22307

National
Foreign
Assessment
Center

~~Secret~~ D 13

567

Soviet and US Investment in Intercontinental Attack Forces, 1960-80, and Outlook for the Future

An Intelligence Assessment

~~Secret~~

SR 81-10103
August 1981

Copy

National
Foreign
Assessment
Center

~~Secret~~

Soviet and US Investment in Intercontinental Attack Forces, 1960-80, and Outlook for the Future /

An Intelligence Assessment

Information available as of 1 June 1981 has been used in the preparation of this report.

The author of this paper is
Office of Strategic Research. Comments and queries are welcome and may be directed to the Chief,
OSR.

The paper was coordinated with the National Intelligence Officer for Strategic Programs and the Office of Scientific and Weapons Research.

~~Secret~~
SR 81-10103
August 1981

Soviet and US Investment in Intercontinental Attack Forces, 1960-80, and Outlook for the Future

Overview

Trends

Overall, during the 1960-80 period the estimated dollar cost of investment activities for Soviet intercontinental attack forces was about $135 billion (in 1980 prices), about 10 percent more than US investment outlays for comparable forces. Despite this rough parity, the direction and pace of the two countries' intercontinental attack programs differed considerably. Soviet investment costs exceeded US investment outlays by about 70 percent for ICBMs and by about 40 percent for SLBMs and ballistic missile submarines. For bomber forces, on the other hand, US investment outlays exceeded Soviet investment costs by about 10 to 1.

The ICBM systems of the early 1960s were expensive to deploy, difficult to operate and maintain, and vulnerable to attack – and therefore were fielded in limited numbers. As the decade progressed, first the United States and then the USSR developed and deployed large numbers of more capable and less costly ICBMs based in survivable silos. By the mid-1960s the US ICBM force was about four times as large as the Soviets', but by 1970 the Soviet ICBM force had overtaken it.

In the 1970s both countries deployed new ICBMs with improved guidance and MIRV technology. These were somewhat more costly than those they replaced but had considerably greater striking power. The United States was the first to deploy MIRVed ICBMs, but the USSR fielded more of them. The Soviet missiles were larger, with more MIRVs, and were deployed in new or converted silos that were harder than US ICBM silos. For MIRVed ICBMs, Soviet investment costs have exceeded US investment outlays by about 3 to 1.

With the Polaris SSBN/SLBM weapon system, the United States built up an SLBM launcher force that was much larger and more capable than its Soviet counterpart during the 1960s. The relatively high investment cost per launcher and the limited capabilities of Soviet SLBMs and submarines during the early and mid-1960s militated against the deployment of a Soviet SLBM force the same size as that of the United States. Late in the decade, however, the Soviets began to expand their forces with the Y-class/SS-N-6 system, which was comparable in many ways to the Polaris.

Both countries improved the capabilities of their SSBN/SLBM forces during 1970-80, but in different ways. The United States modernized most of its SSBNs with MIRVed Poseidon missiles, increasing its total number

of SLBM reentry vehicles more than fivefold at a relatively low investment cost per RV. The Soviet Union deployed far fewer MIRVed SLBMs but invested heavily in new submarines with intercontinental-range missiles. They commissioned about five new ballistic missile submarines per year, while the United States, which began the period with 41 submarines, commissioned none. By the end of 1980, Soviet SLBM launchers exceeded US launchers by about 60 percent

Intercontinental bombers have been maintained in the United States as a force coequal to ICBMs and SLBMs since 1960, while the Soviet Union has emphasized the missile components of its intercontinental attack forces. During 1960-80, Soviet investment costs for intercontinental bomber forces were about one-tenth of US outlays.

Outlook

Plans to modernize US intercontinental attack systems call for average yearly investment outlays through 1989 that will be nearly twice the 1970-80 average.[1] These programs, which include the MX ICBM, the Trident SSBN and SLBM, and air-launched cruise missiles deployed aboard B-52s, reflect concern over the survivability of US ICBMs and the age of the other forces.

The USSR will continue its substantial investment in ICBM and SLBM forces through the 1980s. This projection is based on information on Soviet weapons programs in production or in development and on the expansion currently under way in the defense industries. The Typhoon SSBN/SS-NX-20 SLBM program already is under way, and other major investment programs during the 1980s probably will include a number of new or improved ICBMs and SLBMs and possibly two new strategic aircraft.

During 1981-89, the investment costs for Soviet intercontinental attack programs will depend on the fate of SALT. Under SALT II constraints, these costs (measured in dollars) would probably be about the same as investment outlays for US forces as currently planned. Without such

[1] US investment outlay figures are for programs described in the January 1981 *Report of the Secretary of Defense to the Congress on the FY 1982 Budget*. These investment programs are currently in review, and other investment programs, such as a new bomber aircraft, are also being considered. Major changes to US intercontinental attack programs could change the level of investment outlays through 1989.

constraints, the Soviets could field a larger force of ICBMs with more reentry vehicles and deploy more ballistic missile submarines and MIRVed SLBMs. If they did, their investment costs for intercontinental attack forces during 1981-89 could exceed outlays for currently programed US forces by about $20 billion.

BLANK PAGE

Contents

Appendixes

Figures

Tables

Soviet and US Investment in Intercontinental Attack Forces, 1960-80, and Outlook for the Future

Focus on Investment

For at least two decades the intercontinental attack forces of the United States and the Soviet Union have been the main measure for the balance of strategic power and the principal subject of arms control negotiations. During this time, the Soviets have moved from a position of strategic inferiority, according to almost every measure, to one that is now widely recognized as at least equal to the position of the United States.[1]

Previously published dollar cost comparisons have discussed overall Soviet and US defense activities and have focused on 10-year periods.[2] This paper focuses solely on investment activities for Soviet and US strategic intercontinental attack forces, and it compares these forces in more detail and over a longer period. Specifically, it compares, in dollar cost terms:

- The investment resources committed by the Soviet Union and the United States to the various elements of their intercontinental attack forces since 1960.
- The two forces resulting from these investment flows.
- Some of the capabilities of these forces.

Dollar comparisons of investment flow provide information about the relative resources devoted by each country to equipping its intercontinental attack forces.[3] Dollar cost estimates for Soviet investment represent what it would cost, using US prices, to procure equipment (including major spare parts) and construct facilities for a military force of the same size and with the same weapons inventory as that of the Soviet Union.[4] The investment flows alone, however, do not provide a measure of the size and quality of the two countries' weapons inventories. Inventory value, which measures the cost in dollars of replacing each arsenal, illustrates how the investment flows have accumulated over time into stocks of weapons. Inventory value does not necessarily provide a useful measure of trends in force capabilities, particularly in the case of US and Soviet intercontinental attack forces, where advances in technology have caused the capabilities of newer ICBMs and SLBMs to advance more rapidly than investment costs. It is, however, a useful measure with which to examine trends in the costs of acquiring certain military capabilities.[5]

To examine trends in specific capabilities of the two countries' forces, this paper uses three measures of capability:

- *Number of weapons*, which is the sum of individually targetable ICBM and SLBM reentry vehicles and bomber weapons, provides a rough assessment of the theoretical capability of a force to strike individual targets.[6]
- *Lethal area potential* (LAP) provides a measure of the theoretical area (measured in 1,000 square kilometers) within which the nuclear effects of a

[1] It should be noted that dollar costs do not measure actual Soviet defense spending, the impact of defense on the economy, or the Soviet perception of defense activities. These issues are more appropriately analyzed with ruble expenditure estimates. The most recent assessment of Soviet defense spending, published in October 1979, is the

[2] Appendix A defines the terms and describes the methodology used in calculating these comparisons. This paper does not focus on operating costs, which are associated with pay and allowances for military personnel and the operation and maintenance of military equipment and facilities. During 1960-80 the operating costs for US intercontinental attack forces were about one-half the level of investment costs, and dollar operating costs for Soviet intercontinental attack forces were about 40 percent of the level of investment costs. For a comparison of dollar operating costs for Soviet and US intercontinental attack forces see appendix C.

[3] A detailed comparison of the inventory values of Soviet and US intercontinental attack forces is provided in appendix B.

[4] In counting numbers of weapons, multiple reentry vehicles that can attack only a single target are counted as a single weapon.

weapon (missile reentry vehicle or bomber weapon) could inflict severe damage on a soft area target. The severe damage criterion used in these calculations is 100 kilopascals (kPa), or 15 pounds per square inch (psi)—the overpressure required to destroy a reinforced concrete building.

- *Hard-target potential* (HTP) measures the potential of an attacking force to destroy point targets hardened to some nominal value. The criterion used in this paper for HTP is 13.8 megapascals (2,000 psi) of overpressure. We calculate HTP by determining the probability that each weapon in a force can destroy a target hardened to 13.8 MPa and summing these damage expectancies for all weapons in the force. It should be noted that because of the increasing silo hardnesses and differences in the levels of hardness of Soviet and US silos, this HTP measure does not provide an accurate comparison of actual Soviet and US countersilo capabilities over time.[1] Its use in figure 2, for example, does illustrate what has been a clear trend during the past two decades—the increasing capabilities of both ICBM forces to destroy hard targets.

While these measures portray trends in some specific military capabilities, they do not provide the basis for a net assessment of the two countries' intercontinental attack forces. Such assessments must take into account the number and effectiveness of weapon systems; strategic doctrine and battle scenarios; the tactical proficiency, readiness, and morale of the forces; logistic factors; and a host of other considerations.

Soviet and US Intercontinental Attack Investment Programs, 1960-80

During the 1960-80 period, the estimated dollar cost of investment activities for Soviet intercontinental attack forces was about $135 billion (in 1980 prices)—about 10 percent more than US outlays for comparable forces. Despite this rough parity in overall dollar-valued investment costs, there were considerable differences in the direction and pace of Soviet and US investment programs, as shown in figure 1.

During the period as a whole, the United States allocated substantial investment outlays to each leg of its strategic triad of ICBMs, SLBMs, and bombers, whereas Soviet investment costs were allocated almost entirely to ICBMs and SLBMs. For these forces, Soviet investment costs far exceeded comparable US outlays—by 70 percent in the case of ICBMs, and by 40 percent for SLBMs. This disparity reflected, in large part, higher Soviet levels of ICBM launcher construction and missile procurement and more ballistic missile submarines. It also reflected the fact that many Soviet ICBM and SSBN/SLBM systems were larger and hence more costly than their US counterparts. For intercontinental bomber forces—where US investment outlays exceeded Soviet investment costs by about 10 to 1—the greater US costs reflected the much greater size of the US bomber forces and greater US efforts to modernize these forces.

Asymmetries in the two countries' investment programs during the 1960-80 period have had an important bearing on the capabilities of each element of Soviet and US intercontinental attack forces. (The three measures of capability are compared in figure 2.) The Soviets have relied much more heavily on ICBMs as the mainstay of their forces. Since the mid-1960s they have greatly increased the size and capabilities of their ICBM forces, which by 1980 accounted for about three-quarters of their total weapons and LAP and about nine-tenths of their total HTP. This emphasis on ICBMs is in accord with the Soviet view that the acquisition of a viable war-fighting capability is the best deterrent of attack. The yield, accuracy, and timely response of current ICBMs permit them to be deployed against the entire range of targets, including opposing ICBM silos.

Although the Soviets deployed a large force of ballistic missile submarines, many of which were equipped with SLBMs with intercontinental range, this force accounts for a relatively small share of Soviet capabilities. Unlike the United States, the USSR as yet has deployed only a limited number of MIRVed SLBMs. As a result, SLBM forces by 1980 accounted for less than one-quarter of total Soviet weapons. The

[1] Early US and Soviet ICBM silos were much more vulnerable than current silos. Soviet SS-17, SS-18, and SS-19 silos, moreover, currently have structural hardnesses significantly greater than those of Minuteman silos.

Figure 1

Dollar Cost of Investment in Intercontinental Attack Forces

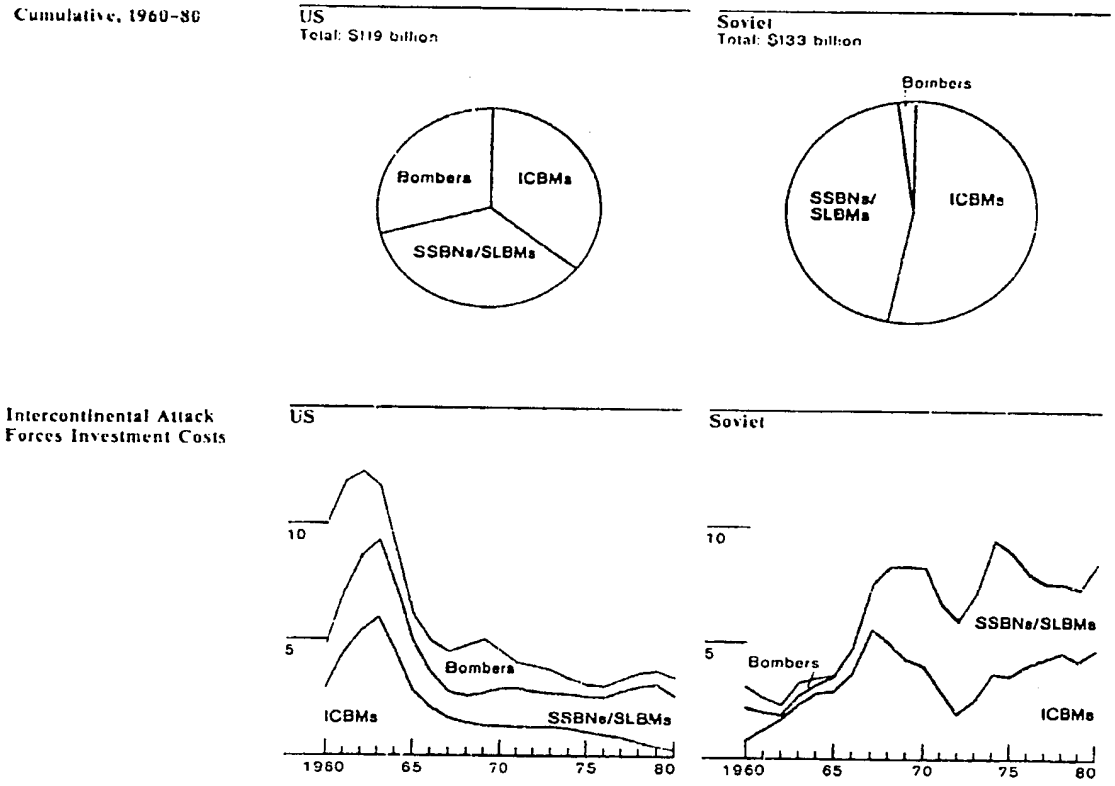
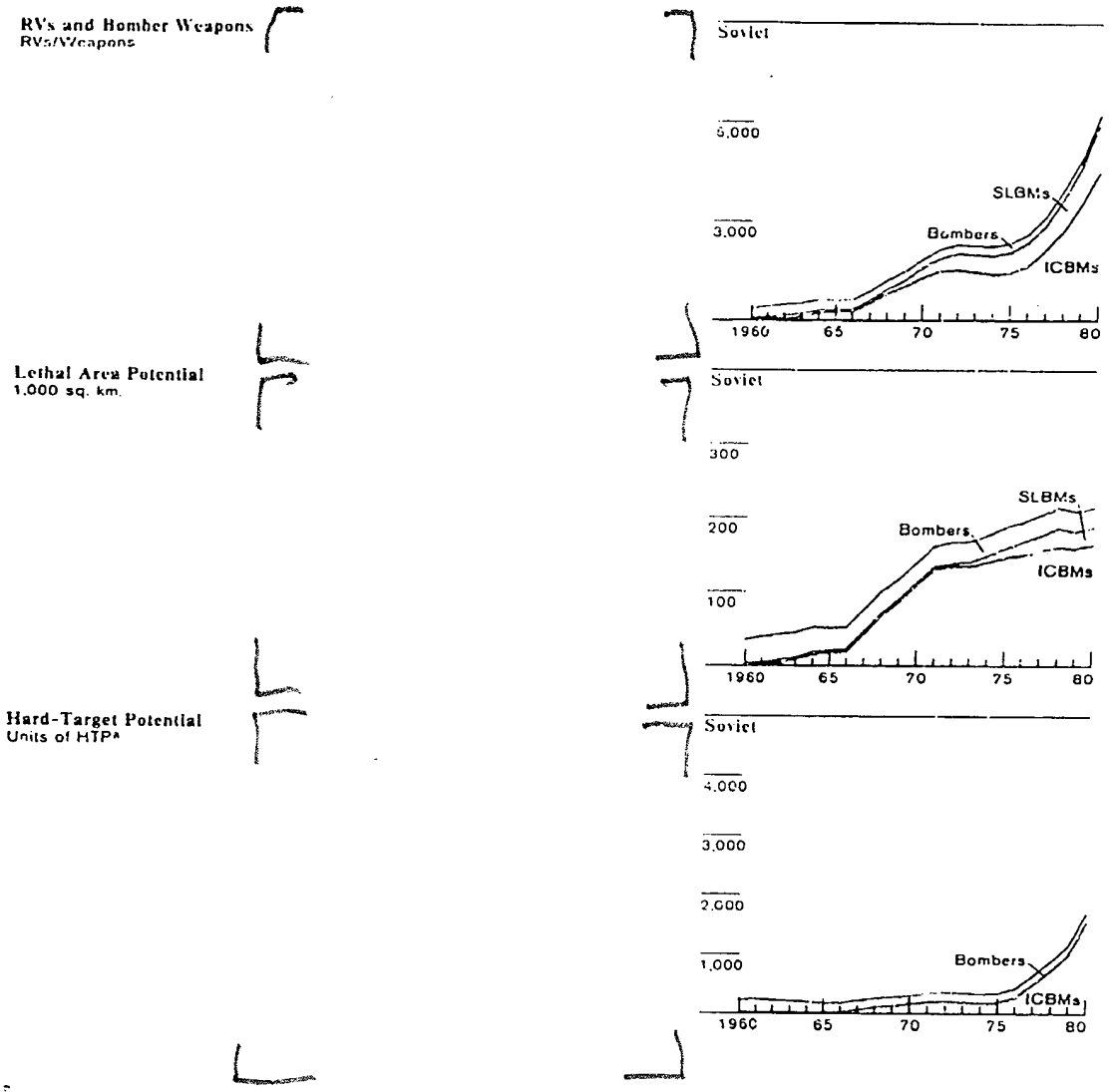


Figure 2
Distribution of Capabilities Among Elements of Intercontinental Attack Forces (Online Forces)



Soviets have made only minimal investments in intercontinental bomber forces since the mid-1960s, and as a result that force provides only a small share of the overall Soviet capabilities

US investment programs, in contrast to Soviet programs, have resulted in a triad of forces with a relatively even distribution of capabilities. Although the capabilities of US ICBM forces have grown with the deployment of new missile systems, by 1980 US ICBMs still accounted for only one-fourth of total weapons and about one-third of total LAP and HTP. US SLBMs, a highly survivable retaliatory force, have accounted for an increasing share of total US weapons. The 1970s saw the introduction of Poseidon missiles capable of carrying as many as 14 MIRVs; this gave SLBMs the largest share of US intercontinental attack weapons (more than two-fifths) as of 1980.

Although the bombers' share of total US capabilities declined during the period, bombers have continued to account for a large portion of total US striking power —consistently over one-half of US LAP and over one-quarter of total US weapons. Bombers also have consistently accounted for over one-half of US HTP — although they are too slow to be used in a first strike against ICBM silos. US defense planners have stated two chief reasons for maintaining a large bomber force: to hedge against unforeseen developments which could affect the reliability of the US ICBM and SLBM forces and to induce the Soviets to invest large sums in costly strategic air defense systems.

The comparison in figure 1 of the two countries' investment costs since 1960 reveals several contrasts in the level of investments for intercontinental attack forces. US investment activities were highest during the early-to-mid-1960s, when the United States completed its deliveries of B-52 and B-58 bombers and KC-135 tankers and deployed most of its ICBM launchers and ballistic missile submarines. Soviet investment activities, on the other hand, peaked in the late 1960s and the mid-1970s, when the Soviet Union expanded and modernized its ICBM and SLBM forces.

Since the beginning of 1970, Soviet investment costs for intercontinental attack forces have exceeded comparable US outlays by about 2 to 1. During the 1970s the Soviets modernized virtually all of their ICBM forces, with the deployment of new missiles at about 1,300 new or converted ICBM silos. (By mid-1980 over 600 of these silos had been equipped with MIRVed ICBMs.) In addition, they commissioned 56 ballistic missile submarines with over 800 SLBM launchers

During this same period, the United States modernized about half of its ICBM force (550 launchers) with the MIRVed Minuteman III missile and converted 31 Polaris submarines with Poseidon SLBMs. Toward the end of the period it began to replace some of these Poseidons with Trident SLBMs. The substantially greater Soviet investment in ICBMs and ballistic missile submarines during the 1970s left the Soviets with a much younger ICBM and SSBN force

During the early 1970s, the United States completed deliveries of its 76 FB-111 bombers and began to modernize its B-52 aircraft. During the decade both bombers were equipped with short-range attack missiles (SRAM). The Soviet Union concentrated more on improving the capability of its medium bombers to strike targets on the periphery of the country and did little to improve the capabilities of its intercontinental bombers

Investment in ICBMs

In 1960 the Soviet and US ICBM forces each had a handful of launchers and accounted for only a small share of their countries' strategic capabilities. During the ensuing 21 years, both countries invested heavily in increasing the size and capabilities of their ICBM forces.

During the whole 1960-80 period, the dollar cost of Soviet investment activities for ICBMs exceeded comparable US outlays by about 70 percent. This disparity reflects both numbers and cost. The Soviets' numerical advantage in ICBM systems and launchers deployed and in missiles procured is shown in table 1 and figure 3. In addition, the investment costs of the larger liquid-propellant Soviet ICBMs were substantially greater than those for the solid-propellant Minuteman—the most widely deployed US system.

Table 1

US and Soviet ICBM Activities, 1960-80

	Systems Deployed	Launchers Deployed	Launchers Converted or Modernized	Missiles Procured [a]
United States	6	1,234	800	2,800
USSR	9	1,638	1,272	4,800

[a] Totals include ICBMs procured for deployment in silos, operational spares and operational tests, but exclude RDT&E missiles.

Since 1960 Soviet and US ICBM investment costs have evidenced substantially divergent trends. US ICBM investment outlays peaked in the first half of the 1960s and then declined, and Soviet ICBM investment costs peaked once in the late 1960s and again at the end of the 1970s. US ICBM investment costs exceeded Soviet ICBM investment costs by about 10 percent during the 1960s, but since the beginning of 1970, Soviet ICBM investment costs have exceeded US ICBM investment costs by about 4 to 1.

Early ICBM Programs. In 1960 the Soviet Union deployed its first operational ICBM system—the SS-6—and the United States deployed its first—the Atlas D.[a] These and other early systems (such as the Soviet SS-8 and the US Atlas E and F and the Titan I) incorporated a number of features that made them expensive to deploy, difficult to operate and maintain, and vulnerable to attack.[b] As a result, these systems were deployed in limited numbers as both countries worked to deploy improved systems.

In 1963 both the United States and the Soviet Union deployed ICBMs that were significantly improved. The US Titan II was an inertially guided ICBM that used storable liquid propellants and could be launched from hardened, dispersed, underground silos. The Soviets' SS-7 had about the same weight as the Titan II and also used inertial guidance and storable liquid propellants. The Soviets deployed most of them at soft sites, although some of the later SS-7s were deployed in hardened silos.

Although the Titan II and the SS-7 ICBMs were technologically much more advanced than the first ICBM systems, their high costs militated against their deployment in large numbers.

Figure 5 shows the two countries' ICBMs, and figure 6 shows their unit cost. A greater number of SS-7 missiles were deployed than of Titan IIs, and this was a major factor behind the SS-7's lower unit cost.

An even more significant milestone in US ICBM programs occurred in the same year, 1963, with the deployment of the Minuteman I. Using solid propellants, it was smaller, more suited for mass production, and less costly than any of the US liquid-propellant ICBMs. Because of its low cost, the Minuteman was selected to become the backbone of the US ICBM force. The United States expanded its ICBM forces rapidly with Minuteman, deploying 600 of these missiles in underground silos by the middle of 1964. In that year, the United States had a large and survivable ICBM force with about four times as many launchers as the Soviet ICBM force and over three times the lethal area potential.

[a] The first Atlas D missile was placed on alert at the Vandenberg Air Force Base test facility in October 1959, but the first Atlas squadron was not declared operational until the following year.
[b] Among the undesirable features common to most of these early Soviet and US ICBMs were the use of cryogenic liquid propellants requiring extremely low temperatures, which were difficult to handle and needed cumbersome and complex plumbing systems, and the use of radio-inertial guidance, which was dependent on expensive, relatively vulnerable, radio guidance stations. Their slow reaction times and their aboveground launch pads also made the early ICBM systems vulnerable to attack by opposing ICBMs.

Figure 3

ICBM Force Levels and Deliveries

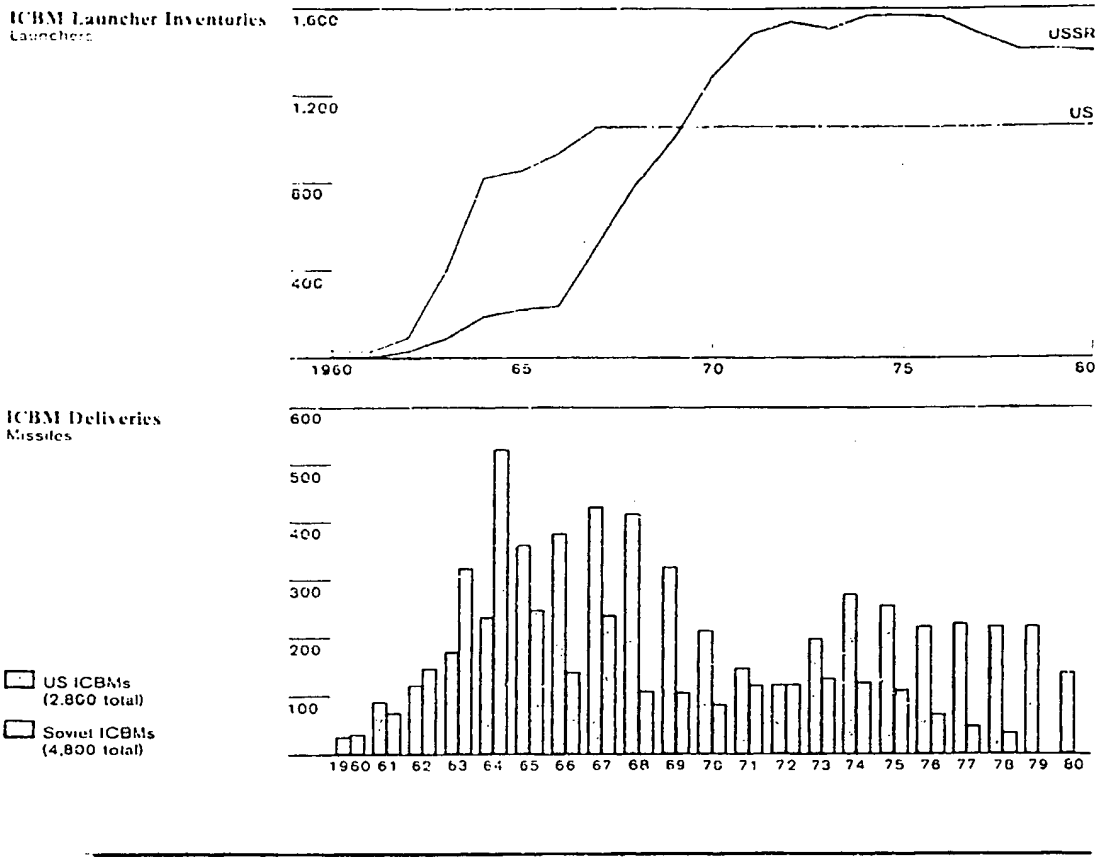


Figure 4

Investment Costs for ICBM Systems

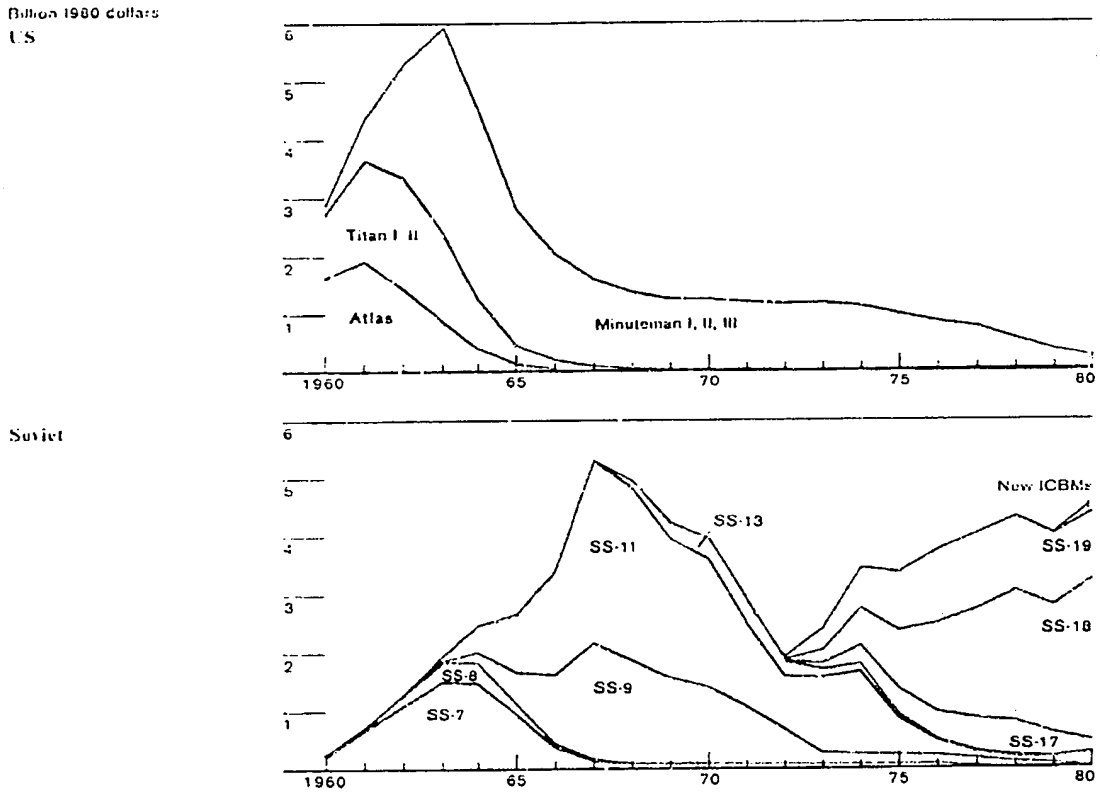
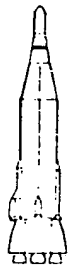
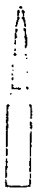
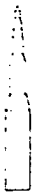
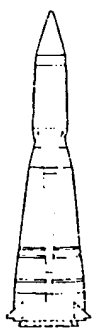
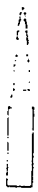
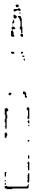
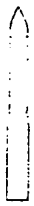


Figure 5

Characteristics of Key ICBMs in Operation Since 1960

Meters		Atlas	Titan I	Titan II	Minuteman I	Minuteman II
US	35					
	30					
	25					
	20					
	15					
	10					
	5					
	0					
RVs		1	1	1	1	1
Range		12,600 km	10,200 km	11,300 km	10,200 km	12,500 km
CEP		3,700 m	3,700 m	1,300 m	1,400 m	700 m
Operational mode		Soft sites, horizontal "coffins," and single silos	Triple silos	Single silo	Single silo	Single silo
Year operational		1960	1962	1963	1963	1966
		SS-6	SS-7	SS-8	SS-9	SS-11 Mod 1
Soviet	35					
	30					
	25					
	20					
	15					
	10					
	5					
	0					
RVs		1	1	1	1 or 3 MRVs	1
Range		12,000 km	13,000 km	10,500 km	9,800–11,100 km	11,000 km
CEP		3,700 m	1,900 m	1,900 m	750–1,900 m	1,400 m
Operational mode		Soft sites	Soft sites and triple silos	Soft sites and triple silos	Single silo	Single silo
Year operational		1960	1962	1963	1966	1966

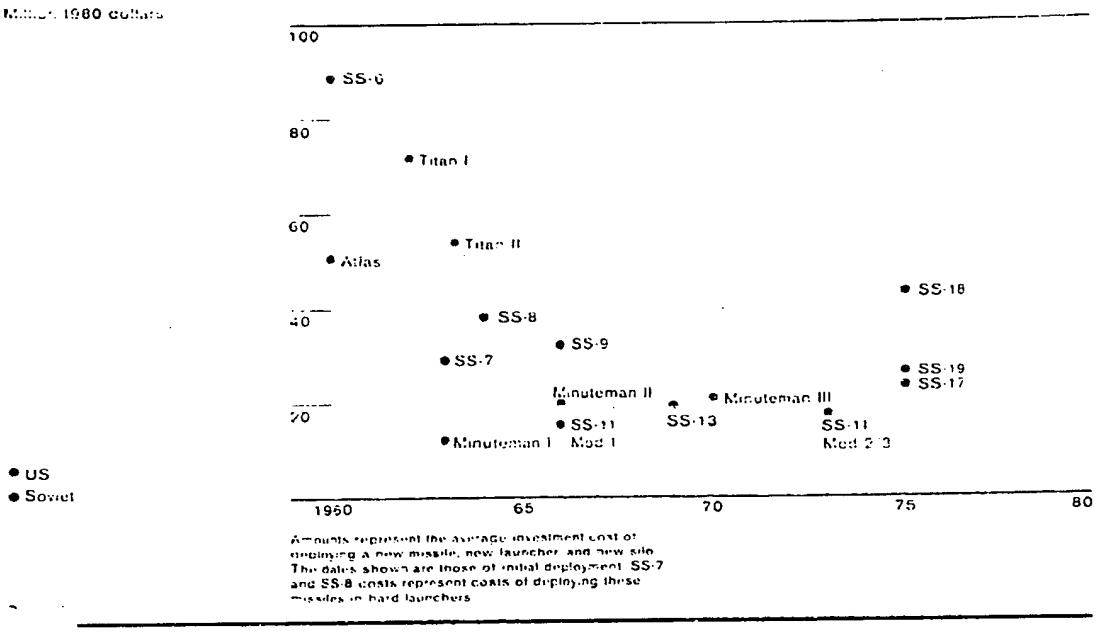
Minuteman I	Minuteman II	Minuteman III
		
1 10,200 km 1.400 m Single silo	1 12,500 km 700 m Single silo	3 MIRVs 13,800 km [redacted] Single silo
1963	1966	1970

SS-9	SS-11 Mod 1	SS-13 Mod 1	SS-17 Mod 1	SS-18 Mod 2	SS-19 Mod 1
					
1 or 3 MRVs 9,800–11,100 km 750–1,900 m Single silo	1 11,000 km 1,400 m Single silo	1 9,400 km 1,900 m Single silo	4 MIRVs 10,000 km [redacted] Single silo	8 or 10 MIRVs 12,000 km [redacted] Single silo	6 MIRVs 9,600 km [redacted] Single silo
1966	1966	1969	1975	1976	1975

BLANK PAGE

Figure 6

Unit Investment Costs for US and Soviet ICBM Systems



Amounts represent the average investment cost of deploying a new missile, new launcher, and new silo. The dates shown are those of initial deployment. SS-7 and SS-8 costs represent costs of deploying these missiles in hard launchers.

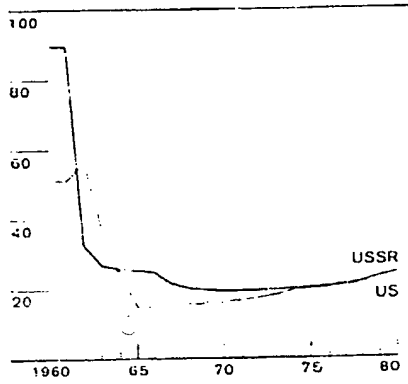
During the second half of the 1960s, both countries deployed ICBMs that were still more advanced. In 1966 the United States began to deploy the Minuteman II, a missile with extended range, improved accuracy, and greater retargeting capability. By 1967 the US force had a total of 1,000 Minuteman I and Minuteman II launchers. In 1966 the Soviets began to deploy in silos two new liquid-propellant ICBMs—the SS-9 and SS-11. The SS-9 heavy ICBM was the first Soviet missile with sufficient accuracy and yield to be effective against hard targets such as ICBM silos. The SS-11, the Soviets' first small-payload ICBM, comparable in throw weight to the Minuteman I, was relatively inexpensive and was quickly deployed in large numbers. By the end of the 1960s, the Soviets had built over 600 SS-11 silos and about 170 SS-9 silos, bringing the number of launchers in the Soviet ICBM force to over 1,000.[9] The deployment of these new silo-based systems gave the Soviets a large and survivable ICBM striking force with roughly the same number of launchers as that of the United States and about 75 percent more lethal area potential.

ICBM Programs, 1970-80. During the 1970s, improvements in ICBM guidance technology and MIRV technology led both the United States and the Soviet Union to modernize their ICBM forces with follow-on missiles. These were somewhat more costly in investment terms than the systems they replaced (figure 7

[9] During 1969 the Soviets also began what eventually turned out to be a token deployment of the SS-13—a solid-propellant ICBM comparable in size to the US Minuteman, but inferior to it in range and accuracy. The SS-13 was also inferior in accuracy and range-payload combination to the Soviets' liquid-propellant SS-11

Figure 7

Average Investment Costs for Online ICBM Launchers



The data for each year are calculated by dividing the inventory value of Soviet and US ICBM forces by the number of launchers in the inventory and illustrate the high cost of the early systems. As they were succeeded by less costly systems, such as the US Minuteman I and the Soviet SS-11, the average investment cost per launcher fell. During the 1970s both countries deployed new systems which were somewhat more costly than the systems deployed in the middle and late 1960s. Appendix B provides more detailed information on this calculation of inventory value.

shows the trends in the average investment cost for Soviet and US ICBMs), but the cost increases were greatly outpaced by their increased striking power, as measured in numbers of RVs and in destructive potential against hard targets such as ICBM silos.

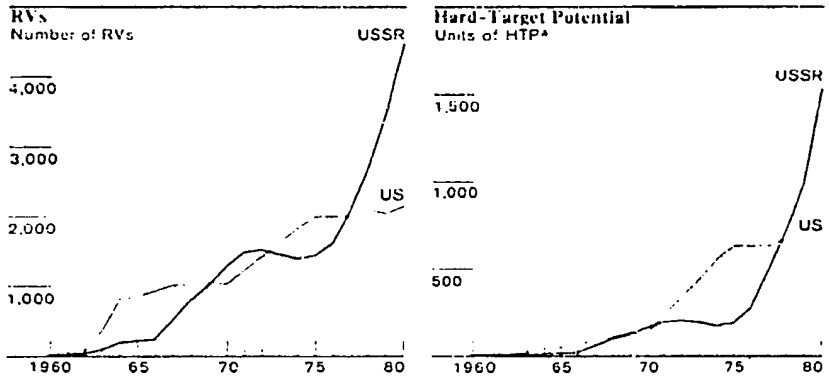
Figure 8 illustrates the increases in Soviet and US ICBM RVs and hard-target potential that accompanied the introduction of these more accurate, MIRVed systems. Figure 9, in which the inventory value of these forces has been divided by the number of RVs and the number of units of HTP, shows how the investment costs to acquire RVs and hard-target potential have decreased with the newer ICBMs.

The United States became the first country to deploy MIRVed ICBMs, when it deployed the Minuteman III in 1970. Comparison of the costs of the missiles alone (excluding launcher and ground support equipment) reveals that although the Minuteman III was about 30 percent more costly in investment terms than the Minuteman II, it could cover three times as many targets and had a potential against hard targets several times as great.

The same trend was evident in newer Soviet ICBMs (SS-17, SS-18, and SS-19) deployed during the second half of the 1970s. (During the early 1970s, the Soviets continued to add SS-9, SS-11, and a small number of SS-13 launchers, until they were limited by the 1972 SALT I Agreement.) Although these new missiles were 50 to 150 percent more costly in investment terms than the SS-9 and SS-11 missiles they replaced, their deployment increased several fold the number of RVs and the hard-target potential of the Soviet ICBM forces.

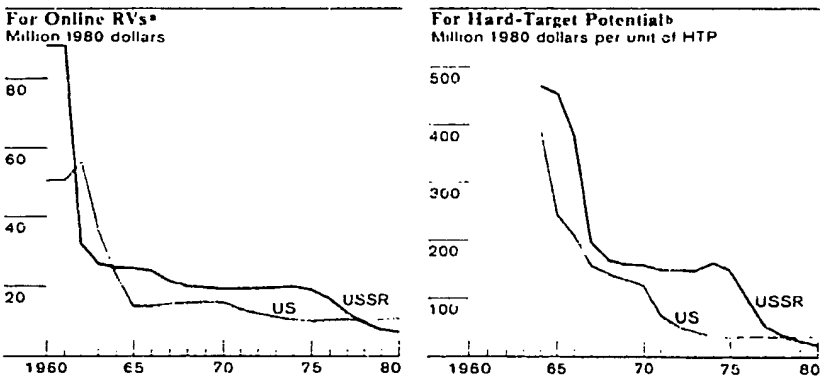
Through 1980, Soviet investment costs for the MIRVed SS-17, SS-18, and SS-19 ICBMs exceeded US investment outlays for the MIRVed Minuteman III by about 3 to 1. This disparity reflected, in large part, the deployment of more MIRVed missiles by the Soviet Union and the greater investment costs associated with the Soviet missiles, which used liquid

Figure 8
Reentry Vehicles and Hard-Target Potential of ICBMs (Online Forces)



[a]HTP is the sum of each weapon's probability of destroying a target hardened to 13.8 mPa (2,000 psi).

Figure 9
Average Investment Costs for ICBM RVs and Hard-Target Potential

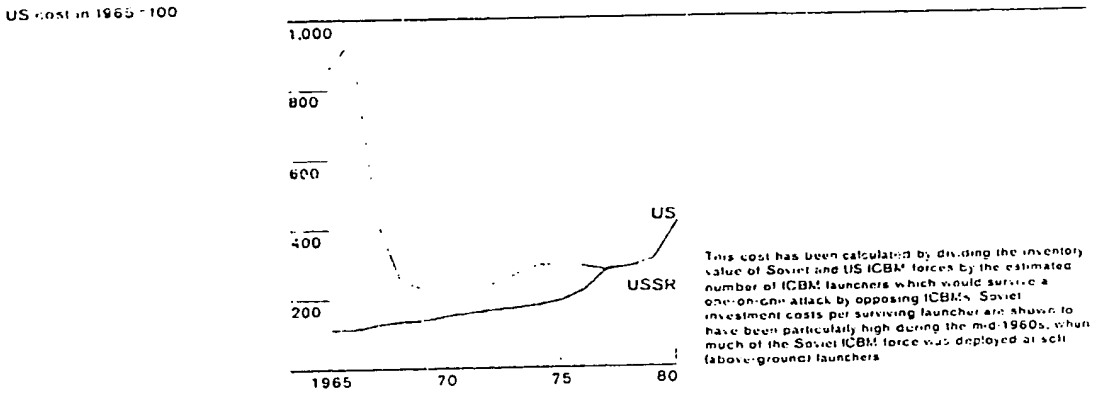


[a]The average investment cost has been calculated by dividing the inventory value of Soviet and US online ICBMs by the number of online RVs shown in figure 8.

[b]The average investment cost has been calculated by dividing the inventory value of Soviet and US online ICBMs by the hard-target potential shown in figure 8.

Figure 10

Trends in Investment Cost per Surviving ICBM Launcher



propellants, were larger, and carried more MIRVs. As a result of this investment for MIRVed ICBMs, by 1980 the Soviet ICBM force had about twice the RVs and twice the hard-target potential of the US ICBM force.

The increasing effectiveness of the newer US and Soviet ICBMs against hard targets has posed an increasing threat to the survival of opposing ICBM silos and has prompted increasing investment in silo hardening to increase the launchers' chances of surviving an attack by opposing ICBMs. During the 1970s both countries implemented hardening programs.

The United States spent between $1 million and $2 million per silo to modify its Minuteman silos to withstand higher levels of nuclear blast and shock. Among other modifications, this Silo Upgrade Program improved the shock isolation of the missile and the suspension systems of the ground electronics. It also enhanced the Minuteman's ability to withstand electromagnetic pulse by better sealing the silo from electromagnetic fields. These efforts, however, have been more than offset by the Soviets' deployment of accurate ICBMs. As they have deployed more of these, the number of Minuteman silos which could be expected to survive an attack has declined. A comparison over time of the number of US ICBMs which could be expected to survive a Soviet ICBM attack with the investment required to deploy the US ICBM force—that is, the inventory value of the force—shows a trend toward increasing investment costs per surviving US ICBM silo. This trend, which is illustrated in figure 10, is particularly pronounced after 1975, when the Soviets began to deploy their newer ICBMs.

The deployment of the US Minuteman III, beginning in 1970, posed an increased threat to Soviet ICBM silos—resulting in an increasing investment cost per surviving Soviet ICBM launcher during the first half of the 1970s. Beginning in 1975, the Soviets improved the survivability of their ICBM force by deploying

Figure 11

Investment Costs for SLBM and Submarine Systems

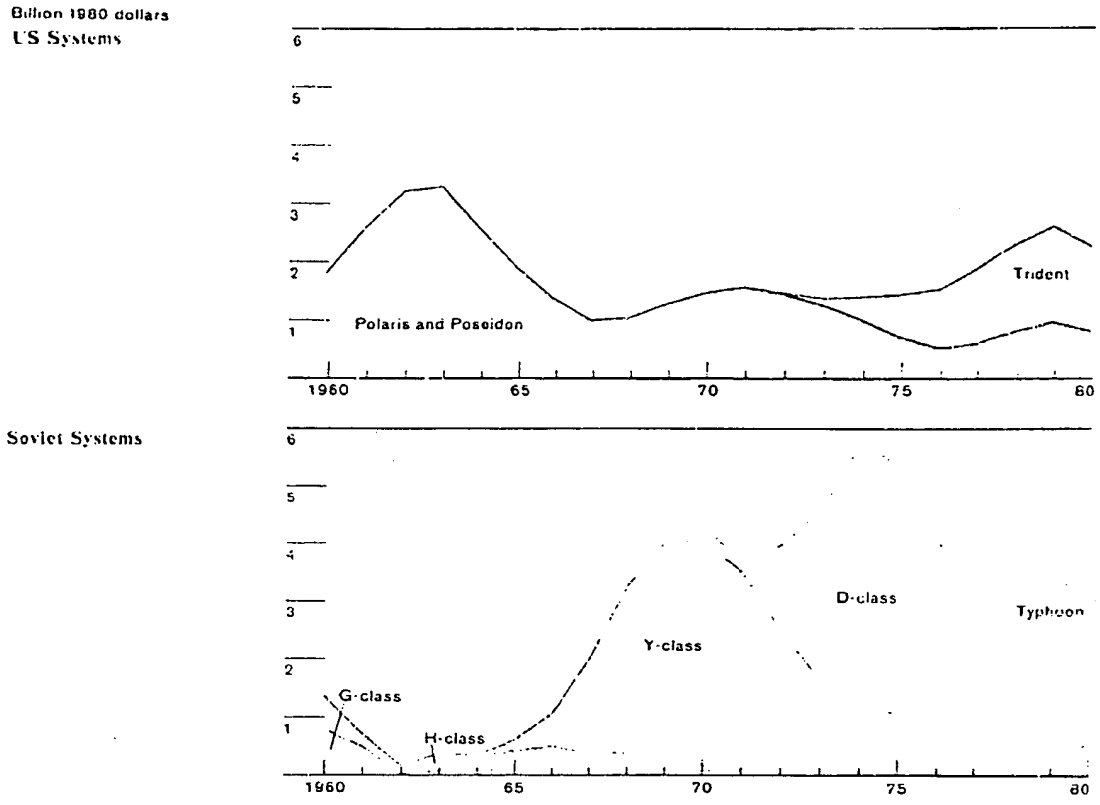
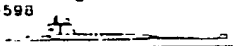
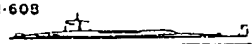
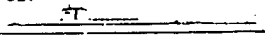
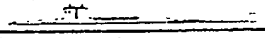
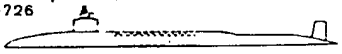
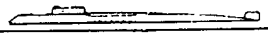
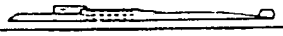
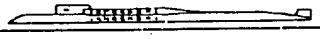
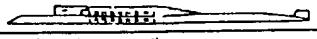
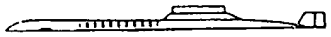


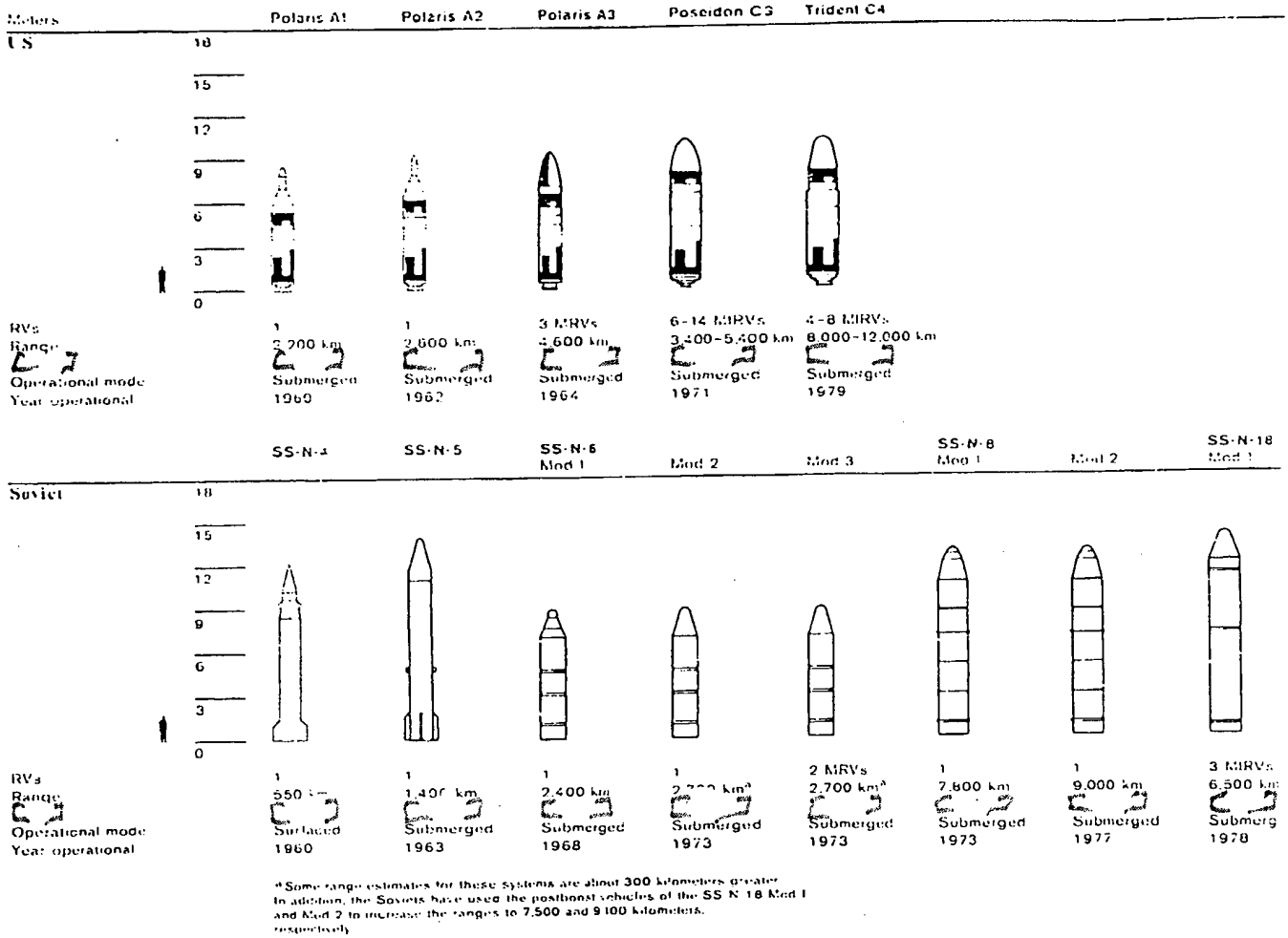
Figure 12
Characteristics of Key Ballistic Missile Submarines in Operation Since 1960

			Missiles	Propulsion	Year Operational
US	George Washington SSBN-598		16 Polaris A3s[a]	Nuclear	1960
	Ethan Allen SSBN-608		16 Polaris A3s[b]	Nuclear	1961
	Lafayette SSBN-616		16 Poseidon C3s[b]	Nuclear	1963
	James Madison SSBN-627		16 Poseidon C3s[c] or 16 Trident C4s	Nuclear	1964
	Benjamin Franklin SSBN-640		16 Poseidon C3s[c] or 16 Trident C4s	Nuclear	1965
	Ohio (developmental) SSBN-726		24 Trident C4s	Nuclear	1981
	50 meters				
Soviet	G-I		3 SS-N-4s	Diesel	1960
	H-I		3 SS-N-4s	Nuclear	1960
	G-II		3 SS-N-5s	Diesel	1962
	H-II		3 SS-N-5s	Nuclear	1963
	Y-I		16 SS-N-6s	Nuclear	1968
	D-I		12 SS-N-8s	Nuclear	1973
	D-II		16 SS-N-8s	Nuclear	1975
	D-III		16 SS-N-18s	Nuclear	1978
	Typhoon (developmental)		SS-N-20s	Nuclear	?
	50 meters				

[a]Initially deployed with 16 Polaris A1s.
[b]Initially deployed with 16 Polaris A2s.
[c]Initially deployed with 16 Polaris A3s.

Figure 13

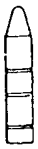
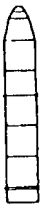
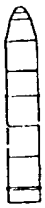
Characteristics of Key SLBMs in Operation Since 1960



*Some range estimates for these systems are about 300 kilometers greater. In addition, the Soviets have used the postboost vehicles of the SS-N-18 Mod 1 and Mod 2 to increase the ranges to 7,500 and 9,100 kilometers, respectively.

ıtion Since 1960

olaris A2	Polaris A3	Poseidon C3	Trident C4
			
[redacted] km [redacted] Submerged 962	3 MIRVs [redacted] km [redacted] Submerged 1964	6–14 MIRVs 3,400–5,400 km [redacted] Submerged 1971	4–8 MIRVs 6,000–12,000 km [redacted] Submerged 1979

S-N-5	SS-N-6 Mod 1	Mod 2	Mod 3	SS-N-8 Mod 1	Mod 2	SS-N-18 Mod 1	Mod 2	Mod 3
								
[redacted] km [redacted] Submerged 963	1 2,400 km [redacted] Submerged 1968	1 2,700 km[a] [redacted] Submerged 1973	2 MIRVs 2,700 km[a] [redacted] Submerged 1973	1 [redacted] km [redacted] Submerged 1973	1 9,000 km [redacted] Submerged 1977	3 MIRVs 6,500 km [redacted] Submerged 1978	1 7,650 km[a] [redacted] Submerged 1978	7 MIRVs 6,250 km[a] [redacted] Submerged 1978

[redacted] for these systems are about 300 kilometers greater
[redacted] have used the postboost vehicles of the SS-N-18 Mod 1
[redacted] the ranges to 7,500 and 9,100 kilometers.

their new ICBMs in new or converted silos with greater hardness.[a] Each upgraded Soviet silo cost several times the US outlay for each upgraded Minuteman silo and has a significantly greater structural hardness. The Soviets' relatively greater effort to harden their ICBM silos has essentially offset the US improvements in yield and accuracy for the Minuteman III, and the cost per surviving Soviet ICBM launcher has not risen appreciably since 1975.

Investment in SSBNs and SLBMs

Since the beginning of 1960 the Soviet Union and the United States have invested substantial sums in SLBM forces. During this period, the overall dollar cost of Soviet SSBN/SLBM investment has exceeded comparable US outlays by about 40 percent. This disparity reflects primarily the greater number of ballistic missile submarines deployed by the Soviets (see table 2); it also reflects the relatively greater cost of most Soviet submarines.

Soviet and US SLBM investment programs have evidenced markedly different trends since 1960 (see figure 11). US investment outlays peaked during the first half of the 1960s, at the height of the Polaris submarine program, and fell off during the second half. Modernizing a large portion of the US SLBM forces entailed a modest level of investment during the early 1970s, and the beginning of the Trident production program caused the level to rise during the last half of the 1970s.

Soviet SSBN/SLBM investment costs — which were about one-fourth of comparable US investment outlays during the first half of the 1960s — rose rapidly during the second half, as the Y-class production program reached full swing. After leveling off during the early 1970s, Soviet SSBN/SLBM investment rose again during the mid-1970s as a result of the D-class production program. Between 1970 and 1980, Soviet investment costs for SLBM forces exceeded comparable US outlays by about 2 to 1.[b]

Early Submarine and SLBM Programs. Although technically the Soviet Union was the first to deploy ballistic missiles aboard submarines, it was the United States that first developed a modern nuclear-powered ballistic missile submarine suitable for deploying large numbers of SLBMs. This Polaris system was the basis for the rapid expansion of the US SLBM force during the early-to-mid-1960s. In the late 1960s, the Soviet Union in turn deployed a system comparable in many respects to the US Polaris — the Y-class/SS-N-6 system — with which that country, in turn, proceeded to expand its SLBM forces.[c]

As the pioneer effort in this field, during 1955-57 the Soviet Union converted six Z-class diesel submarines to carry two ballistic missiles each. The missile (probably a variant of the ground forces Scud-A) used a liquid propellant, required that the submarine surface for launching, and had a short range (280 km). The modest capabilities of these submarines and missiles gave the Soviets a system with minimal strategic capabilities against the United States.

Beginning in 1960 the Soviet Union deployed a new liquid-propellant SLBM, the SS-N-4, aboard two new classes of submarines designed specifically for ballistic missile service. Each class — the G-I and the nuclear-powered H-I — carried only three of these surface-launched missiles. The short range (550 km) of the SS-N-4 missile, the limited capabilities of the diesel-powered G-I-class submarines, and the high cost per launcher of the H-I-class submarines, along with plans to deploy a better system in the future (the Y-class/SS-N-6), discouraged the deployment of large numbers of SLBMs during the early 1960s (figure 14).[c]

Table 2

US and Soviet SLBM and SSB/SSBN Activities, 1960-80

	New SSB/SSBNs Delivered	SSB/SSBNs Converted[a]	SLBMs Procured[b]
United States	41	36	1,950
USSR	85	25	2,250

[a] Includes five Poseidon submarines backfitted with Trident C-4 missiles; the first was deployed in October 1979.

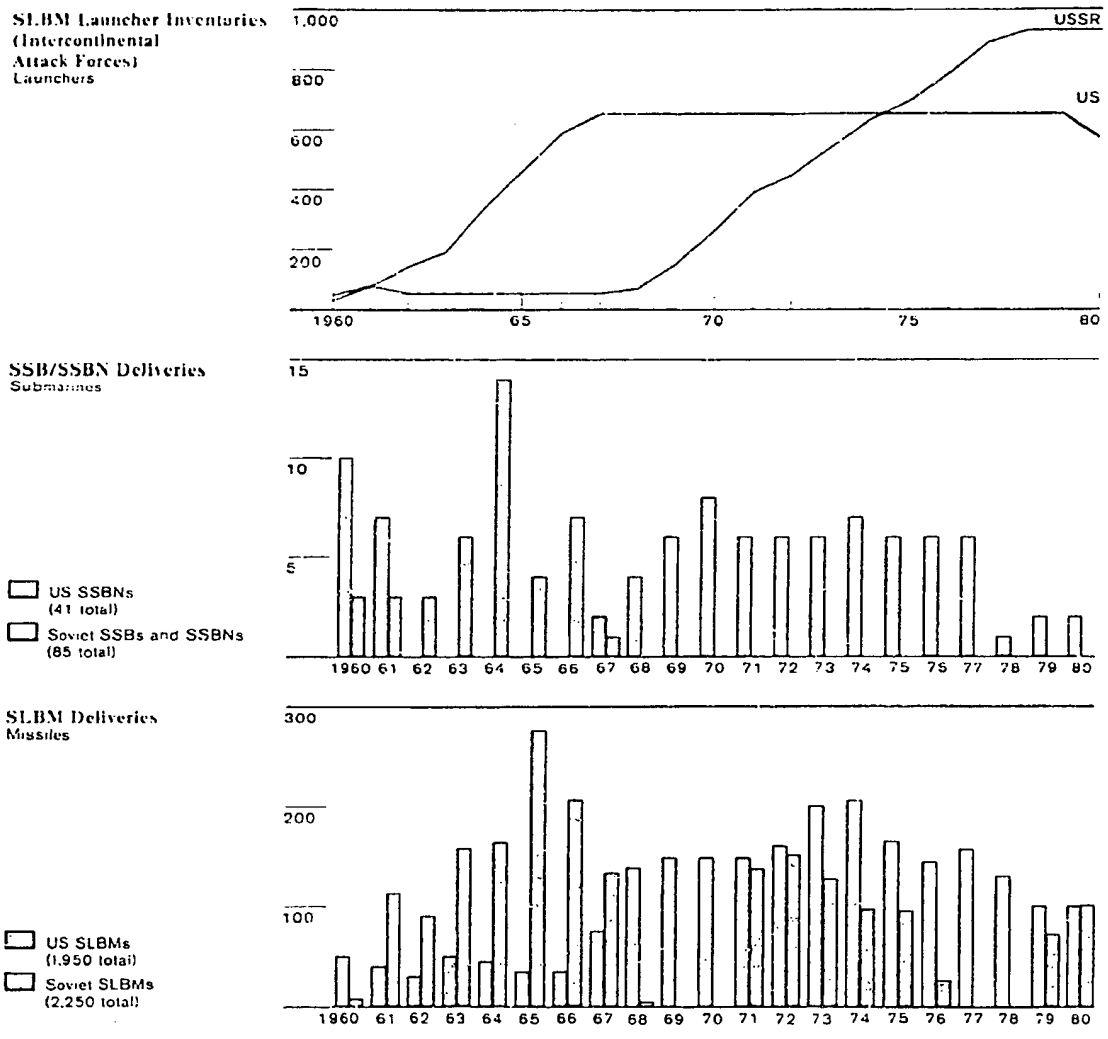
[b] Totals include SLBMs procured for deployment, operational spares, and operational tests, but exclude RDT&E missiles.

[a] Some of the Soviets' new ICBMs were deployed in completely new silos, but most were deployed in converted SS-9 and SS-11 silos.

[c] During the first half of the 1960s, the Soviets deployed 23 G-class and eight H-class ballistic missile submarines, with a combined total of 93 SLBM launchers.

Figure 14

SLBM Force Levels and Deliveries



The United States, in the late 1950s, was developing the much more capable Polaris system, the first unit of which was deployed in November 1960. This nuclear-powered submarine could launch its missiles while submerged and carried 16 solid-propellant Polaris A1 missiles with a range of 2,200 km. The Polaris was a much more advanced weapon system than any submarine then deployed by the Soviet Union. By mid-1964 the United States had deployed 21 of them with 336 missiles; the 41st (and last) was deployed in 1967, bringing the US SLBM launcher total to 656

As it was expanding its SLBM forces with the deployment of Polaris submarines, the United States also was modernizing these forces with new missiles. In 1962 the Polaris A2 was deployed—a larger missile with a more powerful solid propellant and a range of 2,800 km. In late 1964, the United States deployed the Polaris A3—a missile with a 4,600-km range and three reentry vehicles (MRVs).[11] The increased range of the A3 enabled it to cover more targets in the Soviet Union and greatly increased the submarine's operating area, and the MRVs, while not independently targetable, provided coverage of larger urban (soft) target areas with a single missile.

During this same period the Soviet Union converted its numerically smaller force of G- and H-class submarines to carry the SS-N-5 missiles. This new missile had a longer range (1,400 km) than the SS-N-4 and could be launched while the submarine was submerged.

The rapid deployment of 41 Polaris submarines and their modernization with more capable missiles provided the United States with an SLBM force that during the middle and late 1960s was superior to that of the Soviets' in almost every measure. As of 1967 the US SLBM force had over five times the RVs and lethal area potential (figure 15), and its most advanced missiles had over three times the range of the most advanced Soviet SLBMs.

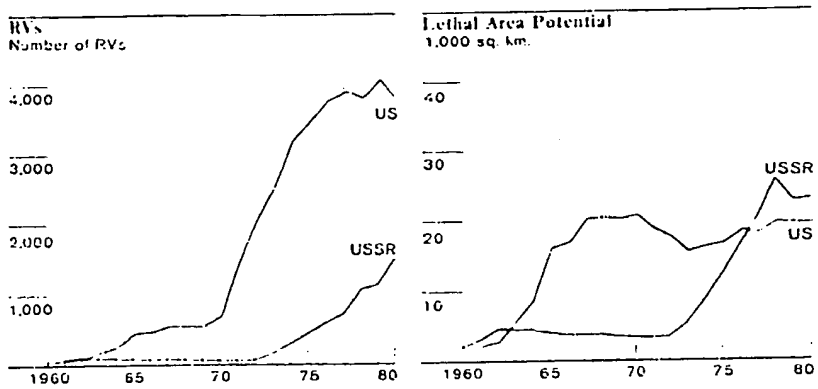
[11] The A3 was the first large ballistic missile to use glass motor cases for all stages, and its inertial guidance system (with miniaturized electronics) was about one-third the size of the A2.

The Soviets, however, were about to expand the size and capabilities of their SLBM forces with a new weapon system. In 1968 they deployed their first Y-class submarine, armed with 16 liquid-propellant SS-N-6 missiles. The missile's range (2,400 km) still required the submarine to deploy to launch areas far from Soviet waters to reach targets in the United States, but it provided the submarine with greater target coverage than the SS-N-4 and greater operating room. The Y-class design used technology already available, and the submarine was rapidly put into series production. By 1969 Soviet shipyards were delivering these submarines at a rate of about six a year.

SSBN/SLBM Programs, 1970-80. Since the beginning of 1970, investment costs for Soviet SSBN/SLBM programs have totaled about $45 billion—roughly twice the US investment outlays for these programs. This is because the Soviet Union commissioned 56 SSBNs and the United States none. Most US investment outlays during the 1970s went to modernize existing submarines with new missiles.

During the early-to-mid-1970s the United States increased its total SLBM RVs about fivefold by backfitting Poseidon C3 missiles on Polaris submarines. The Poseidon had about the same range as the Polaris, with greater accuracy and double the payload, and its RVs were independently targetable. Capable of carrying as many as 14 MIRVs (each with a smaller payload than the Polaris RV), the Poseidon enabled the US SLBM force to cover a much broader range of targets, and it was better equipped to penetrate sophisticated ABM defenses. During the 1970s, the United States converted 31 Polaris submarines to carry Poseidon missiles. Because the conversion costs were modest compared to the investment costs associated with building new submarines, the Poseidon modernization program required only a modest increase in US investment outlays. With the deployment of the Poseidon the United States increased its SLBM RVs over fivefold, while the average investment cost per US online SLBM RV declined sharply (figure 16).

Figure 15
Reentry Vehicles and Lethal Area Potential of SLBM Forces (Online Forces)

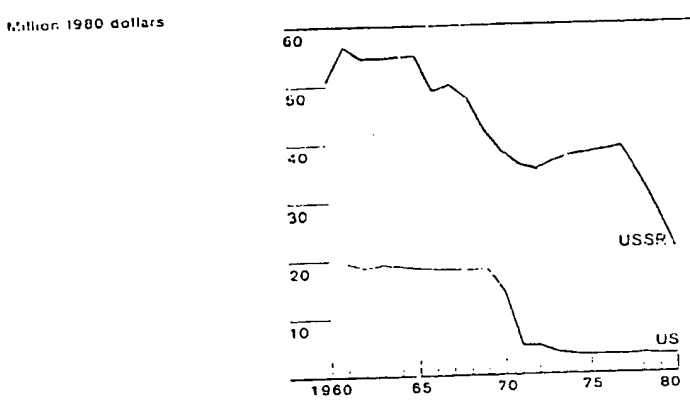


Since 1975 an increasing share of US SLBM forces investment outlays has gone for the Trident SLBM and submarine. The Trident SLBM is a MIRVed missile with greater yield and range than the Poseidon missile; with a full payload it has a range of about 8,000 km, allowing its submarine to operate in much larger ocean areas while on station and complicating Soviet antisubmarine warfare (ASW) efforts. The Trident submarine has more than twice the displacement of the older submarines; it incorporates sound-quieting and other signature-reduction technology and has room for growth to accommodate future SLBMs and systems to counter ASW. The Trident will take the place of some of the older Polaris and Poseidon ships. The first Trident unit—the Ohio—was launched in 1979 and may be delivered to the Navy in late 1981.

During the 1970-80 period, the Soviets commissioned new ballistic missile submarines at a rate of about five per year; whereas the United States did not commission any. In the first half of the 1970s they completed the Y-class submarine production program with the delivery of the 34th submarine. This brought their total investment costs for that program to about $22 billion (roughly the same amount as total US investment costs for the Polaris SSBN/SLBM program). The relatively short range of the SS-N-6 missile, however, probably was a cause for concern for Soviet planners, because it required the Y-class submarines to deploy to launch areas far from Soviet waters to reach targets in the United States.[a] The Soviet submarines had higher radiated noise levels than the US submarines and were vulnerable to detection and tracking by US ASW forces.

[a] During the early 1970s the Soviets deployed two 2,700-km-range variants of the SS-N-6, one of which had a MRV payload

Figure 16
Average Investment Cost per Online SLBM Reentry Vehicle



Includes costs for boosters, RVs, and submarines but excludes costs for nuclear materials. The average investment cost has been calculated by dividing the inventory value of Soviet and US online SLBMs and submarines by the number of online RVs shown in figure 15.

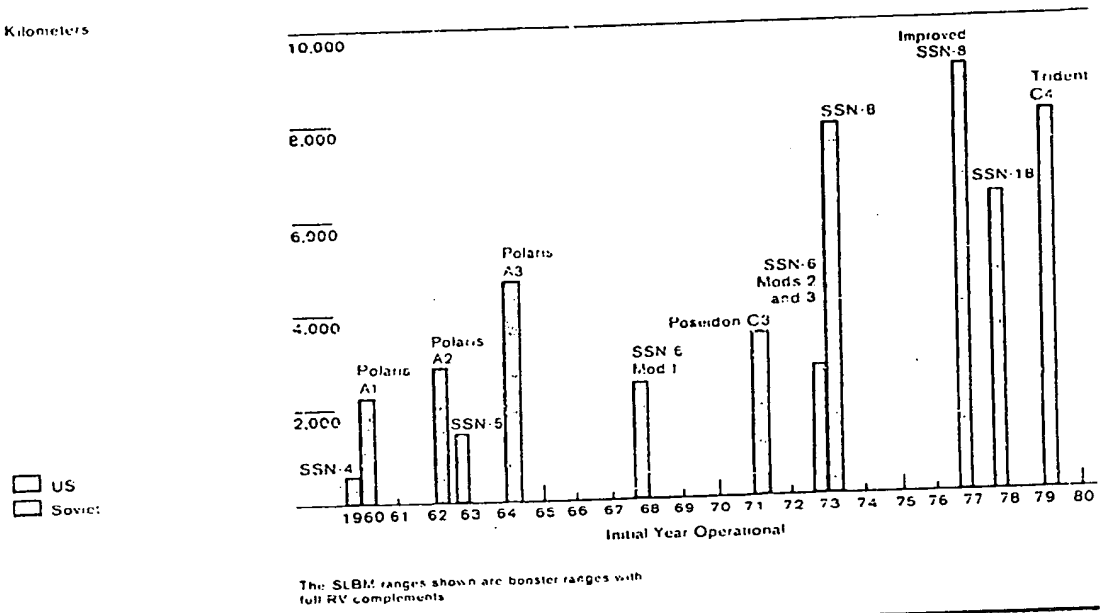
Concern for the survivability of their SSBN force probably was an important factor behind the Soviets' deployment, during the middle and late 1970s, of new SLBMs with intercontinental ranges (see figure 17). Submarines equipped with these new missiles could patrol in areas close to Soviet home waters and farther from operating bases of Western ASW forces. The first of these missiles--the SS-N-8, with a range of 7,800 km —was first deployed in 1973. Because the SS-N-8 was larger than the SS-N-6 and almost twice as heavy, it could not be fitted on the Y-class submarine.[9] As a result, the Soviets began to deploy the SS-N-8 on a new series of submarines—the D-class.[10] During the late 1970s the Soviets began deploying D-class submarines with two new missiles—an SS-N-8 variant with a longer range (9,000 km) and the SS-N-18 (the Soviets' first MIRVed

[9] The Y-class submarine apparently was designed specifically for the weight and space required for its initial armament of SS-N-6 missiles and lacked the growth room required to accommodate the larger SS-N-8 missiles and their associated control and navigation equipment.

[10] The D-series submarines are variants of the Y-class design employing the same reactor, turbines, gears, and other long-leadtime items.

Figure 17

Ranges of SLBMs



The SLBM ranges shown are booster ranges with full RV complements

SLBM).[*] By mid-1980 they had deployed 33 of these submarines, bringing total investment costs for this program to about $25 billion. [redacted]

As of 1980, substantial investment costs were going for the Typhoon submarine—the first unit of which was launched that year. This new submarine has a submerged displacement about 50 percent greater than that of the US Trident and will carry [redacted] SS-NX-20 SLBMs. These new solid-propellant missiles probably will be more accurate than any Soviet SLBM currently deployed and deliver at least [redacted] the payload to the same range. [redacted]

[*] The SS-N-18 has three variants—the Mod 1, with three MIRVs; the Mod 2, with a single RV; and the Mod 3, with seven small MIRVs. [redacted]

Investment in Intercontinental Bombers

At the beginning of 1960 the intercontinental attack forces of both the United States and the Soviet Union consisted primarily of bombers.[a] At that time, US bombers capable of striking the Soviet Union outnumbered Soviet bombers capable of striking the United States by more than 15 to 1 (figure 18). The US strategic bomber force numbered over 1,900 B-47, B-52, and B-58 aircraft, and the US strategic tanker force numbered over 1,100 KC-97 and KC-135 aircraft. The Soviet intercontinental bomber force at that time consisted of approximately 115 Bear and Bison bombers and approximately 35 Bison aircraft configured as tankers.

Since 1960 the United States has placed much greater emphasis than has the USSR on maintaining and modernizing its strategic bombers as a force coequal to its ICBM and SLBM forces. The Soviets have emphasized the ICBM and SLBM components of their intercontinental attack forces and have invested relatively little in the manned bomber component.

This disparity in intercontinental bomber programs is evident from the two countries' total investment costs and weapons deliveries since the beginning of 1960. During the 1960-80 period, total US investment outlays for intercontinental bomber forces were about 10 times the dollar costs for comparable Soviet activities. During this time, the United States procured nearly 10 times as many bomber and tanker aircraft as the Soviet Union.

[a] For the purposes of this comparison, US intercontinental bomber forces are defined to include B-47, B-52, B-58, and FB-111 bombers and KC-97 and KC-135 strategic tankers. This is consistent with the usage in the US Defense Planning and Programing Categories (DPPC). Because the DPPC assigns all B-52 and KC-135 squadrons to offensive strategic forces, all B-52 and KC-135 aircraft are considered as belonging to strategic intercontinental bomber forces, even though these aircraft can perform tactical missions and were used extensively in operations in Southeast Asia.

Soviet intercontinental bomber forces are defined to include the Bear and Bison bombers and Bison tankers of the Long Range Aviation Forces. Excluded are medium bombers such as Badger, Blinder, and the Backfire, which are charged with striking strategic targets along the periphery of the Soviet Union.

There is disagreement within the Intelligence Community concerning the capabilities and probable mission of the Backfire. The Soviets possibly could use this bomber against targets in the United States, but we estimate that they designed it as an intermediate-range bomber and ASW carrier to fulfill peripheral attack and naval attack missions.

Table 3

US and Soviet Intercontinental Bomber Activities, 1960-80

	Bombers Procured	Tanker Aircraft Procured	Air-to-Surface Missiles Procured
United States	340	460	2,150
USSR	85		550

US bomber investment outlays (figure 19) peaked during the early 1960s as production programs were completed for the B-52 and B-58 bombers and the KC-135 tankers. These outlays rose again in the late 1960s and early 1970s with the production and deployment of the FB-111 bomber[a] and the SRAM. Soviet intercontinental bomber investment costs peaked during the early 1960s. Since the mid-1960s, most of the small investment costs for Soviet intercontinental bomber forces have gone for procurement of spare parts, rather than for modernization.

The United States procured more than 250 B-52 and B-58 bombers and more than 400 strategic KC-135 tankers during the first half of the 1960s. Nevertheless, the total number of US strategic bombers and tankers declined substantially, as over 1,000 B-47 and 500 KC-97 aircraft were phased out. During the second half, the US strategic bomber and tanker inventories continued to decline as the United States retired all of its B-58s and some of the older B-52s and removed the last B-47s and KC-97s from the strategic forces.

During the early 1970s the United States added about 65 FB-111 bombers to its strategic forces (about 10 were delivered during the late 1960s) while retiring a roughly equal number of older B-52s. After 1975 the deactivation of about 80 additional B-52s brought the US strategic bomber total down to approximately 400 aircraft at midyear 1980.

[a] The FB-111 is included under the Department of Defense planning category of offensive strategic forces and is included in this paper under US intercontinental attack forces. The FB-111 is operated by the Strategic Air Command. The aircraft are based in the United States and would use aerial refueling to strike targets in the Soviet Union.

Figure 18

Intercontinental Bomber Force Levels and Deliveries

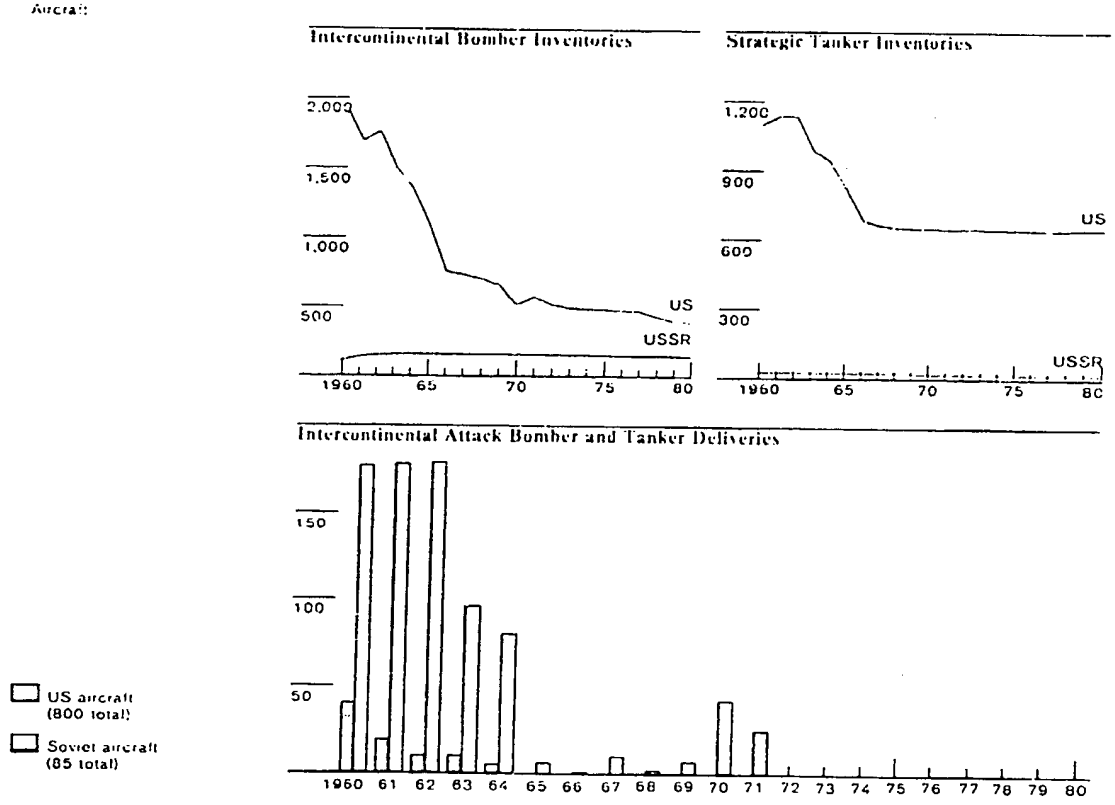
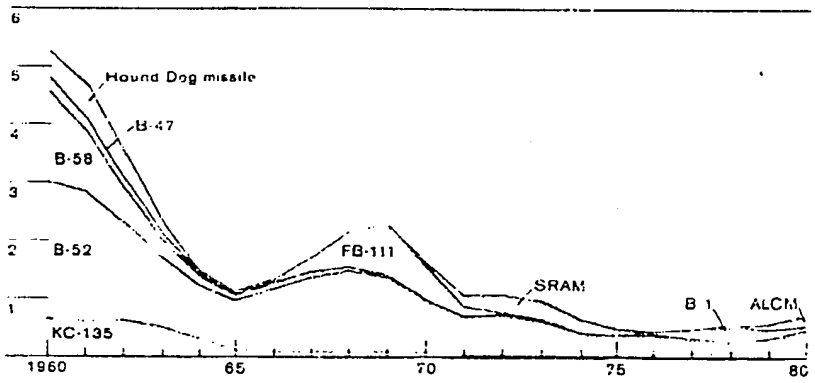


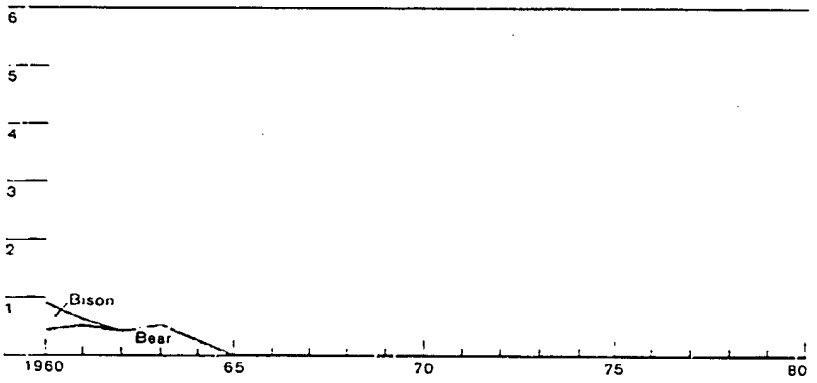
Figure 19
Investment Costs for Intercontinental Bomber and Tanker Systems

Billion 1980 dollars

US

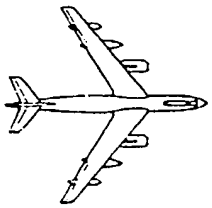
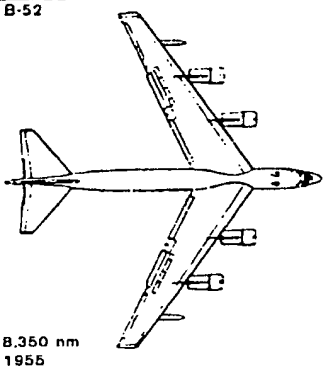
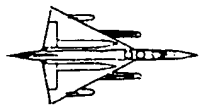
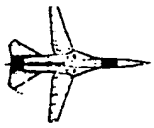
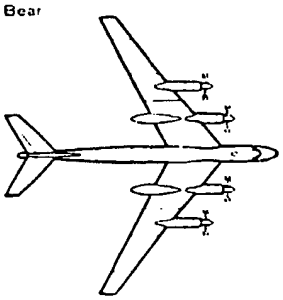
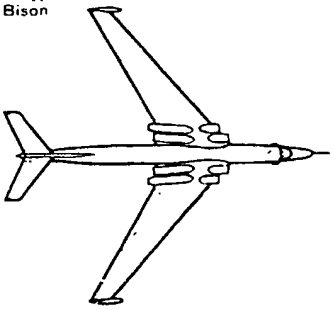


Soviet



Note: Costs for Bear bombers include costs for air-to-surface missiles.

Figure 20
Characteristics of Key Strategic Bombers in Operation Since 1960

US	**B-47**	**B-52**
		
	10 meters	
Maximum operational range[a]	4,100 nm	8,350 nm
Year operational	1951	1955
	B-58	**FB-111A**
		
	10 meters	
Maximum operational range[a]	2,680 nm	3,760 nm
Year operational	1958	1969
Soviet	**TU-95 Bear**	**M-type Bison**
		
	10 meters	
Maximum operational range[a] with	7,000 nm 8,770 nm 1 AS-3 6,600 kg of bombs (About two-thirds carry the AS-3 missile.)	5,400 nm 6,300 kg of bombs (None is equipped to carry missiles.)
Year operational	1956	1956

[a] The range given is for a mission flown entirely at high altitudes.

As the total number of strategic bombers declined, the United States modernized those remaining in the inventory. Structural modifications were made to extend the life of the B-52 bombers. They were also improved with electro-optical viewing systems and with electronic countermeasures (ECM) modifications that improved their ability to assess and counter enemy air defenses. Both the B-52 and the FB-111 bombers were equipped with the SRAM, which gave them a standoff attack capability against targets protected by sophisticated terminal air defenses.

Since the early 1960s, when the last Bison and Bear bombers were delivered to the Long Range Aviation forces, the Soviets have done little to improve their intercontinental bomber force. Instead, they have chosen to modernize the strategic bombers designed for use against targets on the periphery of the Soviet Union. The intercontinental bomber force changed little during the remainder of the period and consisted of about 150 Bear and Bison bombers and 30 tanker-configured Bison aircraft at midyear 1980.

As a result of this difference in emphasis throughout the two decades, the United States continued to maintain a bomber force several times larger and substantially more capable than that of the Soviet Union. At the beginning of the period the overwhelming US advantage in number of bombers resulted in roughly a twentyfold advantage in intercontinental bomber weapons, a fifteenfold advantage in hard-target potential, and about a tenfold advantage in lethal-area potential. Over time, as the United States retired its older bombers, this advantage decreased, but at the end of the 1970s the US intercontinental bomber force still maintained a wide lead over its Soviet counterpart in hard-target potential, lethal-area potential, and number of warheads.

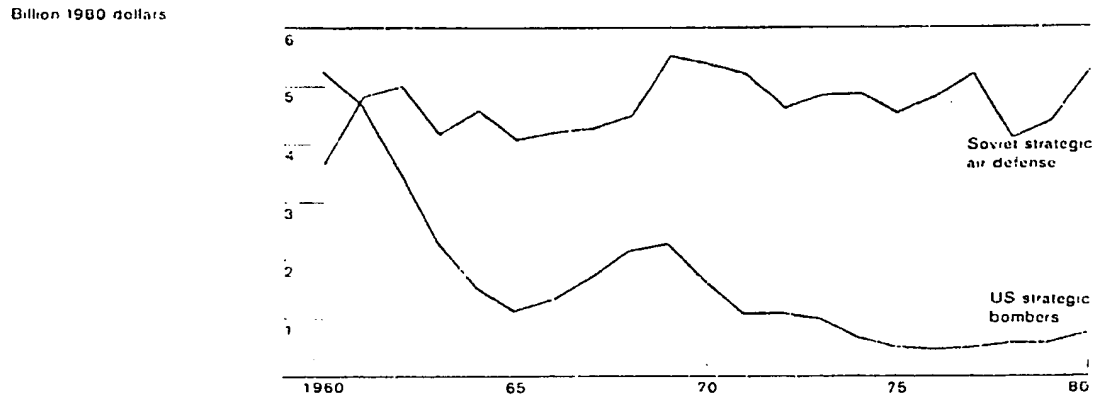
The disproportion in the two countries' strategic bomber programs had a corresponding influence on their air defense programs. Because the Soviet intercontinental bomber force was relatively smaller, US defense planners reduced investment for strategic air defense during the 1960-80 period.[7] The Soviet Union, on the other hand, faced a major threat from the much larger and more capable US strategic bomber force and lesser threats from the nuclear-capable aircraft of China, France, and the United Kingdom—as well as US aircraft deployed on carriers and at airfields in the European and Pacific theaters. The size of these threats, combined with the emphasis Soviet doctrine places on the mission of air defense of national territory, induced the Soviets to invest heavily in strategic air defense forces.

Statements by US defense planners indicate that one reason for maintaining a sizable US strategic bomber force was to encourage just such a development in the Soviet defense posture.[8] It would be incorrect to attribute to US bombers alone the full size and scope of the Soviet strategic air defense program during the past two decades, but they probably were an important influence. Combined with the other threats, US strategic bomber programs appear to have induced a Soviet investment for strategic air defense forces that has been several times the cost of US investment for strategic bombers. Between 1960 and 1980 the estimated dollar cost of Soviet investment in bomber defenses was almost three times as great as US investment outlays for intercontinental bomber forces. The disparity was particularly large during the latter half of the period, when the dollar cost of Soviet bomber defense investment was approximately five times US outlays for intercontinental bombers (figure 21).

[7] The decision not to deploy a nationwide system for defense against missiles was another important factor behind the US reduction in investment for bomber defenses. The assumption was that without an effective ballistic missile defense, a strong bomber defense could do little to limit damage to this country in general nuclear war. (

[8] In his February 1966 posture statement, then Defense Secretary McNamara argued that a few hundred US bombers would force the Soviets to "waste" a large portion of their resources on costly defenses. (

Figure 21
Comparative Investments: US Strategic Bomber Forces and Soviet Strategic Air Defense



Outlook Through the 1980s

Since the beginning of 1970, US investment outlays for intercontinental attack forces have averaged about $3.5 billion per year—about one-half the average dollar cost for Soviet investment activities for these forces. US programs and funding for intercontinental attack forces, which will call for substantially higher investment outlays, are currently being reviewed. Unless they are significantly changed, during the 1981-89 period average investment outlays for planned US intercontinental attack forces could be one and a half to two times the 1970-80 average.

Programs now in production and development for Soviet intercontinental attack forces will almost certainly cause Soviet investment costs for these forces also to rise through 1989. Under SALT II restrictions, Soviet investment costs for intercontinental attack forces during the total 1981-89 period could be about the same as investment outlays for US forces as currently planned (see figure 22). In the absence of SALT II constraints, the Soviets could field a larger force of ICBMs, each with more RVs, and deploy more MIRVed SLBMs aboard D-class submarines and the new Typhoons. The increased costs associated with these no-SALT forces could cause Soviet intercontinental attack forces investment costs during 1981-89 to exceed outlays for currently programed US forces by about $20 billion.[2] (This difference would be reduced, of course, should the United States respond by increasing investment for its intercontinental attack forces.)

US Programs

The Department of Defense Annual Report for Fiscal Year 1982 calls for substantial investment programs for each element of the US strategic triad through the

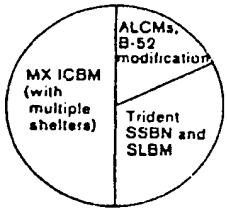
[2] The Intelligence Community's estimates for Soviet strategic forces during the 1980-90 period are contained in NIE 11-3/8-80: *Soviet Capabilities for Strategic Nuclear Conflict Through 1990*. The estimate's Force 1 (SALT) and Force 3 (No-SALT) projections for intercontinental attack forces provide the basis for this paper's cost estimates for future Soviet forces.

Figure 22

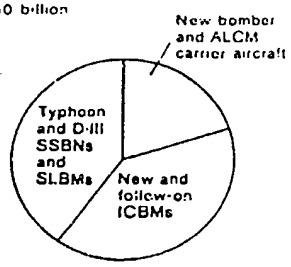
Projected Investments in Intercontinental Attack Forces

Billion 1980 dollars
Cumulative, 1981-89

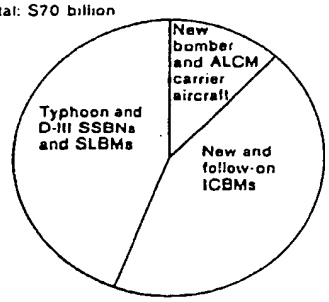
Major US Programs
Total: $50 billion



Major Soviet Programs (Projected with SALT II)
Total: $50 billion



Major Soviet Programs (Projected without SALT II)
Total: $70 billion



These totals include investment costs for new programs only. Additional investment will be required for submarine overhauls and for spare parts and modernization of already deployed ICBM and SLBM systems. These additional costs could constitute an additional $10-15 billion for each country.

1980s. These programs reflect US concern over the survivability of the silo-based ICBM force, the age of the SSBN fleet, and the age and obsolescence of the B-52 bomber force.

During the early-to-mid-1980s, the improved accuracies of Soviet ICBMs will pose an increasing threat to the US silo-based ICBM force. The most expensive of the US intercontinental attack forces programs currently planned for 1981-89 is the MX ICBM. The FY 1982 plan is to deploy each MX missile on a mobile launcher within a system of about two dozen shelters, in order to assure the survivability of a certain number of US land-based ICBMs through location uncertainty. The current administration, however, is considering other modes of deployment for this ICBM. The increased payload and improved accuracy of the MIRVed MX will greatly increase its potential against Soviet ICBM silos. The FY 1982 Defense Program projects initial operational capability for 10 missiles in 1986, with the full deployment of 200 missiles and 4,600 shelters scheduled by the end of 1989.

Second in cost is the Trident SSBN/SLBM program. The Trident submarine will replace the older Polaris first. Five of the Polaris submarines have already been removed from active service as ballistic missile submarines after nearly 20 years of service, and the remaining five are being considered for retirement in 1981. The 31 newer Poseidon submarines are to remain in operation for 30 years of service (that is, until retirement in the mid-1990s). Twelve are programed for deployment with Trident I missiles. The ultimate size of the Trident submarine force has not yet been determined. Work on nine Trident submarines has been authorized through FY 1981 and long-lead funding authorized for two others. The deployment of the intercontinental-range Trident I SLBM aboard the Poseidon SSBN, which began in 1979, and the Trident SSBN, which may occur in 1981, almost triples the operating area and greatly increases the area Soviet ASW forces must cover.

The increasing age and the technological obsolescence of the B-52 bomber force—plus the projected improvements in Soviet air defenses—have prompted US investment programs to improve the capabilities of the B-52s. Various longer term solutions are also being considered.

The main elements of the near-term investment program are the introduction of improved avionics and the deployment of air-launched cruise missiles (ALCMs) on the B-52 bombers. The new Offensive Avionics System will be installed on all B-52Gs and B-52Hs, making them more reliable and easier to maintain and increasing the accuracy of their weapons. The B-52G needs the system to deliver ALCMs, and it would permit conversion of the B-52H for ALCMs. The ALCM, a small, accurate missile with a range that will allow it to be launched by an aircraft outside Soviet air defenses, is programed to enter the force in 1982. Current plans call for the procurement of over 3,000 ALCMs, to be loaded on 151 B-52G aircraft—at first only under the wings and later in the bomb bays as well. The first B-52G squadron is scheduled to be deployed with externally mounted ALCMs in late 1982, with full operational capability of all 151 B-52Gs in 1990.

The United States is also exploring a variety of candidate bombers to replace the B-52. Among these candidates are a "stretched" FB-111, variants of the B-1, and new bombers using more advanced technologies. The deployment of any of these bombers—and particularly a new bomber—would require substantial investment funds above those projected in the current defense program. Some of these additional funds—a large portion in the case of a new bomber—probably would not be spent until the 1990s.

Soviet Programs

High levels of investment in ICBM and SLBM forces since 1970 have greatly enhanced the capabilities of Soviet intercontinental attack forces at the beginning of the 1980s. The Soviets have deployed ICBMs in sufficient numbers and with sufficient accuracies to be a serious threat to the US silo-based ICBMs. In addition, their conversion to harder silos has made large numbers of their own silo-based ICBMs more survivable, at least until the late 1980s, when the United States plans to deploy the MX ICBM. The Soviets also are beginning the new decade with a large force of relatively new ballistic missile submarines. In mid-1980 they had about 25 more of these than the

United States—and over 300 more SLBMs. About 450 of the Soviet SLBMs were intercontinental-range SS-N-8 and SS-N-18 missiles, capable of hitting targets in the United States from areas in or near Soviet home waters

The Soviets are not relaxing their defense efforts, however, despite the great increases in the capabilities of their ICBM and SLBM forces during the past decade. The number of Soviet intercontinental attack programs in production or development and the expansion currently under way in the defense industries portend substantial further investment for intercontinental attack forces through the 1980s, with or without SALT II constraints

The strong Soviet emphasis on ICBMs is likely to continue through the 1980s. The Soviets currently are developing a number of new or improved systems and probably will begin to deploy some of them by the mid-1980s. The improved accuracies of these systems will give them even greater kill probabilities against US silo-based ICBMs. In the absence of SALT II constraints, the new missiles probably would contain greater numbers of RVs than the current ones, making the Soviet ICBM forces even more capable of attacking silos, MX shelters, and other targets

The Soviets apparently also will continue to invest substantial sums in SSBN/SLBM programs through the 1980s. The launch of the first Typhoon unit in 1980 marked the beginning of a costly new investment program. In addition to the Typhoon/SS-NX-20 system, the Soviets are developing a number of new or improved SLBMs, some of which will be deployed during the 1980s.

During the next decade the Soviets may place more emphasis on the long-neglected bomber component of their intercontinental attack forces. After two decades of minimal investments for long-range strategic bombers, there is some evidence that they are developing two new strategic aircraft. One is a cruise missile carrier aircraft and the other is a long-range bomber that could carry either bombs or cruise missiles or both. These programs probably are in an early stage of preflight development and are unlikely to achieve initial operational capability before the late 1980s. Deployment of these new strategic aircraft would entail substantial investment costs.

Appendix A

Definition and Methodology

Definition

The definition of intercontinental attack forces used in this paper is the same as that of the category Offensive Strategic Forces in the Defense Planning and Programming Categories (DPPC) of the Department of Defense. The major components of these forces are the wings and squadrons for intercontinental bombers and ICBMs and the ballistic missile submarines and their support ships. Other components, less significant in terms of investment, are operational headquarters such as those of Air Force divisions and Navy SLBM groups and squadrons. Excluded from intercontinental attack forces are higher headquarters—for example, those of the numbered air forces, the Strategic Air Command (SAC), the Navy submarine forces, and fleet headquarters; these are grouped in the DPPC category Management Headquarters. The DPPC also excludes a number of command, control, and communications systems (such as the SAC Automated Command Control System and Navy fleet ballistic missile submarine control systems), which it assigns to a category called Strategic Control and Surveillance.

Soviet intercontinental attack forces have been defined for this paper to include units comparable to the US units above. This definition excludes Soviet peripheral attack forces, which have no US counterpart. These are the forces assigned strategic targets along the periphery of the Soviet Union: medium- and intermediate-range ballistic missiles, medium bombers, and some older ballistic missile submarines.

As a measure for comparing US and Soviet resource inputs to intercontinental attack forces we have selected the dollar cost of investment. Investment covers the cost of activities to replace, modernize, or expand the force through the procurement of equipment (including major spare parts) and the construction of facilities; it excludes activities for RDT&E. Also excluded from these investment cost comparisons are the costs for nuclear materials and nuclear warhead fabrication. (C)

Comparisons of long-term investment flows of the two countries can contribute to an understanding of their relative efforts to expand and modernize their intercontinental attack forces.

Methodology

US investment cost data are expressed as outlays. The outlays cited in this paper are derived from the Five-Year Defense Program (FYDP) issued by the Department of Defense in September 1980 and from US budget data. Because the historical data in the FYDP go back only to 1962, other sources were used for US spending in the early 1960s.[a] These data have been converted from fiscal year to calendar year terms, and outlays for each year have been converted to their equivalent in 1980 dollars, using detailed price indexes for each type of military investment. These adjustments enable us to compare US outlays with dollar costs for Soviet activities, but as a result the US figures in this report do not match the yearly budget authorizations and appropriations as they were published.

Our calculation of Soviet investment costs is based on a detailed identification and listing of Soviet forces and their support apparatuses. To arrive at the dollar costs of Soviet investment activities, we estimate what

[a] The principal studies used were: US Air Force Supporting Studies, *A History of Strategic Arms Competition, 1945-1972*, Volume 4: US and USSR Forces and Budgets, June 1976; and *Air Force ICBM Data Package*, compiled by the US Air Force Space and Missile Systems Organization, August 1975.

it would cost to build the equivalent physical objects in the United States at prevailing dollar prices for materials and labor, using current US production technology and practices and assuming that the necessary US plants and supplies would be available. Specifications for the equivalent physical objects are based on detailed estimates of Soviet weapons production and characteristics, which can be ascertained with reasonable confidence with intelligence methods.

Our estimate of trends in the capabilities of Soviet and US intercontinental attack forces uses three static measures (number of weapons, LAP, and HTP), computed for the middle of each year on the basis of online forces. This excludes any ICBM and SLBM launchers in conversion and any SSBs or SSBNs in shipyard overhaul in that year.

Appendix B

Comparison of Inventory Values

Definition and Methodology

Inventory value, as used in this paper, is the cost (in 1980 dollars) of replacing the weapons and facilities in the US and Soviet inventories. This replacement cost has been derived by multiplying each country's mid-year order of battle for bombers, tankers, ICBMs, SSBs, and SSBNs by the estimated average unit investment cost. The average unit investment costs for aircraft and missiles include costs for their airframes, propulsion equipment, electronics, and armament. ICBM launcher costs include costs for silo construction, launcher equipment, launch site activation, and a single missile (costs for spare and reserve ICBMs are excluded). Included for SSB and SSBN costs are average follow-on ship costs and the costs for one complement of SLBMs

Inventory value, which shows how investment flows have accumulated over time into stocks of weapons, reflects the size and technical characteristics of a military force. For example, the inventory value of the US Atlas ICBM force represents the cost in 1980 dollars of the labor and materials that would be needed to duplicate the Atlas force, rather than what it would cost, using 1980 technology, to build a different missile force of equal effectiveness

In calculating the inventory value of the US and Soviet weapon stocks, no attempt has been made to reflect degradation in capabilities due to age and technological obsolescence. The calculation of depreciated inventory values is an extremely difficult and uncertain exercise, and after being undertaken for both sides, it still would not be sufficient to portray the comparative capabilities of Soviet and US intercontinental attack forces. The assessments of capabilities must take into account not only the numbers and effectiveness of weapon systems but also such factors as strategic doctrine and battle scenarios; the tactical proficiency, readiness, and morale of the forces; logistic factors; and a host of other considerations. (

Trends in Soviet and US Inventory Values

In 1960, as a result of the US preponderance in bomber forces, the inventory value of US intercontinental attack forces was over five times that of Soviet forces (see figure 23). During the ensuing years, both countries invested substantial sums in ICBMs and SLBMs. For the United States, the increase in inventory value resulting from deployment of ICBMs and SSBN/SLBM forces was greatly offset by the decrease in inventory value resulting from the deactivation of large numbers of strategic bombers and tankers. As of 1980, the inventory value of US intercontinental attack forces was about 50 percent greater than it had been in 1960--with ICBMs, SSBN/SLBM forces, and bomber forces each accounting for substantial shares

For the Soviet Union, which started 1960 with a much smaller base, the inventory value of intercontinental attack forces in 1980 was almost 12 times the 1960 value, with ICBMs and SSBN/SLBM forces accounting for almost all the growth. As of 1980 the inventory value of Soviet intercontinental attack forces was about 40 percent greater than that of the United States

Examination of Soviet and US ICBM forces shows that in 1964 the inventory value of US ICBM forces was approximately four times that of Soviet ICBM forces (figure 24). This reflected, for the most part, the early numerical advantage of the United States in ICBM launchers. The inventory value of US ICBM forces rose rapidly during the early 1960s, from less than $1 billion in 1960 to about $19 billion in 1964. It dropped sharply in 1965 as the costly Atlas and Titan I missiles were phased out. Between 1965 and 1975 the inventory value of the US ICBM force increased slowly but steadily as the United States built up its force to 1,054 launchers (the level attained in 1967) and then modernized the missiles and launchers in the force.

Figure 23

Inventory Values of Intercontinental Attack Forces

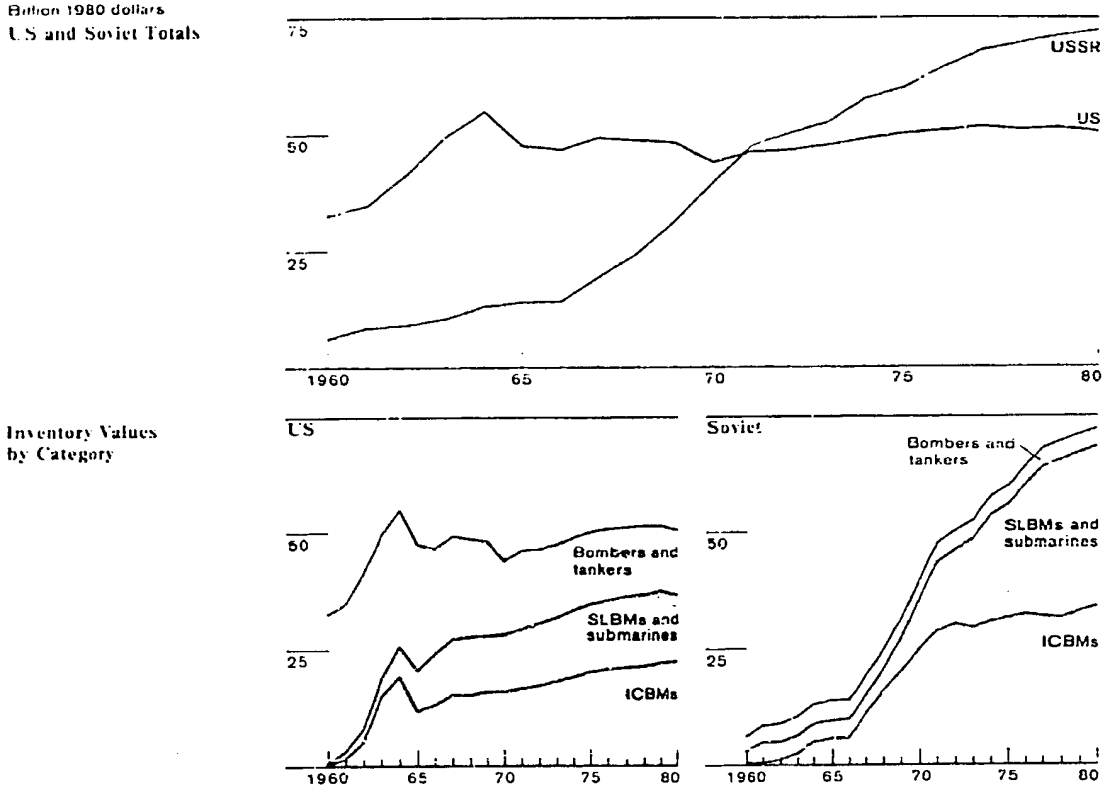
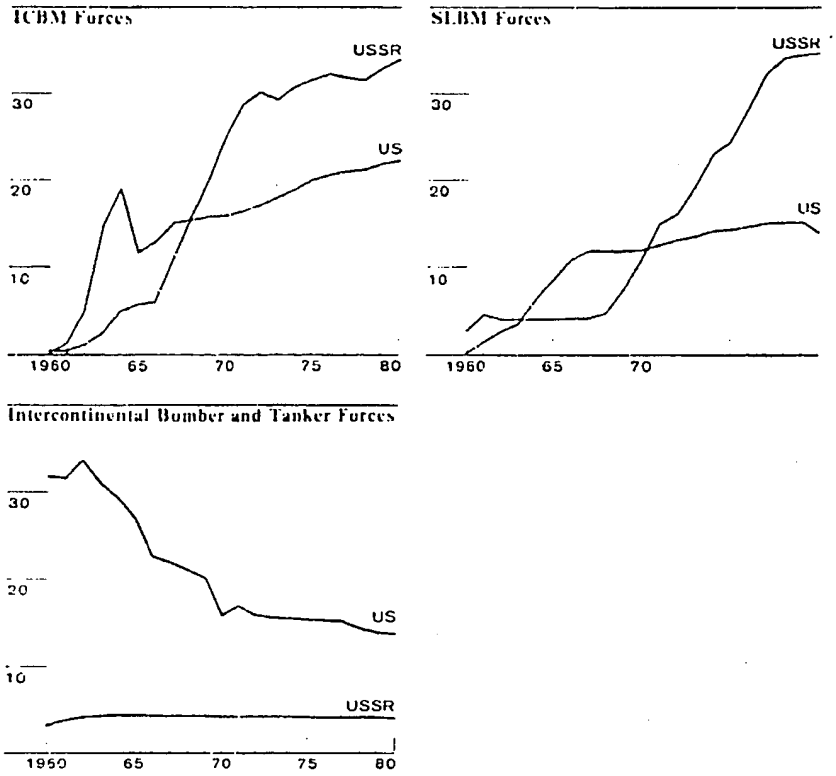


Figure 24
Inventory Values of ICBM, SLBM, and Intercontinental Bomber Forces

Billion 1980 dollars



The inventory value of the Soviet ICBM force grew during the early 1960s at a relatively slower pace, primarily because the rate of ICBM deployment in the Soviet Union was slower than in the United States. Rapid deployment of the SS-9 and SS-11 ICBMs during the late 1960s and early 1970s caused the inventory value of Soviet ICBMs to grow rapidly during that period. The Soviet ICBM force surpassed that of the United States force in inventory value in the early 1970s—about when it surpassed the US force in number of ICBM launchers. The inventory value of Soviet ICBMs grew more slowly in the middle and late 1970s, at a time when the Soviets were introducing the SS-17, SS-18, and SS-19 ICBMs. This was because the Soviets also were deactivating the older, relatively expensive, SS-7, SS-8, and SS-9 ICBMs.

During the early 1960s, the Soviets' greater number of SSBs and SSBNs caused the inventory value of their SLBM forces to exceed that of the US forces. By the mid-1960s, by virtue of the US deployment of large numbers of Polaris SSBNs, the inventory value of US SLBM forces had risen rapidly and exceeded that of the Soviet SLBM forces. By 1967, when the United States deployed the last Polaris SSBN, the US SSBN/SLBM inventory value was about three times that of the Soviet Union. During the 1970s, the Poseidon modernization program resulted in a very modest increase in US SSBN/SLBM inventory value.

During the late 1960s there was a marked increase in Soviet SSBN/SLBM inventory value as the Soviets began to deploy large numbers of Y-class SSBNs. This trend continued through the 1970s with the deployment of large numbers of D-class SSBNs. By 1980 Soviet SSBN/SLBM inventory value was over twice that of the United States.

Although the inventory value of US intercontinental bomber forces declined markedly between 1960 and 1980, at the end of 1980 it was still several times that of the Soviet bomber force. During the early-to-mid-1960s the inventory value of US intercontinental bomber forces declined sharply as the United States replaced hundreds of older B-47 and KC-97 aircraft with fewer B-52s and KC-135s. After 1966 the United States retired smaller numbers of strategic bombers and tankers, and US inventory value declined at a slower rate. The US bomber inventory value rose slightly in the early 1970s, with the deployment of the FB-111 bombers, then declined during the remainder of the decade as older B-52s were deactivated. Soviet intercontinental bomber inventory value rose slightly in the early 1960s as Long Range Aviation completed its deployment of Bear and Bison aircraft. During the remainder of the period, as the bomber inventory value of the USSR remained steady and that of the United States declined, the ratio of the Soviet to the US inventory value rose to about one-third as of 1980.

Appendix C

Comparison of Operating Costs

During the 1960-80 period as a whole, the level of operating costs for Soviet and US intercontinental attack forces in dollar terms was about 40 to 50 percent of the level of their investment costs (figure 25). Operating costs include costs for food, clothing, travel, and pay and allowances for active and reserve military manpower, as well as costs for operating and maintaining military equipment and facilities.

Trends in Soviet and US operating costs during 1960-80 mirror trends in the size of the two countries' deployed forces. Soviet operating costs rose markedly during the period, reflecting the large increases in deployed forces (figure 26). The United States, which began with a large force of bombers and tankers, reduced their number during the period but replaced them with ICBMs and SLBMs. As a result, the overall US intercontinental attack forces grew less than the Soviet forces did, and operating costs for US forces rose little during the period.

During the whole period, bomber forces accounted for about 60 percent of operating costs for US intercontinental attack forces. On the Soviet side, the emphasis was on ICBMs, which accounted for about 70 percent of operating costs for intercontinental attack forces

Operating costs for US bomber forces during the period exceeded Soviet operating costs for bombers by about 5 to 1—reflecting the much larger size and higher level of alert of US bomber forces (figure 27). In contrast, Soviet ICBM operating costs exceeded those of the United States by about 7 to 1. This

Figure 25
Investment and Operating Costs for Intercontinental Attack Forces

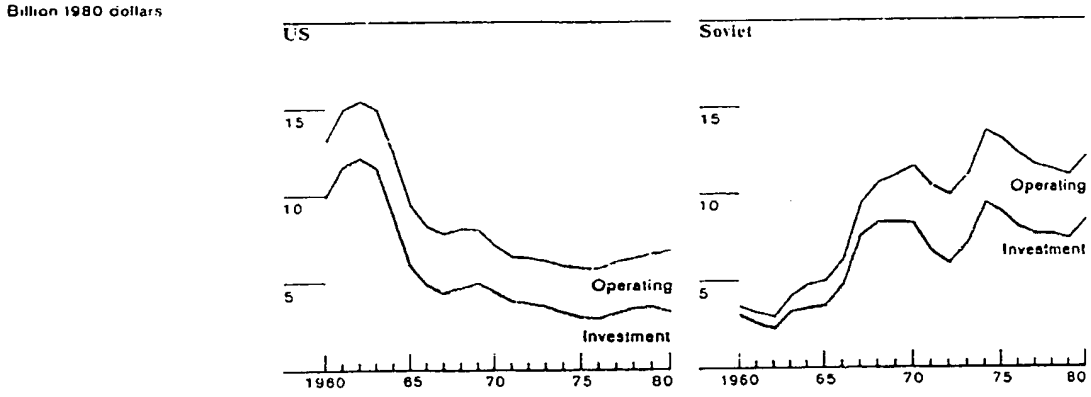
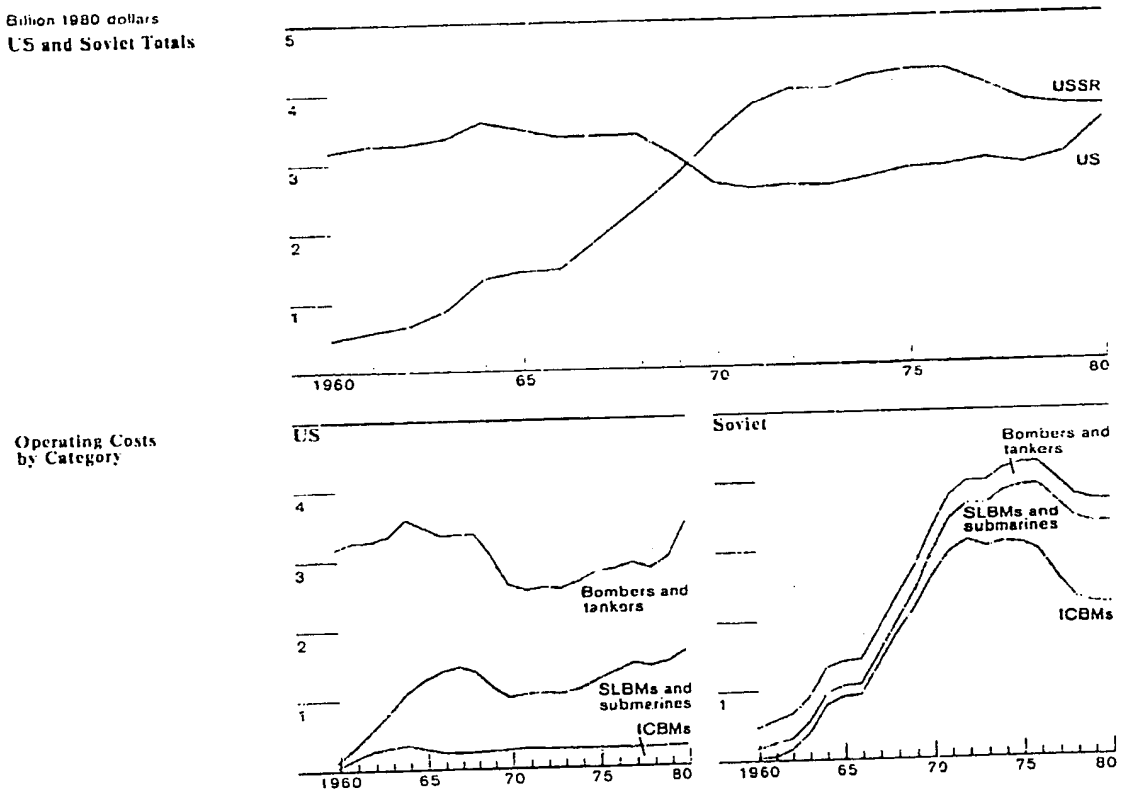


Figure 26

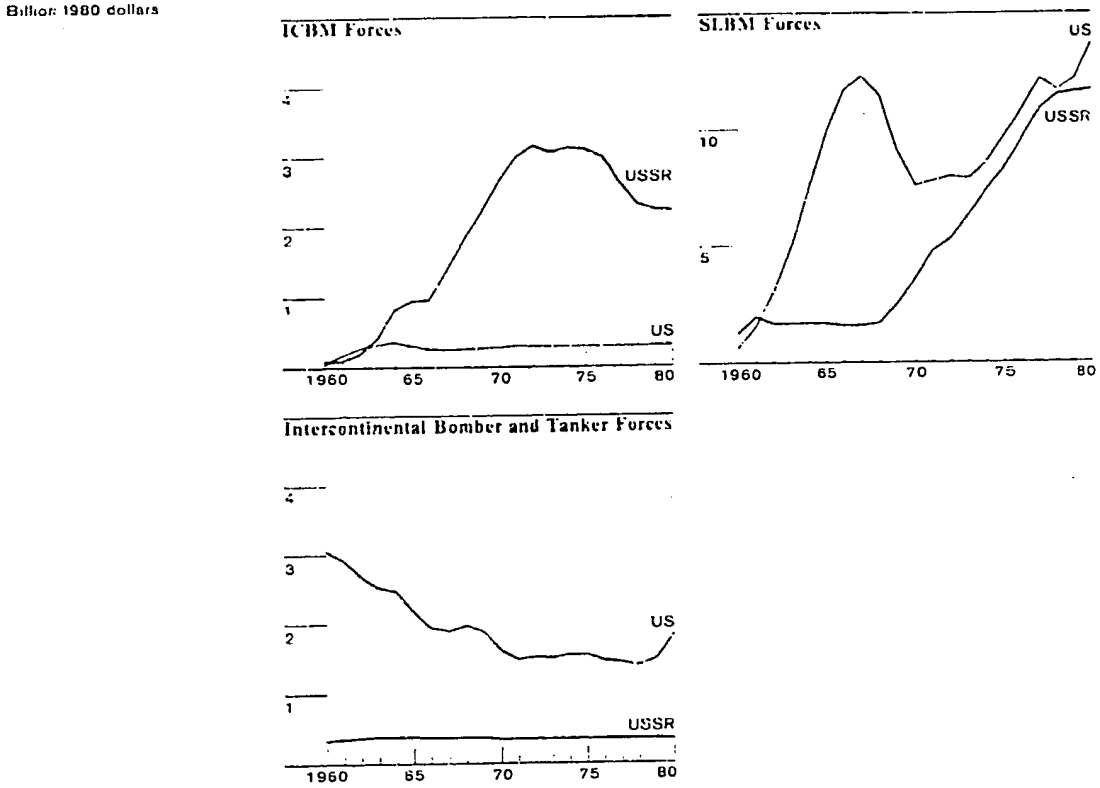
Operating Costs for Intercontinental Attack Forces



reflected the difference in operating costs between liquid- and solid-propellant ICBMs. The Soviet ICBM force, composed primarily of liquid-propellant ICBMs, had relatively greater costs than the US force, composed primarily of solid-propellant ICBMs.[24]

[24] This difference was also evident within US ICBM programs, where the operating cost for each liquid-propellant Titan II launcher was about five times the operating cost for each solid-propellant Minuteman launcher.

Figure 27
Operating Costs for ICBM, SLBM, and Intercontinental Bomber Forces



Operating costs for US SSBN/SLBM forces have exceeded operating costs for Soviet forces since the early 1960s. The disparity was particularly great during the second half of the 1960s, when US SSBN/SLBM forces were much larger than Soviet forces. Soviet operating costs for these forces rose markedly during the 1970s, when the USSR surpassed the United States in numbers of deployed SSBNs and SLBMs. The United States kept a significantly larger portion of its SSBN force on patrol, however, and as of 1980 the US operating costs for these forces remained slightly higher than Soviet operating costs.