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WHO'S AHEAD? EXAMINING THE NUCLEAR BALANCE

by Jane Boulden

'Who's ahead?' is perhaps a crude question, but when applied to the strategic arms race, it is the one most often raised. Despite the thousands of nuclear weapons available to both superpowers, 'who's ahead' remains a question of great importance, affecting defence spending, force structures and arms control negotiating positions.

The significance of the question is rooted in the theory of nuclear deterrence. Mutual deterrence rests on the assumption that both sides have the ability to retaliate and inflict unacceptable damage on the enemy, even *after* having absorbed a first strike. A first strike is an attack carried out against the enemy's nuclear capability with the intent of eliminating his ability to retaliate in kind. If the 'attacker' is uncertain whether he can eliminate the enemy's ability to strike back, he is deterred from striking first, since the potential gain from such a first strike is far outweighed by the potential losses.

Thus, determining who is ahead involves more than counting which side has more weapons. It involves taking account of the characteristics of weapons and their ability to fulfil their functions. Essentially, the key to the balance is determining whether one side is moving substantially ahead in counterforce* capability or is developing the capability to launch an effective first strike. This cannot be determined solely on the basis of a tally of weapons numbers on each side.

* In *counterforce* targeting, missiles are targeted against missiles and other military installations. A nuclear strike against the enemy's population or industrial base, known as a *countervalue* strike, leaves the enemy missile force intact and able to retaliate.

PUBLIC SOURCES

Just as there is no single indicator of 'who's ahead', there is no single source of public information that will provide an accurate and full picture of the military balance. The Canadian government, like most other NATO members, must rely on the American government for accurate information on strategic nuclear forces. However, the American figures are themselves subject to debate, especially in the United States, where they are an important part of the larger public debate on defence spending, arms control and weapons procurement.

It is therefore important to examine more than one source for the nuclear balance and to understand the assumptions and the methodologies of each source. By analyzing and comparing various sources, it is possible to understand the areas of uncertainty and controversy in the debate about the capabilities and characteristics of strategic weapons systems, as well as to gain a better understanding of the balance itself.

The Military Balance is published annually by the London-based International Institute for Strategic Studies (IISS), and contains a detailed, worldwide listing of both conventional and nuclear forces. The data is based on a wide range of unlisted sources and is up-to-date as of 1 July of each year. The Institute notes that the data published is based on information available at the time; thus, changes from year to year do not necessarily reflect changes in national forces, but may be due to changes in the primary sources of information.

The Stockholm International Peace Research Institute (SIPRI) Yearbook, *World Armaments and Disar-*

mament, is the other widely used annual source on the subject. Each edition of the Yearbook includes a chapter on the nuclear balance which gives an overview of new developments accompanied by charts of the strategic and tactical forces of all nuclear weapon states. In 1985, SIPRI began to use a new set of authors and thereby introduced a different emphasis into their evaluation of the balance. In the previous years SIPRI had always presented what might be termed a 'traditional' evaluation of the balance, listing missile and warhead totals along with missile characteristics such as yield and accuracy. The 1985 and 1986 charts placed more emphasis on warhead stockpiles and less emphasis on qualitative factors. Members of the US-based Natural Resources Defense Council, who also publish the Nuclear Weapons Databook series (see below), now prepare this chapter for SIPRI. As with the IISS, changes in the data from year to year may be the result of factors other than changes in force levels.

Soviet Military Power (SMP) is an annual review of Soviet forces published by the US Department of Defense. There is heavy emphasis on the quantity and size of Soviet forces and little discussion of quality and performance. The publication also contains information on American force deployments but this information is much more general in nature. While *Soviet Military Power* tends to serve a public relations role, it is an important barometer of official American thinking on Soviet forces, and on upcoming Soviet weapons systems.

The military posture statement published by the US Joint Chiefs of Staff every fiscal year is the best summary of the American government's view of its own forces and defence spending. The *Annual Report to Congress* by the US Secretary of Defense also provides a view of American forces and provides an estimate of Soviet forces similar in nature and intent to *Soviet Military Power*.

Whence the Threat to Peace is published by the Soviet Union primarily as a response to *Soviet Military Power*. *Whence the Threat to Peace* emphasizes the quality of American strategic forces and, like *Soviet Military Power*, makes no direct comparison between Soviet and American forces. The Soviet publication contains very little information on Soviet forces. The most recent edition of *Whence the Threat to Peace* was published in 1984.

Information on Soviet nuclear forces can also be found in the Soviet media. (See, for example, "The Armaments of the USSR and the US: Data to Compare," *USSR News Release*, no. 10, 23 January 1987.)

A comprehensive examination of the characteristics and capabilities of US nuclear weapons systems is provided by the Natural Resources Defense Council, an independent research organization. *US Nuclear Forces and Capabilities*, the first volume in their series of Nuclear Weapons Databooks, is a detailed compendium of information compiled from an extensive list of sources, including more than 200 requests under the Freedom of Information Act. The volume is an indispensable reference manual although it does not undertake counts of deployed missiles such as those found in other sources.

The US-Soviet Military Balance 1980-1985 by Congressional Research Service analyst John M. Collins offers an extensive record of the US-Soviet balance in nuclear, chemical and conventional arms. Fact sheets or press releases from the Arms Control Association and the Center for Defense Information in Washington, D.C., also provide assessments of the strategic balance and are useful updates on the latest developments.

The Institute for Defense and Disarmament Studies in Brookline, Massachusetts has published the first edition in their World Weapons Databook series, *Soviet Missiles*. The first volume provides a comparison of estimates of missile numbers and characteristics from a number of different sources, providing a useful overview of the range of opinion on Soviet missile characteristics. IDDS also publishes the *Arms Control Reporter*, an annual summary of key negotiations; it is supplemented with monthly updates.

In addition to these publications, information is available from other sources which are not necessarily solely concerned with nuclear forces. *Aviation Week and Space Technology* (AW&ST), *Air Force Magazine* and *Jane's Defence Weekly* can all be valuable sources. Designed primarily for a military and trade readership, these journals have excellent 'inside' sources and often contain detailed information on both Soviet and American strategic forces. While these periodicals are very useful, care must be taken in using the information; there is a fine distinction between access to inside sources and the release of information designed to lead the public debate in a desired direction.

The CIA National Intelligence Estimates sometimes offer key insights into the evaluation process. For example, in July 1985 the CIA revised its previous judgement on the accuracy of the Soviet SS-19 missile, concluding that it was about 100 metres less accurate than had previously been thought. Although largely unnoticed in public debate, this revision had a critical effect on the estimated counterforce capability of the SS-19 (see below) and consequently on the perceived vulnerability of American land-based missiles. Apart from the substantive issue, the CIA revision — disputed by its sister organization the Defense Intelligence Agency

— demonstrates the hazards of relying on even the most sophisticated sources for details of Soviet weapons capabilities.

BASIC FACTORS IN THE STRATEGIC FORCE BALANCE

As stated above, no single indicator gives an accurate picture or estimate of the US-Soviet military balance. An effective analysis of the comparative value of strategic nuclear weapons systems involves consideration of a number of variables. Those variables that can be *quantified* include: the number of missiles and warheads deployed by both sides, the yield of the warhead, the accuracy of the warhead, the hardness of the targets, the throw-weight of the missile and the overall reliability of the delivery system.

In addition to these factors, there are a number of other variables which are not easily quantified, but are critical to calculations of the force balance. These include the readiness of operational forces, the survivability of command and control centres, the time between launch and target of a delivery system, the ability of offensive weapons to penetrate defences, and the defensive capabilities of each side. Allowing for these factors generally involves devising complicated scenarios, which are themselves the subject of considerable debate regarding their real-life plausibility. This paper addresses the *quantifiable* variables which, used in combination and in a step-by-step process, can act as useful tools to understanding the superpower competition in nuclear weapons.

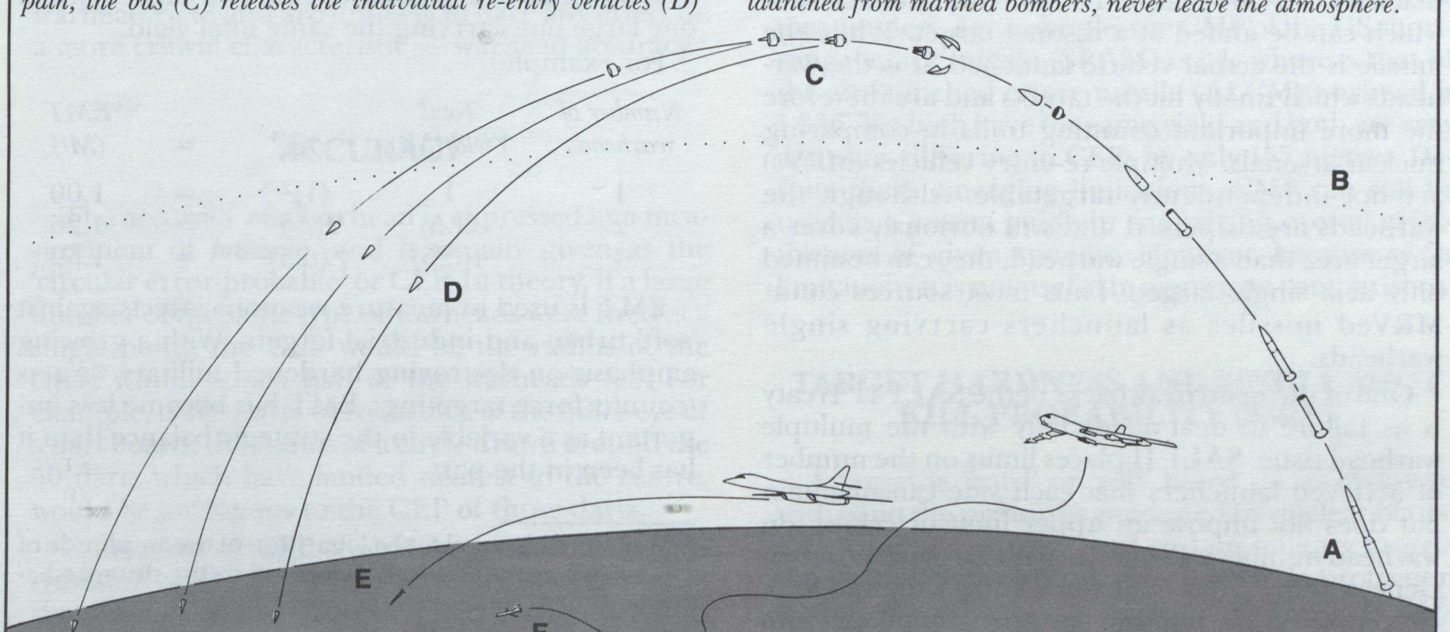
MISSILES/WARHEADS

The numbers of missiles and warheads possessed by each side are the basic counting variables. A missile carries the warhead(s) and is the actual vehicle launched. The terms 'missile' and 'launcher' are sometimes used interchangeably and it is therefore important to be aware of which term is being used. Missiles and launchers are not always equivalent and it is possible that a single *launcher* can fire more than one *missile*. For example, recent American INF arms control proposals counted a battery of four ground-launched cruise missiles (GLCMs) as a single launcher. Launcher totals often include missiles *and* strategic bombers which are capable of firing missiles.

Missiles can be launched from the ground, from the sea or from the air. These three elements together make up what is known as the strategic triad. Each leg of the triad is meant to act as an independent deterrent, thus reinforcing the others and deterrence as a whole.

There are basically two types of nuclear missiles: those that must operate within the atmosphere and those that can leave the atmosphere. Strategic *ballistic* missiles are propelled out of the earth's atmosphere by rocket propulsion. At some point in the middle of the trajectory, the re-entry vehicles, which house the warheads and shield them from the effects of re-entering the atmosphere, are released.

This diagram illustrates the ballistic missile (A) which leaves the atmosphere (B). Sometime during the midcourse of its flight-path, the bus (C) releases the individual re-entry vehicles (D) which travel independent trajectories to distinct targets. Other missiles, such as the SRAM (E) and the cruise missile (F), launched from manned bombers, never leave the atmosphere.



They re-enter the atmosphere and travel a course determined by the initial thrust and the force of gravity. A *cruise* missile is an air-breathing missile which is propelled by a jet engine and never leaves the earth's atmosphere. Other missiles such as the short-range attack missile (SRAM) also operate within the atmosphere.

Nuclear weapons are classified as strategic, intermediate or tactical. However, these distinctions are not always clear and can be the subject of much debate in arms control forums. For the purpose of arms control negotiations, the Soviets have traditionally wanted to classify strategic missiles as all those missiles capable of hitting the enemy's territory, regardless of the actual physical distance they can travel or where they are deployed. Under this definition, American missiles such as the Pershing II and the GLCM, which are deployed in Europe, are classified as strategic and therefore are subject to overall reduction proposals, while Soviet SS-20 missiles, also deployed in Europe but not capable of hitting the United States, are excluded.

However, this general definition finds little acceptance outside of the Soviet Union and previous arms control treaties and negotiations have classified missiles according to their range, that is, the distance the missile can travel. For example, the SALT II Treaty defined a strategic missile as one with a range in excess of 5,500 km. Tactical nuclear weapons (TNW) are generally considered to have a range less than 1,000 km. Missiles with ranges falling between these two values are referred to as intermediate-range nuclear forces (INF).

Some missiles carry multiple, independently-targetable re-entry vehicles (MIRVs). This means that they can carry more than one warhead, each of which can be aimed at a distinct target. While the missile is the actual vehicle launched, it is the warheads which finally hit the targets and are therefore the more important counting units in comparing nuclear arsenals. Multiple re-entry vehicles (MRVs) are not independently targetable. Although the warheads are dispersed and will obviously cover a larger area than a single warhead, they can be aimed only at a single target. Thus most sources count MRVed missiles as launchers carrying single warheads.

One of the main drawbacks of the SALT II Treaty is its failure to deal adequately with the multiple warhead issue. SALT II places limits on the number of MIRVed launchers that each side can maintain but does not impose an upper limit or ceiling on warhead numbers. Recent arms control proposals in Geneva address this issue for the first time and have concentrated on limiting warhead numbers, with launcher ceilings given a secondary role.

YIELD AND EQUIVALENT MEGATONNAGE (EMT)

The yield of a warhead provides a measure of its explosive energy yield expressed in kilotons (kt) or megatons (Mt). (1 Mt = 1,000 kt.) As a useful comparison, the atomic bomb dropped on Hiroshima is generally considered to have had a yield of 14 kt or 0.014 Mt. The Soviet SS-18 warhead has a yield of 0.500 Mt and the American Minuteman III 12A W78 warhead has a yield of 0.335 Mt.

Estimates of the yield of Soviet warheads are primarily determined through seismic monitoring of Soviet underground nuclear tests. The magnitude* of a seismic event is used to determine the explosive yield of a Soviet test by calibrating it with measurements of other underground explosions of known yields.

Because of the nature of the nuclear explosion, however, destructive power and the yield of the warhead do not grow linearly in a 1:1 relationship. When an explosion takes place, a great deal of the energy released as blast wave is concentrated in the centre vertical plane of the explosion, as opposed to expanding equally outwards in the shape of a sphere. As the yield of a weapon increases, the energy 'lost' to the concentration effect in the centre also increases, but not in a one-to-one relationship to the increase in yield. Equivalent megatonnage (EMT) reflects this distribution of energy and provides a better measurement of overall destructiveness than yield alone.

$$EMT = Y^{2/3} \; {**}$$

From this it can be seen that several smaller warheads will have a greater destructive capacity than one large one carrying the same total yield.

For example:

Number of warheads	*Total Yield (Mt)*	$Y^{2/3}$	=	*EMT (Mt)*
1	1	$(1)^{2/3}$	=	1.00
2	2(.5)	$2(.5)^{2/3}$	=	1.26
4	4(.25)	$4\,(.25)^{2/3}$	=	1.59

EMT is used to measure weapons effects against 'soft' urban and industrial targets. With a growing emphasis on destroying hardened military targets (counterforce targeting), EMT has become less important as a variable in the strategic balance than it has been in the past.

* Magnitude is equal to the logarithm of the amplitude of a seismic event adjusted according to the distance between the seismic event and the seismic station.

** At yields of greater than one megaton, $EMT = Y^{1/2}$.

THROW-WEIGHT

Throw-weight is the total weight that can be thrust into a trajectory over a given range by the propulsion stages of a ballistic missile. Throw-weight includes the warhead, its guidance system and any penetration aids the missile might carry. In general, Soviet ICBMs have been built with larger throw-weights than their American counterparts. Americans view the combination of larger Soviet throw-weights and the overall trend of accurate MIRVed missiles as threatening because they fear that the large throw-weights could be 'fractionated' to produce missiles carrying a larger number of smaller warheads. In particular the US is concerned with the Soviet SS-18, a ten-warhead missile with an estimated throw-weight of 16,700 pounds. Some estimates have suggested the SS-18 could be converted to carry as many as 30 warheads. American arms control proposals have attempted to deal with this situation by setting throw-weight limitations. For example, at the Nuclear and Space Arms talks in Geneva, the October 1985 American proposal called for both a 50% reduction in Soviet throw-weight and a sub-ceiling on the number of ICBM warheads.

SALT II places limits on the number of warheads that can be deployed on a missile and therefore limits fractionation. Although the Soviet Union has stated it will continue to comply with the SALT limits, the US decision to violate SALT II could bring about the very situation the Americans have been trying to avoid. Furthermore, the implicit assumption that throw-weight is synonymous with destructive power is misleading. Limits on throw-weight do not necessarily mean proportional cuts in warhead yield and are unlikely to have any effect on a more critical characteristic — warhead accuracy.

ACCURACY

The accuracy of a warhead is expressed as a measurement of *precision*, and is usually given as the 'circular error probable' or CEP. In theory, if a large number of the same type of warheads were fired at a single point, the CEP would be the radius of the circle within which half of the warheads fell. For example, if 100 darts were thrown at the bull's-eye of a dart board, the radius of a circle drawn around the 50 darts which have landed nearest to the centre, would be analogous to the CEP of those darts.

Estimation of CEP should be based on the distribution of a large number of test firings. In reality, the number of test firings carried out by the US is usually not large and the measurement of accuracy is subject to significant uncertainties. The uncertainty involved in estimating Soviet CEPs is even greater since these estimates are made by piecing together various fragments of information. As mentioned earlier, in July 1985, the CIA revised its estimate of the CEP of the Soviet SS-19, increasing the CEP (decreasing the accuracy) by about 100 metres. While the adjustment appears small, it has a substantial effect on the overall evaluation of Soviet counterforce capabilities, and demonstrates the uncertainties involved in these estimates.

COUNTERMILITARY POTENTIAL (CMP)

CMP, sometimes referred to as lethality, expresses a warhead's capabilities against point targets such as missile silos. It is not strictly a *measure* as such but a numerical expression of potential. It can be used most effectively as a general idea of *design efficiency* in qualitatively comparing different missile systems. CMP is related to yield and to accuracy, but has mechanical limits. Because of the nature of the relationship, CMP varies inversely with CEP; as warheads become more accurate (that is, as the CEP decreases), the value for CMP grows exponentially:

$$\text{CMP} = \frac{Y^{2/3}}{(\text{CEP})^2}$$

However, as Kosta Tsipis has noted, CMP has "a maximum numerical value beyond which its magnitude has no physical meaning."[1] As technology improves warhead accuracies, this maximum is approached more often and in some cases has been exceeded. The result is that, at high levels of accuracy, the calculated values for CMP become meaningless. For example, the CMP of the US short-range attack missile (SRAM) is 34, whereas that of the air-launched cruise missile (ALCM) warhead is 1,336. Yet both have the same yield and both are very accurate, differing in CEPs by only 157 metres. Despite these emerging limitations, CMP can still be used as a *general* guide in comparing overall effectiveness of given systems. However, because of its limitations it is not useful in aggregate comparisons.

TARGET HARDNESS AND SINGLE SHOT KILL PROBABILITY (SSKP)

A target is 'hard' or 'soft' based on its ability to withstand the pressures generated by nuclear blasts. Cities, industrial bases and certain military targets are termed 'soft' because they have little protection against the effects of a nuclear explosion. ICBMs are shielded by silos made of reinforced concrete and steel, specifically designed to withstand a nuclear explosion. These are called 'hard' targets. Estimates of the hardness of Soviet and American missile silos are not readily available but it is generally assumed that US silos can withstand up to 2,000 pounds per square inch (psi) and Soviet silos 2,000-5,000 psi. One of the options considered for deploying the new MX missile was to house them in superhardened silos capable of withstanding 25,000 to 50,000 psi.

The probability that a given warhead will destroy a silo of a given hardness is known as the Single Shot Kill Probability (SSKP).[2] It is related to warhead yield, accuracy and the hardness of the target as shown by the following equation:

$$SSKP^* = 1 - 0.5^{\frac{(8.41\,Y^{2/3})}{(H^{0.7}\,CEP^2)}}$$

OVERALL RELIABILITY (OAR) AND TERMINAL KILL PROBABILITY (TKP)

A ballistic missile has five stages of operation: launch phase, boost phase, separation, penetration and detonation. Each stage can be assigned a specific reliability, that is, the probability that it will not fail in that stage. The missile's overall reliability (OAR) is a product of the reliabilities at each individual stage of flight:

OAR = Reliability at stage 1 × reliability at stage 2 × reliability at stage 3 × reliability at stage 4 × reliability at stage 5.

Values for the OARs of Soviet and American missiles are not publicly available and can only be estimated. Reliability is an extremely important variable. The overall reliability (OAR) of a missile is used to determine the probability that a given warhead will reach and destroy its target. This is known as Terminal Kill Probability (TKP).[3]

$$TKP = SSKP \times OAR$$

Thus, the probability of a warhead destroying its target (SSKP) may be 70%, but if the missile has an overall reliability (OAR) of only 50% (i.e., only 50% of those fired will complete all five stages of operation), then only 35% of the total warheads fired will reach and destroy their targets. Therefore OAR can be a significant factor in the evaluation of strategic forces. A relatively simple case in which these equations can be examined is to hypothesize that the Soviet Union uses 1,000 SS-18 warheads (100 missiles) to attack the 1,000 American ICBMs. It is assumed that the American missiles are in silos hardened to 2,000 psi, OAR is assumed to be 70%, and the other values are taken from the accompanying tables:

SS-18

$$\begin{aligned} SSKP &= 0.654 \\ TKP &= SSKP \times OAR \\ &= (0.654) \times (0.70) \\ &= 0.46 \end{aligned}$$

In sum, 46% of 1,000 warheads or 460 warheads could be expected to hit and destroy their targets.

WHO'S AHEAD

The values used in the following discussion are taken from the accompanying tables. The figures used in the tables are those generally accepted by the sources discussed earlier in this paper. Differences of opinion among the sources are footnoted.

Ballistic Missiles

The Soviet Union maintains a large percentage of its nuclear forces on land and, as can be seen in the tables below, these missiles are generally larger in throw-weight and yield than their American counterparts. In contrast, the Americans maintain a smaller percentage of their nuclear forces on land. This difference in emphasis between the two sides has contributed to American fears that US ICBMs are vulnerable to a Soviet first strike.

A move to mobile, land-based missiles might help to alleviate some of the fears of vulnerability on both sides. Mobile missiles would be far more difficult to target, and a much larger number of incoming warheads would be required to destroy them.

The Soviets are currently ahead of the US in this area, having already deployed about 72 of the single-warhead, mobile SS-25, and are close to deploying the ten-warhead, rail-mobile SS-24.

Although the USSR has more ballistic missile *submarines* and submarine-launched ballistic *missiles* (SLBMs) than the US, the United States has more SLBM *warheads* (5,632) than the Soviet Union (3,143) and these are, on the whole, more capable than many of the Soviet SLBM warheads.

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* To estimate SSKP, the CEP must be given in nautical miles (nm) and the hardness (H) in pounds per square inch (psi).

American plans to deploy Trident D-5 SLBMs in 1989 will bring a new element into the balance. Because of the accuracy of these warheads, there will be for the first time a significant counterforce capability at sea. Submarines are less vulnerable launching platforms than land-based missile silos because they are mobile and have large areas of the ocean in which to hide. The deployment of the D-5 will give the United States a very strong, relatively secure, counterforce capability (at the highest accuracy estimates the SSKP of the Trident D-5 approaches 100%). There are no signs that the Soviet Union will be able to match this capability within the same time frame.

Strategic Bombers

The United States has the superior capability in this leg of the triad. The US has 278 active bombers (with approximately 250 B-52s in storage) as compared to 160 Soviet bombers. The American bombers are able to carry more weapons than the Soviet bombers, and the weapons they carry — the ALCM and the SRAM — are more capable than the Soviet equivalents. In this light it is interesting to note that the American Reykjavik proposal to eliminate all ballistic missiles would leave the Americans with a substantial advantage because of the size of its bomber force.

Long-range Cruise Missiles

By deploying the cruise missile-capable Bear H bomber, a new version of an old bomber, the Soviet Union has been able to achieve an ALCM capability sooner than expected. However, with around 1500 ALCMs, the United States remains ahead of the Soviet Union, and plans to deploy the stealth advanced cruise missile.

With respect to sea-launched cruise missiles (SLCMs), the Soviets are said to be close to deploying the SS-N-21 with a range of 3000 km. The US Tomahawk SLCM, now being deployed on surface ships and submarines, has a range of 2500 km.

Intermediate-range Nuclear Forces

The Soviet SS-20 continues to be the dominant factor in the INF missile balance, giving the Soviet Union a decided edge in missile warhead numbers. An agreement to remove or drastically reduce the numbers of INF missiles in Europe appeared to have been close at the time of the Reykjavik summit and would bring an end to Soviet superiority in this category. Even if such an agreement were reached and were coupled with the planned phasing out of the Soviet SS-4, a number of shorter-range Soviet missiles would still remain in Europe with no NATO counterpart. This is an issue of concern to the Europeans and, at the Reykjavik summit, the Soviet Union apparently agreed to freeze these shorter-range missiles at their present levels and to enter negotiations "to determine their future."

CONCLUSIONS

Who's ahead? The evidence suggests that neither side holds an overall advantage. Advantages in certain categories of weapons are offset by disadvantages in others. These offsetting asymmetries contribute to a sense of stability; both sides are confident in their ability to retaliate and thus deter an attack. While improved counterforce capabilities (for example, the Trident D-5), may undermine this sense of confidence for a time, past experience has shown that short-term technological gains have not, in the long run, led to a decisive edge for one side or the other.

On the other hand, every new weapon complicates strategic arms control negotiations, as do the asymmetries in force structures. The accompanying set of tables may serve as a basic reference for understanding and assessing current and future arms control proposals and counter-proposals.

NOTES

1. K. Tsipis, *Arsenal*, Simon and Schuster, New York, 1963, p. 307.
2. L.E. Davis and W.R. Schilling, "All You Ever Wanted to Know About MIRV and ICBM Calculations But Were Not Cleared to Ask," *Journal of Conflict Resolution*, vol. 17, no. 2, June 1973, p. 210.
3. *Ibid.*, p. 217.
4. See, for example: *Soviet Military Power 1986*, p. 30.

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The author has benefitted from the advice of colleagues within CIIPS and elsewhere, but the views expressed in this paper are the author's own and should not be taken to represent the views of the Institute and its Board.

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Le présent exposé est également publié en français.

TABLE I United States Strategic Nuclear Forces

System	Missiles	Warhead(s)/ Missile	Total Warheads	Yield/ Warhead (Mt)	Total Yield (Mt)	Range (km)	Throw-weight (× 1000 lbs)	Counterforce Characteristics: CEP (nm)	Counterforce Characteristics: SSKP (H = 2000 psi)
ICBMs									
Minuteman II	450[a]	1	450	1.200	540.00	11300	1.60	0.120	0.89
Minuteman III	240[b]	3	720	0.170	122.40	14800	2.20	0.110	0.51
Minuteman III Mk12A	300	3	900	0.335	301.50	12900	2.40	0.120	0.62
Titan II	5[c]	1	5	9.000	45.00	15000	8.30	0.700	0.22
MX (Peacekeeper)[d]	10	10	100	0.300	30.00	11000	7.00	0.050	0.99
	1005		2175		1038.90				
SLBMs[e]									
Poseidon C3	256	10	2560	0.040	102.40	4600	3.30	0.240	0.06
Trident C4	384	8	3072	0.100	307.20	7400	3.00	0.120	0.35
Trident D5[f]	0	8	0	0.475	0.00	7500	5.08	0.080	0.93
	640		5632		409.60				
Air-launched missiles									
ALCMs	1488	1	1488	0.200	297.60	2500	n/a	0.016	1.00
SRAMs and Bombs[g]	2066	1	2066	0.170	351.22	220	n/a	0.100	0.58
	3554		3554		648.82				
Bombers[h]	Number							Payload[j]	
B-52G	98					12000		12 ALCMs	
	69							14 SRAMs/bombs	
B-52H	26					12000		12 ALCMs	
	70							14 SRAMs/bombs	
B-1B[i]	15					12000		8 SRAMs/bombs	
	278								
Total launchers (ICBMs, SLBMs, Bombers)	**1923**	**Total Warheads**	**11361**		**2097.32**	**Total Yield (Mt)**			

a In place of their warheads, ten Minuteman II missiles are equipped with the Emergency Rocket Communications System (ERCS), which transmits the authority to release nuclear weapons. There is speculation that these communications packages may be removed and replaced with Minuteman warheads, however no decision has yet been taken. The number of Minuteman II warheads is, however, assumed to be 450. See: "ERCS Future in Doubt," *Air Force,* June 1985, p. 30.

b Ten Minuteman III silos at F.E. Warren Air Force Base in Wyoming have been modified to house MX missiles.

c The Titan II missile continues to be phased out at a rate of about one per month.

d Characteristics for the MX are taken primarily from T.B. Cochran *et al., US Nuclear Forces and Capabilities,* Nuclear Weapons Databook, vol. 1, 1984, which states that the CEP is "less than 400 feet"; other sources estimate the CEP at 300 feet. The more recent value of 300 feet is used in the tables. See, for example: John Collins, *US/Soviet Military Balance,* CRS Report, No. 85-83 F, 15 April 1985.

e The United States maintains 36 ballistic missile submarines:
8 Ohio-class with 24 Trident C-4 missiles
28 Lafayette- and Benjamin Franklin-class:
16 with 16 Poseidon C-3 missiles each
12 with 16 Trident C-4 missiles each

A 12 September 1986 decision by the Reagan Administration to overhaul, rather than dismantle, the *Alexander Hamilton* and *Kamehameha* resulted in the US exceeding the SALT II limits when the 131st B-52 bomber was deployed in November. A further decision on dismantlement or overhaul will have to be made with respect to *John Adams* and *Andrew Jackson* in the summer of 1987.

f The Trident D-5 is expected to be operational in 1989 on Ohio-class submarines. The warhead characteristics used in the table are taken from Robert S. Norris, "Counterforce at Sea," *Arms Control Today,* September 1985. A mix of two warheads is being considered; the heavier warhead, which would be deployed on the majority of missiles, is used here. Estimates for the CEP of the warhead extend as low as 100 metres (0.05 nm). See: *Jane's Defence Weekly* (JDW), 24 August 1985, p. 347.

g Weapons characteristics such as range and CEP refer only to SRAMs.

h The Soviet Union counts all American B-52 bombers, including those in storage, for a total of 518 heavy bombers. See: "The Armaments of the USSR and the US: Data to Compare," *Soviet Embassy News Release,* no. 10, 23 January 1987.

i The first squadron of fifteen B-1B bombers was activated on 1 October 1986. However, Hugh Lucas reports that only one B-1B is considered to be fully operational because of unexpected problems. See: H. Lucas, "Pentagon concerned over B-52 to B-1B transition," *JDW,* 22 November 1986, p. 1219.

j Estimates of bomber loadings vary considerably. The figures used here are taken from "Strategic Nuclear Forces of the United States and the Soviet Union," a factsheet printed by the Arms Control Association, 7 October 1986. IISS lists only 90 B-52G and 90 B-52H bombers. The conversion of B-52 bombers to cruise missile carriers is ongoing.

TABLE II Soviet Strategic Nuclear Forces

System	Missiles	Warhead(s)/ Missile	Total Warheads	Yield/ Warhead (Mt)[k]	Total Yield (Mt)	Range (km)	Throw-weight (× 1000 lbs)	Counterforce Characteristics: CEP (nm)	Counterforce Characteristics: SSKP (H = 2000 psi)
ICBMs									
SS-11 Mod 1[a]	28	1	28	0.95	26.6	10000	2.2	0.75	0.05
SS-11 Mod 2/3	420	1	420	1.00	420	13000	2.5	0.59	0.08
SS-13 Mod 2	60	1	60	0.60	36	10000	1.3	1.01	0.02
SS-17 Mod 3	150	4	600	0.75	450	10000	6.4	0.19	0.48
SS-18 Mod 4[b]	308	10	3080	0.50	1540	11000	16.7	0.13	0.65
SS-19 Mod 3	360	6	2160	0.55	1188	10000	7.5	0.21[l]	0.35
SS-25[c]	72	1	72	0.55	39.6	10500	1.6	0.11	0.79
SS-X-24[d]	0	10	0	0.10	0	10000	8.0	0.11[m]	0.40
	1398		6420		3700.2				
SLBMs[e]									
SS-N-5[f]	39	1	39	1.00	39	1400	n/a	1.49	0.01
SS-N-6 Mod 1/2	152[g]	1	152	1.00	152	3000	1.5	0.80	0.04
SS-N-6 Mod 3	152	1	152	0.35	53.2	3000	1.5	0.48	0.07
SS-N-8 Mod 1/2	292	1	292	0.80	233.6	7800	n/a	0.48	0.10
SS-N-17	12	1	12	1.00	12	3900	2.5	0.80	0.04
SS-N-18 Mod 3	224	7	1568	0.20	313.6	6500	2.5	0.32	0.09
SS-N-20	80	9	720	0.50	360	8300	5.6	0.25	0.25
SS-N-23[h]	32	7	224	0.25	56	7240	3.4	0.32[n]	0.10
	983		3159		1219.4				
Air-launched missiles									
AS-15 ALCMs[i]	160	1	160	0.25	40	3000			
Bombs	280	1	280	1.00	280	n/a			
	440		440		320				
Bombers[j]	Number						Payload		
Bear Tu-95 B/C/G	100					12800	2 Bombs		
Bear Tu-95 H	40					12800	4 ALCMs		
Bison Mya-4	20					11200	4 Bombs		
	160								
Total launchers (ICBMs, SLBMs, Bombers)	**2541**	**Total Warheads**	**10019**		**5239.6**	**Total Yield (Mt)**			

a SS-11 Mod 1 missiles first deployed in 1966 are being dismantled to compensate for the deployment of the SS-25. The SS-11 Mod 2 is a single-warhead missile and the SS-11 Mod 3 carries 3 MRVs. SIPRI lists 30 Mod 1, 360 Mod 2, and 60 Mod 2 and 3 with 3 MRVs.

b NATO estimates provided at the NATO Nuclear Planning Group meeting in October 1986 apparently put the SS-18 at 310 missiles. See: G. Manners, "SACEUR's plans for nuclear stockpile," *Jane's Defence Weekly (JDW)*, 25 October 1986, p. 948.

c The SS-25 is a single-warhead, road-*mobile* missile now deployed at two sites, Yurya and Yashkarola. CIA estimates (National Intelligence Estimate NIE-11-3-885) suggest that 20 bases are being prepared for the SS-25, and that ten missiles will be deployed at each base for a total of 200 missiles by the mid-1990s.

d The SS-X-24 is a ten-warhead missile. NIE-11-3-885 suggests the SS-24 is being deployed out of bases at Plesetsk and Kostroma. *Soviet Military Power* (SMP) 1986 states that the SS-X-24 could be deployed in a rail-mobile mode "as early as late 1986" (p. 27). Other estimates seem to agree that SS-X-24 deployment may have begun. See, for example: G. Manners, "SACEUR's plans for nuclear stockpile," *JDW*, 25 October 1986; and P. Samuel, "Big Soviet Buildup Foreseen," *Defense Week*, 17 June 1986, p. 15. IISS estimates the SS-X-24 warhead yield as 100 kt, the figure used in the table, while SIPRI suggests 550 Kt.

e The USSR currently maintains the following 61 SALT-accountable strategic submarines:

- 4 Typhoon with 20 SS-N-20 missiles each
- 18 Delta I with 12 SS-N-8
- 4 Delta II with 16 SS-N-8
- 14 Delta III with 16 SS-N-18
- 2 Delta IV with 16 SS-N-23
- 18 Yankee I with 16 SS-N-6
- 1 Yankee II with 12 SS-N-17

On 6 October 1986 a Yankee II submarine with 16 SS-N-16 SLBMs sank in the Atlantic Ocean. This loss is taken into account in the numbers given. The Soviet total for Soviet SLBMs is 992, of which 352 are MIRVed. See: "The Armament of the USSR and the US: Data to Compare," *op. cit.*

f Although included in this table, the SS-N-5 is deployed on the Golf II submarine which is currently assigned a theatre role.

g SIPRI 1986 suggests the distribution between the SS-N-6 Mod 2 and the SS-N-6 Mod 3 is about 50-50. None of the other sources used attempted a distribution estimate. The SS-N-6 Mod 3 has 2 MRVs.

(please see over)

h All the warhead characteristics used for the SS-N-23 are taken from Jeffrey I. Sands and Robert S. Norris, "A Soviet Trident II?," *Arms Control Today*, September 1985, p. 7. The SS-N-23 is deployed on the new Delta IV submarines. IISS does not attempt an estimate of its yield or range. *SMP* gives the range as 8300 km. SIPRI lists the yield as 350 to 500 kt.

i The AS-15 air-launched cruise missile became operational in 1984 and is deployed on the Bear H bomber. *SMP* 1986 states its range as 3000 km; IISS puts it at 1600 km. The Bear H may carry up to 8 AS-15 but an average number of 4 is used in this table. Gorbachev's data states that, of the 160 Soviet bombers, 53 are equipped to carry cruise missiles. See: "The Armaments of the USSR and the US: Data to Compare," *op. cit.*

j The Bear H is a new version of an old bomber and began operations in 1984. The Bear B is capable of carrying 2 free-fall bombs or 1 AS-3 Kangaroo missile. The Bear C carries 1 Kangaroo missile. The Bear G has been refitted 2 AS-4 missiles. [The AS-3 and AS-4 are short-range (300-500 km) cruise missiles with 1 Mt warheads.] SIPRI states the Bear G now carries 4 warheads. For the purposes of the tables the Bear B/C/G versions are listed as carrying, on average, 2 bombs of 1 Mt each. See: John W.R. Taylor, "Gallery of Soviet Aerospace Weapons," *Air Force*, March 1986, pp. 83-98; and IISS, *The Military Balance* 1986-87.
The Bison bomber initially deployed in 1956 is now being phased out. SIPRI states there are 18 to 33 Bison bombers, while the Arms Control Association (7 Oct. 1986) puts the number at 30 and notes that the issue is under dispute. The figure used is taken from IISS. Estimates of the Bison payload range from 2 to 4 bombs. As the maximum, the figure of 4 is used in the tables. The USSR has stated that 15 Bison were destroyed by removal of their tail sections and placed in full view on an airstrip. Fifteen others were converted to tankers. (This conversion has not been accepted by the US.) See: *Arms Control Reporter,* 1985, p. 607B76.

k Estimates of Soviet warhead yield can vary considerably. The values used in the tables are those *generally* accepted by the sources used. Exceptions of note are footnoted. (See, for example, notes d and h.)

l National Intelligence Estimates quoted in B. Keller, "US Study Finds a Soviet ICBM is less of a Threat to Missile Silos," *New York Times*, 19 July 1985, p. 1.

m IISS, *The Military Balance 1986-87*.

n See footnote h; IISS puts the CEP at 0.48 nm.

TABLE III United States Intermediate and Short Range Nuclear Forces*

System	Missiles	Warheads	Total Warheads	Yield/ Warhead (Mt)	Range (km)
GLCMs	208[a]	1	208	0.200	2500
Pershing II	108	1	108	[0.005-0.050]	1800[b]
Pershing Ia	72	1	72	[0.060-0.400]	720
Aircraft	Number	Range (km)			
F-111	280	4700			
F-16	510	3800			
FB-111A	55	4700			
F-4	392	2100			

a Paul Nitze reported that 128 GLCM would be deployed by 31 December 1985. See: Speech to Overseas Writers Club, 8 November 1985, in the *Department of State Bulletin.* NATO figures released on 2 January 1987 stated that a further 80 GLCMs had been deployed during 1986. See, for example: "Western Allies deployed 80 Cruise Missiles in '86," *Baltimore Sun,* 3 January 1987.
b The Soviet Union claims the range of the Pershing II is 2,500 km. See: *Whence the Threat to Peace,* Moscow, 1984.

TABLE IV Soviet Intermediate and Short Range Nuclear Forces*

System	Missiles	Warheads	Total Warheads	Yield/ Warhead (Mt)	Range (km)
SS-4	112	1	112	1.00	2000
SS-12[a]	130	1	130	[0.20-1.00]	900
SS-20 (Asia)	171	3	513	0.15	5000
SS-20 (Europe)	243[b]	3	729	0.15	5000
SS-21	300	1	300	0.10	120
SS-23	240	1	240	0.10	500
Aircraft	Number	Range[c] (km)			
Badger	480	4800			
Blinder	165	2200			
Backfire (Navy)	120	3700			
Backfire (Air Force)	140	3700			

a The newer SS-22 is replacing the SS-12.
b The US still considers that there are 270 SS-20s in Europe because of lack of evidence that the other 27 have been destroyed.
c SIPRI range estimates are used here. Range estimates vary. For example:

	IISS (km)	*Soviet Mil. Power* (km)
Badger	4,800	3,100
Blinder	6,200	2,900
Backfire	11,000	4,000

*At the intermediate and shorter range levels, the problem of deciding which weapons should be counted becomes more complex. The figures used in these tables are not meant to be an accurate reflection of the balance in Europe. Bombers in particular create counting problems. Figures used are IISS estimates of bomber forces with ranges above 2000 km available to the United States and the Soviet Union. NATO aircraft are not included.