6) to U.S. missile silos is 3:1, seemingly the most worrisome situation to the Bush Administration. With an eventual Soviet force of 1540 heavy ICBM warheads, plus more accurate versions of other types of missiles, all aimed at what will likely be a slightly fewer number of U.S. fixed land-based silos the ratio does not improve very much. Judging then on what is touted as the treaty's chief virtue START does not succeed very well.

The "vulnerability" of land-based forces would change markedly with addition of mobile missiles. The U.S. position on this matter is schizophrenic. Repeatedly the U.S. has stated that the essence of deterrence is the U.S. ability to hold Soviet targets at risk while its own targets

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[17] William J. Broad, "Crown Jewel of 'Star Wars' Has Lost Its Luster," New York Times, 13 February 1990, p. C1.

remain invulnerable. This is partially its justification for highly accurate missiles like the MX and the Trident II. The best situation for the U.S. under this "logic" is to have fixed Soviet targets to aim at and invulnerable U.S. targets, but this is a difficult negotiating proposal. To allow mobile Soviet missiles means that it would be more difficult to "hold them at risk." Since certain bomber weapons are not constrained in START, the shift to mobile missiles will set off the development of new bomber weapons to target mobile missiles. At one point the need for the B-2 bomber was justified as being able to accomplish this. More recent statements have downplayed this difficult task.

Transforming the SIOP

The single most important act the U.S. could take to slow the pace and change the character of the strategic arms race would be to radically revise its employment plan for nuclear war. This plan is known as the Single Integrated Operational Plan (SIOP). The SIOP is enormously complex. It matches thousands of targets with thousands of weapons, all with proper timing and sequence of execution. If real disarmament is ever to take place then the problem of the nature of the war plan must be addressed.

The current version, SIOP 6F, sets extraordinary demands and goals.[18] Large numbers of highly accurate and capable weapons are required. It is this dynamic that generates continuing Air Force and Navy requirements for more capable and sophisticated weapons. The commanders responsible for executing the SIOP continue to demand new and better weapons to accomplish their duties.

The United States has decided that the sine qua non of deterrence shall be the precise targeting of the Soviet leadership. To accomplish this requires highly accurate weapons, which are now being deployed in large numbers. A circularity is evident between technological advances and nuclear war plans. Technological advances in accuracy need a strategic rationale. What follows is the issuance of Presidential guidance which eventually becomes an employment plan for nuclear war. Conversely, targeters always "need" better weapons to do their jobs. Manipulating the target base can also generate a "need" for new weapons.[19]

What constitutes deterrence? The definition is an arbitrary one. The U.S. could decide that much less ambitious requirements will suffice to deter the Soviet Union from launching a nuclear attack. The U. S. has had these lesser definitions of deterrence over the past four decades and they have worked quite well. It is time to return to those simpler plans and set much less ambitious definitions of deterrence. This is no more arbitrary than the way we go about the process today. A less ambitious war plan, based on a less exacting definition of deterrence will then alleviate the need for the more capable weapon systems. In short, we can

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[18] According to a recent article the major revision incorporated into SIOP 6F has been to attempt to hit the Soviet leadership promptly; Desmond Ball and Robert C. Toth, "Revising the SIOP: Taking War-Fighting to Dangerous Extremes," International Security, Spring 1990, pp. 65-92.

[19] David Lynch, "Nitty-Gritty Of Nuclear Targeting Draws Scrutiny," Defense Week, April 16, 1990, p. 1; John Barry, "Attention, SAC: The War's Over," Newsweek, March 12, 1990, pp. 29-30.

get by with less, a lot less. There is ample evidence that deterrence requirements have diminished and future warplans should reflect it.[20]

Conclusions

A close analysis reveals that the once high hopes for a meaningful and effective START treaty have been dashed. Bureaucracies and the military establishments on both sides have, through persistence, rivalry, and self interest, desiccated the treaty. The public has not yet awakened to this fact, and when it does disillusionment and anger may follow. The INF Treaty had the effect, as did SALT I in the era of detente, of tranquillizing the fears of worried and concerned publics. It appeared to most observers after the INF signing that now the problem of the nuclear arms race was being taken care of. The true disappointment of START is that there has never been a more opportune time to address these problems. The treaty that will soon result only formalizes what was scheduled to happen in any event. All new programs are permitted and all the retirements would have occurred anyway. Real disarmament and arms control must involve fundamental change to be effective. It cannot be business as usual. Severe dislocations must jolt the bloated military establishments. The institutional infrastructure of the Cold War and the arms race is still basically intact and will continue to operate merely at a reduced scale under a START regime. The infrastructure must not only be reduced but ways must be found to dismantle it. If that task is to be accomplished a more ambitious set of initiatives and goals must be proposed.

At the very least START II negotiations should get under way immediately upon entry into force of START I. Deep reductions and outright bans of certain weapon types should be among the goals. All weapons should be included with no discounts. START is a relic of the Cold War and the 1980s. What is needed is a treaty for the 1990s that looks toward the twenty-first century reflecting altered world developments. A comprehensive approach that constrains all types of nuclear weapons will be most effective. In January 1986 President Gorbachev proposed a plan to eliminate nuclear weapons in three phases over a 15 year period. It is time that that plan, or one like it, be resuscitated.

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[20] Thomas L. Friedman, "NATO Adopts Plan to Revamp Itself For German Unity," New York Times, 4 May 1990, p. A1; R. Jeffrey Smith, "Powell Days Defense Need Massive Review," Washington Post, 7 May 1990, p. A1.

TABLE 1

U.S. STRATEGIC NUCLEAR FORCES (mid-1990)

Type	Name	Number/ SSBN	Year Deployed	Warheads x Yield (Mt)	Total Warheads	Total Mt
ICBMs						
LGM-30F	Minuteman II	450	1966	1 x 1.2	450	540
LGM-30G	Minuteman III	500			1500	404
	Mk-12	(200)	1970	3 x .170 (MIRV)	(600)	(102)
	Mk-12A	(300)	1979	3 x .335 (MIRV)	(900)	(302)
LGM-118A	MX	50	1986	10 x .300 (MIRV)	500	150
Total		**1000**[1] **(53%)**			**2450 (20%)**	**1094 (38%)**
SLBMs						
UGM-73A	Poseidon	176/11	1971	10 x .050 (MIRV)	1760	88
UGM-96A	Trident I	384/20	1979	8 x .100 (MIRV)	3072	307
UGM-133A	Trident II	24/1	1990	8 x .475 (MIRV)	192	91
Total		**560/32**[2] **(31%)**			**5024 (42%)**	**486 (17%)**
Bombers/weapons						
B-1B		90	1986	ALCM .05 -.150	1600	240
B-52G/H		173	1958/61	SRAM .170	1100	187
FB-111A[3]		48	1969	Bombs .500 (avg.)	1800	900
Total		**311 (16%)**			**4500 (38%)**	**1327 (45%)**
Grand Total		**1871**			**11,974**	**2907**

[1] ICBM throwweight is approximately 2.3 million pounds: Minuteman II (1600 lbs), Minuteman III (2400 lbs), MX (7900 lbs).

[2] SLBM throwweight is approximately 1.8 million pounds: Poseidon C-3 (3300 lbs), Trident I C-4 (2900 lbs), Trident II D-5 (5040 lbs).

[3] FB-111As will not be counted as SNDVs. In 1990 and 1991 they will be transferred to the Tactical Air Command.

TABLE 2

SOVIET STRATEGIC NUCLEAR FORCES (mid-1990)

Type	Name	Number(SSBN)	Year Deployed	Warhead x Yield (Mt)	Total Warheads	Total Mt
ICBMs						
SS-11	Sego					
M2		150	1973	1 x 1.1	150	165
M3		210	1973	3 x 350 (MRV)	210*	221
SS-13 M2	Savage	60	1973	1 x .750	60	45
SS-17 M3	Spanker	100	1979	4 x .750 (MIRV)	400	300
SS-18 M4/M5	Satan	296/12	1979	10 x .550/.750 (MIRV)	3080	1637
SS-19 M3	Stiletto	300	1979	6 x .550 (MIRV)	1800	990
SS-24 M1/M2	Scalpel	18/40	1987	10 x .550 (MIRV)	580	319
SS-25	Sickle	170	1985	1 x .550	170	94
Total		**1356[1] (55%)**			**6450 (57%)**	**3770 (61%)**
SLBMs						
SS-N-6 M3	Serb	192 (12)	1973	2 x 1 (MRV)	192*	384
SS-N-8 M1/M2	Sawfly	286 (23)	1973	1 x 1.5	286	429
SS-N-17	Snipe	12 (1)	1980	1 x 1	12	12
SS-N-18 M1-3	Stingray	224 (14)	1978	7 x .500 (MIRV)	1568	784
SS-N-20	Sturgeon	120 (6)	1983	10 x .200 (MIRV)	1200	240
SS-N-23	Skiff	96 (6)	1986	4 x .100 (MIRV)	384	39
Total		**930[2] (38%)**			**3642 (32%)**	**1888 (30%)**
Bombers/weapons						
Tu-95	Bear B/C	20	1962	4 bombs or 1 AS-3	80	100
Tu-95	Bear G	45	1984	4 bombs and 2 AS-4	270	184
Tu-142	Bear H	80	1984	8 AS-15 or bombs	640	160
Tu-160	Blackjack	17	1988	6 AS-15 ALCMs, and 4 AS-16 SRAMs, and 4 bombs	238	119
Total		**162 (7%)**			**1228 (11%)**	**563 (9%)**
Grand total		**2448**			**11,320**	**6220**

*SS-11 Mod 3 and SS-N-6 Mod 3 MRV warheads are counted as one.

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[1] ICBM throwweight is approximately 9.9 million pounds: SS-11 (2500 lbs), SS-13 (1100 lbs), SS-17 (6300 lbs), SS-18 (16,700 lbs), SS-19 (8000 lbs), SS-24 (5000 lbs), SS-25 (2600 lbs).

[2] SLBM throwweight is approximately 2.3 million pounds: SS-N-6 (1500 lbs), SS-N-8 (1500 lbs), SS-N-17 (2500 lbs), SS-N-18 (2900 lbs), SS-N-20 (5000 lbs), SS-N-23 (3000 lbs).

TABLE 3
START NEGOTIATING PROPOSALS (April 1990)

	UNITED STATES	SOVIET UNION
General Approach:	Reduction to equal levels in strategic offensive arms, carried out in a phased manner achieving equal intermediate ceilings by agreed dates over seven years from the date the treaty comes into force.	Reduction to equal levels in strategic offensive arms, carried out in two phases over seven years from the date the treaty enters into force, with equal ceilings after phase 1.
	Completion of Start not contingent upon the resolution of Defense and Space issues.	Conclusion of Start agreement not contingent upon reaching a Defense and Space agreement. However, Soviets indicate that they claim a right to withdraw from START if they determine that the U.S. has gone beyond the Anti-Ballistic Missile (ABM) Treaty as they define it.
	No further strategic arms control treaties can be concluded with the Soviet Union until it corrects its violation of the Anti-Ballistic Missile (ABM) Treaty involving Krasnoyarsk radar in a verifiable manner that meets U.S. criteria. The U.S. has expressed satisfaction with the Soviet announcement that it will completely eliminate the Krasnoyarsk radar station.	The Soviets have states that they will completely eliminate the Krasnoyarsk radar station.
Delivery Vehicles:	1,600 ceiling on the number of strategic nuclear delivery vehicles (SNDVs) which comprise deployed (ICBMs) and their associated launchers, deployed submarine-launched ballistic missiles (SLBMs) and their associated launchers, and heavy bombers.	Same at the U.S. position.
Warheads:	6,000 warhead ceiling, to include the accountable number of deployed ICBM and SLBM warheads and long-range, nuclear-armed ALCMs (air-launched cruise missiles) (see ALCMs), and with each heavy bomber equipped only for nuclear-armed gravity bombs and short-range attack missiles (SRAMs) counting as one warhead.	Same at the U.S. position.
Warhead Sublimits:	Sublimits of 4,900 ballistic missile warheads and 3,000-3,300 ICBM warheads.	Sublimit of 4,900 ballistic missile warheads; if 3,300 sublimit on ICBMs, then must also be 3,300 sublimit on SLBMs. Sublimit on 1,100 on deployed heavy bomber-carried warheads.
Heavy ICBMs:	A limit of 1,540 warheads on 154 deployed heavy ballistic missiles. Ban on production, flight testing or modernization of new or existing types of heavy ICBMs.	A limit of 1,540 warheads on 154 deployed heavy ICBMs. Production, flight testing or modernization of existing types of heavy ICBMs permitted. Development, testing and deployment of new types of heavy ICBMs banned.
Throwweight:	The aggregate throwweight of Soviet ICBMs and SLBMs will be reduced to 50 percent below their throwweight level as of December 31, 1986. Neither side will exceed this level for the duration of this treaty.	Same as the U.S. position in principle, but differences remain on how to determine accountable throwweight. Reductions will be from the throwweight level existing at treaty signature.
Ballistic Missile Warheads:	Each ballistic missile warhead counts as one warhead under the 6,000 warhead ceiling. For existing types, a quota of on-site inspections to verify that deployed missiles contain no more than the number of warheads declared and agreed for each type at the Washington Summit.	Same as U.S. position for existing types.

	For future types, as well as changes in the number of warheads on existing types, procedures remain to be agreed.	
Mobile ICBMs:	The U.S. has lifted ban on mobile ICBMs. START negotiators must work out the appropriate details of limits to be applied to mobile ICBMs and effective verification measures.	Permitted, with numerical limits on launchers and warheads.
Non-deployed Missiles:	There will be numerical limits (exact numerical limit still to be agreed) on non-deployed ballistic missiles and the warheads attributable to them for all ICBMs of a type that has been flight-tested from a mobile launcher. Other non-deployed ballistic missiles will not be subject to numerical limits, but there will be restrictions on their location and movement. The sides have also agreed there will be no restrictions on non-deployed cruise missiles and non-deployed heavy bomber weapons.	Same at the U.S. position.
Heavy Bombers:	Each heavy bomber counts as one strategic nuclear delivery vehicle (SNDV). Each heavy bomber equipped only for gravity bombs and short-range attack missiles (SRAMs) would count as one warhead under the 6,000 limit. An agreed number of heavy bombers could be removed from accountability under the 1,600 SNDV limit by conversion to a conventional-only capability.	Same as the U.S. position, except that Soviet agreement on conversion of heavy bombers to a conventional-only capability is contingent on U.S. acceptance of Soviet position on ALCM range.
ALCMs:	ALCMs defined as air-launched, nuclear armed cruise missiles with a range in excess of 1,000 kilometers. An agreed number of ALCMs shall be attributed to each type of heavy bomber equipped for ALCMs (10 for U.S. heavy bombers, 8 for existing Soviet heavy bombers and 10 for future Soviet heavy bombers), for the purpose of counting against the 6,000 warhead limit. U.S. heavy bombers could actually be equipped for up to 20 ALCMs, while existing Soviet heavy bombers could actually be equipped for up to 12 ALCMS, and future Soviet heavy bombers could actually be equipped for up to 20 ALCMs.	Same as the U.S. position, except ALCMs defined as air-launched cruise missiles with a range in excess of 600 kilometers.
SLCMs:	SLCMs defined as sea-launched, nuclear-armed cruise missiles with a range in excess of 3000 kilometers. For the duration of the treaty, the sides will make parallel, politically binding declarations of the maximum number of SLCMs they plan to deploy. The initial declaration of each side will include the maximum number to be deployed for each of the first five years of the treaty; each following year a maximum number will be declared for the next succeeding year beyond the original five-year period. The declared SLCMs will not come under any of the START provisions, e.g., the 6000 warhead and 1,600 strategic nuclear delivery vehicle (SNDV) limits.	Same as the U.S. position, except SLCMs defined as sea-launched, nuclear-armed and conventionally-armed cruise missiles with a range in excess of 600 kilometers.

Verification of Compliance	Provisions, at a minimum, to include: exchange of data both before and after the reductions take place; on-site inspection to verify data and to observe elimination of weapons; continuous onsite monitoring of the perimeter and portals of critical production facilities; and short-notice inspection of sites where treaty-limited systems are located both during and after the reduction period. Inspections requested at sites where a party considers that covert production, storage, repair or deployment may be occurring. Right to short-notice inspections at certain types of "suspect sites." Right to request inspection at other "suspect sites." If challenged party refuses inspection, it must make good faith effort to resolve concerns.	The Soviets have accepted much of the U.S. verification position, although many details remain to be resolved, especially in the area of mobile ICBM verification.
	The U.S. has proposed that the two sides accelerate efforts to agree on, and begin implementing as soon as possible, verification and stability measures to acquire practical experience and speed up resolution of verification issues. Proposed measures include: early establishment of on-site perimeter/portal monitoring of certain missile production facilities, exchange of data on each side's strategic nuclear forces, and addressing the problem of short-time-of-flight SLBMs.	The Soviets have accepted the principle of verification and stability measures, have made some proposals of their own, and have been discussing U.S. proposals in detail in Geneva.
	Agreement reached with the Soviets on: 1) advance notification of one major strategic exercise involving heavy bomber aircraft per calendar year; 2) exhibitions of one type of heavy bomber on each side to demonstrate verification procedures for distinguishing ALCM heavy bombers from non-ALCM heavy bombers; and, 3) demonstration of each side's proposed procedures for on-site inspection of reentry vehicles for each side's ballistic missiles. The sides have also exchanged information on missile tagging technologies. The sides agree on major elements of a regime to ensure the non-denial of telemetry data during test flights of START-accountable ballistic missiles. These provisions will be included in the START treaty, but will be implemented early, at the time of treaty signature, through an exchange of letters.	Agreement reached with U.S. on: 1) advance notification of one major strategic exercise involving heavy bomber aircraft per calendar year; 2) exhibitions of one type of heavy bomber on each side to demonstrate verification procedures for distinguishing ALCM heavy bombers from non-ALCM heavy bombers; and, 3) demonstration of each side's proposed procedures for on-site inspection of reentry vehicles for each side's ballistic missiles. The sides also exchanged information on missile tagging technologies. The sides agree on major elements of a regime to ensure the non-denial of telemetry data during test flights of START-accountable ballistic missiles. These provisions will be included in the START Treaty, but will be implemented early through an exchange of letters.

Source: U.S. ACDA, Issues Brief, Nuclear and Space Talks: U.S. and Soviet Proposals, April 4, 1990.

TABLE 4

NOMINAL U.S. STRATEGIC FORCES AFTER START (1998)

ICBMs	SNDVs	Nuclear Warheads Accountable	Actual
MX (silo or rail-garrison-based)	50	500	500
Minuteman III (MIRV x 2)	500	1000	1000
Minuteman II	100	100	100
Small ICBM)[1] (silo and/or mobile)	200	200	200
subtotal	**850 (58%)**	**1800 (30%)**	**1800 (20%)**
SLBMs			
Trident II D5[2]	378	3024	3024
subtotal	**378 (26%)**	**3024 (51%)**	**3024 (34%)**
Ballistic missile warheads	--	4824	4824
Bombers			
B-52H/10 ALCM/ACM	95	950	1900[3]
B-1B/16 bombs or ASMs	97	97	1550
B-2/18 bombs or ASMs	36[4]	36	648
subtotal	**228 (15%)**	**1083 (19%)**	**4098 (46%)**
TOTAL	**1456**	**5907**	**8922**

[1] If the SICBM is never deployed then an additional 200 Minuteman IIs could be retained.

[2] On 21 Trident (Ohio class) submarines with 18 missile tubes each, MIRV x 8. The same number of warheads could reached with 21 submarines, using all 24 tubes, with MIRV x 6. This would raise the launcher number to 504. Sixteen 24 tube SSBNs with MIRV x 8 provides an equivalent number of warheads (3072). The table does not include the exempted 72 launchers or warheads.

[3] The counting rule is 10 though the bomber is capable of carrying 20. Any future ALCM carrying bomber will be counted as 10.

[4] The original program called for 132 operational bombers. Secretary of Defense Cheney announced that the program was reduced to 75 on April 26, 1990. Sixteen aircraft have been authorized through FY 1990. Fiscal constraints may limit the program further. The table assumes one wing of 28-30 B-2s with the rest for training and maintenance.

TABLE 5

NOMINAL SOVIET STRATEGIC FORCES AFTER START (1998)

	SNDVs	Nuclear Warheads Accountable	Actual
ICBMs			
SS-18 Mod 4/5/6 (silo)	154	1540	1540
SS-24 Mod 1/2 (mobile/silo)	75	750	750
SS-19 (silo)	60	360	360
SS-25 (mobile)	400	400	400
subtotal	**689 (59%)**	**3050 (51%)**	**3050 (45%)**
SLBMs			
Typhoon/SS-N-20	108[1]	1080	1080
Delta III or IV/SS-N-23	192[2]	768	768
subtotal	**300 (26%)**	**1848[3] (31%)**	**1848 (27%)**
Ballistic missile warheads	--	4898	4898
Bombers			
Blackjack/10 ALCMs[4]	32	320	640
Bear G/2 ASMs and 4 bombs	45	45	270
Bear H/8 ALCMs[5]	90	720	1080
subtotal	**167 (15%)**	**1085 (16%)**	**1990 (28%)**
TOTAL	**1156**	**5983**	**6888**

[1] On six Typhoon class submarines detubed to 18 missile tubes each with ten warheads per SS-N-20 SLBM.

[2] On 12 Delta III/IV class submarines with 16 missile tubes for SS-N-23 SLBMs. Assumes four warheads on each SS-N-23 SLBM.

[3] Throwweight is 5.6 million pounds, less than 50 percent of 1990 forces. See Table 2.

[4] Assumes modest force of Blackjack bombers with future ALCM capability. It was agreed that all future ALCM-carrying bombers would count as ten warheads with a maximum of 20.

[5] In February 1990 it was agreed that current Soviet ALCM carrying bombers would count as eight with a maximum capability of 12. Future Soviet heavy bombers would count as ten with a maximum of 20.

TABLE 6

CURRENT AND FUTURE WEAPON PROGRAMS

UNITED STATES	SOVIET UNION
Small ICBM (MGM-134A)	SS-24 (mobile/silo)
MX/rail garrison	SS-25 (mobile/silo ?)
Trident II SLBM (21 SSBNs)	SS-18 follow-on ?
Trident SSBN (21-24)	Typhoon SSBN (up to 6)
B-2 Bomber	Delta IV SSBN (up to 12)
Advanced Cruise Missile (AGM-129A)	SS-N-20 SLBM (for 6 SSBNs)
SRAM II (AGM-131A)	SS-N-23 SLBM (12 SSBNs)
Gravity bombs (B83/B61)	Bear H bomber
Warhead/Reentry Vehicle programs	Blackjack A bomber
Zero/near Zero CEP RVs	AS-15 Kent ALCM
MaRV	AS-16 Kickback SRAM
Earth penetrator warhead	Gravity Bombs
Third generation warhead concepts	Warhead/Reentry Vehicle programs
SLCMs	Zero/near zero CEP RVs
	MaRV
	Earth penetrator warhead
	Third generation warhead concepts
	AS-X-19 Koala ALCM
	SLCMs

TABLE 7

U.S. AND SOVIET WEAPON RETIREMENTS UNDER START

	UNITED STATES	SOVIET UNION
ICBMs		
	350 MM IIs & 350 W56 warheads[1] 200 Minuteman III W62 warheads 300 Minuteman III W78 warheads	360 SS-11 with 780 warheads 60 SS-13 with 60 warheads 100 SS-17 with 400 warheads 154 SS-18 with 1540 warheads 240 SS-19 with 1440 warheads
Total	**350 ICBMs with 850 warheads**	**914 ICBMs with 4220 warheads**
SLBMs/SSBNs		
	192 Trident I C4[2] & 1536 W76 warheads 176 Poseidon C3 & 1760 W68 warheads 23 SSBNs	192 SS-N-6 with 384 warheads 12 SS-N-17 with 12 warheads 280 SS-N-8 with 280 warheads 224 SS-N-18 with 1568 warheads 42-48 SSBNs[3]
Total	**23 SSBNs** **368 SLBMs** **3296 warheads**	**45-51 SSBNs** **708 SLBMs** **2244 warheads**
Bombers		
	98 B-52G	20 Bear B/C
Total	**98 bombers**	**20 bombers**

[1] If the SICBM is not deployed then only 150 Minuteman II missiles would be retired.

[2] Another 192 Trident I SLBMs are deployed with the first eight Ohio class SSBNs. Most will be removed during the START implementation period and retired, but not for treaty compliance reasons. The first eight Ohio class SSBNs are scheduled to receive the Trident II SLBM during their first major overhaul. Approximately 1500 W76 warheads (from the Trident I missiles) will be used on the Trident IIs.

[3] Retirements include 12 Yankee I, one Yankee II, one Hotel III, 18 Delta I, 4 Delta II, 6-12 Delta III. If 12 Delta IVs are not built the SS-N-23 SLBM could be backfitted into as many as six Delta IIIs.

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The authors would like to thank Dunbar Lockwood, Thomas K. Longstreth, Richard Fieldhouse, William M. Arkin, and Mary White for their comments on various drafts of this paper.

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Since 1980 the Natural Resources Defense Council has sponsored the **Nuclear Weapons Data Center.** The purpose of the Center is to compile and disseminate accurate information on the world's nuclear forces in order to promote a more informed debate on nuclear weapons and arms control issues. The Center has published four volumes of its *Databook* series describing the U.S. and Soviet nuclear arsenals, and the U.S. nuclear weapons production complex. Currently in preparation is another volume, on other nuclear weapons powers and proliferation. Since May 1987, the Center staff has contributed a monthly column to *The Bulletin of the Atomic Scientists*, entitled Nuclear Notebook.

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Generous funding to support the **Nuclear Weapons Data Center** has come from: The William Bingham Foundation, The Bydale Foundation, the Columbia Foundation, The Field Foundation, The Ford Foundation, the W. Alton Jones Foundation, the Ploughshares Fund, the Charles Revson Foundation, the Rockefeller Family Fund, the Role Foundation, The Samuel Rubin Foundation, the Wallace Genetic Foundation, Davis B. Arnold, Jr., Charles Merrill, Mr. & Mrs. Julius Rosenwald II, Frances Tyson, Mrs. Philip S. Weld, and three anonymous donors.

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Nuclear Weapons Databook, Volume IV: Soviet Nuclear Weapons. Thomas B. Cochran, William M. Arkin, Robert S. Norris, Jeffrey I. Sands. New York, NY: Ballinger Publishing Company, 1989. $35.00 pb. $75.00 cloth.

Nuclear Weapons Databook, Volume III: U.S. Nuclear Warhead Facility Profiles. Thomas B. Cochran, William M. Arkin, Robert S. Norris, Milton M. Hoenig. Cambridge, MA: Ballinger Publishing Company, 1987. Out of print.

Nuclear Weapons Databook, Volume II: U.S. Nuclear Warhead Production. Thomas B. Cochran, William M. Arkin, Robert S. Norris, Milton M. Hoenig. Cambridge, Massachusetts: Ballinger Publishing Company, 1987. $29.95 pb. $39.95 cloth.

Nuclear Weapons Databook, Volume I: U.S. Nuclear Forces and Capabilities. Thomas B. Cochran, William M. Arkin, Milton M. Hoenig. Cambridge, Massachusetts: Ballinger Publishing Company, 1984. Out of print. Revised edition due in 1991.

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Other Nuclear Weapons Data Center Publications

"Nuclear Weapons." William M. Arkin, Andrew S. Burrows, Richard W. Fieldhouse, Thomas B. Cochran, Robert S. Norris, Jeffrey I. Sands. World Armaments and Disarmament: SIPRI Yearbook (annual chapter; 1985 - 1990).

The Bomb Book-The Nuclear Arms Race in Facts and Figures, Thomas B. Cochran, William M. Arkin, Robert S. Norris. Washington, D.C.: NRDC, December 1987. Looseleaf Hardcover $15.00, Paperbound $8.00.

"Nuclear Notebook," Bulletin of the Atomic Scientists (monthly).

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