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START and Strategic Modernization

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Introduction

After the Washington summit next week attention will shift to strategic nuclear weapons and the impending Strategic Arms Reductions Talks (START) agreement.

During the two-and-one half years of the reconvened START negotiations a great deal of progress has been made towards reaching a final accord. Many factors are at work which make it possible that a treaty could be completed before the Reagan Administration leaves office. These include:

1) A subtle de-emphasis of the Strategic Defense Initiative (SDI) as a component of START, coupled with Congressional budget cuts and legislative restrictions on what SDI systems may be tested.[1]

2) Repeated pronouncements by both leaders that they will work toward early achievement. Expectations are high and momentum is underway.[2]

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[1] R. Jeffrey Smith, "U.S. Stance on SDI Reviewed," Washington Post, November 29, 1987, p. A1; Sections 221, 226 and 233 of the National Defense Authorization Act for Fiscal Years 1988 and 1989, Conference Report, House Report 100-446, pp. 39-47 and pp. 593-597.

[2] For example, the joint statement of 30 October 1987 announcing the December summit said that the "President and the General Secretary envision a further meeting between them in the Soviet Union in the first half of 1988" and that "both sides will work toward early achievement of a treaty implementing the agreement to reduce strategic offensive arms by 50 percent, which could be signed during the President's visit to Moscow." In his November 2 speech commemorating the 70th anniversary of the Bolshevik Revolution General Secretary Gorbachev said that the

3) High level personnel changes within the Reagan Administration that reduce the divisiveness that has characterised arms control policy for the past seven years. The most important critics of arms control no longer occupying key positions are William Casey, Caspar Weinberger, Richard Perle, Frank Gaffney and Kenneth Adelman.

4) A conservative Republican president, a Democratic Senate, and a majority of the public that favors deep reductions.

5) The momentum of the INF Treaty which creates unprecedented conditions for verification.

6) Basic agreement by the U.S. and Soviet Union on key components of a START treaty, including virtual agreement on all major weapons limits.

At the same time other factors are also at work that will make it difficult if not impossible for a treaty to be completed during the first half of 1988. These include:

1) U.S. electoral campaigns which will grow in intensity throughout 1988. The latest date for a treaty to be signed which

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"world expects the third and fourth Soviet-U.S. summits to produce more than merely an official acknowledgement of the decisions agreed upon" at the second summit in Reykjavik and that the Soviet Union "will work unremittingly at these meetings for a palpable breakthrough, for concrete results in reducing strategic offensive armaments and barring weapons from outer space - the key to removing the nuclear threat."

could still be ratified in 1988 would probably be May with ratification hearings no later than June or July.[3]

2) Growing resistance by certain members of Congress, the military services, and contractors against a treaty that would dramatically alter the status quo of nuclear forces.

3) The difficulties of simultaneously having to ratify the Intermediate Range Nuclear Forces (INF) Treaty and conclude the START Treaty.

4) Resolving the enormously complex and difficult issues outstanding in a short period of time, even once the basic framework of numerical reductions are agreed to.

It is for these reasons that we believe that time is too short for there to be a START Treaty in 1988. Further progress will be made through the first half of the new year. Many arms control analysts have suggested that a Vladivostok type set of "principles" might be agreed to and signed at a Moscow summit in the spring or early summer, setting out basic limits and sublimits.[4] If such an accord could endure into the next

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[3] The SALT II Treaty was signed on 18 June 1979. The Senate Foreign Relations Committee held twenty-eight days of hearings over a four month period during July, August, September and 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.

[4] Secretary of State George Shultz stated in Geneva on November 22 that a framework agreement was not the U.S. preference; see Michael R. Gordon, "Arms Inspection for 13-year Span Is Seen by Shultz," New York Times, November 23, 1987.

Administration the details might be wrapped up and a treaty signed at a later date.

There is already enough of a shape to a START agreement to think through the military, technological, political and economic implications. This report discusses some of those implications and several of the difficult problems and issues that remain to be resolved. Among the major findings are:

* Actual reductions of strategic offensive nuclear weapons will be 30-35 percent rather than 50 percent. This would return warhead levels to the 1975-80 period.

* Every current and future U.S. and Soviet nuclear weapon system would be permitted under the terms of the current proposals though perhaps not in as large numbers as originally planned.

* The nuclear modernization process may be accelerated in some cases.

* START will result in little economic saving in the short term, as modernization programs move forward if not accelerate.

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

* Depending on the exact composition of forces created under START, stability could decrease.

* Without adequate verification procedures, especially for reentry vehicles on ballistic missiles and the number of air-launched cruise missiles per bomber, concerns over treaty "breakout" will likely grow.

* A article limiting future missile types should be added to the START agreement to strengthen the treaty and eliminate modernization.

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

The conclusions in this report are illustrated by seven Tables. Tables 1 and 2 are estimates of current U.S. and Soviet strategic forces at the end of 1987. Table 3 presents the current START negotiating proposals. Tables 4 and 5 are projections of nominal U.S. and Soviet strategic forces after a START treaty. Table 6 lists current and future weapon programs that would be allowed in part or in full under START. Table 7 details the extensive retirements that would have to take place to comply with the START limits.

Conspicuous by its absence thus far in the START debate has been any detailed analysis of the impact of START on U.S. and

Soviet strategic forces. Such an analysis provides enormous insight into the impediments which might exist for both nation's military establishments. Little public evidence exists that the Air Force, Navy and Joint Chiefs of Staff are energetically investigating, the acquisition, employment and deployment policy implications that a treaty would have.

The SALT treaties provided a measure of predictability about strategic force trends even while warhead numbers grew significantly. The two sides added almost 13,000 warheads to their respective strategic arsenals since SALT I was signed fifteen years ago.* Launcher limits were set largely to accomodate future programs and did not radically alter the relationship of the different "legs" of the strategic triads of each nation. During the Reagan Administration (1981-1987) the Soviet Union added 3,100 strategic warheads to its arsenal while the U.S. added 2,400. A START treaty will not allow such growth in strategic force. It will essentially reduce U.S. and Soviet nuclear forces back to the level of the late 1970s.

Background to the START negotiations

On 9 May 1982 President Reagan presented a new U.S. Strategic Arms Reduction proposal and announced that negotiations

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* See Robert S. Norris, William M. Arkin and Thomas B. Cochran, "US-USSR Strategic Offensive Nuclear Forces 1946-1987," Nuclear Weapons Databook Working Paper 87-1 (Rev.1), December 1987.

would begin in Geneva the following month. A parallel set of negotiations dealing with Intermediate Range Nuclear Forces (INF) began in November 1981. Five START negotiating Rounds were conducted between 29 June 1982 and 8 December 1983. On December 8 the Soviets declined to set a date to resume the talks because of the deployment of Ground-launched cruise missiles (GLCMs) and Pershing II missiles to Europe.

On 7-8 January 1985, Secretary of State Shultz and Foreign Minister Gromyko met in Geneva and agreed to initiate a new series of negotiations - the Nuclear and Space Arms Talks, consisting of START, Intermediate Range Nuclear Forces, and new Defense and Space negotiations.

In October 1985, prior to the first summit, the Soviet Union put forth proposals to reduce strategic nuclear delivery vehicles (SNDV), and limit the number of "nuclear charges" (warheads) to 6,000 with no more than 60 per cent on any one leg of the triad. Several of the proposals were one-sided and unacceptable to the U.S. For example Moscow included certain U.S. theater weapons (forward-based systems) while excluding comparable Soviet systems. It also called for the banning of air-launched and sea-launched cruise missiles (ALCMs, SLCMs) and set unequal delivery vehicle levels.

In November the U.S. proposed to limit ballistic missile warheads to 4500 of which no more than 3000 could be on land-based Intercontinental Ballistic Missiles (ICBMs). The U.S. also proposed separate limits of 350 heavy bombers and 1,250-1,450

total ballistic missiles. The U.S. agreed to a limit of 1,500 ALCMs if the Soviet Union would agree to the U.S. ballistic missile warhead limits.

At the Geneva Summit of 19-20 November 1985 President Reagan and General Secretary Gorbachev agreed to focus on the principle of 50 per cent reductions in START. After some marginal progress in 1986 the summit at Reykjavik refocused attention on 50 per cent reductions. Agreement was reached on a 1,600 delivery vehicle limit, 6,000 warheads, special counting rules for bomber weapons, and a Soviet reduction of "heavy" ICBMs by half.

After Reykjavik differences were narrowed through the development of a joint working document which specified points of agreement and disagreement on key issues. This document was used by the U.S. to prepare a draft treaty which was tabled on 8 May 1987. The draft treaty:[6]

* Called for a roughly 50 per cent reduction to equal levels in strategic offensive arms, carried out in a phased manner over seven years from the date the treaty comes into force.

* Specified a 1,600 ceiling on the number of SNDVs and a ceiling of 6,000 warheads on those delivery vehicles.

* Established a 4,800 ballistic missile warhead sublimit, of which no more than 3,300 warheads can be on ICBMs, and no more

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[6] U.S. Department of State Special Report No. 169, "Negotiations on Strategic Arms Reductions," September 1987. See also Ambassador Ronald Lehman, "The Strategic Arms Reduction Talks: A Treaty Takes Shape," NATO Review, August 1987, pp. 19-23; Congressional Research Service, "Arms Control: Negotiations to Reduce Strategic Offensive Nuclear Weapons," by Steven A. Hildreth, (IB 86051) updated 1 October 1987.

than 1,650 can be on heavy ICBMs (those other than silo-based light or medium ICBMs with six or fewer warheads).

* Sought limits to codify and sustain a 50 per cent reduction in current Soviet throwweight.

* Banned all mobile ICBMs.

* Counted each heavy bomber as one SNDV; each heavy bomber armed with gravity bombs and air-to-surface missiles would count as one warhead in the 6,000 limit.

* Included a comprehensive verification regime providing for the exchange of data both before and after arms reductions take place, onsite inspection to verify the data exchange and to observe the elimination of weapons, and an effective onsite monitoring arrangement for facilities and remaining forces following the elimination of weapons; provided for noninterference with national technical means of verification.

The Soviet Union reciprocated by tabling its own draft treaty on 31 July 1987 and put forward further proposals on 23 October 1987. At the Geneva meeting between Secretary of State Shultz and Foreign Minister Shevardnadze at the end of November to complete the INF Treaty, Marshall Sergei Akhromeyev discussed a ballistic missile warhead limit of 5100.[7] By December 1987 there was common agreement in most key areas and the shape of what a final treaty limits and sublimits might look like was becoming clearer.

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[7] Don Oberdorfer, "Soviets Push New Arms Plan," Washington Post, November 28, 1987, p. A1.

A major obstacle to a treaty remains the issue of strategic defenses. The Soviet Union has continuously emphasized the relationship between strategic offensive forces and strategic defenses while the Reagan Administration has contended that an agreement to reduce the former need not be tied to the latter. While this remains a major impediment recent subtle changes of tone by the Soviets suggest that there may be a short-term resolution.* It is assumed that the problem of strategic defenses can be resolved by deferring it to achieve an offensive accord.

The most likely agreement would seem to be a compromise of the current proposals reflected in Table 3. The Soviet proposal of 23 October 1987 set sublimits of 3000-3300 warheads for ICBMs, 1800-2000 warheads for submarine-launched ballistic missiles and 800-900 warheads for bombers. On the one hand it is not a serious proposal because the U.S. would never agree to such a radical restructering of its forces, which favor submarines and bombers. On the other hand it could be a significant development, if there is a follow-up proposal that states that each side can determine which leg of the triad will have these sublimits or does not

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* The crux of a possible new strategy by Moscow is to have the U.S. agree not to withdraw from the ABM Treaty for a period of 10 years and to adhere to the traditional interpretation; Michael R. Gordon, "A Shift by Soviet Toward Subtlety on Arms Foreseen," New York Times, November 1, 1987, p. 1. The strategy partially rests on a belief that a Democratic Congress will keep the SDI budget somewhat constrained, and that legislation like that put forward by Senators Nunn and Levin can prevent the Administration from implementing a permissive or "broad" interpretation of the ABM Treaty.

specifiy sublimits other than 4800-5100 ballistic missile warheads and a 50% reduction in throwwight.* Allowing each side to have either 3000-3300 ICBM or SLBM warheads would seem to accomodate both sides. A second way to bridge the differences would be to slighly expand the sublimit ranges: 3000-3300 warheads for either ICBMs or SLBMs, 1500-2000 for either ICBMs or SLBMs, and 700-1500 bomber warheads. Table 4 represents a U.S. force structure with the 3300 warhead limit on the submarine leg. Table 5 represents a Soviet force structure with the 3300 warhead limit on the ICBM leg.

Advertised Versus Real Reductions

The Reagan Administration sublimits and the media routinely reports that the START Treaty "calls for 50% reductions to equal levels in strategic offensive arms." This is a common misperception about what would actually happen under START. In fact, neither SNDVs, total warheads, or ballistic missile warheads would be cut in half:

1) The U.S. currently has 2000 SNDVs and the Soviet Union 2475. If the U.S. reduced to 1600 it would be only a 20 per cent reduction. If the Soviet Union reduced to 1600 it would be a 35 per cent reduction.

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* The Akhromeyev suggestion of a 5100 ballistic missile warhead limit splits the difference of the implicit 4800-5300 limit of October 23.

2) Comparing warheads before and after an agreement reveals that there would be a reduction of approximately 30 per cent for the U.S. (from 13,000 warheads to some 9000) and a reduction of about 35 per cent for the Soviet Union (from 11,000 warheads to some 7000). The combined strategic arsenals would drop from 24,000 to 16,000 or one-third.

3) In ballistic missile warheads the U.S. would reduce from 7950 to 4764, a 40 per cent drop. The only area where there is a 50 per cent reduction is in Soviet ballistic missile warheads. The forces would be reduced from approximately 9400 to around 4800 warheads.

One reason why there is some confusion has to do with the way bomber weapons are counted. Modern strategic bombers carry three different types of weapons; gravity bombs, air-to-surface missiles (ASMs),[10] and air-launched cruise missiles. Both sides have agreed, primarily because of verification difficulties, that all bombs and ASMs on one bomber will count as one warhead under the 6000 warhead ceiling. Thus a bomber carrying 24 bombs/ASMs will be counted as one warhead, not 24. On the other hand, each air-launched cruise missile will count as one warhead. Thus a bomber carrying 8, 12 or 22 ALCMs will count as 8, 12 or 22 warheads. The actual number of bombs currently deployed with each nation's strategic bombers is difficult to gauge and would be equally difficult after a START agreement. The U.S. currently has

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

a much larger bomber force and would presumably retain a warhead advantage after the treaty.

An important issue to be resolved in START has to do with deployed versus non-deployed forces. Which is to be used in the 1600 launcher and 6000 warhead ceiling? Since delivery vehicles are likely to be fixed missile silos, submarine launch tubes, heavy bombers and mobile ICBM launchers and ALCMs, the differnece could be significant. Tables 4 and 5 assume deployed forces but obviously both sides have numerous extra missiles and warheads for testing and spares and could have reloads for SS-24s, SS-25s and SICBMs as well as numerous extra ALCMs. Without an adequate verification solution this problem could exacerbate fears of a "breakout" from the treaty.

New Weapons

Under the START treaty all future U.S. weapon systems would be allowed to proceed. These include: the SRAM II, the Advanced Technology Bomber (ATB), Trident II Submarine-launched Ballistic Missile (SLBM), and the Advanced Cruise Missile (ACM). Oddly under its own current position the U.S. would be forced to cancel two mobile ICBM programs. Abandoning this position on mobile missiles, which seems likely, would allow deployment of the Small ICBM ("Midgetman") and rail based MX.

Programs now in production and currently being deployed would be allowed, for the most part, in their entirety (100 B-1Bs

and B83 gravity bombs) or be slightly curtailed (17 Trident submarines with Trident II SLBMs instead of 20). The U.S. would have to make a choice on the mix and/or composition of its air-launched cruise missile inventory. With approximately 800-1000 ALCMs allowed under a treaty the U.S. could either choose to cancel the ACM outright and retain 800-1000 ALCMs, build 800-1000 ACMs and retire all of the current ALCMs, or have a mix of both kinds up to approximately 1000. At least 600 ALCMs would have to be withdrawn under the START proposals. It is still unclear whether ALCMs removed from strategic forces under START can be transferred to tactical air forces or carrier-based aircraft.

Under the START treaty all Soviet weapon systems would be allowed to 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 air-launched cruise missile and new gravity bombs for the bombers. With only 1500-2000 warheads allowed on the sea leg a significant limit would be placed on the number of Soviet Typhoon and/or Delta IV SSBNs.

START evidently provides for open ended modernization in which weapon systems currently in research and development can proceed, and as yet unthought of weapon systems are encouraged. Allowing open ended modernization will certainly assist in gaining support for the treaty from the respective military establishments. Following the SALT II precedent of banning certain types of new missiles would strengthen the treaty.

One of the presumed purposes for both the U.S. and the Soviet Union to engage in arms control or reductions is to alleviate some of the burden that the arms race causes to both economies. For the U.S. enormous deficits have accrued partially as a result of large military budgets. For the Soviet Union 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 deep cuts 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. It is reductions in conventional forces that can save money and those can come about through conventioanal arms control. Cutting nuclear weapons programs can make marginal contributions to reducing the military budget but allowing a host of very expensive weapon systems to go forth, albeit on a somewhat reduced scale, will probably cost about the same or more than is being spent today. The reductions will no doubt stimulate a natural military reaction to compensate with more capable weapons to replace those just removed, and to try and solve a host of new military problems created by limitations in the number of warheads allowed in strategic forces.

Retirements

Under a START Treaty, the retirements on both sides would be substantial. For the U.S. these would include:

- 850 Minuteman ICBMs and silos
- 448 Poseidon and Trident I SLBMs
- 5750 ballistic missile warheads
- 28 Lafayette/Franklin class SSBNs
- 263 B-52 bombers
- 500-600 ALCMs

For the Soviet Union these would include:

- 1071 SS-11, SS-13, SS-17, SS-18, and SS-19 ICBMs
- 788 SS-N-6, SS-N-8, SS-N-17, and SS-N-18 SLBMs
- 6879 ballistic missile warheads
- 54 Hotel, Yankee, and Delta class SSBNs
- 60 older Bear bombers

It should be kept in mind that retirements could start in about 1989, would be in phases, and would not be done all at once but would be spreadout over a six year period.[11] If one looks at the status of each weapon system, retirement in many cases does not conflict with the end of the useful life of the weapons anyway.

* The Minuteman II force was deployed between 1966 and 1969. Assuming a thirty year life span retirement by 1994 would be two to four years early.

* The Minuteman III force was deployed between 1970 and 1975. More than half the missiles were fitted with new reentry

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[11] The current Soviet position on implementation is five years, the U.S. position seven years. It is assumed that six years could be the compromise.

vehicles between late 1979 and early 1983. Retirement of most of them would be five to ten years early.

* Poseidon (C3) SLBMs were deployed between 1971 and 1978 and Trident I (C4) SLBMs (aboard Lafayette/Franklin class SSBNs) were deployed between 1979 and 1983. Retirement of missiles by the end of 1994 would be well before their scheduled time, but plans to replace the missiles with the Trident II and retire them early were already underway.

* The remaining 28 (of the original 31) Lafayette/Franklin class SSBNs were commissioned between 1963 and 1967. Under current plans they were scheduled for decommissoning between 1993 and 1999 as they are replaced by Ohio class submarines.

* 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. With the introduction of the ATB the B-52s were scheduled for retirement in any event.

* ALCM deployments began in 1982 and were completed in 1987. A new Advanced Cruise Missile is about to enter production, though, and the ALCM was already earmarked for replacement anyhow.

Beyond the large amount of hardware that would be retired the impact on the local level with regard to potential base closures or cutbacks in support functions and manpower levels could be profound. The extensive Minuteman missile fields at five of the six Strategic Air Command (SAC) bases in North Dakota, South Dakota, Montana and Missouri would have to be dismantled.

The bases are scheduled to host two new mobile ICBM programs and thus there is little chance that they would have to close, but the level of activity would decline. Twenty-five MX trains each carrying two missiles are planned to operate from seven to eleven SAC bases. Plans for the SICBM are to use existing SAC bases as well. In sum, an ICBM silo infrastructure which cost billions to create would be dismantled and replaced by a new mobile infrastructure.

The retirement of more than two dozen SSBNs would have a dramatic impact on the ports of Charleston, South Carolina, Groton, Connecticut and Holy Loch, Scotland.[12] While attack submarines would continue to be based at Charleston and Groton there would be a rather severe decrease in the number of personnel and support services at each base. Due to a decrease in the number of strategic bombers it may be necessary to terminate the bomber mission at several SAC bases.

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

* Over 450 Soviet ICBMs proposed for elimination are equivalent to the Minuteman II. The SS-11s were first operational in 1966 and the SS-13s date from 1969.

* 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

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[12] Nineteen SSBNs use Charleston, SC as a homeport. Charleston is also the central support point for all of the Navy's Poseidon submarines. The other nine 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.

deployed between 1975 and 1980 and have been undergoing modification and upgrading programs until very recently.

* Over fifty 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.

* The older Bear A/B/C bombers date from the mid-1950s and like the B-52 are surely already scheduled for retirement.

A significant economic implication of deep reductions and the retirement of thousands of warheads would be to eliminate the need to produce plutonium and highly enriched uranium for weapons.

Effects on Megatonnage and Throwweight

In 1961 the U.S. nuclear arsenal reached a peak of 19,000 megatons, most of which was in the strategic forces. From then until now the amount has been reduced by approximately 75 per cent. The prime reason for this trend has been the increase in missile accuracy which permits a smaller yield warhead to be just as lethal. U.S. nuclear war planners use a formula that specifies that a doubling of missile accuracy can result in an eightfold reduction in yield. After a steady downward trend in yield for ballistic missile warheads during the 1970s the direction is now reversing. Ballistic missile warheads are higher in yield than those they replace and are also very accurate. While it is difficult to be precise it appears that

after a START agreement even though the U.S. strategic arsenal woulld have approximately 4000 fewer warheads it would have approximately the same amount of megatonnage. With all high accuracy warheads the lethality of the force would increase. Less is known about the yields of Soviet missiles. They too have undergone a decrease in megatonnage for the same reasons as the U.S. As a rule their warheads have been larger in yield in part to compensate for a lack of accuracy. Eventually Soviet missiles will be as accurate and as lethal as the U.S. force.

Throwweight is the maximum weight of the warheads, guidance unit and penetration aids which can be delivered by a missile over a particular range. Traditionally Soviet ballistic missiles have had a greater throwweight than U.S. ballistic missiles. It has been a long-standing U.S. objective to try and reduce the Soviet advantage and the current U.S. position is to try and reduce it by half. The Soviets position is that such a reduction will take place indirectly if the sublimits occur. Currently Soviet ballistic missile throwweight (ICBMs and SLBMs) totals some 12 million pounds. Under the hypothetical future Soviet force structure (Table 4) the throwweight falls to 5.2 million pounds.

The Continuing Technological Arms Race

The purpose of the START negotiations is to reduce the number of strategic weapons. It does not address the competition

for technological breakthroughs in future weapons systems. That important feature of the arms race will no doubt 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)[13] weapons, Manuevrering reentry vehicles (MaRVs), Earth Penetrator warheads, and "third generation" warheads. A START agreement would likely encourage accelerated research into all of these areas.

At present nuclear war planners normally allocate two warheads per target to be sure it is destroyed. With fewer warheads to allocate it would become more important to nuclear planners to achieve high single-shot kill probabilities.[14]

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. 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 trying for greater and greater accuracy. We can expect that any

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[13] 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.

[14] 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.

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. or 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. More than 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 warhead that would first burrow underground before exploding. Another use for the warhead is to penetrate the Arctic icecap to destroy Soviet SSBNs. The warhead could be on ballistic missile reentry vehicles or on 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.

Research into combining MaRV and penetrator technologies are being investigated as well. Recent Air Force Ballistic Missile

Office contracts to General Electric and Lockheed call for developing operational prototypes of earth-penetrating maneuverable re-entry vehicles (EPMaRV). 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. Four basic concepts are being investigated.

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.

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. Farther down the technological road are microwave weapons and optical frequency lasers that are being designed to have similar functions. All of these third generation weapons would be suitable for attacking mobile missiles and thus would be encouraged under a START treaty.

Effects of START of Strategic Stability

One of the stated goals of the START negotiations is to improve stability, that is, to lessen the temptation to strike first out of a fear that if weapons are not launched they will be destroyed. To work towards a situation where each sides forces are less vulnerable to the other 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 carry few warheads and are therefore more survivable.

Because of the time span (5-7 years) of START reductions, the U.S. and Soviet Union will only be able to field the nuclear weapons that are currently in the pipeline. Most 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 such a goal of redesigning nuclear forces to make them more stable will not be possible in a six year period, and may not be possible in the long-term given economic constraints on defense spending.

In other ways, START does not improve stability. The current ratio of Soviet "heavy" ICBMs (SS-18 Mod 4) to U.S. missile silos is 3:1, seemingly the most worrisome situation to the Reagan Administration. With a Soviet force of 1500 or more heavy ICBM

warheads and fewer U.S. fixed land-based silos the ratio actually rises to 10:1. Adding U.S. fixed and mobile launchers together produces a ratio of about 4:1.

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 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 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.

One of the most difficult problems to be worked out and one that has a great bearing on stability has to do with how to count the number of warheads on types of ballistic missiles.

The method used in the SALT treaty to determine the number of reentry vehicles carried by a particular missile was to use the maximum number that it has been tested with. While there were certain exceptions (e.g. the Minuteman III has been tested with seven, but is counted with three) the rule has a certain simplicity to it and can be verified by national technical means.

At the time it was a legitimate assumption that a missile would not likely be deployed with more warheads than it had been tested with. More current thinking suggests that simulations could augment knowledge about a missile and by using data from such simulations it is conceivable that a missile could be deployed with more warheads than it has been tested with.

What limits and sublimits are eventually agreed to is of crucial importance especially for determining the size of the submarine force. Tables 5 and 6 assume that differences in U.S. and Soviet negotiating positions are resolved favorably to maximize the number of platforms. This means 10 reentry vehicles for the SS-18 follow-on, SS-24 and MX, 8 for the Trident I and II, and 6 for the SS-19, SS-N-20 and SS-N-23. But these numbers may not be what is finally determined. To use 9 or 10 RVs for the SS-N-20, 10 for the SS-N-23, and 12 for the Trident II would change the number of submarines allowed significantly. A higher counting rule on any or all of these missiles would result in smaller submarine fleets, a situation likely to be unacceptable to the respective navies and one that could decrease stability.

The U.S. has already tested the Trident II SLBM with 10 RVs and a test scheduled for November (temporarily postponed) was scheduled for 12. If the Soviet Union holds the U.S. to those numbers the SSBN fleet shrinks dramatically. If 12 RVs per missile becomes the number only eleven Trident submarines could be deployed with only 5 or 6 on patrol at any given time, a situation that would stimulate anti-submarine warfare (ASW)

research and reduce stability. Likewise using counting rules of say 9 for the SS-N-20 and 10 for the SS-N-23 shrinks the Soviet SSBN fleet to about 9 submarines an equally dangerous and unstable situation.

An additional counting rule problem has to do with the number of ALCMs per bomber. To assign a high number for each aircraft ensures a small bomber force, a situation which may be unacceptable to the respective militaries. The B-1B can carry up to 22 ALCMs internally and externally and Soviet bombers will have equivalent capabilities. If the counting rule becomes 12 how will either side know that an additional 4, 6, or 10 ALCMs are not deployed? Without an adequate verification solution to this problem concerns about treaty "breakout" would likely grow.

A potential unforseen consequence of deep reductions may be to make strategic defenses more attractive. With smaller numbers of fixed (and possibly vulnerable) sites a scaled down version of anti-ballistic missiles to defend them might go forth.

Conclusion

Countermeasures by one side to make their forces invulnerable merely set new research agendas for the other side to try and overcome. These features of the arms race could be constrained through such measures as bans or limits on ballistic missile flight testing or nuclear testing. START by itself won't contain the arms race. The more comprehensive the arms control,

arms reduction, and disarmament agenda is the better it will succeed.

On balance the pluses of a START treaty outweigh the minuses. It takes a significant step forward in attempting to reduce the numbers of weapons. Its defects can be addressed by more comprehensive approaches that limit the technological and qualitative competition that will result and by limiting weapon systems not covered like the sea-launched cruise missile.

TABLE 1
U.S. STRATEGIC NUCLEAR FORCES (end 1987)

Type	Name	Number	Year Deployed	Warheads x Yield (Mt)	Total Warheads	Total Mt
ICBMs						
LGM-30F	Minuteman II	450	1966	1 x 1.2	450	540.0
LGM-30G	Minuteman III	520			1560	413.7
	Mk-12	(220)	1970	3 x .170 (MIRV)	(660)	(112.2)
	Mk-12A	(300)	1979	3 x .335 (MIRV)	(900)	(301.5)
LGM-118A	MX/Peacekeeper	30	1986	10 x .300 (MIRV)	300	90.0
TOTAL		1000 (50%)			2310 (18%)	1043.7 (34%)
SLBMs						
UGM-73A	Poseidon C-3	256	1971	10 x .040 (MIRV)	2560	102.4
UGM-96A	Trident I C-4	384	1979	8 x .100 (MIRV)	3072	307.2
TOTAL		640 (32%)			5632 (43%)	409.6 (14%)
BOMBERS/WEAPONS						
B-1B		64	1986	ALCM .05 -.150	1614	242.1
B-52G/H		241	1958/61	SRAM .170	1140	193.8
FB-111A		56	1969	Bombs .500 (avg.)	2316	1158.0
TOTAL		361 (18%)			5070 (39%)	1593.9 (52%)
GRAND TOTAL		2001			13,012	3047.2

TABLE 2
SOVIET STRATEGIC NUCLEAR FORCES (end 1987)

Type	NATO codename	Number	Year Deployed	Warhead x yield (Mt)	Total Warheads	Total MT
ICBMs						
SS-11	Sego					
M2		184	1973	1 x .950 - 1.1	184	202.4
M3		210	1973	3 x .100 -.350 (MRV)	630	220.5
SS-13 M2	Savage	60	1973	1 x .600 -.750	60	45
SS-17 M3	Spanker	139	1979	4 x .750 (MIRV)	556	417
SS-18 M4	Satan	308	1979	10 x .500 - .550 (MIRV)	3080	1694
SS-19 M3	Stiletto	360	1979	6 x .550 (MIRV)	2160	1188
SS-24	Scalpel	5	1987	10 x .100 (MIRV)	50	5
SS-25	Sickle	126	1985	1 x .550	126	69.3
TOTAL		1392[1] (56%)			6846 (61%)	3841.2 (60%)
SLBMs						
SS-N-6 M3	Serb	272	1973	2 x .375 - 1 (MRV)	544	544
SS-N-8 M1/M2	Sawfly	292	1973	1 x 1 - 1.5	292	438
SS-N-1 7	Snipe	12	1980	1 x .500 - 1	12	12
SS-N-18 M1-3	Stingray	224	1978	6 x .200 -.500 (MIRV)	1344	672
SS-N-20	Sturgeon	80	1983	7 x .100 (MIRV)	560	56
SS-N-23	Skiff	48	1986	10 x .100 (MIRV)	480	48
TOTAL		928[2] (37%)			3232 (29%)	1770 (28%)
BOMBERS/WEAPONS						
Tu-95	Bear A	30	1956	4 x bombs (1)	120	120
Tu-95	Bear B/C	30	1962	5 bombs or 1 AS-3	150	150
Tu-95	Bear G	40	1984	4 bombs and 2 AS-4	240	208
Tu-95	Bear H	55	1984	8 x AS-15 ALCMs (.250) and 4 bombs (1)	660	330
TOTAL		155 (6%)			1170 (10%)	808 (12%)
GRAND TOTAL		2475			11,248[3]	6419.2

1 ICBM throwweight is 10.4 million pounds.
2 SLBM throwweight is 1.9 million pounds.
3 If SS-11 and SS-N6 MRVs are counted as one ICBM total is 6426 and SLBM total is 2960.

TABLE 3
START NEGOTIATING PROPOSALS (December 1987)

	United States position	Soviet position
LAUNCHERS ALLOWED	1600	1600
WARHEADS ALLOWED	6000	6000
SOVIET THROWWEIGHT	50% reduction	Accepts in principle, reject U.S. formula
BALLISTIC MISSILE SUBLIMITS		
* Maximum warheads allowed	4800	4800-5300[1]
* ICBM warheads allowed	3300	3000-3300
* SLBM warheads allowed	no specific ceiling	1800-2000
* "Heavy"[2] ICBMs allowed	1650	50% reduction from current levels
BOMBER WEAPON SUBLIMITS		
* Bomber warheads allowed	Implicit ceiling of 1200	800-900
* ALCM counted as	one warhead	one warhead
* Bombs/ASMs	unlimited deployments allowed	unlimited deployments allowed
MOBILE ICBMs ALLOWED	no	yes
SOVIET BACKFIRE INCLUDED	yes	no
IMPLEMENTATION PERIOD	7 years	5 years

1 A Soviet proposal of 5100 may be tabled soon.
2 A heavy ICBM is defined as any ICBM other than silo-based light or medium ICBMs with 6 or fewer warheads (i.e., the U.S. MX, the Soviet SS-18, and silo-based SS-24s).

TABLE 4
NOMINAL U.S. STRATEGIC FORCES AFTER START

	Launchers	Nuclear Warheads	
ICBMs		Accountable	Actual
MX (silo-based)	50	500	500
MX (rail-garrison)	50	500	500
Minuteman III (silo-based)	100	300	300
"Midgetman" (SICBM)	200	200	200
subtotal	400 (39%)	1500 (25%)	1500 (16%)
SLBMs			
Trident I/II D5[1]	408	3264	3264
subtotal	408 (40%)	3264 (55%)	3264 (35%)
Ballistic missile warheads		4764	4764
Bombers			
B-1B w/ 12 ALCMs and 8 bombs	90	1080	1800
ATB w/ 20 SRAM II and bombs	132	132	2640
subtotal	222 (21%)	1212 (20%)	4440 (48%)
TOTAL	1030	5976	9204

[1] On 17 Trident (Ohio class) submarines with 24 missile tubes each. Assumes eight warheads on each SLBM.

TABLE 5
NOMINAL SOVIET STRATEGIC FORCES AFTER START

	Launchers	Nuclear Warheads	
ICBMs		Accountable	Actual
SS-18 follow-on (silo-based)	50	500	500
SS-24 (mobile/silo-based)	100	1000	1000
heavy missile subtotal	(150)	(1500)	(1500)
SS-19 (silo-based)	190	1140	1140
SS-25 (mobile)	550	550	550
subtotal	890 (65%)	3190 (53%)	3190 (45%)
SLBMs			
TYPHOON/SS-N-20 modified	140[1]	840	840
DELTA IV/SS-N-23 modified	128[2]	768	768
subtotal	268 (20%)	1608[3] (27%)	1608 (23%)
Ballistic missile warheads	--	4798	4798
Bombers			
BLACKJACK w/ 12 ASMs and bombs	90	90	1080
BEAR G w/2 ASMs and 4 bombs	30	30	180
BEAR H w/12 ALCMs	90	1080	1080
subtotal	210 (15%)	1200 (20%)	2340 (32%)
TOTAL	1368	5998	7138

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1 On 7 Typhoon class submarines with 20 missile tubes each. Assumes six warheads on each SLBM.
2 On 8 Delta IV class submarines with 16 missile tubes each. Assumes six warheads on each SLBM.
3 Throwweight is assumed to be 16,700 lb for SS-18 follow-on, 8000 lb for the SS-24, 8000 lb for the SS-19, 2200 lb for the SS-25, 3000 lb for the SS-N-20 and 3500 lb for the SS-N-23.

TABLE 6
Current and Future Weapon Programs

United States	Soviet Union
Small ICBM	SS-24 (mobile/silo)
MX/rail	SS-25 (mobile/silo)
Trident II SLBM (for 17 SSBNs)	SS-18 follow-on
Trident SSBN (no more than 17)	Typhoon SSBN (up to 7)
Advanced Technology Bomber	Delta IV SSBN (up to 8)
Advanced Cruise Missile (only if substituted for ALCM)	SS-N-20 SLBM (for 7 SSBNs)
SRAM II	SS-N-23 SLBM (for 8 SSBNs)
Gravity bombs	Bear H bomber
Warhead/Reentry Vehicle programs	Blackjack A bomber
Zero/near Zero CEP RVs	AS-15 air-launched cruise missile
MaRV	Gravity Bombs
Earth penetrator warhead	Warhead/Reentry Vehicle programs
Third generation warhead concepts	Zero/near Zero CEP RVs
	Marv
	Earth penetrator
	Third generation warhead concepts

Table 7
U.S. and Soviet Weapon Retirements Under START

	United States	Soviet Union
ICBMs		
	450 Minuteman II with 450 warheads 400 Minuteman III with 1200 warheads	394 SS-11 with 394 warheads 60 SS-13 with 60 warheads 139 SS-17 with 417 warheads 308 SS-18 with 3080 warheads 170 SS-19 with 1020 warheads
Total	950 ICBMs with 1650 warheads	1071 ICBMs with 4971 warheads
SLBMs		
	192 Trident I C4 with 1536 warheads 16 SSBN/256 C-3 SLBMs 2560	272 SS-N-6 with 272 warheads 12 SS-N-17 with 12 warheads 280 SS-N-8 with 280 warheads 224 SS-N-18 with 1344 warheads
Total	448 SLBMs with 4096 warheads	788 SLBMs with 1908 warheads
Bombers		
	167 B-52G 96 B-52H	60 Bear A/B/C
Total	263 bombers	60 bombers

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Since 1980 the Natural Resources Defense Council has sponsored the Nuclear Weapons Databook Project. The purpose of the project 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 Project has published three volumes of its Databook series describing the U.S. nuclear arsenal and weapons production complex. Currently in preparation are a volume on Soviet nuclear weapons and another on other nuclear weapons powers and proliferation. Starting in May 1987, the Project staff is contributing a monthly column in The Bulletin of the Atomic scientists, entitled Nuclear Notebook.

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

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