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The MX Missile and Multiple Protective Structure Basing: Long-Term Budgetary Implications

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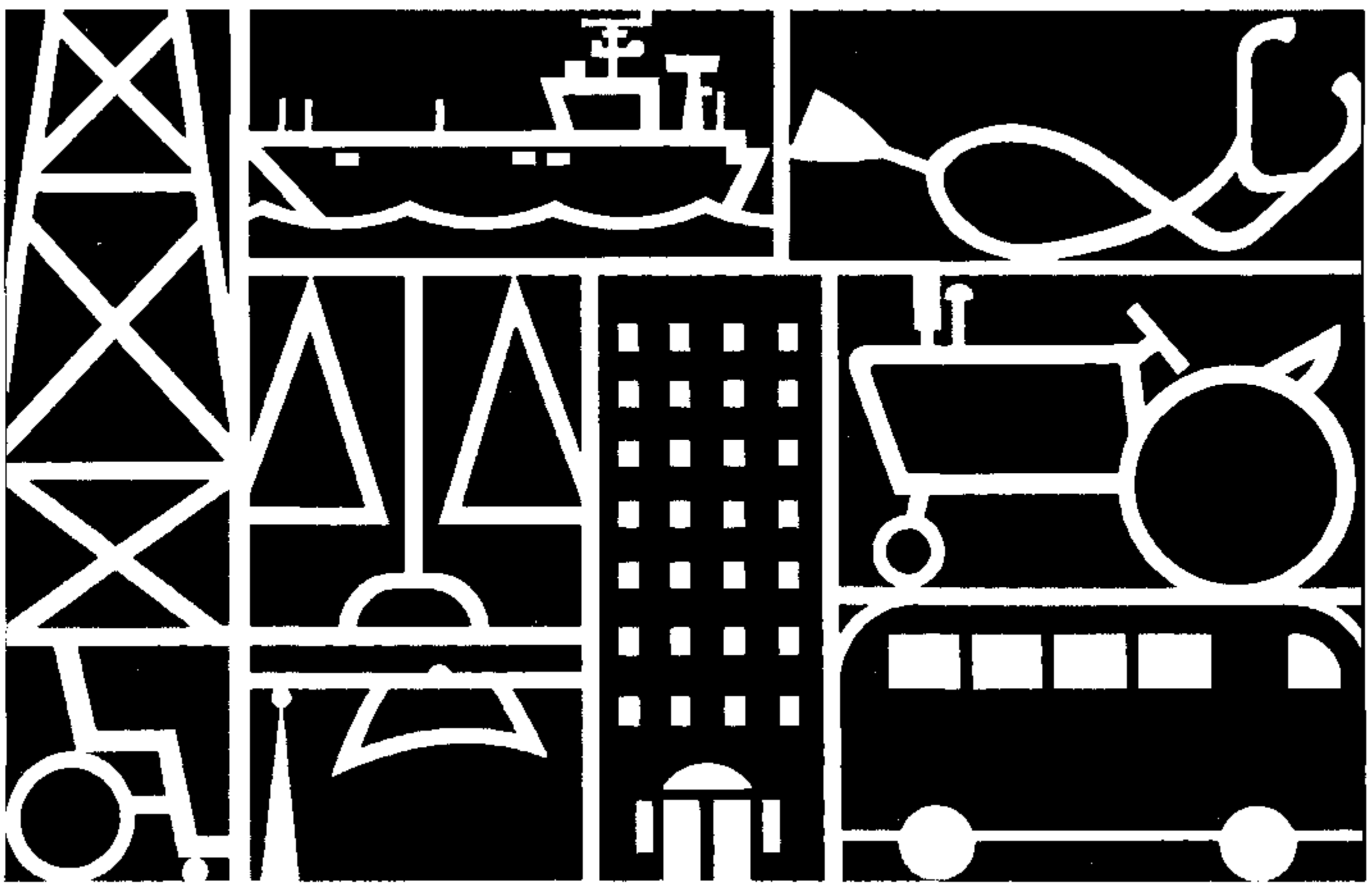

Congressional Budget Office
Congress of the United States

THE MX MISSILE AND MULTIPLE PROTECTIVE STRUCTURE BASING: LONG-TERM BUDGETARY IMPLICATIONS

The Congress of the United States
Congressional Budget Office

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This paper, prepared at the request of the Senate Committee on the Budget, examines one of a series of programs to modernize U.S. strategic forces that the Congress will consider during the 1980s. It focuses on the long-term costs of developing and deploying a multiple protective structure (MPS) basing system for U.S. land-based intercontinental ballistic missiles (ICBMs). Particular attention is paid to the implications of possible Soviet responses and to the effect of future SALT limitations. The paper also examines three missile options that could be associated with deployment of an MPS basing system. Finally, the report reviews the arguments for and against the development and deployment of an MPS basing system.

During the last two years, several versions of MPS basing systems have been studied by the Department of Defense and other groups. A complex of vertical shelters received the greatest attention; this concept was found to be the least expensive. Because concerns have been raised about the difficulties in monitoring the number of missiles deployed in a vertical shelter system, an MPS basing system involving horizontal protective shelters is also being considered by the Administration. In recent weeks, the Administration has focused on one type of horizontal shelter system in which missiles would move along rails built at the bottom of trenches that would be covered with removable roofs. (Although the Administration has yet not made a final decision on a particular MPS basing concept, it has indicated an intention to deploy the MX missile in some sort of a multiple protective structure basing system.) This study focuses specifically on the vertical shelter system, but its general conclusions would apply to other versions of MPS basing as well. In keeping with CBO's mandate to provide nonpartisan and objective analysis, this paper offers no recommendations.

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Director

June 1979

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SUMMARY

The imminent vulnerability of the U.S. land-based missile force poses several major questions that the Congress will have to consider over the next few years. Today, the strategic deterrent forces of the United States consist of long-range bombers, submarine-launched ballistic missiles, and land-based intercontinental ballistic missiles (ICBMs). The ICBM portion of this Triad consists of 1,000 Minuteman and 54 Titan missiles housed in underground silos. By the early to middle 1980s, the Soviet Union is expected to be able to destroy more than 90 percent of this land-based force.

Among several possible responses that the Department of Defense has been studying are:

- A new basing system for land-based ICBMs that would provide greater protection, or "survivability," against a Soviet attack; and
- New missiles that would be capable of carrying more nuclear warheads and might: potentially be more accurate.

The fiscal year 1980 budget proposed by the President contains $675 million for the development of these systems, but does not specify a particular missile or basing system. The Congress could choose among several candidates.

This study examines what effects the possible new missiles and a new basing system would have on the federal budget, and particularly how costs would vary with changes in the number of warheads in the Soviet ICBM force. The importance of Soviet responses suggests the importance of negotiating permanent, verifiable limits on ICBM forces. The study also addresses a wide range of other concerns that will influence Congressional decisions about the program.

ALTERNATIVE BASING SYSTEMS AND MISSILE OPTIONS

Multiple Protective Structure Basing. Several new ways of basing missiles have been proposed. Interest in the Department of Defense and the Congress has focused on a multiple protective

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structure (MPS) basing system, One version of an MPS basing system would consist of 4,500 or more vertical underground shelters, each of which could potentially house a missile. A force of perhaps 200 new missiles would be covertly rotated among the shelters. The objective would be to provide survivability for some of the missiles by building so many shelters that the Soviets would not have enough warheads in their ICBM force to destroy the entire U.S. force.

Other versions of an MPS basing system are also being considered. One would place missiles on special trains that would move randomly along railroad tracks set in trenches with removable roofs; concrete structures along the trenches would protect the missiles. Although this study focuses on an MPS basing system that would rely on vertical shelters, the study's general conclusions would apply to other versions of MPS basing.

Missile Candidates. Several missiles could be deployed in an MPS basing system. These include a new, larger, and more accurate missile known as the MX; a "common" missile that could be used in both an MPS basing system and the Navy's new Trident submarines; or a modified version of an existing land-based missile, the Minuteman III.

COSTS OF AN MPS BASING SYSTEM

Base-Case Costs Assume No Soviet Responses. The costs of an MPS basing system would be sensitive to the number of Soviet warheads available to attack it. This study's "base-case" MPS basing system assumes that, between now and about 1990 when the U.S. system would become fully operational, the Soviets would deploy no more than 820 multiple-warhead ICBMs (the ceiling in the proposed SALT II agreement) and would make no attempt to increase the number of warheads carried on each of their missiles. Such a "no-response" missile force would leave the Soviets with as many as 5,928 warheads in their multiple-warhead ICBM force.

The base-case system also assumes that the United States would want 1,000 warheads to survive a Soviet first-strike attack. This number of surviving warheads would provide the capability to destroy most industrial targets in the Soviet Union or, alternatively, to attack a large portion of Soviet military targets.

Under these assumptions, two major sets of conclusions follow:

- o An MPS basing system would cost about $35 billion in 1980 dollars. This sum would pay for the development, deployment, and 12.5 years of operation for a system of 5,500 vertical shelters and 310 MX missiles, each armed with 10 warheads. Together with the silo-housed Minuteman and Titan ICBMs that would remain after deployment of an MPS basing system, these MX missiles could absorb the 5,928 Soviet warheads and still provide 1,000 surviving warheads for a U.S. retaliatory strike.

- o An MPS basing system would require a large investment before any substantial number of warheads would survive. To provide even 500 surviving warheads, for example, would cost $31 billion. But increasing the number of surviving warheads would be relatively less expensive. For $41 billion, the United States could provide 2,000 surviving warheads.

Soviet Responses Could Increase Costs. One Soviet response would be to increase the number of nuclear warheads available to attack an MPS basing complex. Costs to maintain the same number of surviving warheads would then be higher because the United States would have to construct additional shelters and deploy additional missiles.

Predicting Soviet responses over the next decade, especially those that would involve an expensive missile buildup, is highly speculative. Thus, the cases discussed below should be considered only as plausible examples of Soviet actions that could increase the costs of an MPS basing system.

- o The Soviets could remain within the limits of the proposed SALT II agreement but still increase the number of warheads in their multiple-warhead ICBM force. They could, for example, replace their silo-housed SS-17 and SS-19 missiles, which carry up to four and six warheads, respectively, . with a new ICBM that carries 10 warheads. This would allow the Soviets to deploy up to 8,200 warheads on their 820 multiple-warhead ICBMs. The cost of an MPS basing system that would provide 1,000 surviving warheads would then rise to $41 billion.

- By 1990, when an MPS basing system would be completed, the Soviets might have gone beyond the limits in the proposed SALT II agreement, which would expire at the end of 1985. One way for the Soviets to exceed the limits would be to keep 820 multiple-warhead ICBMs but modify each missile to carry a larger number of smaller warheads. This strategy would allow them to deploy some 15,000 200-kiloton warheads, the approximate size of the warheads reportedly deployed on the existing U.S. Minuteman III missiles. Such a change in the number and size of Soviet warheads would raise the cost of an MPS basing system that could provide 1,000 surviving warheads to about $48 billion.

- The Soviets could also exceed the proposed SALT II limits and increase the number of their multiple-warhead ICBMs. At current rates of deployment, the Soviets could have a force of 1,400 multiple-warhead missiles well before 1990. These missiles could carry about 9,100 warheads if the Soviets made no special effort to increase the number of warheads carried on each missile. An MPS basing system designed against this threat would cost about $45 billion. If the Soviets also equipped each of these 1,400 multiple-warhead ICBMs with a larger number of smaller warheads, they could deploy a force of some 23,000 200-kiloton warheads. In this event, the cost of a U.S. MPS basing system designed to maintain 1,000 surviving warheads would be about $63 billion.

Hedging Against Uncertainty Could Increase Costs. Uncertainty about the number of Soviet missiles and warheads available for an attack against a U.S. MPS basing system could also increase the costs of such a system. The Soviets could produce and stockpile a large number of missiles and nuclear warheads beyond those deployed in silos. Neither the existing SALT I treaty nor the proposed SALT II agreement prohibits this stockpiling. Indeed, both the United States and the Soviet Union routinely produce more missiles than they deploy in silos in order to provide spares for maintenance, missile testing, and crew training. If the Soviets could find a way to launch any extra missiles that might be stockpiled, these missiles could pose an unexpected threat to an MPS basing system.

As a hedge, the United States might wish to build more shelters than required by the number of Soviet multiple-warhead ICBMs known to be deployed in silos.

- For example, a U.S. MPS basing complex with 310 MX missiles and 11,000 shelters, twice the number of shelters included in the base-case system, could provide 1,000 surviving warheads even if the Soviet Union possessed 4,500 extra warheads. This would double the number that could be targeted on the complex by the "no-response" missile threat discussed above. Construction of 5,500 additional shelters would add as much as $14 billion to the costs of an MPS basing system.

Some U.S. Responses Could Minimize Cost Increases. In the face of a massive Soviet buildup or substantial uncertainty about Soviet stockpiles, it might be more economical to defend U.S. missiles deployed in an MPS basing system rather than to protect them by building more shelters. This would, however, require abrogation or renegotiation of the permanent treaty between the United States and the Soviet Union banning mobile ballistic missile defense systems.

Regardless of the size of the Soviet response, the United States could avoid cost increases by accepting fewer surviving warheads. Even if a missile buildup allowed the Soviets to destroy all the U.S. missiles and warheads in an attack, the MPS basing system might still serve an important purpose by forcing the Soviets to use warheads that could otherwise be targeted against other elements of the U.S. nuclear deterrent or against U.S. cities.

Future Agreements Reducing Warheads Could Lower Costs. The costs of an MPS basing system could be lower than the cost of the base-case system if a future agreement reduced numbers of Soviet warheads.

- For example, the Soviets could accept the limits proposed by the Carter Administration in March 1977. These would hold the Soviet Union to 550 multiple-warhead ICBMs, with a subceiling of 150 large missiles of the SS-18 type. If, in addition, there were a prohibition against each missile carrying a larger number of smaller warheads--insured by a verifiable ban on flight-testing of such missiles--then the Soviet multiple-warhead ICBM force might contain as few as 3,900 warheads. In this case, the cost of a U.S. MPS basing system that could provide 1,000 surviving warheads would be about $27 billion, or $8 billion less than the cost of the base-case system.

Summary Table 1 shows how Soviet responses could affect the costs of an MPS basing system.

SUMMARY TABLE 1. IMPACT OF SOVIET REPONSES ON COSTS OF A U.S. MPS BASING SYSTEM

	Number of Soviet Warheads	U.S. MPS Basing System Cost for 1,000 Surviving Warheads a/
"No-Response" Base Case	5,928	35
Soviets Observe SALT II Limits, but Maximize Warheads	8,200	41
Soviets Exceed SALT II Limits by Increasing Warheads per Missile	15,000	48
Soviets Exceed SALT II Limits by Increasing Missiles	9,100	45
Soviets Exceed SALT II Limits by Increasing Both Missiles and Warheads per Missile	23,000	63
Soviets Accept Limits Below Those in SALT II	3,900	27

a/ In billions of fiscal year 1980 dollars.

IMPORTANCE OF SALT LIMITS

The survivability and costs of an MPS basing system would be substantially more certain if there were permanent, verifiable limits on ICBM forces. Of particular importance would be provisions to:

- o Limit the number of multiple-warhead ICBMs;
- o Limit the number of warheads that could be flight-tested on ICBMs; and
- o Limit the production and stockpiling of ICBMs.

SALT II a First Step. The proposed SALT II agreement would be a first step toward achieving these kinds of limits. Until it expired at the end of 1985, the proposed agreement, if ratified, would prevent the Soviets from deploying more than 820 launchers for multiple-warhead ICBMs, a level that they could surpass by 1982 if there were no SALT restrictions. The proposed SALT II agreement would also limit to 10 the number of warheads that may be flight-tested on an ICBM. Without such a limit, the Soviets might begin testing missiles with larger numbers of warheads; once a series of such tests had occurred, it would be difficult, perhaps impossible, to verify that missiles with larger numbers of smaller warheads had not been deployed.

Stockpile Limits Absent. The proposed SALT II agreement would not, however, limit Soviet: missile production or stockpiles. Such a limit would be the best way to eliminate uncertainty about the number of Soviet missiles and warheads available for an attack on a U.S. MPS basing complex. To date, limits of this type have not been included in SALT agreements because of the difficulty of monitoring missile production and stockpiles.

COSTS OF U.S. MISSILE OPTIONS

In addition to considering basing options in fiscal year 1980, the Congress will be considering whether or not to develop a new missile and, if so, what kind. Of the $675 million proposed in fiscal year 1980 for a new ICBM system, about $450 million would fund missile development activities. The choice of a missile is a separate decision from the choice of a basing system, though it would influence the cost of the basing system.

Three Missile Options Are Available. The Congress could consider the following three missile options:

- o Full-scale development of the new MX missile, a large ICBM designed to deliver many powerful nuclear warheads with high accuracy;

- o Initial development of a "common" missile that could be deployed both in an MPS basing system and in the large missile tubes of the Trident submarines now under construction; and

- o Modification of the 550 existing silo-housed Minuteman III missiles for deployment in an MPS basing system.

Relative Costs Depend on Surviving Warheads. As Summary Table 2 shows, the relative ranking of missile options on the basis of total cost would vary with the number of surviving warheads the United States chooses.

- o If low numbers of surviving warheads are chosen, the Minuteman III missile option would be the least-cost alternative because modification of an existing missile would minimize the required missile development and procurement costs.

- o If high numbers of surviving warheads are chosen, the MX missile, with its large number of warheads per missile, represents the least expensive alternative.

- o If a middle range of surviving warheads is chosen, the common missile option, with its shared development costs, could be the least costly. This conclusion assumes that, in the absence of a common missile program, the Navy would fund a separate program to develop a new missile for the Trident submarine.

These conclusions about relative costs of the missile options assume no Soviet responses. As was pointed out above, costs of all missile options could increase under several kinds of Soviet

SUMMARY TABLE 2. **COMPARISON** OF COSTS OF MISSILE OPTIONS IN AN MPS BASING SYSTEM: IN BILLIONS OF 1980 DOLLARS

Desired Number of Surviving Warheads	MX Missiles	Common Missiles	Modified Minuteman III Missiles
500	30.9	26.7	19.6
1,000	34.7	31.0	30.9
1,500	37.8	35.0	109.0
2,000	40.7	41.5	Infeasible

NOTE: Costs of the common missile options have been reduced by the amount that the Navy would have spent in developing a new missile for the Trident submarine, but they reflect the added costs expected in a common missile development program. All costs assume that the Soviets would not respond to U.S. deployment of an MPS basing system.

buildup. The relative rankings of the missile options, however, would remain similar under most types of Soviet response.

NON-COST CONSIDERATIONS INFLUENCE U.S. MISSILE OPTIONS

Desire to Limit U.S. Capability Favors Minuteman. One non-cost consideration could favor the choice of the modified Minuteman III missile.

- The Minuteman III missile is less accurate than the MX missile would be. Thus, the Minuteman III missile option would avoid the acquisition of an improved capability to destroy Soviet ICBM silos. Some view this limit as contributing to strategic stability.

On the other hand, the modified Minuteman III missile has disadvantages:

- Because of the limited number of missiles and warheads per missile, it would be prohibitively costly or even infeasible to deploy an MPS basing system with Minuteman III missiles intended to provide more than about 1,000 surviving warheads.

- To keep costs low, Minuteman III missiles would have to be based in the northern United States, using some of the facilities at existing missile bases. Weather and other factors make this a less attractive deployment area than the Southwest, where MX or common missiles would be based. If Minuteman III missiles were deployed in the Southwest, additional basing construction and missile modifications, including extending their range, would be necessary. Costs would go up by about $3.5 billion, which would eliminate much of the cost savings.

Desire for Size and Accuracy Favors MX. Several factors other than costs could favor the MX missiles:

- The MX missile would be more accurate than the other two. Thus, it would be an attractive option if the United States wished to acquire an improved capability to attack Soviet military targets, especially Soviet ICBM silos.

- The large size of the MX missile, and the resulting ability to carry many warheads, would maximize U.S. capabilities under future SALT provisions that might limit the number of missiles that may be deployed.

Common Missile Offers a Hedge. Several important factors could favor the common missile:

- Development of a common missile would hedge against a decision not to deploy an MPS basing system. In the event of such a decision, development costs of a common missile would not have been wasted, since the missile could be deployed aboard Trident: submarines. And development of a new missile for the Trident would have been speeded up, which would be important if the United States eventually decides not to have a new land-based missile.

- If an MPS basing system is deployed, its large costs, coupled with the need for overall budgetary constraints, might preclude funding for the development of a second missile. Thus, the common missile might be the only way to develop a new, large missile for the Trident submarines, along with an MPS basing system. Such a new missile might be desirable to enhance the effectiveness of the Trident force.

The common missile, however, has disadvantages:

- o Savings in development costs might be partly or completely eroded because of difficulties in designing a missile to be compatible with two different basing systems. Cost estimates shown here allow for some difficulties, but the magnitude of these extra costs is hard to predict.

- o Use of a common missile for deployment in both an MPS basing system and Trident submarines would increase the risk that unexpected problems with the reliability or aging of the missile would jeopardize both the submarine missile force and the land-based ICBM force.

ASSESSING THE NEED FOR A LAND-BASED MISSILE SYSTEM

This study focuses on the costs of a new land-based missile system. A decision about whether or not to develop and deploy such a system, however, must also consider the submarine- and air-based forces, both of which are aging. Programs to modernize these forces could include building Trident submarines or other strategic submarines and new strategic aircraft to replace or augment B-52 bombers. Thus, the key question is not whether to add a new land-based system to submarine and strategic aircraft forces whose future capabilities are fixed in size. Rather, the question is what comprises the most desirable mix of new forces as the entire U.S. strategic arsenal is modernized during the 1980s.

Two general strategies to provide a given level of retaliatory capability are available to the Congress:

- o Maintain the Triad by developing and deploying an MPS basing system while also modernizing both the submarine and strategic aircraft forces; or

- o Move to a Dyad by deploying a relatively more capable force of strategic submarines and aircraft.

Relative Costs May Be Comparable. Although CBO has not undertaken an analysis of the relative costs of these two general options, studies conducted within the Department of Defense apparently indicate that a U.S. arsenal with a new land-based missile system would, under the constraints of the SALT II agreement, be "no more costly" than a force of submarines and strategic aircraft of "comparable levels of capability." It is not clear, however, whether these cost comparisons account for possible Soviet responses. These responses might affect land-based and aircraft-based systems more than submarine-based systems, assuming that U.S. submarines remain undetectable.

Triad Preserves Diversity. One argument in favor of a Triad, and hence in favor of a new land-based missile system, is that it preserves diversity. Diversity in the basing of U.S. strategic forces has been considered a desirable characteristic because it means that the Soviets must attack three different systems, each with different vulnerabilities, in order to destroy the entire U.S. nuclear deterrent in a first-strike attack. Each element of a diversified force may also contribute to the survivability of the other elements. For example, the construction of a large number of shelters for an MPS basing system, all of which would have to be targeted by the Soviets in order to destroy the entire system, might make it more difficult to execute an effective attack on U.S. air bases for strategic aircraft.

Land-Based Systems Have Special Capabilities. In considering whether or not to keep a survivable land-based missile force, one must also take into account the special capabilities of land-based systems. Land-based missiles offer high accuracy, short missile flight times, and reliable two-way communications; these characteristics are not all present in either submarines or strategic aircraft. These characteristics could provide the United States with a capability to destroy a large portion of Soviet military targets, particularly hardened ICBM silos. Some types of missiles that could be deployed in an MPS basing system would retain other advantages of land-based systems but avoid the capability to destroy ICBM silos; it has been suggested that this limit would reduce incentives to strike first in a nuclear crisis.

A survivable land-based missile system would also allow the United States to withhold weapons from use over an extended period after an initial nuclear attack. This flexibility is inherent in missile-carrying submarines as well, but it may not be available in strategic aircraft.

Threats to the Survivability of Land-Based Missiles. One possible disadvantage of an MPS basing system is that its ability to provide surviving warheads for a U.S. retaliatory strike might be threatened over the long run by possible increases in the number of warheads in the Soviet: ICBM force, unless permanent, verifiable SALT limits could be negotiated. Survivability could also be affected by U.S. uncertainty about the number of Soviet missiles and warheads available to attack the system. Neither of these threats would require a Soviet technological breakthrough, which would *be* necessary to threaten the Survivability of strategic submarines.

Missiles Must be Countable. Questions have been raised about the ability of the Soviet Union to count the number of missiles deployed in a U.S. MPS basing system and about the U.S. ability to monitor a similar Soviet mobile missile-basing system. If an acceptable counting method could not be devised, the ability to verify compliance with future SALT limits would be threatened. Recent verification concepts may, however, provide a means to resolve this difficulty.

Conclusion. Ultimately, the decision on a new land-based missile system depends on the course that the Congress selects for future U.S. strategic forces. Should the diversity inherent in the present Triad be preserved, or should increased reliance be placed on a Dyad of sea-based and airborne forces? Would a land-based system be viable in the face of possible Soviet responses? The ultimate decision will involve weighing the costs and capabilities of all the systems--including the costs to expand sea-based and airborne forces if the United States decides to move away from the present Triad concept.

Silo-housed Minuteman and Titan intercontinental ballistic missiles (ICBMs) constitute one component of the U.S. Triad of strategic nuclear forces, a three-part arsenal that also contains missile-carrying, nuclear-powered submarines and long-range bombers. 1/ U. S. strategic nuclear forces are designed to deter the Soviet Union from launching a nuclear attack against the United States or its principal allies by enabling the United States to retaliate against a variety of industrial and military targets in the Soviet Union. 2/ This retaliatory capability should remain secure even if Soviet nuclear weapons were used to attack U.S. strategic forces in a first strike. The perception that the United States has capable forces may also reassure allies and deter adversaries from other forms of aggression, thereby helping to achieve some valuable international political objectives.

THE GROWING VULNERABILITY OF THE U.S. SILO-HOUSED MISSILE FORCE

The Soviet Union is acquiring a growing capability to destroy U.S. Minuteman and Titan ICBM silos. Over the last several years, the Soviets have developed and deployed a force of large

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1/ U. S. strategic nuclear offensive forces currently consist of 1,000 Minuteman ICBMs (450 single-warhead Minuteman II missiles and 550 three-warhead Minuteman III missiles) and 54 single-warhead Titan II ICBMs based in fixed silos; 41 nuclear-powered submarines with 656 submarine-launched ballistic missiles (160 single-warhead Polaris missiles and 496 multiple-warhead Poseidon missiles); and 348 operational B-52 bombers. Together, these forces are armed with 9,200 independently targetable nuclear warheads and bombs, of which about 25 percent are deployed in the ICBM force. See U. S. Department of Defense, Annual Report, Fiscal Year 1980, p. 71.

2/ U.S. Department of Defense, Annual Report, Fiscal Year 1980, pp. 74-79.

ICBMs, each capable of carrying several powerful nuclear weapons. The Soviets have also made great strides in developing more advanced missile guidance systems that provide a potential for greatly improved missile accuracy. In the near future, they are expected to be able to deploy a large force of these increasingly accurate multiple-warhead ICBMs, 3/ enough to give them a theoretical capability to destroy more than 90 percent of the U.S. Minuteman and Titan ICBM force, while using about one-third of their own ICBM warheads in the attack. 4/ A Soviet leadership contemplating an actual strike against U.S. ICBMs would face great uncertainties and risks, and that could help deter an attack. 5/ Nevertheless, the United States will soon be in a situation in which it will have little confidence that more than 10 percent of its Minuteman and Titan ICBMs could survive a Soviet preemptive first strike and be available for a U.S. retaliatory attack.

The Department of Defense expects this threat to the U.S. silo-housed ICBM force to become "substantial" by the early 1980s. 6/ Because any new U.S. strategic weapon program undertaken in response to the threat would require several years to complete, the Congress will face pressures to deal with this issue in 1979. The current debate over the second Strategic Arms Limitation Treaty (SALT II) also brings the issue of ICBM vulnerability to the fore.

At the same time that the silo-housed ICBM force is becoming increasingly vulnerable, the existing fleet of missile-armed

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3/ Multiple-warhead missiles are often referred to as "MIRVed" missiles. MIRV stands for multiple independently targetable reentry vehicle.

4/ See Congressional Budget Office, Planning U.S. Strategic Nuclear Forces for the 1980s, Budget Issue Paper (June 1978).

5/ See Congressional Budget Office, Counterforce Issues for the U.S. Strategic Nuclear Forces, Background Paper (January 1978).

6/ U.S. Department of Defense, Annual Report, Fiscal Year 1980, pp. 116-17.

Polaris and Poseidon submarines, constructed during the 1960s, and the force of B-52 bombers, all built during the late 1950s and early 1960s, are both approaching the end of their service lives. Programs to replace these forces have been initiated or are under study. Thus, during the 1980s, the Congress will consider programs to modernize the entire strategic nuclear arsenal. This provides an opportunity to debate how best to structure U.S. forces.

The United States could respond to the projected threat to the silo-housed ICBM force in one of two general ways:

- o Develop a new ICBM system; or

- o Place increased reliance on missile-carrying submarines and strategic aircraft by procuring a large force of Trident submarines, by developing the Trident II missile, and by deploying a new force of strategic aircraft for cruise missiles or airmobile ICBMs.

This study examines the first of these two options. It does not provide a comprehensive analysis of all the options available to the United States for modernizing its strategic forces. Many issues would have to be considered in such an analysis. Among the most important is whether the United States should maintain a Triad of strategic forces. By deploying a new ICBM system, one designed to provide missiles with better protection from a Soviet attack, the United States could maintain an arsenal containing three survivable basing systems, each having different potential vulnerabilities. Such a diversified posture serves to complicate Soviet efforts to develop an ability to neutralize U.S. retaliatory capabilities.

Placing primary reliance on the retaliatory capabilities of weapons based in submarines and aircraft might sacrifice some of the diversity that has characterized U.S. strategic forces in the past. It might also require giving up some characteristics now unique to the land-based ICBM force that could not be replicated in submarines or strategic aircraft. On the other hand, questions have been raised both about the long-term survivability of new systems for basing missiles on land and about the arms control implications of new land-based ICBM systems. All these factors, as well as a comparison of relative costs, would have to be weighed in deciding how best to modernize U.S. strategic forces.

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THE MX MISSILE PROGRAM

The Department of Defense budget request for fiscal year 1980 includes $675 million for full-scale engineering development of a new intercontinental ballistic missile system, called the MX mobile missile system. 7/ In addition, the DoD supplemental budget authorization for fiscal year 1979 requested by the Administration includes $265 million for the MX program, with $190 million allocated to accelerate the development of the new ICBM system and $75 million to study alternative ICBM basing systems. This money would be in addition to the $158 million already authorized by the Congress in 1978 for fiscal year 1979.

The Department of Defense proposal includes both a new basing system for ICBMs and a new missile. A new basing system would be designed to provide greater protection, or "survivability," than is currently available to the Minuteman and Titan ICBMs deployed in fixed underground silos. The new missile would be larger and capable of carrying more nuclear warheads than existing Minuteman ICBMs; it would also be more accurate, providing an improved capability to destroy Soviet military targets. Over the next two decades, expenditures for a new ICBM system would total $20 billion to $35 billion (in fiscal year 1980 dollars) and possibly more. Table 1 shows an illustrative funding schedule for a program that would include the development, deployment, and operating expenses of both a new basing system and a new missile.

Although the Department of Defense has requested funds for full-scale development activities for the MX program, the exact characteristics of the new basing system have not been determined. During the last few years, several studies have examined many possible solutions to the projected vulnerability of stationary, silo-housed ICBMs, generally in mobile basing systems. Studies conducted by the Air Force in 1978 focused on multiple protective structure (MPS) basing systems, a concept formerly known as multiple aimpoint (MAP) basing. Under this concept, 200 or more missiles would be covertly rotated among several thousand concrete shelters, or "protective structures." The principal

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7/ Full-scale engineering development activities include the fabrication and testing of prototypes of missiles and other weapons system components. Production of missiles and deployment of the basing system would not begin until the early 1980s.

TABLE 1. ILLUSTRATIVE MX PROGRAM EXPENDITURES BY FISCAL YEARS: IN MILLIONS OF FISCAL YEAR 1980 DOLLARS

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Development												
Missile	446	850	1,000	900	750	500	250	--	--	--	--	4,700
Basing	229	450	600	400	250	250	150	50	—	—	—	2,400
Total	675	1,300	1,600	1,300	1,000	750	400	50	--	--	--	7,100
Investment												
Missile	--	--	--	400	1,100	1,000	900	900	800	50	50	5,200
Basing	--	--	—	1,700	3,800	4,000	3,700	3,300	500	--	--	17,000
Total	—	—	—	2,100	4,900	5,000	4,600	4,200	1,300	50	50	22,200
Operations and Maintenance	—	—	--	--	--	--	300	300	400	400	400 a/	5,400
TOTAL	675	1,300	1,600	3,400	5,900	5,750	5,300	4,550	1,700	450	450 a/	34,700

NOTE: This table illustrates the kind of expenditures that would be implied by an MX program that included the development of a new missile and a multiple protective structure (MPS) basing system; the deployment of 310 MX missiles and 5,500 vertical shelters; and operations and maintenance of the system for 12.5 years. The table assumes that the new ICBM system would become operational in fiscal year 1986 and be completed in fiscal year 1991. The numbers shown for fiscal year 1980 are the actual Department of Defense budget request.

a/ Annual system operating costs of $400 million would continue for nine additional years not shown on this table.

objective would be to build so many shelters--any one of which could contain a missile--that the Soviet Union would not have enough warheads in its missile force to destroy them all. If, for example, the Soviets could destroy only half of the U.S. shelters, and if they could not determine in which structures the U.S. missiles were housed, roughly half of the U.S. missiles could be expected to survive an attack.

The specific MPS basing design favored by the Air Force would involve the deployment of 200 new MX missiles in a complex of 4,500 vertical shelters. The shelters would be connected by a network of special aboveground roads, over which large trucks would move the missiles among the shelters. In a similar MPS basing concept, the horizontal shelter system, the protective structures would house the missiles in a horizontal position, rather than in vertical structures. 8/

Alternatively, missiles might be moved among several thousand horizontal protective structures constructed inside a series of underground tunnels. In this MPS basing system, missiles would move underground among the protective structures. Initial testing of one such "trench" concept--including the construction of a prototype trench--was undertaken during the last two years.

A somewhat different trench system has been under serious consideration by the Administration during the last few weeks. In this version of MPS basing, 200 missiles would be placed on special trains that would move among horizontal protective shelters along rails built at the bottom of unburied trenches. The 8,800 shelters built inside the 200 trenches would be covered with removable blast doors, and the sections of the trenches connecting the shelters would be covered with removable roofs. These doors and roofs could be opened in order to allow Soviet reconnaissance satellites periodically to count the number of U.S. missiles deployed in the network. When closed, the removable roofs might provide enough protection to the trenches that only small areas around the shelters would be fenced off from the public, a security concept similar to that envisaged

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8/ For a detailed description of MPS basing concepts, see Department of the Air Force, MX: Milestone II, Final Environmental Impact Statement, Part I, Program Overview (October 1978), pp. I-8 through I-47.

for the vertical or horizontal shelter systems and to the existing security system for silo-housed Minuteman and Titan missiles. The roofs covering the trenches might also make it difficult for the Soviets to observe the movement of the missiles among the horizontal protective shelters. In addition, an attempt might be made to design the railroad system and the missile trains in a way that would allow missiles to be moved rapidly within the trenches after reception of a warning that a Soviet attack had been launched. 9/

Although the specific design features are somewhat different, all of these systems share the concept of multiple protective structure basing. There is the question of whether the protective shelters would be connected by aboveground roads or by underground trenches. There is also the question of whether the missiles would be stored on their ends in vertical shelters or on their sides in horizontal protective structures. But in any of these MPS basing systems, the concept of building more shelters for U.S. ICBMs than the Soviets could destroy would be the same.

During 1978, several studies examined alternative types of MPS basing systems. 10/ At that time, various groups reached a consensus in preferring the vertical shelter system. A complex of vertical shelters has been estimated to be the least expensive MPS basing system. The Air Force estimates that 200 MX missiles deployed in a complex of 4,500 vertical shelters would cost about $30 billion. A comparable system of horizontal shelters would cost about $32 billion. Preliminary estimates indicate that

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9/ For a description of the open trench concept, see Clarence A. Robinson, Jr., "Acceptable Basing Mode for MX Sought," Aviation Week and Space Technology (May 21, 1979), pp. 14-16.

10/ Studies were conducted by the Air Force Space and Missile Systems Organization (SAMSO), the MX Basing Ad Hoc Working Group of the Air Force Systems Command, and the Defense Science Board. For a description of these studies, see Department of Defense Authorization for Appropriations for Fiscal Year 1979, Hearings before the Senate Committee on Armed Services, 95:2 (April and May 1978), Part 9, pp. 6505-09.

a network of unburied trenches would cost about $36 billion. 11/ Vertical shelters also provide the highest confidence in the technical assessment of the ability of missiles housed within protective structures to survive nuclear blast and shock effects.

Concerns have been raised, however, about the ability of the Soviet Union to count the number of U.S. missiles deployed in a complex of vertical shelters and about the U.S. ability to monitor a similar Soviet system, if deployed. Some sort of a network of horizontal protective shelters is being considered in an attempt to improve the prospects for successful monitoring of an MPS basing system.

Although alternative MPS basing concepts are still under study, this report focuses specifically on the vertical shelter system. All the costs shown in the report are based on the vertical shelter design, though the study's general conclusions would apply to other versions of MPS basing as well.

During the early months of 1979, the Air Force studied the feasibility and costs of basing ICBMs aboard transport aircraft, rather than on land in multiple underground protective structures. This basing concept was found to be significantly more expensive than the land-based systems, and it appears to be a relatively unattractive basing option.

THE FOCUS OF THE STUDY; SOVIET RESPONSES AND THE LONG-TERM BUDGETARY IMPLICATIONS OF MULTIPLE PROTECTIVE STRUCTURE BASING

This paper focuses on the long-term budgetary implications of developing and deploying a multiple protective structure basing system for land-based intercontinental ballistic missiles.

11/ A system of buried trenches without high-speed trains would cost about $32 billion. (Information supplied to CBO by U.S. Air Force, June 7, 1979.) The Air Force has much higher confidence in the cost estimates for vertical shelters, horizontal shelters, and buried trenches than for open trenches because those concepts have been studied longer and have been reviewed closely by the Air Force and other agencies within the Department of Defense. The cost estimates for the open trench system are the result of a two-week study.

In assessing the long-term budgetary implications, the effects of possible future Soviet strategic weapons programs on the costs and survivability of a U.S. MPS basing system will be an important concern. Of particular concern will be those Soviet actions that might be taken in response to U.S. development and deployment of such a system. Also of great importance will be how U.S. uncertainty about the number of Soviet ICBMs available for an attack would affect the costs and survivability of an MPS basing system. The Soviet responses and the U.S. uncertainties examined in this paper include:

- o Soviet efforts to increase the number of missiles and warheads that could be targeted against a U.S. MPS basing system; and

- o U. S. uncertainty about whether the Soviets might possess extra stockpiled missiles that could rapidly be made ready for use in an attack on a U.S. MPS basing system.

Threats to the survivability of an MPS basing system could be redressed by U.S. countermeasures, especially construction of additional shelters. Thus, the long-term survivability of an MPS basing system is related to the willingness of the Congress to spend additional funds beyond the initial costs of the system, should this become necessary to neutralize Soviet responses.

THE IMPORTANCE OF SALT LIMITS ON THE SOVIET MISSILE FORCE

Efforts to place verifiable limits on the number of Soviet missiles and warheads through the proposed SALT II treaty and future SALT agreements would help minimize the costs of an MPS basing system. It should be emphasized that a U.S. MPS basing system would not be completed until about 1990 or 1991, while the proposed SALT II treaty would expire at the end of 1985, unless it was extended. Thus, limits on Soviet missile programs imposed by a future SALT agreement would be at least as important as those imposed by a SALT II treaty.

THE MISSILE ISSUE

In considering the Department of Defense request for full-scale development funding for the MX program, the Congress will face two closely related, but separable, decisions. One decision concerns whether or not to develop a new, more survivable basing system for ICBMs; the other, whether or not to develop a new long-range ballistic missile. The development and deployment of an MPS basing system would have the greater budgetary impact over the long run (see Table 1). Development of a new missile, however, would have the larger impact on the budget in the early 1980s. For example, of the total fiscal year 1980 budget request for the MX program of $675 million, about $450 million would fund missile development activities.

The basing and missile decisions are separable because the Congress could choose to deploy a new basing system without developing and procuring a new missile for deployment in that system. Existing Minuteman III missiles could be modified for that purpose. Also, if a new missile is developed, several options are available. Deciding among the alternatives involves considering their relative costs and also whether or not the United States should develop a new missile that would be more accurate and could deliver a larger number of warheads than existing Minuteman III ICBMs, thus providing an improved capability to destroy Soviet military targets.

While separable, the basing and missile decisions are closely related for two major reasons. First, the estimated deployment and operating costs of an MPS basing system could be affected somewhat by the type of missile deployed in the system. Second, the degree of Congressional commitment to the eventual deployment of an MPS basing system will be an important factor in weighing the missile choices. If the Congress wishes to maintain an option to deploy an MPS basing system while maintaining flexibility to deploy a new missile in an alternative basing system, one option would be to develop a missile that could be based either in an MPS basing complex or aboard new Trident missile-carrying submarines now under construction.

OUTLINE OF THE PAPER

Chapter II of this study provides a general description of the concept of multiple protective structure basing. It outlines the purposes of such a system and the conditions necessary for its success. The chapter presents the costs of an MPS basing system under two key assumptions: that the Soviet Union would make no special efforts to respond to U. S. development and deployment of such a system, and that the United States would be able to determine with reasonable accuracy the number of Soviet missiles and warheads available to attack the complex. Finally, it discusses the need to prevent the Soviets from developing a means to distinguish shelters housing missiles from those that are empty.

Chapter III assesses the implications of possible Soviet responses to U.S. deployment of an MPS basing system, and also of U.S. uncertainties about the number of Soviet missiles and warheads available to attack an MPS basing complex. It examines the impact of Soviet responses and U.S. uncertainties on the survivability of the system and estimates the costs of possible U.S. countermeasures.

Chapter IV outlines the relative costs and the primary advantages and disadvantages of several alternative U.S. missile options.

Finally, Chapter V discusses the reasons why the United States might want to deploy an MPS basing system as the existing silo-housed Minuteman and Titan ICBM force becomes increasingly vulnerable.

This chapter provides an introduction to multiple protective structure basing for land-based ICBMs. It describes how such a system could potentially improve the ability of U.S. missiles to survive a Soviet first-strike attack by providing more shelters than the Soviets could destroy with their ICBM force. The chapter constructs a "base-case" U. S. MPS basing system. The base-case system contains 5,500 vertical shelters and 310 MX missiles, each armed with 10 warheads. It is estimated to cost about $35 billion in fiscal year 1980 dollars. 1/ This system could provide 1,000 surviving warheads for a U. S. retaliatory strike. The costs of an MPS basing system would not be particularly sensitive to variations in the desired retaliatory capability. The number of shelters and missiles in the base-case system would be adequate to provide 1,000 surviving warheads only if three key conditions were met:

- The Soviets could not increase the number of warheads in their ICBM force in response to U. S. deployment of an MPS basing system;

- The United States would be highly confident that it could determine within a reasonably narrow range the number of Soviet missiles and warheads available to attack its MPS basing complex; and

- The Soviets could not distinguish the shelters that contained missiles from those that were empty.

The first two assumptions are analyzed further in Chapter III. The need to prevent the Soviets from distinguishing shelters containing missiles from those that would be empty is discussed in the last section of this chapter.

1/ All cost estimates shown in this paper are in constant fiscal year 1980 dollars. The actual dollar amounts that would be spent would be much higher if prices and wages continue to increase in the future.

THE PURPOSES OF A MULTIPLE PROTECTIVE STRUCTURE (MPS) BASING SYSTEM

With the deployment of several hundred large and increasingly accurate multiple-warhead ICBMs, the Soviet Union is expected to acquire a theoretical capability to destroy more than 90 percent of the U. S. force of silo-housed Minuteman and Titan missiles. Such an attack would involve only about 2,000 of the 6,000 or more warheads that the Soviets could have in their ICBM force by the early to middle 1980s under the terms of the proposed SALT II agreement. The improved capabilities and expanded size of the Soviet ICBM force present the United States with two related problems.

Declining Retaliatory Capability

First, the United States will, in the future, no longer be able to rely upon the existing land-based missile force to contribute significantly to the U.S. ability to retaliate after a Soviet first-strike attack on U. S. strategic forces. The overall U.S. nuclear deterrent will not be compromised by the growing vulnerability of silo-housed ICBMs, because the ICBM force is only one part of the three-part U.S. arsenal. Rather, the growing vulnerability of silo-housed ICBMs creates a need to consider programs to replace their retaliatory capabilities along with programs to modernize the aging submarine and strategic aircraft forces that the Congress will consider during the 1980s. Because of the declining retaliatory capabilities of silo-housed ICBMs, the United States will have to buy relatively more forces as the entire strategic arsenal is modernized during the 1980s than would have been necessary if the existing silo-housed ICBM force had retained its ability to survive a Soviet attack. This requirement for expanded programs to modernize U.S. strategic forces will exist whether the overall retaliatory capabilities of U.S. forces are to be kept at current levels or whether they are to be reduced or expanded.

The deployment of an MPS basing system provides an option to maintain the survivability of land-based ICBMs, thereby preserving both the Triad concept and the unique characteristics of ICBMs that may be deemed desirable. Alternatively, the United States could place increased reliance on missiles based in submarines and on strategic aircraft. Which of these two general options is selected will affect not only the MX program but also the ultimate scope of U.S. modernization programs for the submarine force and the strategic aircraft force. These considerations are addressed in Chapter V.

Large Number of Soviet Warheads

The second problem created by the improved capabilities and expanded size of the Soviet ICBM force relates to the large number of warheads that the Soviets would have remaining in their ICBM force after an attack on U.S. missiles. Because the Soviets would have to use only about one-third of the warheads in their ICBM force to destroy the bulk of the U.S. silo-housed missile force, a large part of the Soviet ICBM force--with some 4,000 warheads--could be held in reserve for later strikes or for attacks against other U.S. targets. A particularly important concern is that the Soviets might: be able to use the other warheads in their ICBM force to attack large areas surrounding U. S. air bases, thereby possibly destroying in the air significant numbers of U.S. B-52 bombers as well as any aircraft carrying cruise missiles or airmobile ICBMs that the United States might deploy in the future. 2/

Improving the Survivability of ICBMs

In the past, U.S. efforts to maintain the survivability of the land-based missile force in the face of improving Soviet ICBMs have taken the form of making missile silos "harder" (that is, making them more capable of withstanding a nearby nuclear explosion). This approach is no longer viable. In the not-too-distant future, powerful Soviet warheads carried on missiles with improved accuracy will render vulnerable any known, fixed target.

One possible solution to the problem lies in the development of a mobile basing system for U.S. ICBMs. If the Soviet Union were uncertain about the location of U.S. missiles, it would have difficulty targeting them in a nuclear attack.

2/ See, for example, the testimony of Lt. Gen. Glenn A. Kent, USAF (Ret.), on the future of the land-based leg of the strategic Triad in hearings before the House Committee on Armed Services, 96:1 (February 7, 1979; processed).

A "soft" mobile basing system--one that included no hardened concrete shelters for the missiles--could contribute to the survivability of the ICBM force only if the Soviet Union had no knowledge of the general location of the missiles. If U.S. mobile missiles were loaded aboard transporter-launcher vehicles and deployed within military bases or other relatively confined areas, the Soviets could target those general areas and perhaps disable a large portion of the U.S. land-based missile force in a first strike. Thus, to be survivable, the U.S. missiles would have to be widely dispersed and frequently on the move in order to deny knowledge of their location to the Soviets. Because of the possibility of accidents, the public would likely find unacceptable a system that involved the movement of large missiles with nuclear warheads over roads or railroad lines. Moreover, missiles based on trucks or trains would be more vulnerable to terrorist attacks than missiles stored in protective concrete silos or shelters.

A multiple protective structure basing system might provide an alternative means of reestablishing the ability of U.S. land-based missiles to survive a Soviet first strike. In an MPS basing system, hundreds of missiles would be covertly emplaced among several thousand concrete shelters, thereby presenting the Soviets with a large number of potential missile locations that would have to be targeted in order to destroy the U.S. force of mobile missiles. Although they would be deployed in a confined area, the missiles would be housed within protective shelters, spaced in such a way that a single Soviet warhead of a given size could destroy no more than one shelter. If the United States were to construct more shelters for its MPS basing complex than the number of reliable, accurate Soviet warheads that could be used to attack the complex, and if it were possible to ensure that the Soviets could not determine in which shelters the missiles were housed, a significant number of U.S. missiles could survive an attack. For example, if the United States built twice as many shelters as the Soviets could destroy, half of the shelters could be expected to survive a Soviet attack; on average, therefore, half of the U.S. missiles deployed in an MPS basing complex would survive and be available for a retaliatory strike.

Raising the Price of a Soviet Attack

By increasing the number of shelters that the Soviet Union would have to target, an MPS basing system would also seek to address concerns about the large number of warheads that the Soviet Union would have remaining in its ICBM force after an attack on existing U.S. silo-housed Minuteman and Titan missiles. In order to attack an MPS basing complex, the Soviets would have to target several thousand shelters, a task that could nearly deplete their own ICBM force. The price of a Soviet: attack on U.S. ICBMs would become more exacting. Raising the price might help deter such an attack by ensuring that the Soviets would be relatively less powerful afterward, and it would reduce the ability of the Soviet Union to use its ICBMs for attacks against other U. S. targets.

THE COSTS OF A MULTIPLE PROTECTIVE STRUCTURE BASING SYSTEM

The costs of constructing and operating an MPS basing system could vary greatly, depending upon assumptions made about a few key factors that would determine the required size and design of such a basing system. The most important factors are the number of Soviet missiles and warheads available for an attack on an MPS basing complex and the degree of U.S. confidence in its estimates of the size of that missile force.

As indicated above, the ability of U.S. ICBMs deployed in an MPS basing complex to survive a Soviet first strike would depend on the United States having more shelters than the Soviet Union could destroy with its missile force. Thus, the number of shelters constructed for a U.S. MPS basing system would depend crucially on the size of the Soviet missile force. Constructing shelters, maintaining the missiles and other equipment placed within them, and building a road network to connect the shelters would be among the major components of the costs of an MPS basing complex.

In order to ensure that an MPS basing system contained more shelters than the Soviet missile force could destroy, the United States would need to know within a narrow range the number of Soviet warheads that might be available to attack the system. If a wide range of uncertainty about the size of the Soviet missile force existed, efforts to protect the survivability of an MPS basing complex might require the United States to hedge against the upper range of its estimates by constructing enough shelters to absorb a larger Soviet attack than expected. Thus, U.S. confidence in its estimate of the size of the Soviet missile force would be just as important in determining the required size of an MPS basing complex as would the actual number of Soviet missiles available for an attack.

It is important to remember that, since an MPS basing system would not become operational until 1986 and would not be completed until 1990 or 1991, it would have to be designed to counter the Soviet missile threat of the 1990s. Predicting the size and composition of Soviet strategic nuclear forces in the 1990s is difficult, however, especially since those forces may evolve both in response to U. S. development and deployment of a new basing system for ICBMs and in accordance with future SALT limitations and regulations. For this reason, the costs of an MPS basing system could vary widely. Chapter III examines how the costs of a U.S. MPS basing system would be affected both by variations in the number of warheads in the Soviet missile force in the 1990s and by U.S. uncertainty about the accuracy of its estimate of the number of Soviet missiles available to attack a U.S. MPS basing complex.

A "No-Response" Soviet Multiple-Warhead ICBM Force

In order to see how the costs of an MPS basing system would be affected by variations in the number of warheads in the Soviet missile force and by U.S. uncertainties about the number of Soviet missiles available for an attack, it is necessary to estimate the costs of a "base-case" MPS basing complex; the impact of changes in the Soviet missile force and of U.S. uncertainties can then be measured against the base-case system. For the base-case system, it is assumed that during the next decade the Soviet Union would make no special efforts to respond to U.S. deployment of an MPS basing complex. It is also assumed that the United States would be able to estimate accurately the number of Soviet warheads available to attack its MPS basing system.

Three specific assumptions define this hypothesized "no-response" Soviet missile threat. First, it is assumed that the number of Soviet launchers for ICBMs that could be armed with multiple warheads would be limited to 820 by the constraints imposed by the proposed SALT II agreement. 3/ Second, it is

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3/ For a limited description of the numerical limits that would be imposed by the SALT II agreement, see U.S. Department of Defense, Annual Report, Fiscal Year 1980, p. 39.

assumed that the Soviets would be prevented from increasing the number of warheads currently tested and deployed on each of their multiple-warhead ICBMs. 4/ (Although a SALT II treaty would expire at the end of 1985, the "no-response" Soviet missile threat is based on an assumption that SALT II limits on the number of multiple-warhead ICBM launchers that may be deployed and on the number of warheads that may be tested on an ICBM would be extended into the 1990s.) Third, it is assumed that the United States would be highly confident that the Soviets did not possess extra missiles that could rapidly be made ready for launch in a crisis and used in an attack on a U.S. MPS basing system.

If the Soviets made no effort to arm their missiles with more warheads than they have been tested with to date, they could deploy 5,928 warheads on a force of 820 multiple-warhead ICBMs, assuming that the mix of different missile types shown in Table 2 was deployed. It is assumed in this study that the Soviets would use all of the 5,928 warheads deployed on their multiple-warhead ICBMs in an attack on the U.S. ICBM force. Two warheads would be targeted on each Minuteman and Titan missile silo remaining in the U.S. force. 5/ The rest of the Soviet warheads would then be available to attack the MPS basing complex.

4/ The SALT II agreement would prohibit the flight-testing of existing ICBMs with more warheads than they have carried on previous flights. One "new" ICBM could be developed and deployed during the life of the treaty; it would be limited to 10 warheads. The Soviets could, in theory, develop a new 10-warhead ICBM to replace their existing four-warhead SS-17 and six-warhead SS-19 missiles, thereby deploying up to 8,200 warheads on their 820 multiple-warhead ICBMs. This potential option, which is examined in Chapter III, would require that the Soviets forego any plans they might have had to develop a new, large single-warhead ICBM to replace their older single-warhead SS-11 ICBMs. For a description of the SALT II limits on the number of warheads that Soviet ICBMs may carry, see remarks of Secretary of Defense Harold Brown, reprinted in "SALT II," Congressional Record (April 5, 1979), p. S4089.

5/ It would be advantageous for the Soviets to launch two warheads at each U.S. silo-housed ICBM in order to increase the probability that at least one warhead would reach the target and explode even if the first one proved to be unreliable.

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TABLE 2. THE "NO-RESPONSE" SOVIET THREAT: ESTIMATED SOVIET MULTIPLE-WARHEAD ICBMS IN THE POST-1990 PERIOD

Type of Missile a/	Number b/	Warheads per Missile c/	Total Warheads	Yield in Megatons d/	Accuracy e/	Reliability f/
SS-18	308	10	3,080	0.6 to 1.5	500 feet	0.85
SS-19	400	6	2,400	0.55 to 0.8	500 feet	0.85
SS-17	112	4	448	0.6	500 feet	0.85
Total	820		5,928			

NOTE: This table includes only Soviet multiple-warhead ICBMs. The Soviet Union also deploys a large number of SLBMs and single-warhead ICBMs, which this paper assumes would not be used in an attack on a U. S. MPS basing complex. Moreover, it is assumed that some Soviet multiple-warhead ICBMs would be used to attack U. S. silo-housed Minuteman and Titan missiles.

a/ Includes existing Soviet multiple-warhead ICBMs and similar replacement missiles that may be developed and deployed in the future.

b/ Assumes SALT II multiple-warhead ICBM limit of 820, postulated to be extended into the 1990s. The mix of SS-17 and SS-19 missiles shown here assumes a ratio of the two missiles similar to that which existed in 1978, when the Soviets were reported to have deployed more than 60 SS-17 and more than 200 SS-19 launchers. See U.S. Department of Defense, Annual Report, Fiscal Year 1979, p. 49.

c/ The number of warheads currently deployed on Soviet ICBMs. See U.S. Department of Defense, Annual Report, Fiscal Year 1978, p. 62. All of the Soviet multiple-warhead ICBMs have been tested with single warheads and some may be deployed in this fashion. In the future, the United States would have to assume that all missiles that had been tested with multiple warheads were so deployed. This would also be the rule for counting the number of multiple-warhead ICBMs that may be deployed under a SALT II treaty.

d/ For the lower end of the range, see Walter Pincus, "U.S. Downgrades Soviet ICBM Yield," Washington Post (May 31, 1979), p. A-1. For the upper end of the range, see Clarence A. Robinson, Jr., "MX Deployment Urged for Parity," Aviation Week and Space Technology (December 5, 1977), pp. 12-15.

e/ This is the reported current U. S. advanced technology capability and the reported limit of accuracy for purely ballistic reentry vehicles. See Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978), pp. 20-22.

f/ Reliability refers to the percentage of the missiles and warheads that would function reliably and explode in the area of the intended target. See Congressman Thomas A. Downey, "How to Avoid Monad and Disaster," Foreign Policy (Fall 1976), pp. 180-81.

In addition to these multiple-warhead ICBMs, a SALT II ceiling of 2,250 total strategic nuclear delivery vehicles would allow the Soviets to deploy up to 580 single-warhead ICBMs, assuming that the existing force of 1,400 silo-housed missiles was retained. 6/ This would, however, require the Soviets to retire their force of long-range bombers and to decrease their force of submarine-launched ballistic missiles (SLBMs) from 950 to 850 missiles. If the Soviets chose to retain 950 submarine-launched missiles, they would be allowed no more than 480 single-warhead ICBMs. If the Soviets also wanted to retain a long-range bomber force, perhaps one armed with long-range cruise missiles, they would have to reduce their force of single-warhead ICBMs even further.

In any case, it is assumed that the Soviets would not use all of their land- and submarine-based missiles to attack a U.S. MPS basing complex; in fact, a U.S. MPS basing system would not be designed to survive an attack by the entire Soviet ballistic missile force. Other important targets would have to be considered in Soviet attack planning, including U. S. industrial complexes--especially defense industries--and conventional military facilities such as air bases, naval ports, and troop headquarters.

Single-warhead ICBMs would be less effective in an attack on the widely scattered shelters in an MPS basing complex than would multiple-warhead missiles, each of which could potentially destroy several U.S. shelters. It is therefore assumed that Soviet single-warhead ICBMs either would be withheld from an attack to serve as a reserve force or would be targeted on U.S. military targets--including air bases, underground Minuteman launch control centers, or other command and control facilities.

Some Soviet submarine-launched ballistic missiles might be targeted on U.S. strategic bomber bases, naval ports, or other military facilities. Others might be used to attack U.S. industrial complexes or perhaps would be held in reserve to deter U.S. retaliation against Soviet cities and industries or to form a reserve force for postwar purposes. In any case, it is assumed

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6/ U.S. Department of Defense, Annual Report, Fiscal Year 1980, p. 71.

that submarine-launched missiles would not be used in an attack against a U.S. MPS basing complex. Because existing Soviet SLBMs are relatively inaccurate and carry only a small number of warheads, this is probably a reasonable assumption for the next several years. Although the Soviets can be expected to improve the accuracy of their SLBMs and to increase the number of warheads they can carry by deploying improved multiple-warhead SLBMs, there is some question as to whether the Soviets could ever develop an SLBM accurate enough and capable of delivering enough powerful nuclear warheads to be effective in an attack on a U.S. MPS basing system. On the other hand, increases in the number and accuracy of Soviet SLBMs may provide the Soviets with a capability to target these missiles on U.S. facilities that would previously have been targeted by land-based ICBMs, thus allowing the entire Soviet multiple-warhead ICBM force to be targeted on the U.S. ICBMs deployed in an MPS basing complex and in fixed-base silos.

The Base-Case Multiple Protective Structure Basing System

This section describes the "base-case" MPS basing system. The section shows how the construction of a large number of shelters--any one of which could contain a missile--might provide the U.S. ICBM force with retaliatory capabilities that could survive a Soviet first-strike attack. The number of warheads in the Soviet ICBM force available for an attack on a U. S. MPS basing complex and the degree of U.S. confidence in its estimate of the size of that missile force would be the most important factors determining the size and costs of such a basing system. Two other factors would also have an important impact on the costs of an MPS basing system.

Number of Surviving Warheads. The first factor would be the desired number of surviving U.S. warheads that an MPS basing system would be designed to provide after it had absorbed a Soviet first-strike attack. The desired number of surviving warheads is, of course, an important policy choice. It would depend upon two key judgments. First, a general policy decision would have to be made as to what portion of the various kinds of Soviet targets the United States should be able to destroy in a major retaliatory strike. A second decision would then have to be made as to the specific role of land-based ICBMs in overall U.S. nuclear targeting strategy.

The base-case system assumes that the United States would want 1,000 surviving warheads for a retaliatory strike. Such a force would be able to destroy most industrial targets in the Soviet Union. Alternatively, the surviving warheads could be used to attack Soviet military targets, leaving the task of destroying Soviet industry to submarine and bomber forces. More likely, the surviving U.S. ICBMs would be targeted on a mix of Soviet industrial and military facilities. If the United States wanted an ICBM force that could absorb a Soviet first-strike attack and destroy a significant number of both Soviet industrial targets and military facilities, a larger number of surviving warheads would be required. 7/ The various alternatives are examined in the next section of this chapter and in Chapter IV.

Type of Missile. The second factor that would affect the total costs of developing, constructing, and operating an MPS basing system would be the type of missile deployed. The base-case system assumes that a new large MX missile capable of carrying 10 warheads would be deployed. 8/ Other missile options, such as the use of existing Minuteman III missiles or the development of a smaller missile that could be deployed either in an MPS basing system or aboard Trident submarines, are examined in Chapter IV.

An MPS basing system consisting of 5,500 vertical shelters, spaced at distances of 7,000 feet, 9/ and 310 10-warhead MX

7/ The missiles deployed in an MPS basing system are assumed to be armed with MK-12A warheads, each with a reported yield of 335 kilotons. See Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978), pp. 20-22. Other warhead options are available, including a larger, 500-kiloton warhead. See Edgar Ulsamer, "MX Status Report," Air Force Magazine (May 1979), pp. 22-25.

8/ The proposed SALT II agreement is assumed to limit the number of warheads tested and deployed on each MX missile to 10. See "SALT II," p. S4089.

9/ Shelters in an MPS basing complex would be spaced far enough apart so that a Soviet warhead exploding at or near one shelter could not destroy the adjacent shelters. Spacing of 7,000 feet would provide considerable hedging against the missiles could provide 1,000 surviving warheads if the Soviet Union was limited in the 1990s to the "no-response" multiple-warhead ICBM force shown in Table 2, and if the United States was correct in its estimate of the size of the Soviet missile force. Such a system is estimated to cost $34.7 billion, in constant fiscal year 1980 dollars. This is the least expensive of many possible combinations of vertical shelters and MX missiles that could provide 1,000 surviving warheads after having absorbed an attack by the "no-response" Soviet multiple-warhead ICBM force. 10/

Table 3 provides more detail on the cost of the base-case MPS basing system. Although the costs shown are careful estimates, some uncertainty will surround those for developing, deploying, and operating an MPS basing system until experience has been gained in constructing shelters and roads, in procuring the missiles and other equipment, and in operating the system.

An MPS basing system with 5,500 shelters and 310 MX missiles could provide 1,000 surviving warheads by ensuring that the United States would have more shelters for its missiles than the Soviets could destroy. Of the 5,928 warheads carried on the "no-response" Soviet multiple-warhead ICBM force, only 4,440 warheads would be available to attack a U. S. MPS basing complex. The remaining 1,488 warheads would have to be used to attack 54 Titan ICBMs and the 690 silo-housed Minuteman ICBMs that would remain in the U.S. force after deployment of 310 MX missiles

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possibility that the shelters would be less resistant to nuclear effects than anticipated, that the effects of nuclear explosions would be more destructive than estimated, and that the interaction of multiple nuclear detonations would be more severe than the sum of the effects of individual detonations.

10/ All cost estimates presented in this paper were derived from the MX Cost Effectiveness Model developed by the Space and Missile Systems Organization of the Air Force. All assumptions as to the number and characteristics of Soviet ICBMs and the desired number of surviving U.S. warheads were supplied by CBO. Appendix A provides a brief description of the MX Cost Effectiveness Model.

TABLE 3. COSTS OF THE BASE-CASE MULTIPLE PROTECTIVE STRUCTURE BASING SYSTEM WITH 5,500 VERTICAL SHELTERS AND 310 MX MISSILES: IN BILLIONS OF FISCAL YEAR 1980 DOLLARS

	Development	Investment	Net Operating (12.5 Years) a/	Grand Total
Missile	4.7	5.2	--	--
Basing	2.4	17.0	--	--
Total	7.1	22.2	5.4	34.7

NOTE: Costs assume an MPS basing complex that could provide 1,000 surviving warheads. Not included are the costs of 3,100 nuclear warheads; those costs are classified.

a/ Net operating costs. Total operating costs for 12.5 years would be $7.1 billion. The savings that would be gained from the retirement of 310 Minuteman missile silos, amounting to $1.7 billion, have been subtracted.

in the MPS basing system. 11/ Of the 4,440 Soviet warheads available to attack the U.S. MPS basing complex, it is assumed that only 3,774--or 85 percent--would function reliably and reach their intended targets.

11/ Under a SALT II treaty or a similar future agreement, some existing strategic weapons, probably either silo-housed Minuteman missiles or Poseidon submarine-launched ballistic missiles, would have to be retired from the force as new systems, such as the MX missile, were introduced. It is assumed in this report that the United States would maintain a force of 550 multiple-warhead ICBMs and that one existing silo-housed Minuteman III missile would be retired for each new missile deployed in an MPS basing system. Under the SALT II provision limiting to 1,320 the number of multiple-warhead ICBMs, multiple-warhead SLBMs, and aircraft armed with

Virtually all reliable Soviet warheads would destroy the MPS basing system shelters on which they were targeted. This is because the accuracy of Soviet missiles is likely to continue to improve during the next decade and because Soviet missiles carry large, powerful warheads. In addition, the U.S. shelters constructed for an MPS basing complex would provide less protection against nuclear blast and shock effects than would existing Minuteman silos. If 98 percent of the reliable Soviet warheads were able to destroy the shelters on which they were targeted, the Soviets could destroy about 3,700 U.S. shelters. 12/

If the Soviets could destroy 3,700 of the 5,500 shelters in a U.S. MPS basing system with their multiple-warhead ICBM force, 1,800 shelters--or about 33 percent--would remain intact. If the Soviets did not know in which shelters the 310 MX missiles were located, about 33 percent of the MX missiles, or 100

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long-range cruise missiles, a force of 550 multiple-warhead ICBMs would allow deployment of 173 B-52 bombers with long-range cruise missiles and 597 multiple-warhead SLBMs in Poseidon and Trident submarines.

12/ This is based on two assumptions about the capabilities of Soviet ICBMs in the 1990s: that Soviet missiles would be accurate to within 500 feet of their targets, and that Soviet warheads would have explosive power of 550 kilotons to 1.5 megatons (see Table 2). The assumption is also made that the vertical shelters in an MPS basing system could withstand blast pressures of 600 pounds per square inch. See Clarence A. Robinson, Jr., "SALT Stance Allows New Missiles," Aviation Week and Space Technology (April 24, 1978), pp. 16-19. Finally, the assumption is made that the Soviet warheads exploding in the area of each U.S. shelter would not disable or destroy other Soviet warheads arriving at nearby shelters (that is, there would be no "fratricide"). To the extent that some Soviet warheads would either miss their intended targets or would be disabled by nearby nuclear explosions, more U.S. shelters would survive than assumed.

missiles with 1,000 warheads, would be expected to survive an attack. 13/

The base-case system shown here may differ from the program eventually proposed by the Department of Defense. The Air Force is apparently considering deployment of an MPS basing system with 200 MX missiles and 4,500 vertical shelters, 14/ at a total cost of about $29.6 billion (including an estimated $24.4 billion for development and deployment and about $5.2 billion for operating for 12.5 years). As compared to the CBO base-case system, the smaller system could absorb fewer warheads, provide fewer surviving U.S. warheads, or some combination of the two.

Varying the Desired Number of Surviving Warheads

As already suggested, the costs of an MPS basing system would vary somewhat with the number of surviving warheads that it was expected to provide. Table 4 shows a range of numbers of surviving warheads and the associated costs. Two important conclusions can be drawn from the table. First, providing even a relatively small number of surviving warheads would require major expenditures. Thus, an MPS basing system that could provide 500 surviving warheads would cost $30.9 billion, about $4 billion less than a system that could provide 1,000 surviving warheads. Second, the costs would not vary in proportion to the number of surviving warheads. A system that could provide 1,000 surviving warheads would cost $34.7 billion, while a system providing

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13/ The percentage of surviving missiles would be the same as the percentage of surviving shelters only if the Soviet attack was not unexpectedly lucky or unlucky. There is a slight chance that all of the shelters housing missiles would be destroyed in a Soviet attack; there is a similarly small chance that none of the shelters containing missiles would be destroyed. Either of these outcomes would be very improbable, however. For example, there is only a 10 percent chance that fewer than 80 missiles would survive an attack.

14/ Fiscal Year 1980 Arms Control Impact Statements, Senate Committee on Foreign Relations and House Committee on Foreign Affairs, Joint Committee Print, 96:1 (March 1979), p. 6.

TABLE 4. COSTS OF A MULTIPLE PROTECTIVE STRUCTURE BASING SYSTEM WITH MX MISSILES, IN RELATION TO THE DESIRED NUMBER OF SURVIVING WARHEADS: IN BILLIONS OF FISCAL YEAR 1980 DOLLARS

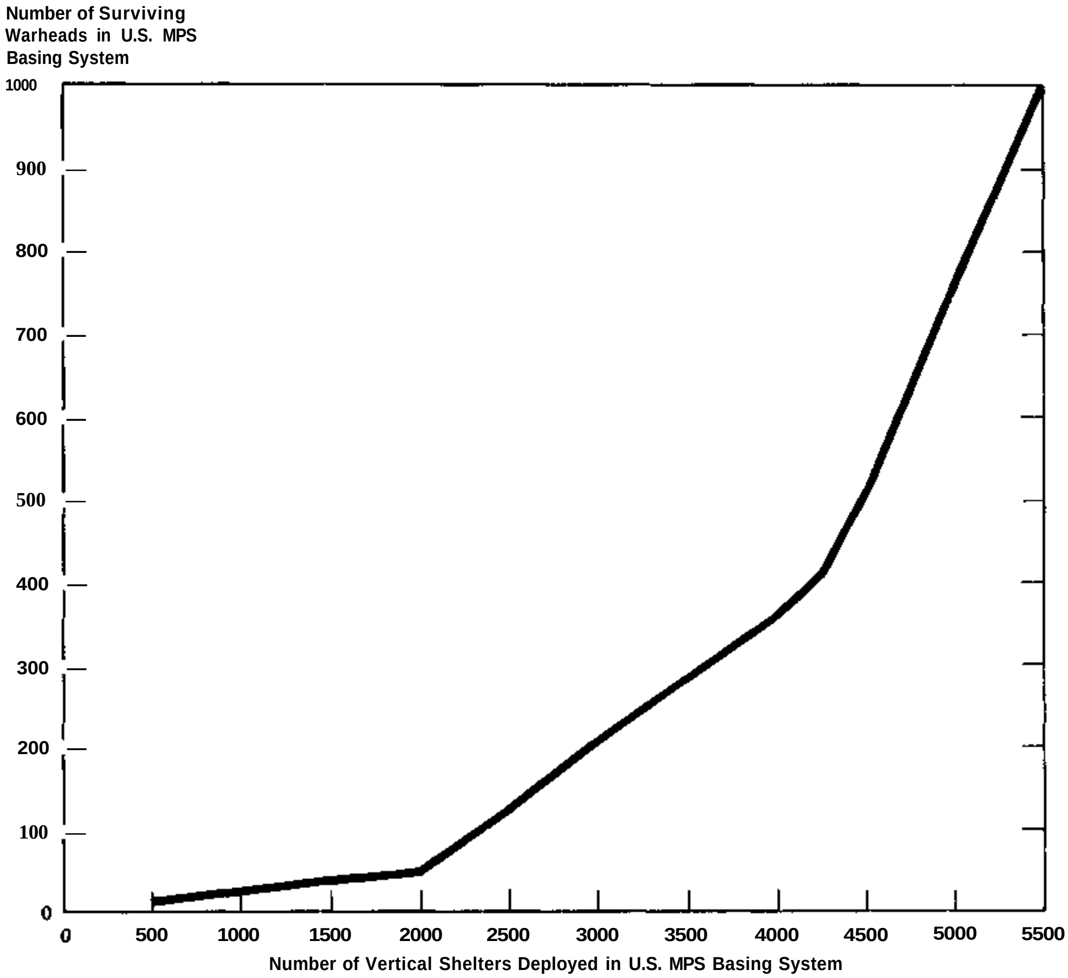
	Desired Number of Surviving Warheads			
	500	1,000	1,500	2,000
Total Cost	30.9	34.7	37.8	40.7
Number of Shelters	4,700	5,500	6,100	6,700
Number of MX Missiles	190	310	420	520

2,000 surviving warheads would cost $40.7 billion--only $6 billion more for twice as many warheads. In short, deploying an MPS basing system would require a high fixed, or "threshold," cost; but increasing the number of surviving warheads would require a relatively small extra, or "marginal," cost.

The fact that an MPS basing system would have a high threshold cost and a low marginal cost is shown in a somewhat different: way in Figure 1. The graph in the figure plots the relationship between the number of U.S. warheads that would be expected to survive a Soviet attack and the number of shelters and MX missiles deployed in the system. The flat portion of the graph on the left represents the high threshold cost. Deployment of the first 2,500 shelters, slightly less than half of the total base-case MPS basing system, would provide only about 150 surviving warheads. This situation would change only gradually until the United States had deployed more shelters than the Soviet Union had reliable, accurate warheads available to attack the complex. By the time the United States had deployed 4,500 shelters, more than the Soviets could destroy with their missile force, each additional increment of shelters and missiles deployed would add significantly to the number of surviving warheads provided by the system. The latter situation is represented by the steep upward portion of the graph.

Figure 1.

Number of Surviving Warheads on MX Missiles in Relation to the Number of Shelters Deployed in a U.S. MPS Basing System



NOTE: This figure is based on the following assumptions: that MX missiles would be deployed in the MPS basing system in a ratio of 1 missile for each 17.7 shelters; that the Soviets would have 5,928 warheads in their "no-response" multiple-warhead ICBM force to target on the U.S. MPS basing complex and on the silo-housed Minuteman and Titan missiles remaining in the U.S. force (assuming that one Minuteman silo would be dismantled for each MX missile deployed); that 85 percent of the Soviet missiles would be reliable; and that each warhead from a reliable missile would have a 98 percent chance of destroying the shelter on which it was targeted. For the cases in which the Soviets would have enough warheads to target two weapons on some or all of the U.S. shelters, the assumption was made that the second warhead would have a chance to reach the area of the target and detonate only if the first warhead proved to be unreliable and failed to reach the targeted U.S. shelter.

Three conclusions can be derived from the relationships shown in Figure 1.

Indivisibility of the System. First, it would make little sense for the United States to deploy only part of an MPS basing system. If an MPS basing complex is to be successful in providing surviving warheads, a large number of shelters and missiles must be deployed. Thus, an MPS basing system is "indivisible" in the sense that the Congress could not reduce the size of the proposed shelter construction program without jeopardizing the primary purpose of the system.

Time Lag. Second, because an MPS basing system for ICBMs would provide very few surviving; warheads until more shelters had been constructed than the Soviets could destroy, the vulnerability problem would not be solved until several years after construction of the system had begun. Under current planning, selection of a site for an MPS basing complex is scheduled to take place in 1980. Acquiring the rights to use the land for a major military project would take another three to four years. Preparation of the land would begin in 1983 and shelter construction would start in 1984, with the first few hundred shelters scheduled to be completed in 1985 and become operational in early 1986. Under current plans, construction would take place over a period of five years, 15/ with completion of the system scheduled for 1990 or 1991. Until the late 1980s, then, the United States would not have more shelters than the Soviet Union had warheads available to attack the system. Although the construction of more shelters each year would increase the number of warheads that the Soviet Union would have to use to attack the U.S. ICBM force, thereby leaving the Soviets with fewer warheads after an attack, an MPS basing system would provide very few surviving warheads until the late 1980s.

Because the Department of Defense expects a substantial threat to the survivability of the existing silo-housed Minuteman and Titan missiles to exist by the early 1980s, the Congress may wish to examine options to accelerate development and deployment of an MPS basing system. Speeding the deployment of shelters--

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15/ U.S. Department of the Air Force, MX; Milestone II, Final Environmental Impact Statement, Part I, Program Overview (October 1978), p. I-20.

either by starting construction earlier or by constructing more each year--would be the most important way of doing this.

The Importance of the Pace of Shelter Construction. A third conclusion follows from the fact that an MPS basing system would provide few surviving warheads until a large number of shelters had been constructed: the completion date would be much more important than the date when an initial operating capability was achieved. Because the pace of shelter construction, rather than of missile production, would probably be the factor determining the date of completion, efforts to accelerate development of a new missile may be less pressing than land acquisition and shelter construction.

PREVENTING SOVIET DETECTION OF MISSILE LOCATION

An MPS basing system that contained more shelters than the Soviets could destroy would provide surviving warheads only if the Soviets could not distinguish the shelters that contained missiles from those that were empty. If the Soviets were able to determine the location of a large number of U.S. missiles, they could target two warheads on each of those shelters known to be occupied, thus providing a high probability of destroying the missiles housed within them. Conversely, if the Soviets could identify shelters that did not contain missiles, they could leave those shelters untargeted and use their warheads to attack a greater percentage of the remaining shelters. Moreover, over time it might be possible for the Soviets to use information about whether or not certain shelters contained missiles to determine the chances that other shelters in the system *contained* missiles. 16/

Potential Methods of Detection

Several potential detection methods might provide the Soviets with a means to distinguish shelters containing missiles from those that were empty. By observing the movement of missile

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16/ For example, if the Soviets knew that a group of 20 shelters contained only one missile, detection of the location of the missile would also reveal the location of the 19 empty shelters.

transporters over the aboveground roads constructed for a complex of vertical shelters, the Soviets might be able to determine in which shelters the U. S. missiles were emplaced unless identical visits were made by transporters to all the shelters, not just to those in which missiles were deposited. Moreover, missiles display an array of potentially observable characteristics, or "signatures"--including their mass, heat, and magnetic properties, as well as their chemical, nuclear and electromagnetic emissions. The presence or absence of these signatures might be detected by Soviet sensors, thereby allowing the Soviets to distinguish shelters containing missiles from those that were empty.

In theory, it might be possible for the Soviets to implant sensing devices close to the shelters or on the roads over which the transporters would move the missiles. This threat would be particularly worrisome if political and environmental constraints dictate that an MPS basing system have "point" security--small fenced-off "islands" of secured land around each shelter--rather than "area" security, which would restrict access to the entire deployment area. Future sensors in satellites might also be able to observe the movement of the transporters or to detect some of the missile signatures.

U.S. Countermeasures

To minimize the danger that the Soviets could distinguish shelters containing missiles from those that were empty, a U.S. MPS basing system would incorporate countermeasures designed to mate the Soviet detection task difficult. The most important U.S. countermeasure would be the use of "simulators," which would duplicate most missile signatures in order to mate it difficult to distinguish shelters and transporters containing missiles from those that were empty. 17/

17/ A number of procedures could be instituted to reduce the signatures themselves. For example, if the guidance system of a missile was kept inactive, or "dormant," it would generate less heat. Measures could also be taken to neutralize the magnetic field created by a missile and its canister--a process known as "degaussing." Some signatures could be shielded. Transporter vehicles could be constructed so as to prevent or reduce the emanation of some signatures--

Vertical Shelter System. In a vertical shelter system, transporters would travel to all of the shelters in the basing complex, not just to those in which missiles were deposited. At the shelters where missiles were deposited, crews would position a transporter over the shelter, remove the door, stand the container holding the missile canister upright, and lower the canister into the shelter. 18/ After a missile was emplaced in a shelter, the transporter would pick up a set of metal rods housed in each shelter between the inside wall and the space allowed for the missile canister. The metal rods, which would have the same weight as a missile in a canister, would then be carried by the transporter among several other shelters. At the shelters where a missile was not deposited, the transporters would lower the rods into the shelters and pull them out again, thus simulating the actual emplacement of a missile (see Figure 2).

The simulators used to duplicate missile signatures would also be "seeded" with chemical materials to foil sensors designed

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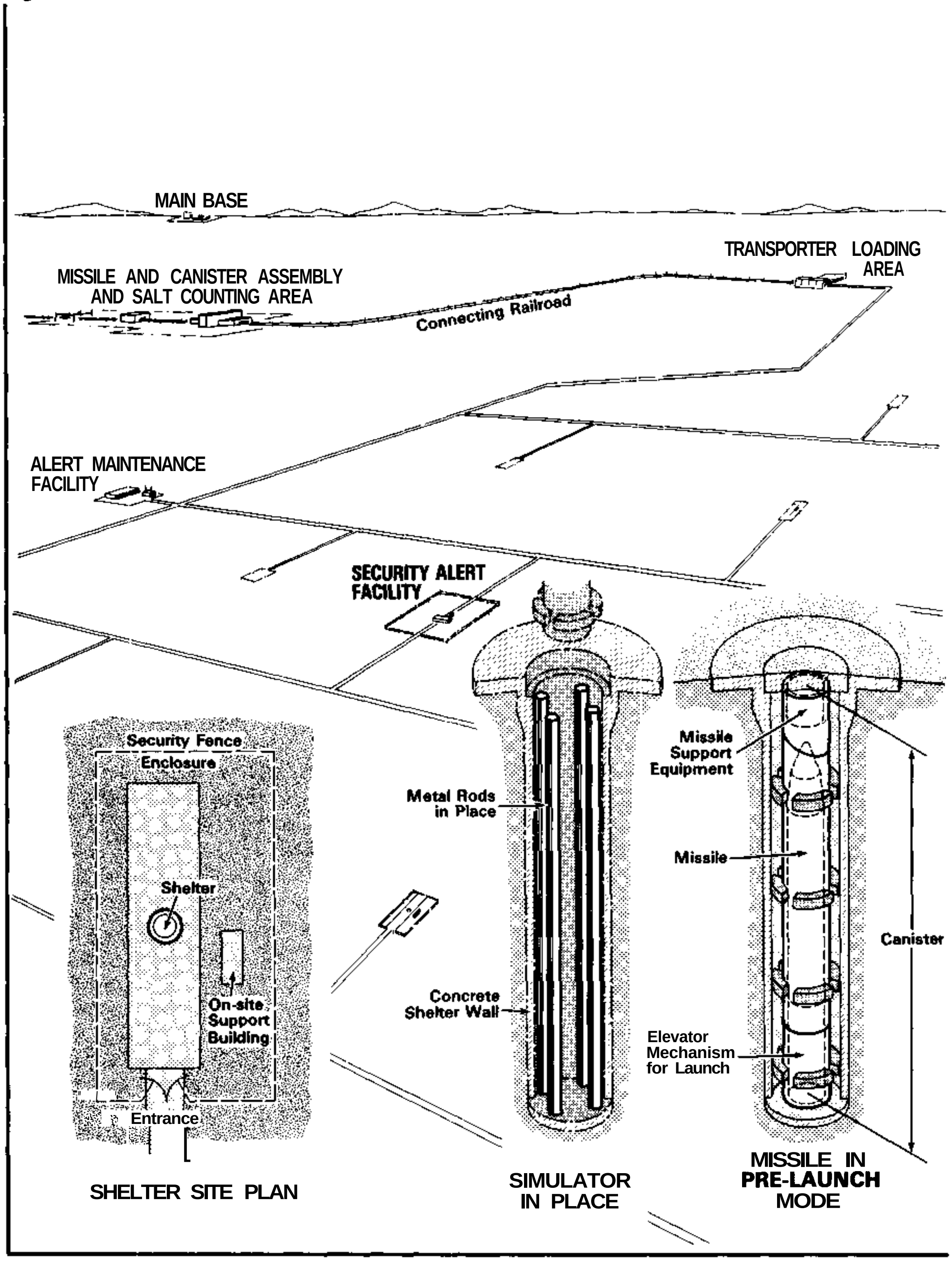
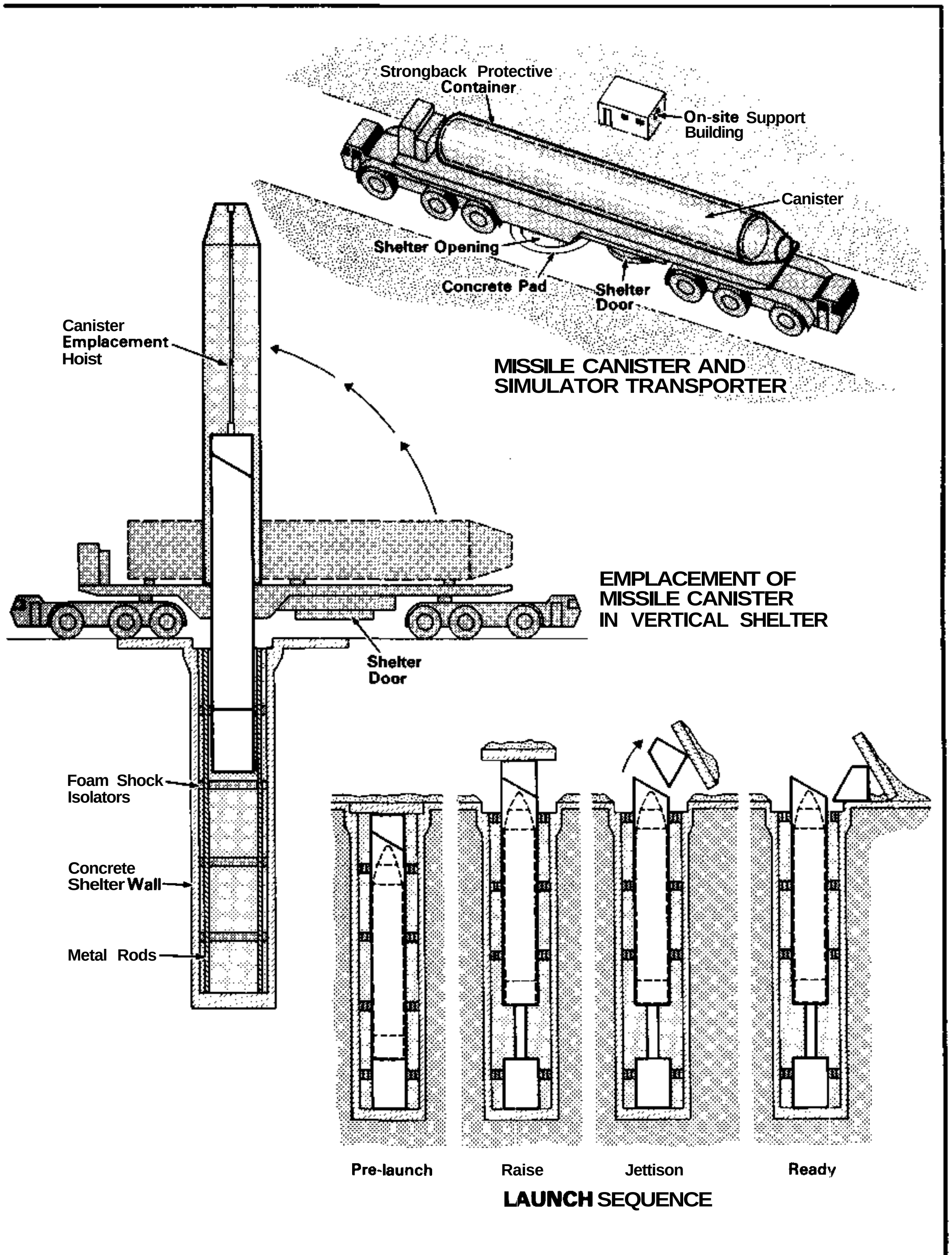
nuclear, chemical, infrared, magnetic, or others. The underground concrete shelters would also have an inherent capacity to shield some missile signatures.

18/ Missiles deployed in an MPS basing system would be placed in cylindrical steel canisters along with the equipment necessary to support and launch the missiles. This would avoid the need to provide missile-support equipment at each shelter, which would be costly in a system containing several thousand shelters. (The missile-support equipment inside the canisters would cost about $4.6 million per set. If this equipment were placed in all 5,500 shelters, total costs for the missile-support equipment alone might be more than $20 billion.) Each canister would contain a missile, an environmental control system designed to maintain the temperature and humidity of the missile within a certain range of toleration, a shock isolation system designed to protect the missile and its support equipment from the ground motion effects of a nearby nuclear explosion, batteries for emergency power, communications equipment, systems for programming the missile's guidance and for monitoring its status, and a launch mechanism. In addition, the canister would provide some protection against electromagnetic disturbances caused by nuclear detonations.

Figure 2. MULTIPLE VERTICAL SHELTER SYSTEM




Strongback Protective Container
On-site Support Building
Canister
Shelter Opening
Concrete Pad
Shelter Door
MISSILE CANISTER AND SIMULATOR TRANSPORTER
Canister Emplacement Hoist
EMPLACEMENT OF MISSILE CANISTER IN VERTICAL SHELTER
Shelter Door
Foam Shock Isolators
Concrete Shelter Wall
Metal Rods
Pre-launch
Raise
Jettison
Ready
LAUNCH SEQUENCE

to detect the presence of rocket fuel; transporters would be seeded with nuclear materials in order to foil sensors designed to detect nuclear warheads. In addition, the simulators would include heat and noise generators that would duplicate the amount of heat and the acoustic signature given off by a missile's guidance system. Shelters housing simulators would have to draw the same level of electric current as those that housed missiles; likewise, these shelters would have to communicate at random times with the launch control facilities in order to duplicate the signals that missiles would send to indicate a malfunction.

As often as required, maintenance crews would visit the shelters to repair malfunctions in the missile-support equipment contained in the canisters along with the missiles. The need to disguise the location of the missiles would require that maintenance crews make visits to "empty" shelters (those containing metal rods) as well, and that crews act in exactly the same fashion at shelters housing metal rods as when making actual repairs at shelters containing missiles. A few times a year, the missiles themselves would require maintenance work; then, the entire canister would be removed from the shelter by a transporter and carried to one of the maintenance facilities interspersed among the shelters. Visits to empty shelters would also have to be made in order to maintain Soviet uncertainty about the former position of the missiles. When repaired missiles were returned to the shelter complex, transporters would visit a series of empty shelters as well, to prevent the Soviets from determining the new locations of the missiles.

If the use of sophisticated simulators and careful operating procedures made it impossible to distinguish a shelter housing a missile from one containing only a simulator, it would not be necessary to shift frequently the location of the missiles. Instead, the missiles would be rotated only a few times each year, when they required repairs. Minimizing the movement of the missiles would be important in holding down operating costs for an MPS basing system.

Of course, elaborate measures taken to conceal the location of the missiles would increase the costs of an MPS basing system. The costs of the base-case MPS basing system include more than $900 million for countermeasures. In addition, the operating and maintenance costs of the base-case system (as well as the other MPS basing system costs shown in this paper) assume that visits would be made by transporters and maintenance crews to shelters not housing missiles.

Trench System. Preventing the Soviets from determining the location of U.S. missiles deployed in a system of underground horizontal shelters connected by trenches covered with removable roofs would be a somewhat different task than maintaining secrecy about the location of missiles deployed in a vertical shelter system. In some ways, the task might be less difficult. Because the missiles would move among the shelters under the cover of the removable roofs, it might be more difficult for the Soviets to observe their movement. In addition, it would not be necessary for repair crews to feign maintenance visits to empty shelters.

An ability to move missiles rapidly on trains within the trenches might also ease the detection problem. If missiles could be moved rapidly after a Soviet missile attack had been launched, their ability to survive the attack would not depend completely on prior success in having prevented the Soviets from determining their location.

Nevertheless, potential problems in preventing the Soviets from locating the missiles deployed in a trench system might still exist. If only small areas around the shelters constructed within the trenches were fenced off for security purposes, the danger would exist that sensors could be placed along sections of the trench connecting the shelters. These sensors might be able to "hear" the movement of the missile trains, thereby indicating where the missiles were stationed. To counter such a threat, it might be necessary to employ "mass simulators" that would move along the trenches, making sounds similar to those generated by the movement of missiles.

Preventing Detection Over the Long Run

The threat of Soviet detection of the location of U.S. missiles deployed within an MPS basing system is not, and can never be, completely eliminated. The problem is of particular concern because the United States might have little or no warning prior to the outbreak of war that the Soviets had developed a system for locating U.S. missiles. In addition, new methods of detection, as well as refinements of old methods, may appear over time with the development of sensor technology; each innovation may, in turn, require implementation of a U.S. countermeasure.

The Mr Force therefore envisages establishing a program that would help ensure the long-term security of an MPS basing system by investigating new methods of detection and devising procedures to foil them. Such a program would be analogous to the SSBN Security Program currently operated by the Navy to assure the enduring survivability of the U.S. ballistic missile submarine fleet.

In developing the costs of the base-case MPS basing system described in Chapter II, two key assumptions about the nature of the future Soviet threat to a U.S. MPS basing system were made. First, it was assumed that the Soviets would make no special effort to increase the number of warheads in their ICBM force. Second, it was assumed that the United States would have high confidence in its estimate of the size of the Soviet missile force. 1/ If these assumptions are accurate, a multiple protective structure basing system that could provide 1,000 surviving warheads would cost about $34.7 billion in 1980 dollars. 2/ This cost is based on the deployment of 310 MX missiles in a complex of 5,500 vertical shelters. Costs would be higher if missiles were deployed in a network of trenches.

But the Soviet threat against which the United States plans its MPS basing system is not fixed and known; rather, it is changing and uncertain. Between now and the 1990s, the time when a U.S. MPS basing system would become fully operational, the Soviets will have many options available to them, and their choices may ultimately be influenced by the specific programs undertaken by the United States. They may, of course, be regulated by the limits of the proposed SALT II treaty and by a future SALT agreement negotiated in the 1980s. It is reasonable, however, to assume that improvements to Soviet strategic nuclear forces will continue during the 1980s.

Indeed, the Soviets may seek to develop and deploy weapons that would threaten the survivability of a U.S. MPS basing system. Soviet military doctrine apparently seeks to deter war with the United States by acquiring capabilities to defeat and

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1/ It was also assumed that the Soviets could not develop a capability to detect in which shelters the U.S. missiles were housed.

2/ All the costs shown in this paper are in constant fiscal year 1980 dollars.

destroy U.S. strategic forces either in a preemptive nuclear strike or by active defense before those forces could inflict damage on the Soviet homeland. 3/ Continued Soviet allocation of large amounts of resources to civil defense programs and to the development of air defenses against U.S. bombers has been cited as evidence that Soviet strategic programs are being implemented in consonance with that doctrine. Moreover, consistent with their stated doctrine of having strategic forces with the ability to destroy an enemy's means of waging war, the Soviets are building missile systems that pose a threat to the U.S. silo-housed Minuteman and Titan ICBM force. The Soviets may, in the future, seek to acquire a capability to strike U.S. land-based ICBMs deployed in an MPS basing system.

More Soviet Warheads. The most obvious Soviet response to deployment of a U.S. MPS basing system would be to increase the number of missiles and nuclear warheads that could be used to attack the complex. An increase in the number of Soviet missiles and warheads would reduce the number of U.S. shelters, and hence missiles, that could be expected to survive a Soviet attack. To maintain the ability of its MPS basing system to provide surviving warheads for a retaliatory strike, the United States would have to construct additional shelters and deploy additional missiles. An expensive competition of this sort might be avoided by negotiating verifiable future SALT limits on the number of missiles and warheads that could be deployed.

U.S. Uncertainty. A more subtle and perhaps more dangerous concern is that the Soviets might produce large numbers of extra missiles that could, in a crisis, rapidly be made ready for launch. Such a danger might exist today. It would grow in importance, however, if the United States deployed an MPS basing system, because the survivability of an MPS basing complex would depend on the U.S. ability to estimate accurately the number of Soviet missiles and warheads that could be targeted against the basing complex. Without an accurate estimate of the size of the Soviet ICBM force, the United States could not determine the number of shelters it would need to

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3/ See Fritz W. Ermarth, "Contrasts in American and Soviet Strategic Thought," International Security (Fall 1978); Stanley Sienkiewicz, "SALT and Soviet Nuclear Doctrine," International Security (Spring 1978).

construct in order to ensure with high confidence that its MPS basing complex contained more shelters than the Soviets could destroy. 4/

To guard against the possibility that the number of Soviet ICBMs available to attack the MPS basing system might be greater than the best estimate provided by U.S. intelligence agencies, the United States could construct more shelters than required by that best estimate. Such a course would, however, increase the costs of a U.S. MPS basing system. Uncertainty about the number of Soviet missiles could be reduced or eliminated by a verifiable limit on missile production and stockpiles, a type of limitation that has not been included in the SALT I treaty or, with one exception, in the proposed SALT II agreement.

If the assumptions made in Chapter II about the nature of the future Soviet ICBM threat were to be altered, the costs of a U.S. MPS basing system would change accordingly. The following sections consider alternative assumptions about the future Soviet threat and about U. S. confidence in its estimate of that threat in order to assess the impact of such changes and possible uncertainties on the costs and survivability of an MPS basing system. The analysis is based on a system of vertical shelters, although the general conclusions would apply to other types of MPS basing systems.

CHANGES IN THE NUMBER OF SOVIET MISSILES AND WARHEADS

The costs of an MPS basing system would depend on the number of warheads in the the Soviet ICBM force. Any effort by the Soviet Union to increase the number of warheads in its multiple-warhead ICBM force would require the United States to construct additional shelters and to deploy additional missiles if it wished to maintain the ability of its MPS basing system to provide surviving warheads. Conversely, if the Soviets were required by

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4/ On the other hand, an MPS basing system would have the desirable attribute that its survivability would not be sensitive to improvements in the accuracy of Soviet missiles or the explosive power of Soviet warheads, two areas where the Soviets have placed great emphasis in the past several years.

a verifiable future SALT agreement to reduce their missile force, the costs of an MPS basing system would drop.

The Soviets could, in the absence of SALT constraints, increase the number of warheads in their ICBM force in two ways. First, the Soviets could convert their large multiple-warhead ICBMs to carry a greater number of smaller, less powerful nuclear warheads than they presently carry. By dividing their missile payloads into a greater number of smaller warheads--a process termed "fractionation"--the Soviets could potentially deliver a larger number of warheads with the 820 multiple-warhead ICBMs contained in the "no-response" Soviet missile threat outlined in Chapter II. Second, the Soviets could deploy more than 820 multiple-warhead ICBMs. In addition, various combinations of these two general responses might be available to the Soviets.

Deployment of More Warheads On a Fixed Number of Missiles

The Soviets possess a significant potential capability to convert their multiple-warhead ICBMs to carry a greater number of smaller warheads. Since the mid-1970s, the Soviets have been deploying very large multiple-warhead ICBMs: the SS-17, SS-18, and SS-19 missiles. These missiles have so far been flight-tested with only a relatively small number of large, powerful nuclear warheads. For example, the SS-18 missile, the largest of the new Soviet ICBMs, has been flight-tested with up to 10 warheads, each with a reported potential explosive power in the 600-kiloton to 1.5-megaton range. 5/ In the absence of SALT restrictions, such powerful missile boosters could be adapted to deliver a much larger number of smaller warheads. For example, it is estimated that, in the absence of verifiable SALT limits, rockets of the SS-18 missile size could theoretically deliver some 25 200-kiloton warheads, the approximate size of the warheads

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5/ See Walter Pincus, "U.S. Downgrades Soviet ICBM Yield," Washington Post (May 31, 1979), p. A-1; and Clarence A. Robinson, Jr., "MX Deployment Urged for Parity," Aviation Week and Space Technology (December 5, 1977), pp. 12-15. The explosive power, or "yield," of a nuclear warhead is commonly measured in tons of TNT. A one-megaton warhead has an explosive power equivalent to one million tons of TNT, and a one-kiloton warhead the power of one thousand tons of TNT.

reportedly deployed on the three-warhead U.S. Minuteman III missile. 6/

To achieve this capability would require extensive flight testing, and difficult engineering problems would have to be overcome. A large number of new, smaller warheads would have to be developed and produced. In addition, by reducing the explosive power of their nuclear warheads, the Soviets would increase the risk that, because of an overly optimistic estimate of the accuracy of their missiles, an attack on a U.S. MPS basing complex might leave many more U.S. shelters and missiles surviving than anticipated. The chances that Soviet missiles might fail to deliver their warheads with sufficient accuracy might also be increased with larger numbers of warheads because accuracy tends to decline as successive warheads are released during a missile's flight. 7/ Traditionally, the Soviets have preferred weapons with massive firepower, but smaller warheads may become practicable if the accuracy of Soviet missiles continues to improve and also if the United States deploys an MPS basing system with shelters less resistant to nuclear blast and shock effects than the existing Minuteman silos.

The Soviet potential for deploying larger numbers of smaller warheads on their missiles may, to a large extent, be limited

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6/ Soviet SS-19 and SS-17 rockets might be capable of delivering 14 200-kiloton warheads. See Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978) pp. 20-22. It is important to note that this is only one estimate of the warhead-carrying capacity of Soviet missiles, an estimate based on a certain warhead size. Secretary of Defense Brown has alluded to the possibility that the Soviets could deploy 20 to 40 warheads on their largest ICBMs. See remarks of Secretary of Defense Harold Brown on SALT II and the national defense before the Council on Foreign Relations and the Foreign Policy Association of New York City, reprinted in "SALT II," Congressional Record (April 5, 1979), p. S4089.

7/ See Department of Defense Authorization for Appropriations for Fiscal Year 1979, Hearings before the Senate Committee on Armed Services, 95:2 (April and May 1978), Part 9, p. 6471.

during the first half of the 1980s by the proposed SALT II agreement. It provides that existing missiles may be flight-tested with no more warheads than they have carried in previous tests. Moreover, the one new ICBM that each side will be allowed during the treaty period may be tested with no more than 10 warheads. 8/ Such a fractionation limit, coupled with a limit on the number of multiple-warhead ICBMs, would put a cap on the allowable number of Soviet warheads--assuming that Soviet compliance with these limits could be effectively monitored and enforced by the United States. 9/ Unless warhead limits of this kind were extended into the 1990s, however, the large size of Soviet rockets would provide a significant potential for the Soviets to increase the number of warheads in their ICBM force.

Deployment of More Multiple-Warhead ICBMs

The Soviets also have the potential to increase the number of multiple-warhead ICBMs in their silo-housed missile force. Three Soviet production lines for multiple-warhead ICBMs are

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8/ See "SALT II," p. S4089.

9/ It should be noted that effective verification of Soviet compliance with a limit on the number of warheads that may be flight-tested on an ICBM rests on the assumption that Soviet missiles converted to carry larger numbers of smaller warheads would have to be fully flight-tested before they could confidently be deployed. Questions have been raised about whether or not the Soviets could test missiles capable of carrying more than 10 warheads without actually releasing more than 10 during the flight. Indeed, the Soviets have reportedly tested a version of their SS-18 missile that is capable of delivering more than 10 warheads. See Edgar Ulsamer, "The Shakiness of SALT II," Air Force Magazine (May 1979), p. 22. Also see Richard Burt, "Soviets Reported to Add to Load Missile Can Fire," New York Times (March 14, 1979), p. 1; and Robert G. Kaiser, "Soviet Rocket Test Raises SALT Issue," Washington Post: (March 15, 1979), p. A-25. Whether further testing of this version of the SS-18 would be prohibited by the SALT II accord would depend on the specific wording of the treaty provisions. There is also the question of whether the United States can effectively monitor Soviet missile testing.

in operation, and about 125 missiles are deployed each year. 10/ Under the terms of the SALT I agreement, which expired in October 1977 but is still being observed by the United States and the Soviet Union, one single-warhead missile must be retired for each new multiple-warhead missile that enters the Soviet force. Hence, while the total number of warheads deployed on Soviet silo-housed ICBMs has increased, the number of ICBMs deployed in fixed silos has remained within the SALT 1 limit of 1,400 launchers. 11/ As of early 1979, the Soviets had deployed 500 multiple-warhead ICBMs. 12/ With continued deployment of 125 missiles each year, the Soviets would have 820 launchers for multiple-warhead ICBMs by 1982.

Under the proposed SALT II agreement, the Soviet program of replacing older single-warhead ICBMs with new multiple-warhead missiles would have to cease in the early 1980s when the allowable limit of 820 multiple-warhead ICBM launchers was reached. But SALT II would expire at the end of 1985. Without future SALT constraints on the size of the Soviet ICBM force, the Soviets could continue to increase the number of multiple-warhead ICBMs that could potentially be used to attack a U.S. MPS basing complex.

In order to show the impact of possible changes in the number of Soviet warheads on the costs of a U.S. MPS basing system, several alternative Soviet ICBM force structures in the post-1990 period are examined in this chapter. Because of the close relationship between the number of Soviet warheads available to attack an MPS basing system and the required number of U.S. shelters, the costs of deploying and operating an MPS basing system would vary greatly with the number of warheads deployed in the Soviet ICBM force. The number of Soviet warheads depends, in turn, on two key factors: the number of Soviet multiple-warhead ICBMs and the number of warheads carried on each Soviet missile. Success or failure in controlling these

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10/ U.S. Department of Defense, Annual Report, Fiscal Year 1980, p. 72.

11/ Ibid., p. 71.

12/ Ibid., p. 72.

measures in future SALT agreements would have a great impact on the costs of an MPS basing system. The lower the limits imposed by future SALT agreements, the lower would be the costs to maintain a given number of surviving warheads in an MPS basing system. This crucial relationship between the costs of a U.S. MPS basing system and verifiable SALT limits on the Soviet ICBM force reinforces the importance of pursuing a strategy that integrates planning for future strategic forces with SALT negotiations.

Table 5 shows several alternative Soviet ICBM force structures in the post-1990 period. No one, of course, can predict future Soviet actions. Thus, the cases, while plausible, should be considered as examples intended to show how the number of Soviet multiple-warhead ICBMs and the number of warheads deployed on them affects the cost of an MPS basing system designed to provide 1,000 surviving warheads.

The first line in Table 5 shows the base-case U.S. MPS basing system derived in Chapter II from the "no-response" Soviet missile threat. The impact of changes in the number of Soviet warheads available to attack a U.S. MPS basing system is measured against this base case.

A SALT II-Limited Soviet Multiple-Warhead ICBM Force

Under the terms of the proposed SALT II agreement, the United States and the Soviet Union would each be allowed to develop one "new" ICBM that is significantly different from an existing missile. If the one "new" ICBM developed were a multiple-warhead missile, it would be limited to 10 warheads. This would allow the United States to develop and deploy its new MX missile, with a payload of up to 10 warheads. It would also allow the Soviets to develop a new 10-warhead ICBM. If the Soviets chose to develop a new 10-warhead ICBM, they could replace the four-warhead SS-17 missiles and the six-warhead SS-19 missiles now being deployed. With deployment of 820 multiple-warhead ICBMs, including 308 10-warhead SS-18 missiles and 512 new 10-warhead missiles, the Soviets could have up to 8,200 warheads, about 2,300 more than in the "no-response" case. 13/

13/ See Table B-1 in Appendix B.

TABLE 5. IMPACT OF CHANGES IN THE NUMBER OF SOVIET WARHEADS ON THE COSTS OF A U.S. MULTIPLE PROTECTIVE STRUCTURE BASING SYSTEM WITH MX MISSILES, POST-1990 PERIOD: IN BILLIONS OF FISCAL YEAR 1980 DOLLARS

Soviet Threat	Number of Soviet Warheads	Number of Vertical Shelters	Number of U.S. MX Missiles	U.S. MPS System Cost (1,000 Surviving Warheads)	Increase Over Cost of "No-Response" Base Case
"No-Response" Base Case a/	5,928	5,500	310	34.7	--
820 Multiple-Warhead ICBMs					
New 10-warhead missile b/	8,200	7,700	360	41.2	7
Fractionation (200 KT) c/	15,000	13,800	420	47.8	13
1,400 Multiple-Warhead ICBMs					
Existing payloads d/	9,100	8,900	380	44.6	10
Fractionation (200 KT) e/	23,000	21,000	520	62.5	28
550 Multiple-Warhead ICBMs					
Existing payloads f/	3,900	3,200	250	26.6	-8
New 10-warhead missile g/	5,500	4,900	300	33.0	-2

NOTE: The table assumes U.S. deployment of an MPS basing system with vertical shelters. All of the Soviet warheads shown in this table would not be used to attack a U.S. MPS basing system. Many would be used to attack fixed-base U.S. Minuteman and Titan missile silos. Moreover, it is assumed that only 85 percent of the Soviet missiles used to attack a U.S. MPS basing complex would be reliable. The numbers of shelters and MX missiles shown for each case represent the combination that would minimize the cost of an MPS basing system designed to provide 1,000 surviving warheads. The cost estimates were derived from the MX Cost Effectiveness Model developed by the Space and Missile Systems Organization of the Air Force. Appendix A provides a brief description of this model.

a/ Assumes SALT II limit of 820 multiple-warhead ICBMs and no increase in the number of warheads carried on each missile (see Table 2).

b/ Assumes SALT II limit of 820 multiple-warhead ICBMs and deployment of a new 10-warhead missile to replace SS-17 and SS-19 ICBMs (see Table B-1).

c/ Assumes SALT II limit of 820 multiple-warhead ICBMs and conversion of all missiles to carry larger numbers of 200-kiloton warheads (see Table B-2).

d/ Assumes 1,400 multiple-warhead ICBMs and no increase in the number of warheads carried on each missile (see Table B-3).

e/ Assumes 1,400 multiple-warhead ICBMs and conversion of all missiles to carry larger numbers of 200-kiloton warheads (see Table B-4).

f/ Assumes future SALT limit of 550 multiple-warhead ICBMs and no increase in the number of warheads carried on each missile (see Table B-5).

g/ Assumes future SALT limits of 550 multiple-warhead ICBMs and deployment of a new 10-warhead missile to replace SS-17 and SS-19 ICBMs (See Table B-6).

It: should be noted that, if the Soviets used their SALT II allowance of one "new" ICBM to develop a new multiple-warhead missile, they would have to forego any plans they might have had to develop a new, large single-warhead ICBM as a replacement for their existing single-warhead SS-11 missiles. Thus, this case represents the maximum number of warheads that the Soviets could deploy in their multiple-warhead ICBM force under the terms of the SALT II agreement.

As shown in the table, such an increase in the number of Soviet warheads would require that the United States construct 7,700 shelters, about 2,200 more than in the base-case system, and deploy 360 MX missiles, 50 more than in the base-case system, in order to maintain the ability of its MPS basing system to provide 1,000 surviving warheads. The required expansion would add about $7 billion to the cost of the base-case system, for a total cost of $41 billion.

Soviet Deployment of a Larger Number of Smaller Warheads on 820 Multiple-Warhead ICBMs

If, in the 1990s, the Soviets were still limited to 820 multiple-warhead ICBM launchers, but were not constrained in the number of warheads that each missile could carry, they could potentially deploy some 15,000 warheads of the 200-kiloton size, 14/ over 9,000 warheads more than in the "no-response" Soviet missile threat case. If Soviet missiles deployed in the 1990s were accurate to within 500 feet of their targets (see Table 2), each of these smaller, less powerful warheads could retain a greater than 90 percent chance of destroying the U.S. shelter on which it was targeted. Thus, the number of shelters that the Soviets could destroy in an attack on a U.S. MPS basing system could rise sharply if there were no limit on the number of warheads that might be flight-tested on an ICBM.

Such an increase in the number and accuracy of Soviet warheads would raise the cost of a U.S. MPS basing system designed to provide 1,000 surviving warheads from the base-case system cost of $35 billion to $48 billion, a $13 billion increase. This cost includes the construction of some 13,800 vertical shelters,

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14/ See Table B-2 in Appendix B.

about 8,300 more than would be required for the base-case MPS basing system. With Soviet deployment of smaller, less powerful warheads, the extra shelters could be spaced only 4,000 feet apart, rather than at intervals of 7,000 feet, as assumed for the base-case MPS basing complex. This reduced spacing would lower the cost of each shelter added to the system from $2.6 million to $1.8 million.

To avoid the additional $13 billion cost of deploying and operating an MPS basing system that could provide 1,000 surviving warheads, it would be important to negotiate a permanent limit on the number of warheads that could be flight-tested on an ICBM. Together with a limit on the number of multiple-warhead ICBMs that might be deployed, restrictions on the number of warheads carried on each missile would put a cap on the total number of Soviet warheads that would be available to attack a U.S. MPS basing complex.

Soviet Deployment of 1,400 Multiple-Warhead ICBMs

The existing Soviet silo-housed ICBM force of 1,400 missiles consists of a mix of newer multiple-warhead ICBMs and older single-warhead missiles. Under the limits imposed by the proposed SALT II agreement, the Soviets could deploy multiple-warhead missiles in only 820 of their existing silos. Without such a limit, however, the Soviets could deploy multiple-warhead ICBMs in all 1,400 existing silos by 1987, assuming that they continued to deploy 125 new missiles each year. Even if a SALT II agreement was implemented, the Soviets could deploy 1,400 multiple-warhead ICBMs by 1990 if the limit on the number of multiple-warhead ICBM launchers ended with the scheduled expiration of the SALT II treaty at the end of 1985.

If, in the post-1990 period, the Soviets had 1,400 multiple-warhead ICBMs but did not increase the number of warheads carried on their missiles, they could have an ICBM force containing some 9,100 large warheads available for an attack on a U.S. MPS basing complex. 15/ As shown in Table 5, an MPS basing system designed against this threat would cost about $45 billion, $10 billion more than the base-case system.

15/ See Table B-3 in Appendix B.

If the Soviets deployed 1,400 multiple-warhead ICBMs and, at the same time, converted their missiles to carry greater numbers of smaller warheads, they might have a force with some 23,000 200-kiloton warheads. 16/ In this case, the cost of a U.S. MPS basing system, consisting of 520 MX missiles and some 21,000 vertical shelters spaced 4,000 feet apart, would be about $63 billion, or $28 billion more than the cost of the base-case system.

Thus, in order to hold down the costs of an MPS basing system, it would be important to negotiate a permanent and verifiable ceiling on the number of multiple-warhead ICBMs that can be deployed, as well as a verifiable limit on the number of warheads that may be carried on each missile.

Future SALT Reductions; 550 Multiple-Warhead ICBMs

The cost of an MPS basing system could be less than the base-case system if the United States succeeded in lowering the ceiling on launchers for multiple-warhead ICBMs in a future SALT agreement that would be in effect into the 1990s. The SALT limits proposed by the Carter Administration in March of 1977 provide one example of the potential for negotiated reductions in arms ceilings to minimize the cost of a. U.S. MPS basing system. In this hypothetical example, the Soviet Union would be limited to a total of 550 multiple-warhead ICBM launchers, with a subceiling of 150 large missiles of the SS-18 type. 17/

If the Soviets were limited by a future SALT agreement to 550 multiple-warhead ICBM launchers, and if there were a total ban on the flight-testing of missiles modified to carry a larger number of smaller warheads, the Soviet multiple-warhead ICBM force might contain as few as 3,900 warheads. 18/ In this case, the Soviets would have about 2,000 warheads fewer than in the "no-response"

16/ See Table B-4 in Appendix B.

17/ See text of April 1977 news conference of Presidential Assistant Brzezinski, reprinted in Harry L. Wrenn, SALT II; Basic Documents, Congressional Research Service (September 8, 1978), pp. 205-12.

18/ See Table B-5 in Appendix B.

missile force. The cost of a U.S. MPS basing system would be about $27 billion, or $8 billion less than the cost of the base-case system.

The Soviets could have a multiple-warhead ICBM force consisting of up to 5,500 warheads if they chose to develop and deploy a new 10-warhead missile during the life of the proposed SALT II treaty but were later compelled to reduce their force of multiple-warhead ICBM launchers from 820 to 550 by a future SALT agreement. 19/ In that case, the estimated cost of an MPS basing system would be $33 billion, about $2 billion less than the cost of the base-case system.

Other Types of MPS Basing Systems

The costs shown in Table 5 assume U.S. deployment of an MPS basing system with vertical shelters. Other versions of MPS basing, such as a network of horizontal shelters connected by trenches covered with removable roofs, would generally be more expensive. There is one possible exception to this general statement. A trench system would have the advantage that its costs would be somewhat less sensitive to Soviet deployment of missiles with larger numbers of smaller warheads. This is because a trench system would contain more shelters, spaced closer together, than a complex of vertical shelters. Although the additional costs to counter Soviet missile fractionation would be lower with a trench system, total costs would probably be comparable to a vertical shelter system because the initial costs to build a trench system would be higher than the initial costs to deploy a complex of vertical shelters.

Varying the Desired Number of U.S. Surviving Warheads

All costs in Table 5 are based on the assumption that the United States would want to maintain an MPS basing system that could provide 1,000 surviving warheads. Table 6 varies this assumption, showing how the costs of an MPS basing system would vary depending upon the number of surviving warheads that the United States wished to provide. The table shows that the costs

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19/ See Table B-6 in Appendix B.

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TABLE 6. CHANGES IN THE NUMBER OF SOVIET WARHEADS AND THEIR IMPACT ON THE COSTS OF A U.S. MULTIPLE PROTECTIVE STRUCTURE BASING SYSTEM WITH MX MISSILES FOR THREE DIFFERENT DESIRED NUMBERS OF SURVIVING WARHEADS, POST-1990 PERIOD: IN BILLIONS OF FISCAL YEAR 1980 DOLLARS

		U.S. MPS System Cost		
Soviet Threat	Number of Soviet Warheads	500 Warheads Surviving	1,000 Warheads Surviving	1,500 Warheads Surviving
"No-Response" Base Case	5,928	31	35	38
820 Multiple-Warhead ICBMs				
New 10-warhead missile	8,200	37	41	44
Fractionation (200 KT)	15,000	44	48	51
1,400 Multiple-Warhead ICBMs				
Existing payloads	9,100	41	45	48
Fractionation (200 KT)	23,000	58	63	66
550 Multiple-Warhead ICBMs				
Existing payloads	3,900	25	27	30
New 10-warhead missile	5,500	30	33	35

would decrease or increase by only about $3 billion to $5 billion if between 500 and 1,500 surviving warheads were desired.

The Significance of the Potential Added Costs to the United States and the Soviet Union

The possibility that the Soviets might increase the number of warheads that their ICBM force could deliver in an attack on a U.S. MPS basing system suggests the importance of negotiating future verifiable SALT limits on both the number of Soviet multiple-warhead ICBMs that might be deployed and on the number of warheads that might be flight-tested on an ICBM. The lower the limits negotiated, the fewer the shelters that would have to be constructed and the lower the costs to deploy and to operate an MPS basing system. Without SALT limits, the costs of an MPS basing system could increase significantly if the Soviets responded by increasing the number of warheads in their ICBM force.

It is important to note that the political environment in the United States could change greatly in the event of a SALT breakdown and a resulting Soviet missile buildup. In the face of a massive and overt Soviet buildup, there might be a greater public willingness to support increased expenditures for U.S. strategic missile programs. Moreover, the increased costs shown in Table 5 would be spread over a period of several years as the Soviet missile threat grew.

It should also be noted that, while the costs of expanding an MPS basing system in response to a Soviet missile buildup could be very large, the costs of at least some other alternatives might also be large. The survivability of the missile-carrying submarine force will remain insensitive to the number of Soviet missiles and warheads as long as the Soviets lack a means to detect and locate U.S. submarines. On the other hand, if the Soviets had a large number of warheads in their missile force, U.S. nuclear weapons based in strategic aircraft--including long-range bombers, cruise missile carrier aircraft, and a possible airmobile ICBM force--might become increasingly vulnerable to a Soviet missile attack. To compensate for this possible vulnerability, it might become necessary to construct additional air bases and to develop improved aircraft, thus increasing costs.

The Soviet missile buildups shown in Table 5, which could greatly increase the costs of a U.S. MPS basing system, would also be very expensive for the Soviet Union. On average, each large warhead on a new multiple-warhead ICBM added to the Soviet force would cost up to $8 million, 20/ an estimate that includes

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20/ In 1974, former Secretary of Defense Schlesinger estimated that, in 1974 U.S. dollars, the deployment of 1,000 six-warhead SS-19 missiles would cost about $30 billion ($47 billion in 1980 dollars) and that the deployment of slightly more than 300 ten-warhead SS-18 missiles would cost $12 billion to $15 billion ($19 billion to $24 billion in 1980 the costs of the nuclear warhead itself, the reentry vehicle designed to carry the nuclear warhead, and a fraction of a new multiple-warhead missile needed to deliver the warhead. For every large warhead added to the Soviet ICBM force, the United States would have to construct slightly more than one shelter and deploy a fraction of an extra MX missile, assuming that the MPS basing system was designed to provide 1,000 surviving warheads. On average, the total cost of a U.S. MPS basing system would increase by about $3 million for each large warhead added to the Soviet force.

It would be less expensive for the Soviets to add warheads to their ICBM force by converting missiles to carry larger numbers of less powerful warheads. The Air Force believes that, with or without a SALT limit on the number of warheads that may be carried on each missile, Soviet costs to increase their forces would be greater than U. S. costs to maintain the survivability of an MPS basing complex. 21/ If the Soviets increased the number of the warheads in their force, but reduced their size and destructive power, the United States would have to deploy more MX missiles and construct more shelters for its MPS basing system, but the U.S. shelters could be spaced at distances of only 4,000 feet. In this case, each small warhead added to the Soviet force would, on average, increase the costs of a U.S. MPS basing system by $1.4 million to $1.8 million.

In both cases, the costs of increasing the number of warheads in the Soviet ICBM force would appear to be similar to or greater than the costs of expanding the U.S. MPS basing system in response.

Relative costs may not, however, be a decisive factor in determining the nature of possible future competition. The fact that the cost of increasing the number of warheads in the Soviet ICBM force would be equal to or greater than the cost of U. S. countermeasures would not necessarily deter the Soviet Union from

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dollars). See U.S.-USSR Strategic Policies, Hearing before the Subcommittee on Arms Control, International Law and Organization, Senate Committee on Foreign Relations, 93:2 (March 4, 1974), p. 20.

21/ Information provided to CBO by U.S. Air Force (May 21, 1979).

undertaking such programs. That decision would depend upon an assessment by the Soviets of their own military need to acquire a capability to destroy U.S. ICBMs deployed in an MPS basing system. For example, over the years the Soviets have probably devoted more resources to their air defense forces than the United States has had to devote to maintaining the ability of its strategic bomber force to penetrate Soviet defenses. The Soviets might make a similar calculation with regard to the desired capabilities of their ICBM forces. Moreover, having established the missile design bureaus and production facilities that are in operation today, the Soviets may not find the costs of continuing ongoing activities at current rates to be prohibitive.

Of course, predicting what the Soviet Union would do in the absence of SALT constraints is necessarily speculative. The Soviets will face competing demands for resources for other military and civilian purposes, and they may at some point face pressures to reduce their spending on missile forces. It is also possible that U.S. efforts to maintain the survivability of its ICBM force by deploying an MPS basing system may impress upon the Soviets a determination to counter any future Soviet threats to the U.S. missile force, thereby demonstrating to them the futility of continued competition.

Perhaps most important, a Soviet leadership contemplating the end of SALT limits and the beginning of a massive arms buildup would have to consider the political costs of such a course. In particular, the Soviets would have to consider the dangers of stimulating the United States into expanded and accelerated strategic programs similar to those undertaken in the late 1950s and early 1960s. At the end of that strategic arms buildup, the Soviets found themselves in an inferior position for the next decade.

Finally, the Soviets may in the future wish to concentrate on improving the survivability of their own land-based missile force. In fact, U.S. development and deployment of accurate and powerful MX missiles might cause the Soviet Union to fear that its own land-based missile force would become increasingly vulnerable to a U.S. first-strike attack. Thus, instead of deploying more missiles and more warheads in an effort to threaten U.S. missiles deployed in an MPS basing system, the Soviets might choose to develop a more survivable basing system for their own ICBMs. Air Force officials believe that U.S. deployment of the MX missile would force the Soviets to spend more of their resources on survivability and less on missile firepower. 22/

A Note on Ballistic Missile Defense and Multiple Protective Structure Basing

If the Soviets greatly increased the number of warheads in their ICBM force that could be used to attack a U.S. MPS basing system, the United States might at some point find it more economical to develop a means to defend U.S. missiles deployed in an MPS basing system than to expand the system by building more shelters. In the past, one of the major obstacles to developing an effective defense against ballistic missiles has been that, with the development of multiple-warhead missiles, it became easier and less costly to increase the number of offensive warheads than to acquire more defensive interceptors. Deployment of a ballistic missile defense (BMD) system as a complement to an MPS basing system might change this situation.

A "preferential" ballistic missile defense system would defend only those shelters in the MPS basing complex that housed missiles. This would greatly reduce the requirements for an effective defense relative to the requirements for a successful attack. A simple example demonstrates the point. Suppose the Soviet Union had 20 reliable, accurate warheads. If the United States deployed an MPS basing system with 40 shelters and two missiles, the Soviets could destroy only half of the shelters and, on average, half of the missiles. Thus, the U.S. MPS basing system could be expected to provide one surviving missile.

If the Soviets then deployed 20 additional reliable, accurate warheads (for a total of 40), the United States would have to construct 40 additional shelters (for a total of 80) in order to maintain a 50 percent survival rate for its MPS basing system. A system with a total of 80 shelters and a 50 percent survival rate could continue to provide one surviving missile.

22/ See Hearings on Military Posture and H.R. 10929 (Department of Defense Authorization for Appropriations for Fiscal Year 1979, Hearings before the House Committee on Armed Services, 95:2 (February, March, and April 1978), Part 3, Book 1, p. 921.

By instead deploying an effective preferential BMD system, the United States could maintain the survivability of one missile without adding to the original 40 shelters. For example, the United States could deploy a preferential defense system with two interceptors that would each have a 50 percent probability of destroying the Soviet warhead against which it was targeted. The two interceptors could, on average, destroy one of the two Soviet warheads targeted on the two U.S. shelters containing missiles. One of the U. S. missiles would survive the attack and the remaining 39 Soviet warheads would be allowed to destroy the other 39 shelters, all but one of which would be empty. Thus, having a preferential defense system with two interceptors would provide an assurance of survivability equal to doubling the number of shelters. Moreover, the United States would offset an increase of 20 Soviet warheads by deploying only two interceptors.

The advances that have been made in ballistic missile technology may make such a preferential defense concept feasible. First, compact radars that have been developed could be placed in shelters constructed for an MPS basing system. If the radars and interceptors could be covertly rotated among the shelters, the Soviets would have difficulty destroying them in a first-strike attack. The vulnerability of the missile defense system itself to a Soviet attack would be lessened, and, thus, the vulnerability of the MX missiles to destruction in a subsequent attack would be decreased. Second, improved sensor technlogy might provide a capability to determine accurately which Soviet warheads were targeted against the U.S. shelters that housed missiles and to defend against only those warheads. Third, improved interceptor guidance systems might: provide an effective capability to destroy Soviet warheads in the atmosphere.

The major disadvantage of a preferential ballistic missile defense system is that the permanent Antiballistic Missile Treaty between the United States and the Soviet Union prohibits the testing and deployment of mobile ballistic missile defense systems. (The treaty also limits the number of interceptors to 100.) Thus, development and deployment of a preferential defense system would require the renegotiation of some of the treaty provisions or U.S. abrogation of the treaty. While such an option would probably be undesirable as long as there were SALT limits on Soviet offensive strategic nuclear arms, it might become more attractive if the SALT negotiations failed and the Soviets began a large buildup of warheads. Under these circumstances, deploying a preferential ballistic missile defense system, if effective, might be less costly than constructing thousands of shelters to counter increases in the number of Soviet warheads. Deploying a defense system would also avoid the need to spread an MPS basing complex: over large tracts of land.

U.S. UNCERTAINTY ABOUT THE SIZE OF THE SOVIET ICBM FORCE

The ability of an MPS basing system to provide surviving missiles and warheads for a U.S. retaliatory strike would require that the United States construct more shelters for its basing system than the Soviet Union could destroy. To succeed, the United States would have to be confident that it could estimate the number of Soviet warheads available for an attack within a reasonably narrow range. While a small amount of uncertainty about the size of the Soviet ICBM force could be tolerated, a major miscalculation could reduce significantly the number of U.S. missiles that would survive an attack.

The base-case MPS basing system described in Chapter II was designed to provide 1,000 surviving; warheads after absorbing an attack by the postulated "no-response" Soviet ICBM force. It was assumed for the purposes of constructing the base-case system that the U.S. estimate of the number of Soviet missiles and warheads available for an attack would be correct. If so, an MPS basing system with 5,500 vertical shelters and 310 MX missiles could provide 1,000 surviving warheads.

If, instead, the U.S. estimate of the number of Soviet missiles and warheads available for an attack was incorrect, the number of U.S. shelters and missiles deployed might prove to be insufficient. Indeed, the base-case MPS basing system would have only about 1,000 more shelters than the Soviets would have warheads available to attack the complex. Thus, although some U. S. warheads could survive even if the Soviets had a large number of extra missiles and warheads, a system with only 5,500 shelters would provide a thin margin for error in estimating the number of Soviet; ICBMs if the United States wanted a system that could provide 1,000 surviving warheads. If substantial uncertainty about the size of the Soviet ICBM threat existed, a range of estimates for the number of Soviet missiles available to attack the system, rather than a fixed number, would have to be taken into account in determining the appropriate number of shelters.

The Problem of Extra Soviet Missiles

U. S. intelligence sources are considered adequate to count the number of Soviet ICBM silos constructed, as well as the number of submarine missile tubes and bombers produced and deployed. 23/ Yet, under both the existing SALT I treaty and the proposed SALT II agreement, no limitations are placed upon the number of missiles and nuclear warheads that the United States and the Soviet Union may produce and stockpile. In fact, both the United States and the Soviet Union routinely produce more missiles than they deploy in order to provide spares for maintenance and for missile testing and crew training.

The possibility that the Soviets could produce and stockpile --but not deploy in silos--a large number of extra missiles and warheads introduces a major potential source of uncertainty about the number of Soviet ICBMs that might be available to attack an MPS basing system. If the Soviets possessed a means to launch the extra missiles that they produced, the resulting threat would be considerably larger than the threat posed by silo-housed Soviet missiles. In that case, the number of shelters constructed might prove to be inadequate to ensure that a significant portion could survive a Soviet missile attack. If such uncertainties existed, the number of Soviet silo-housed ICBMs would not be the relevant missile threat that an MPS basing system should be designed to counter. Instead, the relevant threat would be somewhat larger and undefined.

Extra U.S. Shelters as a Hedge

To hedge against the possibility that the Soviets might possess extra missiles that could rapidly be made ready for launch, the United States might wish to build more shelters than required by the number of Soviet silo-housed ICBMs. Additional shelters would provide greater confidence that a significant number of U. S. shelters and missiles could survive an attack even if the Soviets possessed extra missiles.

23/ See speech by George M. Seignious, Director of the Arms Control and Disarmament Agency, reprinted in "SALT II and National Security," Congressional Record (May 24, 1979), pp. S6755-58.

The potential need to hedge against the possibility that the Soviets might have a large number of extra missiles could be alleviated by a verifiable SALT limit on missile production and stockpiles. Such a limit would probably be difficult to verify, however. Expanded and improved monitoring of Soviet missile production activities and changes in Soviet missile production practices might be necessary to reduce potential U.S. uncertainties in this area.

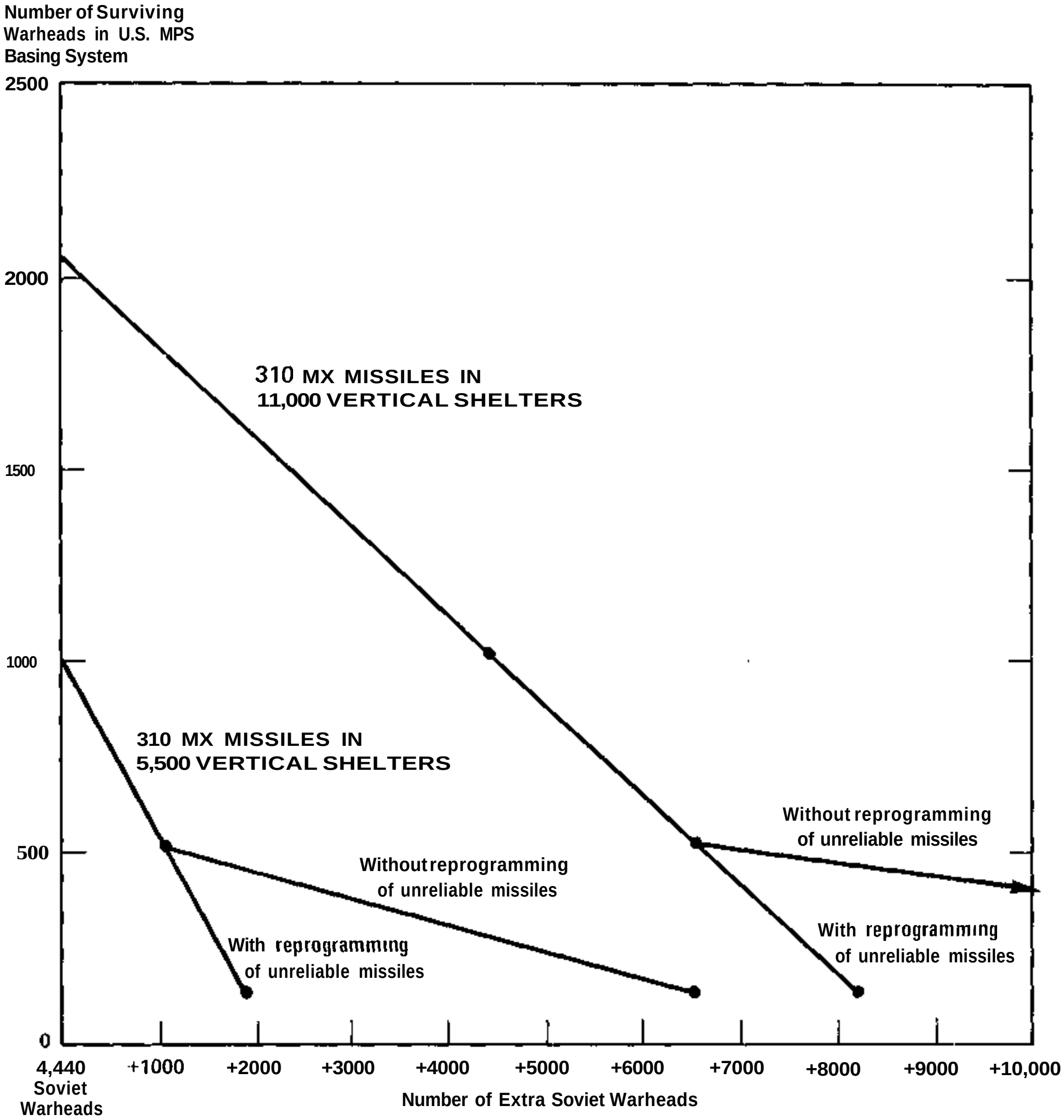
The Effect of Uncertainty on the Number of Surviving Warheads

Figure 3 shows how the number of U.S. surviving warheads provided by an MPS basing system would be affected if the Soviets had a large number of extra missiles that they could rapidly make ready for launch. The lower line in the figure shows how the number of surviving U. S. warheads would be affected by the existence of extra Soviet warheads if the United States had an MPS basing system with 310 MX missiles and 5,500 shelters. Such a system could be expected to provide 1,000 surviving warheads if the Soviets had no extra missiles and warheads--that is, only the 5,928 warheads assumed in the "no-response" threat described in Chapter II. 24/ If, instead, the Soviets possessed extra missiles and warheads that the United States had not taken into account in determining the required number of shelters for its MPS basing complex, fewer U.S. warheads would survive a Soviet attack. For example, suppose the Soviets had slightly more than 1,000 extra warheads, perhaps carried on 100 extra 10-warhead ICBMs. In that case, the Soviets would have enough warheads to target one weapon on each U. S. shelter. Some U.S. shelters would still survive because a fraction of the Soviet missiles would fail to function. If 85 percent of the Soviet missiles functioned reliably (see Table 2), and if 98 percent of the reliable Soviet warheads destroyed the U.S. shelters on which they were targeted, then about 50 MX missiles with some 500 warheads would be expected to survive an attack.

24/ Of the 5,928 warheads in the "no-response" Soviet multiple-warhead ICBM force, only 4,440 warheads would be targeted on a U.S. MPS basing system. The remaining 1,488 warheads were assumed to be targeted on the U.S. force of silo-housed Minuteman and Titan ICBMs.

Figure 3.

Survivability of Two Hypothetical U.S. MPS Basing Systems Against Extra Soviet Missiles and Warheads



NOTE: This figure is based on the following assumptions: that the Soviets would have 4,440 warheads available to attack the U.S. MPS basing system if they had no extra missiles and warheads (1,488 of the 5,928 warheads in the Soviet multiple-warhead ICBM force would be targeted on the silo-housed Minuteman and Titan missiles); that 85 percent of Soviet missiles would be reliable; and that each warhead from a reliable missile would have a 98 percent chance of destroying the shelter on which it was targeted. For the cases in which the Soviets would have enough warheads to target two weapons on some or all of the U.S. shelters, the assumption was made that the second warhead would have a chance to reach the area of the target and detonate only if the first warhead proved to be unreliable and failed to reach the targeted U.S. shelter.

Additional Soviet missiles and warheads would provide an ability to begin targeting two warheads on each U.S. shelter, a tactic that could significantly increase the probability that at least one Soviet warhead would explode in the area of each U.S. shelter. Some 6,500 extra Soviet warheads, together with the warheads deployed on Soviet silo-housed multiple-warhead ICBMs, would allow two weapons to be targeted on each of the 5,500 U.S. shelters, with the result that fewer than 150 U.S. warheads would be expected to survive an attack. This same result could be obtained with only about 2,000 extra Soviet warheads if the Soviet Union possessed a capability to identify unreliable missiles in flight and to launch a small second wave of missiles to replace those unreliable missiles (a tactic known as "reprogramming"). 25/

A U.S. MPS basing complex with a larger number of shelters could provide a hedge against the possibility that the Soviets might possess extra missiles and warheads. The top line in Figure 3 shows how the ability of an MPS basing complex to absorb large numbers of Soviet warheads would be significantly improved if the United States constructed 5,500 additional shelters, for a total of 11,000 shelters. The figure shows that an MPS basing system

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25/ This reprogramming example shows an extreme case, the best one possible for the Soviet Union. The reprogramming cases in Figure 3 assume that the Soviets could identify all missile failures in time to launch a second wave of missiles to replace the unreliable ones. In practice, it would probably be possible to replace only a portion of the unreliable missiles. In order to avoid the possibility that the nuclear explosions from the first wave of missiles might destroy warheads from the second wave of missiles, the second wave would have to arrive on target simultaneously with the first. This would require that the second wave be launched soon after the first on trajectories that would speed the arrival of the warheads. Thus, it would probably be possible to replace only those missiles that failed in the early moments of flight. Missiles that failed to launch altogether or that failed shortly after liftoff--a large portion of missile failures--might be identified in time to launch replacement missiles. Missiles that failed to dispense their warheads properly or that carried warheads that failed to fuse properly could probably not be replaced.

with 11,000 shelters and 310 MX missiles could provide 1,000 surviving warheads even if the Soviet Union possessed 4,500 extra warheads. This would double the number of warheads that could be targeted on a U.S. MPS basing system by the "no-response" Soviet silo-housed ICBM force, 26/

Construction of an additional 5,500 shelters, costing approximately $2.6 million each, would increase the costs of the base-case MPS basing system by about $14 billion, assuming that the shelters were spaced at distances of 7,000 feet. A somewhat less expensive way to hedge against uncertainties about the number of Soviet warheads available for an attack would be to construct additional shelters at distances of 4,000 feet. Although the decreased spacing between the shelters would reduce U.S. confidence in the ability of the shelters to survive the effects of nuclear explosions at nearby shelters, it would permit the construction of a larger number of shelters within a smaller area at lower cost. In this case, each additional shelter would cost about $1.8 million; thus, 5,500 additional shelters would add about $10 billion to the cost of the base-case MPS basing system.

Construction of 11,000 shelters provides only one example of the relationship between uncertainties about the number of Soviet warheads available for an attack and the number of shelters that might be required for a U.S. MPS basing system. The appropriate number of shelters would depend upon the U.S. ability to estimate the number of Soviet missiles and warheads that might be available for an attack. The number of shelters constructed would also depend on judgments made about the degree of confidence the United States should have in the ability of an MPS basing system to provide a given number of surviving warheads.

26/ An MPS basing system with 310 MX missiles and 11,000 shelters would not constitute the minimum-cost combination of missiles and shelters. Rather, this particular combination of missiles and shelters is intended only to illustrate the fact that the construction of extra shelters would provide insurance against the possibility that the Soviets might possess extra missiles. It is possible that a somewhat different combination of U.S. missiles and shelters might provide slightly more insurance for a given amount of money.

Construction of 5,500 shelters would be adequate to provide 1,000 surviving warheads only if the United States was confident that the Soviets possessed no extra missiles. Figure 3 shows that an MPS basing system of this size would provide a thin margin for error in estimating the number of Soviet ICBMs. Although some U.S. warheads would survive even if the Soviets possessed a large number of extra missiles and warheads, the ability of a U.S. MPS basing system to provide the desired 1,000 surviving warheads would be threatened by the existence of extra Soviet missiles.

An MPS Basing System Would Raise the Price of a Soviet Attack

Even if the Soviet Union possessed so many extra missiles and warheads that a U.S. MPS basing; system could provide no surviving warheads, the system might still serve a purpose. In order to destroy the U. S. ICBMs deployed in an MPS basing complex, the Soviets would have to target several thousand shelters, a task that could deplete their own ICBM force. The Soviets might not see an advantage in destroying the U.S. ICBM force if, to do so, they would have to use all the missiles in their own force. Moreover, by absorbing a large number of Soviet warheads, an MPS basing complex might lessen the potential vulnerability of U. S. bombers and other aircraft armed with nuclear weapons. It is conceivable that, without an MPS basing system, the survivability of U.S. strategic aircraft might be threatened by the existence of a large number of extra Soviet missiles and warheads that could be targeted against large areas around U.S. air bases.

Bounding the Number of Extra Soviet Missiles and Warheads

The relationship between uncertainties about the number of Soviet missiles available for an attack and the number of shelters required for a U. S. MPS basing complex raises the important question of how many extra missiles and warheads the Soviets might possess by the 1990s, when a U.S. MPS basing system would become fully operational. One report has indicated that the Soviets currently possess a stockpile of 1,000 extra missiles not deployed in silos, 27/ consisting of a mix of extra

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27/ See Henry S. Bradsher, "New U.S. Study Finds More Soviet Missiles," Washington Star (April 12, 1979), p. A-1.

newer multiple-warhead ICBMs and older single-warhead missiles. The number of extra missiles that the Soviets might possess in the future is uncertain because this will depend on missile production rates maintained in the 1980s.

The number of extra warheads that a given number of stockpiled missiles could provide will depend on the number of warheads flight-tested on Soviet ICBMs in the future. For example, if the Soviets tested missiles with 25 warheads, a stockpile of 1,000 extra missiles might provide up to 25,000 extra warheads (assuming that such a large number of warheads could be manufactured). If missiles were limited to 10 warheads each, then a stockpile of 1,000 missiles could carry no more than 10,000 warheads. Thus, a verifiable limit on the number of warheads that could be flight-tested on an ICBM would help bound the uncertainty about the number of Soviet warheads available for an attack on a U.S. MPS basing system.

It is important to remember that only accurate multiple-warhead Soviet ICBMs would present a serious threat to a U.S. MPS basing system. Extra Soviet missiles that were inaccurate or incapable of carrying more than one warhead would be much less effective in an attack on the protective shelters in a U.S. MPS basing complex. Thus, the possible existence of a stockpile of older Soviet single-warhead SS-11 and SS-9 ICBMs that are being replaced by newer multiple-warhead missiles may not pose a serious threat to a U.S. MPS basing system, because the Soviets would have to possess a very large number of these missiles in order to have enough extra warheads to reduce significantly the number of U.S. warheads that could survive an attack. In the future, however, a potentially serious threat may appear if the Soviets replace with new missiles the accurate multiple-warhead ICBMs now being deployed. At that time, it would be especially important to negotiate SALT provisions dealing with the disposal of missiles retired from the active force.

Launching Extra Missiles

The relationship between uncertainties about the size of the Soviet ICBM force and the number of shelters required for a U.S. MPS basing system also raises the important question of whether the Soviets could, in practice, find ways to launch any extra missiles that they might produce and stockpile. One concern is that Soviet deployment of a multiple-shelter system similar to a

U.S. MPS basing system might provide the Soviets with a means to deploy rapidly a large number of extra missiles. Indeed, a Soviet multiple-shelter system would offer some advantages in this role by providing a large number of extra potential launch sites that would enjoy tested communications and launch control systems as well as substantial protection from nuclear blast effects. On the other hand, many experts believe that the Soviets already possess a potential ability to launch extra missiles from expedient above-ground launch pads. 28/ If these fears proved to be well-founded, then the lack of verifiable limits on Soviet missile production and stockpiles introduces a major source of uncertainty about the number of Soviet warheads that a U.S. MPS basing system might have to absorb. 29/

28/ Examples include: Roland F. Herbst, "SALT Verification Issues Connected with MAP and Mobile ICBM Systems," in remarks of Hon. Robin L. Beard, Congressional Record (January 31, 1979), pp. E281-83; Edgar Ulsamer, "The Shakiness of SALT II," Air Force Magazine (May 1979), p. 22; Fiscal Year 1980 Arms Control Impact Statements, Senate Committee on Foreign Relations and House Committee on Foreign Affairs, Joint Committee Print, 96:1 (March 1979), p. 19; comments of Gen. Lew Allen, Jr., Air Force Chief of Staff, quoted in remarks of Senator Orrin G. Hatch, "SALT II," Congressional Record (February 1, 1979), pp. S981-82; and testimony of Lt. Gen. Glenn A. Kent, USAF (Ret.) on the future of the land-based leg of the strategic Triad in hearings before the House Committee on Armed Services, 96:1 (February 7, 1979; processed). A different view is expressed in the speech of George M. Seignious, Director of the Arms Control and Disarmament Agency, reprinted in "SALT II and National Security," Congressional Record (May 24, 1979), pp. S6755-58.

29/ The Soviet capability to reload ICBM silos that have launched one round of missiles would probably present a less worrisome threat. It seems doubtful that the Soviets would have time to reload their silos before a U.S. counterattack could destroy the missile silos and the missile-support buildings and equipment in the area. Moreover, the proposed SALT II agreement includes restrictions on the storage of extra missiles in ICBM deployment areas. See speech by George M. Seignious, Director of the Arms Control Agency, reprinted in "SALT II and National Security," Congressional Record (May 24, 1979), pp. S6755-58.

There are, however, reasons to question the ability of the Soviets to launch extra missiles from expedient, aboveground launch pads. Such a capability would require a means to erect the missiles as well as the electronic systems used to target, control, and launch them. Missile testing and crew training might also be required in order to gain confidence in the reliability of expedient launch systems. In peacetime, preparations undertaken in these areas would involve great risks because any U.S. detection of suspicious activities could trigger a serious crisis, thereby jeopardizing continued U.S. observance of SALT limits and spurring the United States into accelerated strategic programs. In wartime, risks would be equally great. Upon detection of Soviet preparations for the expedient launching of extra missiles, the United States would almost certainly order additional bombers and submarines to assume an alert posture, thereby greatly increasing the number of U.S. weapons that could be expected to survive a Soviet attack. Moreover, missiles deployed with expedient aboveground launchers, if detected by the United States, would be extremely vulnerable to a U.S. preemptive attack.

Uncertainty about the Soviet ability rapidly to prepare for launch any extra accurate multiple-warhead missiles they might possess may become a more worrisome concern in the future. Today, underground missile silos are considered to be the launchers for ICBMs because, under current deployment practices, the support equipment necessary to maintain, target, and launch a missile is an integral part of the silo. As this missile support equipment is miniaturized in the future, it will become possible to place the equipment in missile canisters. Indeed, this is the concept envisioned for the missiles deployed in a U. S. MPS basing system. By placing the support equipment in the canisters, the ability to launch the missiles will become relatively independent of the underground silos. In fact, if the United States deployed an MPS basing system, it would be the U.S. position that the canisters, rather than the underground shelters, would constitute the missile launchers. Under these circumstances, the number of underground shelters would no longer provide a practical surrogate for the number of ICBMs that could be launched. Yet, counting the number of canisters produced might be a difficult task, depending on the deployment and operating practices adopted by the country deploying canister launchers. Thus, placing support equipment in canisters may reinforce the need to begin to limit missile production and stockpiles.

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FUTURE SALT NEGOTIATIONS AND MULTIPLE PROTECTIVE STRUCTURE BASING

This chapter has examined those possible Soviet responses that could affect the costs and survivability of an MPS basing system for land-based ICBMs. For example, the Soviets might increase the number of missiles and warheads in their ICBM force. If the United States wanted to maintain the ability of its MPS basing system to provide a large number of surviving warheads, it would be necessary to expand the system, thereby increasing its cost. Likewise, U.S. uncertainties about the number of Soviet ICBMs available for an attack could also create pressures for the expansion of an MPS basing complex.

It is possible that the Soviets would refrain from making any overt response to U.S. deployment of an MPS basing system. They might accept the U.S. determination to maintain a survivable land-based ICBM system. They might be unwilling to bear the great costs that efforts to threaten the survivability of an MPS basing complex would impose. Yet, because the possibility exists that the Soviets would respond, it is important to consider the implications of possible responses. Moreover, U.S. uncertainties about the number of Soviet missiles that could be deployed rapidly in a crisis might present a more worrisome danger to the survivability of an MPS basing system than an overt Soviet missile buildup.

The impact of possible Soviet responses and U.S. uncertainties points to the importance of pursuing a strategy that integrates planning for an MPS basing system with future SALT negotiations. Of particular importance to an MPS basing system would be verifiable future SALT provisions designed to:

- Limit the number of Soviet multiple-warhead ICBMs;
- Limit the number of warheads that could be flight-tested on an ICBM;
- Limit production and stockpiling of ICBMs;
- Establish verifiable procedures for dismantling launchers and missiles retired from the active force; and
- Establish reliable procedures for verifying limits on the number of mobile missile launchers that could be deployed.

The importance of these kinds of SALT provisions to a U.S. MPS basing system raises the question of whether or not the Soviets would accept limits on their ICBM force that would have the effect of enhancing the survivability of U.S. land-based ICBMs. They have apparently been unwilling to do so in the past, and they could be expected to engage in hard bargaining in future SALT negotiations.

The possibility that the Soviets might not see their interests in the SALT negotiations to be parallel to U.S. interests in this area suggests a need to consider what actions the United States might take to influence the Soviet SALT position. For example, the United States would probably want to demonstrate a determination to counter any Soviet responses that could threaten a U.S. MPS basing system. Some have also suggested that U.S. development of a missile capable of threatening Soviet silo-housed ICBMs would make the. Soviets more inclined to see a common interest in negotiating measures designed to enhance the survivability of mobile missile systems. Others have suggested the opposite course, urging the United States to avoid posing a threat to Soviet silo-housed ICBMs; in this view, such a threat might cause the Soviets to deploy missiles in a way that would make it difficult for the United States to assess accurately the size of the Soviet ICBM force. At a minimum, it would be necessary to design a U.S. MPS basing system to be verifiable; otherwise, the United States would be unable to insist that a Soviet mobile missile system be designed with SALT verification in mind.

It is important to remember that the SALT provisions of relevance to a U.S. MPS basing system would be those in effect in the 1990s, including both new provisions negotiated in the future and those that might be retained from the SALT I treaty or the proposed SALT II agreement, if ratified. The proposed SALT II agreement, which would expire at the end of 1985 unless extended, might be considered a first step toward achieving the kinds of future SALT provisions important to an MPS basing system. During its life, the SALT II treaty would legally limit the Soviets to the deployment of no more than 820 launchers for multiple-warhead ICBMs, a limit that they could surpass by 1982 if there were no SALT restrictions and current deployment rates continued. In addition, the SALT II agreement would limit to 10 the number of warheads that could be flight-tested on an ICBM. Without such a limit, the Soviets might begin testing missiles with larger numbers of warheads; once such tests had occurred, it would be very difficult, perhaps impossible, to verify that the Soviets had not deployed missiles with larger numbers of smaller warheads.

The proposed SALT II agreement would leave unresolved the issue of establishing specific cooperative verification procedures for counting numbers of mobile ICBMs deployed, although precedents for cooperative measures may be established in the treaty. A protocol to the treaty, which would last until the end of 1981, would temporarily ban the deployment of mobile ICBM systems and the flight-testing of ICBMs from mobile launchers. The proposed SALT II agreement, however, explicitly permits deployment of mobile ICBM launchers after the expiration of the temporary protocol period. 30/

The SALT II agreement would, with one exception, contain no restrictions on missile production--another provision that might be important in the future if the United States decides to deploy an MPS basing system.

30/ See Fiscal Year 1980 Arms Control Impact Statements, Joint Committee Print, pp. 12-13.

CHAPTER IV. U.S. MISSILE OPTIONS

The MX program budget request contains funds for both a new, more survivable basing system and a new missile. Over the long run, the deployment of a new basing system would have the larger budgetary impact. In fiscal year 1980 and during the next two or three years, on the other hand, the major issue in the program budget will be whether or not to develop a new missile. Of the total fiscal year 1980 budget request of $675 million for the program, about $450 million would fund missile development activities. In addition, about $170 million of the $265 million fiscal year 1979 supplemental request would be for missile development.

In considering the MX program budget request, the Congress may find it useful to separate the basing and the missile decisions. Although the two decisions are related, they are separable since many types of missiles could be deployed in a multiple protective structure basing system. For example, it would be possible to redeploy a portion of the existing Minuteman force in an MPS basing system. Alternative options are also available among the new missiles. 1/

The missile and basing decisions also raise somewhat different issues that should be logically separated. For example, one reason for developing a new missile would be to improve the U.S. capability to destroy Soviet military targets, especially hardened underground ICBM silos. A new, more survivable basing system, on the other hand, might be deployed in order to maintain the present nuclear Triad, in which strategic weapons are distributed among three different basing systems. The question of what types of Soviet targets the U.S. arsenal should be able to destroy is a separable issue related more closely to the type and number of missiles deployed.

1/ Although the missile and basing decisions are conceptually separable, they are closely related in a technical sense. The characteristics of the missile--including size, weight, power requirements, and electronic systems--would have to be specified before the equipment for the basing system could be designed and tested.

This chapter examines three general missile options that the Congress could consider for deployment in an MPS basing system:

- o Full-scale development of the MX missile, a large ICBM designed to deliver many powerful nuclear warheads with high accuracy;

- o Initial development of a "fully common" missile that could be deployed both in an MPS basing system and in the large missile tubes of Trident submarines; and

- o Modification of the 5.50 existing silo-housed Minuteman III missiles for deployment in an MPS basing system.

Three major issues affect the missile choice. First, the costs to develop, deploy, and operate an MPS basing system for ICBMs would, to a certain extent, be dependent upon the type of missile deployed. Second, the retaliatory capabilities to be provided by the ICBM force deployed in an MPS basing system would have an important effect on the preference for one missile option over another. Third, the degree of commitment to the ultimate deployment of an MPS basing system would affect a choice among the missile options.

Cost Considerations. Costs would be affected in a variety of ways by the type of missile deployed in an MPS basing system. Use of existing Minuteman III missiles would minimize development and procurement costs, while efforts to combine the MX and Trident II missile programs would diminish missile development costs.

To some extent, the costs of an MPS basing system itself would be affected by the missile deployed in the system. The size of the missile and, thus, the number of warheads carried on each missile would be a particularly important factor. The number of warheads carried on each missile would determine the total number of missiles needed in order to provide a given number of warheads. Many MPS basing system costs would increase with the number of missiles deployed. A larger number of sets of missile-support equipment would have to be procured. The increased cost would not be insignificant; for example, 250 additional missile canisters and sets of support equipment would cost about $1.2 billion. Indirectly, the number of shelters would also depend on the number of missiles deployed. It has been assumed in this study that one U. S. silo-housed Minuteman missile would be retired for each missile deployed in an MPS basing system in order to remain within a future SALT limit on the number of multiple-warhead missiles that may be deployed. Each silo-housed missile retired would free two Soviet warheads for targeting on the U.S. MPS basing complex, thus requiring construction of an offsetting number of shelters. On the other hand, the unit cost of the shelters would increase with the size of the missiles deployed in the system; therefore, some costs would be lower if smaller missiles were deployed. Total basing costs would depend upon all these factors.

Retaliatory Capabilities. The retaliatory capabilities to be provided by an MPS basing system is the second issue that would affect the choice among missile options. Two specific questions about U.S. retaliatory capabilities relate closely to the missile decision. First, how many surviving warheads should an MPS basing system be designed to provide? Second, should the United States develop a missile with improved accuracy and an enhanced potential to destroy Soviet hard targets, especially ICBM silos?

The ranking of the missile options on the basis of cost would vary with the desired number of surviving U.S. warheads. An MPS basing system with Minuteman III missiles might constitute the least expensive option if the United States wanted a small number of surviving warheads--that is, about 500 surviving warheads. If the United States wanted an MPS basing system that could provide 2,000 or more surviving warheads, the development of a large MX missile would be the most attractive option on the basis of cost.

If the United States wanted to acquire an enhanced capability to destroy Soviet hard targets, the MX missile option would offer the greatest advantage. In addition, the MX missile might provide other technical improvements that would make it an attractive option.

Degree of Commitment. A common missile program, combining the MX and Trident II missile development programs, might be an attractive option if the Congress were uncertain about whether it ultimately wished to deploy an MPS basing system. If serious doubts existed, it might be more appropriate to develop a missile that could be deployed either in an MPS basing system or aboard Trident submarines, rather than a missile that was designed specifically for deployment in an MPS basing system. Thus, the missile choice should be considered in the context of larger questions about the U.S. commitment to maintain a survivable land-based ICBM force and about the relationship of the MX program to other programs, especially the Trident II missile program.

The following three sections briefly describe three missile options available to the United States. The discussion focuses on the major advantages and disadvantages of each missile. A fourth and final section compares the costs of an MPS basing system deploying the three alternative missile types. The comparison shows the effects on costs of varying the number of desired surviving U.S. warheads.

THE MX MISSILE

The MX missile would be a large intercontinental ballistic missile, measuring up to 92 inches in diameter and 70.5 feet in length and weighing up to 190,000 pounds. 2/ It would be designed to deliver a payload of 10 or more warheads. 3/ This would represent a significant increase in warhead-carrying capacity over the newest existing U.S. ICBM, the three-warhead Minuteman III missile. (The MX missile would provide approximately the same lifting power as the Soviet SS-19 missile, but would be about half as powerful as the Soviet SS-18 ICBM.) The MX missile would also be more accurate than the Minuteman III missile; its advanced

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2/ U.S. Department of the Air Force, MX; Milestone II, Final Environmental Impact Statement, Part I, Program Overview (October 1978), pp. I-11, I-15.

3/ The MX missile would be restricted to 10 warheads by the SALT II limit on the number of warheads that may be flight-tested on an ICBM. Without SALT restrictions, the missile would reportedly be capable of carrying 11 MK-12A warheads with a reported explosive yield of 335 kilotons. See Edgar Ulsamer, "Toward a New World Strategy," Air Force Magazine (January 1979), pp. 60-65; and Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978), pp. 20-22. Alternatively, MX missiles might be armed with 10 Advanced Ballistic Reentry Vehicles (ABRVs), which would have a reported explosive power of about 500 kilotons. See Edgar Ulsamer, "MX Status Report," Air Force Magazine (May 1979), pp. 22-25.

inertial guidance system could reportedly deliver warheads to within 400 feet of their targets. 4/

The MX missile's ability to carry 10 warheads would provide the maximum capability allowed an ICBM under the proposed SALT II treaty. With a large 10-warhead MX missile, the United States would need a smaller number of missiles in order to provide a given total number of warheads. In the future, the United States may begin to press against SALT missile limits. For example, the proposed SALT II agreement, if ratified, would limit to 1,320 the total number of multiple-warhead ICBMs, multiple-warhead submarine-launched ballistic missiles and aircraft armed with long-range cruise missiles. If the United States deployed about 600 multiple-warhead Poseidon and Trident SLBMs and 173 B-52s armed with long-range cruise missiles, then no more than about 550 multiple-warhead ICBMs could be deployed. Development of a new missile that could carry more than the three warheads mounted on the 550 existing Minuteman III missiles would be the only way to increase the number of warheads in the U.S. multiple-warhead ICBM force above the current level of 1,650. This would be an especially important concern for missiles deployed in an MPS basing system, because a large number of warheads would have to be deployed in order to allow for the fact that a portion of them could be destroyed in a Soviet first strike.

The improved accuracy and the large number of powerful warheads that could be provided by the MX missile could also improve the U.S. ability to destroy hard targets in the Soviet Union--including ICBM silos, nuclear weapon storage bunkers and other weapon depots, and underground command centers. If MX missiles were accurate to within 400 feet of their targets, each warhead delivered by a reliable missile would have a 90 percent chance of destroying a target hardened to resist blast pressures of 2,000 pounds per square inch. Thus, the MX missile could provide the United States with an improved capability to launch a second-strike retaliatory attack against well-protected Soviet military targets, in addition to a capability to destroy Soviet industrial complexes and soft military targets.

4/ Clarence A. Robinson, Jr., "MX Deployment Urged for Parity," Aviation Week and Space Technology (December 5, 1977), p. 14.

A large force of MX missiles would also pose a more serious first-strike threat against the Soviet silo-housed ICBM force. For example, with a force of MX missiles large enough to target two warheads on each Soviet ICBM silo, a task that would require some 2,000 to 3,000 warheads, the United States could destroy more than 90 percent of the Soviet: silo-housed missile force in a first strike. 5/ This attribute of the MX missile has been a particularly controversial issue.

By establishing a new active missile production line, the United States would also improve its ability to increase rapidly the *size* of the U.S. ICBM force. This would provide a hedge against the possibility that the U.S. submarine fleet or bomber force might encounter unexpected future problems, requiring rapid U.S. corrective action. It would also hedge against the possibility that SALT limits might be discontinued in the future, allowing the Soviets to build up their ICBM force.

The MX missile, like the common missile, could incorporate several technical improvements not available in existing Minuteman III missiles. The new missiles would have better protection against the dust, heat, and radiation encountered in a flight from an MPS basing complex that had already been attacked by the Soviet Union. An improved computer would allow more rapid retargeting of the missiles remaining after a Soviet first-strike attack. The missiles would also be designed so that the guidance system (the part of a missile that needs repair most frequently) could be removed without requiring the removal of the nuclear warheads positioned at the top of the missile, a design feature not available in existing Minuteman missiles.

Alternative Versions. Two versions of the MX missile are under consideration within the Department of Defense. The Air Force has recommended development of a missile with a diameter of 92 inches. Such a missile could reportedly carry 11 MK-12A warheads. 6/ Also under consideration is a missile with a

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5/ See Congressional Budget Office, Counterforce Issues for the U.S. Strategic Nuclear Forces, Background Paper (January 1978).

6/ Ulsamer, "Toward a New World Strategy," pp. 60-65.

diameter of 83 inches that would allow two of the three main booster stages to be used in the Navy's planned Trident II missile when that missile was developed later in the 1980s. The Air Force version of the missile, known as the "partly common" missile, would be much larger than the Trident II missile and would probably use a different guidance system. The 83-inch diameter missile, however, would be somewhat smaller in total volume than the 92-inch diameter version. Although smaller in volume, most of the lifting power of the MX missile would be retained by using high-energy rocket propellants. A small amount of power would be lost, however, reducing the number of MK-12A warheads that could potentially be carried from 11 to 10 and cutting the range slightly. 7/

By making two MX missile booster stages compatible with the Navy's Trident II missile design, savings of approximately $350 million could be achieved if a Trident II development program were undertaken later in the 1980s. Three possible disadvantages might be associated with a program linking the development of the MX and Trident II missiles. First, because the precise design of the Trident II missile is as yet undefined, coordination of the two programs would slow the MX development schedule, thereby possibly eroding the cost savings. Second, any reliability or aging problems encountered in the two common booster stages would affect both the ICBM force and the submarine missile force, thus reducing the hedging provided by having three separate strategic forces. Third, the reduced-diameter missile would provide somewhat less lifting power, or "throwweight." Although the MX missile would be limited to 10 warheads by the proposed SALT II agreement, the extra throwweight provided by the 92-inch diameter missile could be used to carry decoy warheads designed to confuse a Soviet ballistic missile defense system or to carry larger, more powerful warheads. 8/

7/ Ibid.

8/ For example, the MX missile could carry 10 ABRVs, which would have a reported explosive power of about 500 kilotons. See Ulsamer, "MX Status Report," pp. 22-25. A warhead of this size would improve the ability of the MX missile to destroy Soviet hard targets, and it could increase the area destruction potential of each warhead. The ABRV would cost about $750 million to develop, and each warhead would cost

Development of the MX missile would cost about $4.7 billion. A major portion of that cost--about $500 million--would be associated with the development of an the Advanced Inertial Reference Sphere (AIRS) for the guidance system. If the Congress does not wish to provide the United States with an improved capability to destroy Soviet hard targets, consideration could be given to the possibility of vising a modified version of the existing NS-20 guidance system designed for the Minuteman III missile. 9/

Table 7 shows the estimated costs to develop, deploy, and operate an MPS basing system with MX missiles for four different numbers of surviving warheads.

THE COMMON MISSILE

The Navy designed the Trident submarine to carry a missile 83 inches in diameter and 44 feet in length. Such a missile, which could be developed during the latter half of the 1980s, would be about twice *as* powerful as the Trident I missiles now being produced for deployment aboard 12 existing Poseidon submarines and the first Trident submarines that are to enter the fleet in the early and middle 1980s.

Instead of developing two new missiles, one for the Air Force's MPS basing system and one for the Navy's Trident submarines, it might be possible to develop one missile that could serve both purposes. By developing such a "fully common" missile, some of the expense of developing two separate missiles might be saved.

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about 10 percent more than an MK-12A warhead. See Department of Defense Authorization for Appropriations for Fiscal Year 1978, Hearings before the Senate Committee on Armed Services, 95:1 (April 1977), Part 10, p. 6560.

9/ Use of a guidance system based on the NS-20 design, but with an improved capability to withstand nuclear effects and with a capability to travel in all directions, would save about $150 million in development and about $230 million in procurement (based on procurement *of* a total of 500 MX missiles).

TABLE 7. COSTS OF MX MISSILES IN A MULTIPLE PROTECTIVE STRUCTURE BASING SYSTEM: IN BILLIONS OF FISCAL YEAR 1980 DOLLARS

Desired Number of Surviving Warheads	Total System	Development			Investment			Operating
		Total	Missile	Basing	Total	Missile	Basing	
500 a/	30.9	7.1	4.7	2.4	18.5	3.9	14.6	5.3
1,000 b/	34.7	7.1	4.7	2.4	22.2	5.2	17.0	5.4
1,500 c/	37.8	7.1	4.7	2.4	25.3	6.3	19.0	5.4
2,000 d/	40.7	7.1	4.7	2.4	28.1	7.3	20.8	5.5

NOTE: The costs are based on the "no-response" Soviet ICBM threat described in Chapter II. Cost estimates were derived from the MX Cost Effectiveness Model developed by the Space and Missile Systems Organization of the Air Force. Appendix A provides a brief description of this model. The costs do not include warhead costs, which are classified. Costs assume that one silo-housed Minuteman III missile would be retired for each missile deployed in an MPS basing system.

a/ 190 MX missiles and 4,700 vertical shelters.

b/ 310 MX missiles and 5,500 vertical shelters.

c/ 420 MX missiles and 6,100 vertical shelters.

d/ 520 MX missiles and 6,700 vertical shelters.

Because the constraints imposed by the Trident submarine would determine both the size and the type of guidance system of such a common missile, a missile to be used by both the Air Force and the Navy would have to resemble closely the Trident II missile design. Thus, a fully common missile, like the Trident II, would have only about one-half the lifting power of the MX missile. 10/ It would, however, be roughly twice as powerful

10/ U.S. Department of the Air Force, MX; Milestone II, Final Environmental Impact Statement, Part I, Program Overview (October 1978), pp. I-14, I-15.

as the existing Minuteman III ICBM. The common missile would have a throwweight of about 5,000 pounds, compared with 7,850 pounds for the MX missile. The Minuteman III missile has a throwweight of 2,200 pounds. 11/

Some adjustments would have to be made in order to assure that the common missile would be compatible with deployment in an MPS basing system. For example, at a minimum, the missiles could be designed to provide protection against the nuclear effects they would encounter in flight from an MPS basing complex that had been attacked by the Soviet Union. 12/ In addition, the Navy would have to accelerate its Trident II development program in order to achieve an initial operational capability for a common missile in fiscal year 1987, closer to the time when the Air Force would have its first set of shelters ready.

Potential Advantages. There are two major potential advantages to be gained from a common missile program. First, some of the costs associated with the development of two new long-range ballistic missiles might be saved. The MX and Trident II missiles would cost about $5 billion each to develop, so the potential savings are significant. A common missile program would not necessarily save $5 billion, however. Developing *a* common missile that would be compatible with both MPS basing and submarine basing would increase development costs. In addition, deployment of a missile smaller than the MX in an MPS basing system might increase the costs of the basing complex, a possibility that is addressed in a following section.

If a separate MX missile were developed and an MPS basing system deployed, the large costs of the Air Force program, coupled with the need for overall budget: constraints, might preclude major funding for the separate development of a second missile for the Navy. As Table 1 in Chapter I indicates, the MX program could require annual funding of $3 billion to $6 billion from fiscal

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11/ See Edgar Ulsamer, "The Survivable ICBM Challenge," Air Force Magazine (September 1978), pp. 25-26.

12/ Common missiles deployed in an MPS basing system would have to be fitted with a different shroud than would the missiles deployed in submarines. The Air Force shroud would be designed to provide substantial protection against dust in the atmosphere.

year 1983 through fiscal year 1987. This high budgetary impact would mean that funds for other strategic programs would be especially scarce. Moreover, because funds are needed for other naval programs, the Navy has been reluctant to commit major resources to the Trident II missile development program, for which annual funding requirements could reach $1 billion or more. Full-scale development of the Trident II missile might well be deferred until the late 1980s, thereby delaying its availability until the middle 1990s. A common missile program might be the only way to develop more rapidly a new, large missile for the Trident submarines, along with an MPS basing system. 13/

Flexibility in missile basing is the second potential advantage to be gained from a common missile program. A common missile, if developed, could be deployed either aboard Trident submarines or in an MPS basing system. Thus, if the Congress were to decide ultimately not to deploy an MPS basing system, funds spent on the development of a new missile would not have been wasted. Such a hedge against a decision not to deploy an MPS basing system may be deemed desirable because the Congress may be undecided about whether or not the deployment of a new land-based ICBM system would be preferable to a policy of placing increased reliance on strategic submarines and aircraft.

As pointed out earlier, the Congress will face a major decision about the development of a new missile before it must commit major funding to the deployment of a new basing system. By pursuing a common missile program, it could avoid the commitment of major funding to a missile suited primarily for deployment in an MPS basing system. The option discussed here assumes that

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13/ The earlier availability of the Trident II missile could offer potential budgetary savings. Procurement of a relatively small number of Trident submarines with large Trident II missiles might provide a less expensive alternative to the deployment of an equally capable force consisting of a larger number of Trident submarines armed with smaller Trident I missiles. Moreover, if the Trident II missile became available sooner, fewer Trident I missiles would have to be bought for Trident submarines that entered the fleet before the Trident II missile became available. This consideration is discussed in a forthcoming CBO paper on the costs of future sea-based deterrent systems.

full-scale development of a common missile would begin in fiscal year 1981 and that a production line would be established in fiscal year 1984. The Navy could start buying missiles in fiscal year 1984, with the first missiles available for deployment by fiscal year 1987. Meanwhile, the Congress could continue funding the development of components for an MPS basing system designed for compatibility with the fully common missile, and it could initiate the land acquisition process for the new basing system. Major funding for construction of an MPS basing system would not begin until fiscal year 1983. Until that time, the Congress would maintain the option to forego deployment of an MPS basing system and to procure common missiles for Trident submarines only.

A common missile program would also hedge against a decision not to deploy an MPS basing system by speeding the availability of a more capable missile for the Navy's Trident submarines. If such a missile became available for deployment in Trident submarines by fiscal year 1987, the Congress would have the option to increase rapidly the capabilities of the strategic submarine force as new Trident submarines entered the fleet in the latter half of the 1980s. By contrast, if the MX missile was developed, and if the Navy developed its Trident II missile at a slower pace because of budgetary constraints, the United States would have few options immediately available in the latter half of the 1980s in the event that an MPS basing system was not deployed.

Potential Disadvantages. Although a common missile program might offer important potential advantages, it could also suffer from possible disadvantages. First, there is a risk that missile development cost savings might be eroded despite the common program. Complications and coordination problems associated with the development of a missile designed for compatibility with two different basing systems might significantly increase the costs of the missile development program. Each change in the missile design might have to take into account the complex electronic systems of both a Trident submarine and an MPS basing system, resulting in costly delays and redesigns. Over the course of the program, the missile design might become more and more complicated and constrained by the necessity of having to provide connections with two different basing systems. This added complexity could create a potential for delays and cost overruns that would not be experienced in separate missile development programs.

It is difficult to estimate the effect such added complexity might have on costs. The extent of the problem might depend upon such imponderables as the design of the electronic systems, or on whether each of the two services would insist that a common missile incorporate all of the unique design features that its own missile would have had. The Navy estimates that a realistic budget for the development of a fully common missile would be at least $6.9 billion in 1980 dollars, an estimate that includes a 20 percent added reserve for possible cost increases due to added complexity. 14/ (This estimate is used in the costs for the common missile option shown in Table 8.) This cost, however, is still lower than the combined cost of separate MX and Trident II missile development programs ($4.7 billion and $5.2 billion, respectively, for a combined total of $9.9 billion).

Second, use of a common missile for deployment both in Trident submarines and in an MPS basing system would increase the risk that unexpected reliability or aging problems found in U.S. ballistic missiles would jeopardize both the submarine missile force and the land-based ICBM force. Such problems have been encountered in the past. For example, in the early 1970s, a reliability problem was discovered with the Poseidon submarine-launched ballistic missile. 15/ Aging problems have also been encountered; for example, aging of the second booster stage of the Minuteman II missile may, in the future, require corrective action. 16/

A third possible disadvantage of a common missile program might be smaller missile size. Smaller fully common missiles could carry fewer warheads than MX missiles, thus providing somewhat less capability under SALT missile ceilings.

Because the common missile would carry fewer warheads than the MX missile, more common missiles would have to be deployed

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14/ Information provided to CBO by the Office of Legislative Affairs, U.S. Navy (May 15, 1979).

15/ U.S. Department of Defense, Annual Report, Fiscal Year 1975, pp. 57-58.

16/ Department of Defense Authorization for Appropriations for Fiscal Year 1979, Hearings before the Senate Committee on Armed Services, 95:2 (April and May 1978), Part 9, p., 6513.

in an MPS basing complex in order to provide a given number of warheads. Deployment of a larger number of smaller missiles would affect the costs of an MPS basing system. A larger number of sets of missile-support equipment would have to be procured. And because more missiles would be deployed in an MPS basing system, more silo-housed Minuteman ICBMs would have to be retired (under the assumption that one silo-housed missile would be retired for each missile deployed in an MPS basing system). This would allow the Soviets to target additional warheads on the MPS basing complex, thereby requiring a slightly larger number of shelters. On the other hand, smaller missiles would require smaller shelters, thereby reducing the total cost of adding a shelter to an MPS basing complex from $2.6 million to $2.2 million. On balance, basing costs for smaller fully common missiles would be comparable to those for larger MX missiles.

The guidance system used in the common missile would probably be somewhat less accurate than the advanced inertial guidance system planned for the MX missile, although missile accuracy would probably be "nearly comparable." 17/ This lesser accuracy would mean less U.S. ability to destroy hard targets in the Soviet Union. If the Congress wishes to acquire an improved capability to destroy Soviet hard targets, deployment of common missiles in an MPS basing system would be a less attractive option than the MX missile option.

A common missile program would also slightly slow the availability of a new missile for deployment in an MPS basing system. The fiscal year 1986 initial operational capability for the MX missile would probably be slowed by one year. The Navy's Trident II missile is in a less advanced stage of development than the Air Force's MX missile. The design of the Trident II missile is not precisely defined; initial testing of components to be used in the missile has not taken place; and some time would probably be required for design and management coordination between the Navy and the Air Force. The option described here assumes that, by undertaking intensive efforts in the remainder of fiscal year 1979--using funds from the supplemental authorization--and in fiscal year 1980, a common missile might be ready for full-scale

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17/ U.S. Department of the Air Force, MX; Milestone II, Final Environmental Impact Statement, Part I, Program Overview (October 1978), p. I-14.

development in fiscal year 1981. The first missiles could be deployed six years later, in fiscal year 1987.

A delay of one year in the availability of a new missile for an MPS basing system may not be considered a serious problem. Because it would take several years to construct enough shelters for the system, the completion date of an MPS basing system may be more important than the date of initial missile deployment. Thus, the schedule for the land acquisition process and for shelter construction may be more important than the missile development schedule.

Table 8 shows the costs for an MPS basing system with common missiles deployed. Table 9 shows an illustrative funding schedule for a common missile development program.

MODIFIED MINUTEMAN III MISSILES

The existing force of 550 Minuteman III missiles now deployed in fixed silos could, with relatively minor modifications, be deployed in an MPS basing system. Minuteman III missiles carry only three warheads, compared with at least 10 warheads on MX missiles. 18/

Potential Advantages. Deployment of Minuteman III missiles in an MPS basing system would eliminate the high development and procurement costs that would be incurred if new MX or Trident II missiles were deployed. Development costs for the modification of Minuteman III missiles would be only about $600 million, compared with a cost of about $5 billion to develop a new missile. Modifying enough Minuteman III missiles to support a deployed force of 550 missiles would cost only about $900 million, 19/ compared

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18/ The Minuteman III missile measures 52 inches to 66 inches in diameter, 60 feet in length, and weighs 78,000 pounds. See Department of Defense Authorization for Appropriations for Fiscal Year 1979, Hearings, Part 9, p. 6464.

19/ Modifications to Minuteman III missiles would include making them compatible both with launching from canisters and with the movement of fully assembled missiles among the shelters and maintenance facilities in an MPS basing system. (Under

TABLE 8. COSTS OF COMMON MISSILES IN A MULTIPLE PROTECTIVE STRUCTURE BASING SYSTEM: IN BILLIONS OF FISCAL YEAR 1980 DOLLARS

Desired Number of Surviving Warheads	Total System	Development				Investment			Operating
		Total	Missile	Navy Missile Savings	Basing	Total	Missile	Basing	
500 a/	26.7	4.0	6.9	-5.2	2.3	17.3	3.5	13.8	5.4
1,000 b/	31.0	4.0	6.9	-5.2	2.3	21.6	5.1	16.5	5.4
1,500 c/	35.0	4.0	6.9	-5.2	2.3	25.1	5.9	19.2	5.9
2,000 d/	41.5	4.0	6.9	-5.2	2.3	29.7	5.9	23.8	7.8

NOTE: The costs are based on the "no-response" Soviet ICBM threat described in Chapter II. Cost estimates were derived from the MX Cost Effectiveness Model developed by the Space and Missile Systems Organization of the Air Force. Appendix A provides a brief description of this model. The costs do not include warhead costs, which are classified. Costs assume that one silo-housed Minuteman III missile would be retired for each missile deployed in an MPS basing system. The costs that the Navy would have incurred in developing the Trident II missile ($5.2 billion) and in establishing a production line ($310 million) have been subtracted from the total program costs. (The Navy would fund separately the development of the special equipment required for Trident II missiles deployed in Trident submarines.) The costs shown here are for a common missile capable of carrying six warheads.

a/ 270 common missiles and 5,200 vertical shelters.

b/ 450 common missiles and 6,300 vertical shelters.

c/ 550 common missiles and 7,600 vertical shelters.

d/ 550 common missiles and 10,500 vertical shelters. This option is limited to the deployment of 550 missiles by a postulated future SALT limit.

TABLE 9. ILLUSTRATIVE FUNDING PROFILE FOR COMMON MISSILES IN A MULTIPLE PROTECTIVE STRUCTURE BASING SYSTEM: BY FISCAL YEARS, IN MILLIONS OF FISCAL YEAR 1980 DOLLARS

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Development												
Missile	450	900	1,400	1,200	1,100	900	700	250	--	--	--	1,700 a/
Basing	200	400	500	400	300	200	200	100	--	--	--	2,300
Total	650	1,300	1,900	1,600	1,400	1,100	900	350	--	--	--	4,000 a/
Investment												
Missile	--	--	--	400	1,100	1,000	900	900	800	--	--	5,100
Basing	--	--	--	1,700	3,700	4,000	3,600	3,100	400	--	--	16,500
Total	--	--	--	2,100	4,800	5,000	4,500	4,000	1,200	--	--	21,600
Operations and Maintenance	--	--	--	--	--	--	300	300	400	400	400 b/	5,400
TOTAL	650	1,300	1,900	3,700	6,200	6,100	5,700	4,650	1,600	400	400 b/	30,700 a/

NOTE: The costs assume an MPS basing system that could provide 1,000 surviving warheads. The costs are based on the "no-response" Soviet ICBM threat described in Chapter II. Cost estimate* were derived from the MX Cost Effectiveness Model developed by the Space and Missile Systems Organization of the Air Force. The costs do not include warhead costs, which are classified.

a/ The costs of the Navy's Trident II missile development program ($5.2 billion) have been subtracted.

b/ Annual system operating costs of $400 million would continue for nine additional years not shown on this table.

with a cost of at least $3.5 billion for the procurement of new missiles. Although the costs of the MPS basing complex itself would be higher if Minuteman III missiles rather than larger MX or Trident II missiles were deployed, total costs could be lower if the United States designed its MPS basing system to provide about 500 surviving warheads.

By cancelling or delaying plans to develop a new missile, deployment of Minuteman III missiles in an MPS basing system would also allow the United States to reduce the amount of funding required in the early 1980s for a new ICBM system (see Table 11). This would allow near-term budgetary savings. It would also have the effect of separating politically the decision to deploy a new, more survivable basing system from the decision to develop a new, more powerful and more accurate missile.

Deployment of modified Minuteman III missiles in an MPS basing system might be an attractive option to those who wish to avoid the acquisition of an improved capability to destroy hard targets in the Soviet Union, especially Soviet ICBM silos. As discussed in the next chapter, such a capability is considered undesirable by some observers because it might increase Soviet incentives to strike first in a crisis and to develop new strategic weapons systems. Existing Minuteman III missiles, even though their accuracy has been recently improved, and even if more powerful MK-12A warheads were deployed on all 550 missiles, 20/ would have at best a modest capability to destroy hard targets.

Potential Disadvantages. Although the Minuteman III option has some potentially positive features, it also has several

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existing practices, missile boosters are transported separately from guidance system components and nuclear warheads.) A new sabot for the first booster stage would be necessary for launching from a canister. Horizontal movement of fully assembled missiles would require the modification of the propellant tanks for the fourth-stage post-boost propulsion system. Strengthening of the platform that holds the missile's nuclear warheads and rotation of the missile's guidance equipment would also be required. See Ibid., p. 6501.

20/ Current planning calls for the deployment of MK-12A warheads on 300 Minuteman III missiles. See U.S. Department of Defense, Annual Report, Fiscal Year 1980, p. 66.

significant disadvantages. For several reasons, deployment of Minuteman III missiles would increase the costs of an MPS basing system. These additional costs would erode and could, at some point, overwhelm the savings gained in missile development and procurement. Most important, an MPS basing system deploying Minuteman III missiles would require a large number of shelters. This would be the only way to provide a large number of surviving warheads because possible SALT missile ceilings and the lack of a production line would limit the number of Minuteman III missiles that could be deployed in an MPS basing system. 21/ For example, if the United States wanted 1,000 surviving warheads, about 61 percent of the 1,650 warheads on the existing 550 Minuteman III missiles would have to be able to survive a Soviet attack. This would require the construction of enough shelters to ensure that 61 percent of the shelters could survive an attack. If the Soviets were limited to the "no-response" ICBM threat described in Chapter II, more than 10,000 shelters would be required in order to ensure the survival of 61 percent of the shelters and missiles and, thus, 1,000 warheads. This compares with a requirement for 5,500 shelters if MX missiles were deployed.

Other factors would contribute to the high costs of an MPS basing system with Minuteman III missiles deployed. Many sets of missile-support equipment would be required because of the large number of deployed missiles. Moreover, because all 550 existing silos for Minuteman III missiles would be dismantled as the missiles were redeployed in an MPS basing complex, more Soviet warheads could be targeted on the complex and, thus, more U.S. shelters would be required. With a large number of deployed missiles and shelters, a large number of operating personnel would be required.

21/ It would take about three and one-half years and $600 million to resume production of additional missiles. (Information provided to CBO by U.S. Air Force, October 25, 1978.) In addition, production of additional missiles would diminish one of the major potential cost advantages provided by the Minuteman III option. In any case, future SALT limits on the number of multiple-warhead ICBMs, multiple-warhead submarine-launched ballistic missiles, and aircraft armed with long-range cruise missiles would probably prohibit the deployment of a large number of additional Minuteman III missiles.

Even if the total costs for an MPS basing system with Minuteman III missiles deployed were lower than the costs for a system with new MX or Trident II missiles, the Minuteman III option would still suffer from significant disadvantages. The costs shown later in this chapter for the Minuteman III option assume that the missiles would be based in the northern section of the United States, in areas near existing missile bases. In contrast, new MX or Trident II missiles would be based in the Southwest, probably in Nevada or Arizona. Northern basing would entail potential problems not found in the same degree in the Southwest. The land in the North would be privately owned agricultural land, more heavily populated than areas in the Southwest that are under consideration. Attempts to acquire such land for a new missile basing system would likely encounter more serious public opposition. In addition, the weather in the North would hinder both construction and operations. Moreover, weight limits for the existing road system would prohibit the future deployment of a larger missile in an MPS basing complex located in the North.

If Minuteman III missiles were deployed in an MPS basing system in the Southwest, the missiles would lack sufficient range. To provide extra range, a new second stage would have to be developed and procured. Obviously, if Minuteman III missiles were deployed in the Southwest, existing base facilities and roads in the North could not be used. Overall, Southwest basing of Minuteman III missiles would increase costs by about $3.5 billion if 550 missiles were deployed in a system of about 10,000 shelters.

Use of existing Minuteman III missiles would also deny the United States an opportunity to incorporate missile technology improvements into a new missile. These improvements include increased protection for the missiles against nuclear effects encountered in flight and an improved capability to retarget the missiles deployed in an MPS basing system after surviving a Soviet attack. The opportunity to improve the accuracy of U.S. ICBMs, a controversial issue, would also be relinquished if Minuteman III missiles were deployed in an MPS basing system.

Finally, the age of the Minuteman III missiles, the oldest of which will be approaching 15 years of age by the mid-1980s, may be a matter of concern. The expense of extending the service life of 550 Minuteman III missiles into the 1990s has not been included in the costs shown in this chapter. It should be noted, however, that much of this potential cost would have to be borne even if new MX or Trident II missiles were deployed in an MPS basing system. Indeed, in both these cases, the number of shelters constructed for an MPS basing complex assumes that the bulk of the silo-housed missile force would be retained indefinitely and that these silos would absorb a large number of Soviet warheads that could otherwise be targeted on an MPS basing complex.

Deployment of 550 Minuteman III missiles in an MPS basing system would also make it more difficult for the United States to fit its strategic programs within future SALT limits on the number of multiple-warhead ICBMs, multiple-warhead submarine-launched ballistic missiles, and aircraft armed with long-range cruise missiles. For example, with 550 multiple-warhead ICBMs and 173 B-52 bombers armed with long-range cruise missiles, 22/ the United States could deploy only 597 Trident submarine-launched ballistic missiles and new cruise missile carrier aircraft and still remain within the 1,320 limit imposed by the proposed SALT II agreement. 23/ If allowable limits were lowered in a future SALT agreement, constraints on U.S. programs would become tighter.

The costs to deploy 550 modified Minuteman III missiles in an MPS basing complex are shown in Table 10. An illustrative funding schedule for a Minuteman III missile program is shown in Table 11.

COMPARISON OF MISSILE AND BASING COSTS OF THE THREE OPTIONS

This section compares the total costs to develop, deploy, and operate an MPS basing system deploying three alternative missiles. The ranking of the missile options in order of relative

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22/ Fiscal Year 1980 Arms Control Impact Statements, Senate Committee on Foreign Relations and House Committee on Foreign Affairs, Joint Committee Print, 96:1 (March 1979), p. 31.

23/ The MX and common missile options also contain 550 multiple-warhead ICBMs because they assume that the United States would retire only one silo-housed Minuteman III missile for each missile deployed in an MPS basing system. The silo-housed Minuteman III missiles assumed to be kept in the force could, however, be retired without significantly reducing the capabilities of an MPS basing system with MX or common missiles deployed.

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TABLE 10. COSTS OF 550 MODIFIED MINUTEMAN III MISSILES IN A MULTIPLE PROTECTIVE STRUCTURE BASING SYSTEM: IN BILLIONS OF FISCAL YEAR 1980 DOLLARS

Desired Number of Surviving Warheads	Total System	Development Total	Development Missile	Development Basing	Investment Total	Investment Missile	Investment Basing	Operating
500 a/	19.6	2.6	0.6	2.0	14.5	0.9	13.6	2.5
1,000 b/	30.9	2.6	0.6	2.0	23.8	0.9	22.9	4.5
1,500 c/	109.0	2.6	0.6	2.0	87.9	0.9	87.0	18.5

NOTE: The costs are based on the "no-response" Soviet ICBM threat described in Chapter II. Cost estimates were derived from the MX Cost Effectiveness Model developed by the Space and Missile Systems Organization of the Air Force. Appendix A provides a brief description of this model. The costs do not include warhead costs, which are classified, although 300 of the 550 Minuteman III missiles will be armed with MK-12A warheads in a separate program. Costs assume that the lack of a missile production line and future SALT missile ceilings would limit to 550 the number of Minuteman III missiles that could be deployed. Costs also assume that missiles would be based in the North, using facilities at existing bases (including base facilities, upgraded roads, and modified silos). If Minuteman III missiles were based in the Southwest, additional expenditures would be required, including $1.15 billion for new second stages for the missiles to extend their range, about $1.2 billion for new base facilities, and an additional $110,000 per shelter for new roads.

a/ 550 modified Minuteman III missiles and 5,900 vertical shelters.

b/ 550 modified Minuteman III missiles and 10,300 vertical shelters.

c/ 550 modified Minuteman III missiles and 41,800 vertical shelters.

cost would vary with the number of surviving warheads the United States would design its basing system to provide. Table 12 shows the costs of the three missile options for four numbers of surviving warheads, ranging in increments of 500 warheads from 500 to 2,000 warheads. In general, the table shows that the use of existing Minuteman III missiles could be the least expensive option only if the United States wanted a relatively small number of surviving warheads. The MX missile would represent the cheapest alternative for high numbers of surviving warheads. In the middle of the range, the common missile option could be about $3 billion to $4 billion cheaper than the MX missile option if it is assumed that a separate Trident II missile development program would have been funded by the Navy.

TABLE 11. ILLUSTRATIVE FUNDING PROFILE FOR MODIFIED MINUTEMAN III MISSILES IN A MULTIPLE PROTECTIVE STRUCTURE BASING SYSTEM: BY FISCAL YEARS, IN MILLIONS OF FISCAL YEAR 1980 DOLLARS

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Development												
Missile	--	--	100	200	100	100	100	--	—	—	—	600
Basing	200	600	600	350	200	50	--	--	--	--	--	2,000
Total	200	600	700	550	300	150	100	--	--	--	--	2,600
Investment												
Missile	--	--	--	50	50	100	200	200	150	150	—	900
Basing	—	--	--	2,200	5,200	5,300	4,900	3,300	1,850	150	—	22,900
Total	--	--	--	2,250	5,250	5,400	5.100	3,500	2.000	300	--	23,800
Operations and Maintenance	—	--	—	—	—	—	150	150	350	350	350 a/	4,500
TOTAL	200	600	700	2,800	5,550	5,550	5,350	3,650	2,350	650	350 a/	30,900

NOTE: The costs assume an MPS basing system that could provide 1,000 surviving warheads. The costs are based on the "no-response" Soviet ICBM threat described in Chapter II. Cost estimates were derived from the MX Cost Effectiveness Model developed by the Space and Missile Systems Organization of the Air Force. Costs assume basing in the North.

a/ Annual system operating costs of $350 million would continue for nine additional years not shown on the table.

All the costs shown in Table 12 assume vertical shelter basing. Relative missile costs could be somewhat different if missiles were based on special trains in a network of trenches.

The United States might want an MPS basing system that could provide 500 surviving warheads if an ability to destroy a large number of Soviet cities were deemed a sufficient retaliatory mission for the ICBM force. An MPS basing system that could provide 1,000 surviving warheads would allow the more complete

TABLE 12. COMPARISON OF COSTS OF MISSILE OPTIONS IN AN MPS BASING SYSTEM: IN BILLIONS OF FISCAL YEAR 1980 DOLLARS

Desired Number of Surviving Warheads	MX Missiles	Common Missiles a/	Modified Minuteman III Missiles b/
500	30.9	26.7	19.6
1,000	34.7	31.0	30.9
1,500	37.8	35.0	109.0
2,000	40.7	41.5	Infeasible

NOTE: The costs are based on the "no-response" Soviet ICBM threat described in Chapter II. They also assume vertical shelter basing. Cost estimates were derived from the MX Cost Effectiveness Model developed by the Space and Missile Systems Organization of the Air Force. The costs do not include warhead costs, which are classified.

a/ Costs of the common missile have been reduced by the amount that the Navy would have spent in developing a new missile for the Trident submarine, but they reflect the added costs expected in a common missile development program.

b/ The costs for the Minuteman III option assume that only 550 missiles would be deployed and that these missiles would be based in the North. Southwest basing would increase costs.

destruction of Soviet industrial targets; alternatively, the 1,000 warheads could be used to destroy a substantial number of Soviet military facilities. A force with 1,500 to 2,000 surviving warheads would allow targeting of the U.S. ICBM force on a substantial portion both of Soviet industrial targets and of Soviet military facilities.

Deployment of modified Minuteman III missiles in an MPS basing system would be the least expensive option if the United States wanted an MPS basing complex that could provide 500 surviving warheads. In this case, only about 30 percent of the 1,650 warheads on the 550 Minuteman III missiles would have to be able to survive a Soviet attack, thus requiring the construction of only a relatively small number of shelters. The small missile development and procurement costs for the Minuteman III missile option would make this alternative the cheapest of the three for the 500 surviving warheads case.

Costs for the Minuteman III option would increase by more than $11 billion if the United States wanted 1,000 surviving warheads. In this case, more than 60 percent of the Minuteman III missiles would have to be able to survive a Soviet attack, requiring construction of a large number of shelters. The increased shelter costs would make the Minuteman III option about as expensive as the MX and common missile options for the 1,000 surviving warheads case. It would be prohibitively expensive or infeasible to provide 1,500 or 2,000 surviving Minuteman warheads, since there are only 1,650 warheads in the entire Minuteman III force.

Table 12 shows that the common missile option would be less expensive than the MX missile option if the United States wanted between 500 and 1,500 surviving warheads. This conclusion assumes that--in the absence of a common missile program--the Navy would, at some point in the future, fund a separate program to develop a new missile for the Trident submarine. 24/

24/ Although the expense of developing the Trident II missile (estimated to cost $5.2 billion), could be eliminated by a common missile program, the Navy would still have to fund development of the unique components associated with submarine basing. Similarly, the Air Force would still *have* to provide about $2 billion for the development of components for an MPS basing complex.

The costs for the common missile option are based on a development program that includes an added reserve fund of 20 percent to account for extra expenses caused by the complexity of providing compatibility with two basing systems. If extra costs proved to be higher than 20 percent, the common missile option would begin to lose its cost advantage over the MX missile.

If the United States wanted an MPS basing system that could provide 2,000 or more surviving warheads, the MX missile option would be less expensive than the common missile option. Thus, if the United States wanted an ICBM force that could provide a large amount of retaliatory capability, the MX missile would represent the preferred option on the basis of cost. In this case, cost considerations would parallel other considerations, since the improved capabilities of the MX missile would be well suited for the destruction of military targets, a retaliatory mission likely to be associated with a requirement for 2,000 surviving warheads.

All the costs in Table 12 assume that the Soviets would be limited to the "no-response" ICBM force described in Chapter II. As was shown in Chapter III, costs of an MPS basing system could increase if, in the absence of future SALT limits, the Soviets increased the number of warheads in their ICBM force. The relative rankings of the missile options, however, would remain similar under most types of Soviet buildup, assuming that the Minuteman III production line was reopened and additional missiles deployed.

CHAPTER V. ASSESSING THE NEED FOR A MORE SURVIVABLE LAND-BASED MISSILE SYSTEM

By deploying an MPS basing system for ICBMs, the United States could maintain a Triad of strategic forces similar to that which exists today. The general alternative to this course would be to place increased reliance on strategic submarines and aircraft. This chapter examines the advantages and disadvantages of the former option: development and deployment of an MPS basing system in response to the growing vulnerability of existing silo-housed Minuteman and Titan ICBMs.

MODERNIZING U.S. STRATEGIC FORCES

Although this paper has focused on MPS basing, the land-based ICBM force cannot be considered in isolation from other strategic forces. Neither can programs to modernize the submarine and aircraft components be considered independently from decisions about the future of the land-based ICBM force. Indeed, the Congress faces decisions about programs to modernize all three parts of the strategic nuclear Triad.

Submarine Programs. The Trident submarine program was begun in the early 1970s in response to the eventual aging of the fleet of Polaris and Poseidon missile-carrying submarines. Seven Trident submarines have already been authorized by the Congress through fiscal year 1979. The new, long-range Trident I missile now in production will be deployed in the first Trident submarines constructed and on at least 12 Poseidon submarines currently in the fleet. Major submarine force modernization issues remain, however. First, the total number of Trident submarines to be produced has not been determined. Second, there is the question of whether or not the United States should develop and produce a larger and potentially more accurate Trident II missile for deployment aboard Trident submarines. How these issues are resolved will depend upon decisions made concerning improvements to the ICBM force. For example, one alternative to the deployment of a new, more survivable ICBM system is the procurement of a fleet of Trident submarines larger than the force that would have been deployed along with a new ICBM system.

Strategic Aircraft. Continually improving Soviet air defense systems threaten the future ability of U.S. B-52 bombers to penetrate Soviet defenses and deliver their weapons to assigned targets. A program to arm 173 B-52 bombers with long-range air-launched cruise missiles has been undertaken in order to counter projected improvements in Soviet defenses. Yet, other strategic aircraft modernization issues remain. For example, the Department of Defense is studying the possibility of procuring a variant of an existing transport jet for use as a cruise missile carrier aircraft. Such an option would allow large numbers of cruise missiles to be added to the U.S. force. Also under study is the possibility of deploying a force of airmobile ICBMs aboard new transport aircraft. In addition, it is possible that the capabilities of the aging B-52 bomber force may have to be replaced in the late 1980s or 1990s. Again, whether any new strategic aircraft option is pursued may depend upon decisions made about the deployment of ICBMs in an MPS basing system.

The Mix of Strategic Nuclear Forces. In considering all of the various programs outlined above, the Congress will be deciding how best to modernize the entire U.S. strategic nuclear arsenal. Thus, the key question is not whether to add a new land-based system to strategic submarine and aircraft forces whose future capabilities are fixed in size. Rather, the question is: What comprises the most desirable mix of new forces as the entire U.S. strategic arsenal is modernized during the 1980s? One path would be to maintain a Triad of strategic forces similar to the existing arsenal. By deploying an MPS basing system, the United States could preserve many of the characteristics of existing silo-housed ICBMs and maintain a strategic arsenal with retaliatory capabilities divided in a balanced way among three different basing systems.

Alternatively, the United States could place primary reliance on the retaliatory capabilities of weapons based in submarines and aircraft. It could increase the capabilities of the submarine force by accelerating the rate of Trident submarine construction and by developing rapidly the Trident II missile. The capabilities of the strategic aircraft force could be expanded by several means, including the procurement of new cruise missile carrier aircraft and additional cruise missiles or the development and deployment of an airmobile ICBM force. The survivability of the strategic aircraft force could also be improved by constructing additional air bases in the United States, a program that would complicate a Soviet preemptive attack on the U.S. aircraft force.

Some may judge that existing U.S. strategic forces are more than adequate to deter a Soviet attack and that it is unnecessary to replace all the capabilities embodied in the existing Triad. Such a judgment would not be inconsistent with a modernization program that included the deployment of an MPS basing system for ICBMs. If reduced capabilities were deemed sufficient, the United States could deploy an MPS basing system with a less powerful retaliatory capability than the existing silo-housed ICBM force, along with a Trident fleet and a strategic aircraft force with capabilities reduced in a comparable degree from the capabilities of the existing submarine and aircraft forces.

The Issue of Cost

This study does not provide a comprehensive analysis of all the options available to the United States for modernizing its strategic forces. Many issues would have to be considered in such an analysis. One issue is cost. In particular, the costs of modernizing U.S. strategic forces with deployment of an MPS basing system should be compared with the costs of modernizing those forces with procurement of a large number of Trident submarines, Trident II missiles, and a force of new strategic aircraft. While CBO has not undertaken an analysis of the costs of different force mixes, studies conducted within the Department of Defense apparently indicate that, under the constraints of a SALT II agreement, strategic Triads including ICBM force modernization are "no more costly" than Dyads of submarines and strategic aircraft of "comparable levels of capability." 1/ It is not clear, however, whether these cost comparisons account for possible Soviet responses. These responses might affect land-based and aircraft-based systems more than submarine-based systems, assuming that submarines at sea remain undetectable and, thus, untargetable.

Other Issues

In addition to cost, other issues important to a consideration of strategic force modernization alternatives include:

1/ U.S. Department of Defense, Annual Report, Fiscal Year 1980, p. 119.

- The value of diversity in basing;
- The desired retaliatory capabilities to be provided by U.S. strategic forces;
- The effect of U.S. strategic programs on international perceptions; and
- Specific questions raised about MPS basing, including the sensitivity of the costs and survivability of MPS basing to Soviet reponses and U.S. uncertainties about the size of the Soviet missile force, public acceptance of the deployment of an MPS basing system, and arms control implications.

THE VALUE OF DIVERSITY IN BASING

The primary mission of U.S. strategic nuclear forces is to deter a Soviet attack by providing sufficient capability to carry out a devastating retaliatory strike against the Soviet Union. To make its retaliatory threat an effective deterrent, the United States designs its strategic forces to be able to survive an unexpected Soviet first-strike attack; that is, even if the Soviets used a large number of their weapons to attack U.S. forces, a significant portion would survive the attack and be available for a U.S. retaliatory strike.

In designing strategic forces to be survivable, conservative planning assumptions have traditionally been employed and a high degree of insurance against the unexpected maintained. The Triad provides this insurance because a secure retaliatory capability would remain even if Soviet forces suddenly posed a threat to the survivability of one type of U.S. strategic system, or if part of the U.S. force suffered unexpected reliability or aging problems.

A three-part arsenal complicates Soviet efforts to develop an effective disarming first-strike capability against U.S. strategic deterrent forces. With a diverse arsenal composed of three different parts, no single threat could compromise the entire U.S. deterrent. For example, the survivability of land-based missiles would not be compromised by Soviet development of an open-ocean surveillance capability, a development that could threaten U.S. submarines. Similarly, the survivability of land-based ICBMs would not be compromised by failure of the warning systems designed to ensure that U.S. strategic aircraft can take off and fly away from their bases in time to escape a missile attack launched from Soviet submarines. In general, ICBMs based in a survivable system, unlike aircraft, have the desirable attribute that they can absorb a Soviet surprise attack; that is, their ability to survive an attack does not depend upon strategic warning (for example, a buildup of international tensions) or tactical warning (a warning from sensor systems that a Soviet missile attack has been launched). Moreover, the effectiveness of ICBMs, like that of submarine-launched ballistic missiles, would not suffer from Soviet development of improved air defenses against low-flying bombers and cruise missiles.

A Triad of strategic forces is also said to enhance the U.S. deterrent by preventing the Soviet Union from concentrating its military resources on the development of systems to counter only one or two types of U.S. weapons. For example, Soviet allocation of more resources to the development and deployment of advanced air defense systems might, in the absence of U.S. countermeasures, reduce the retaliatory capability provided by U.S. cruise missiles. 2/ Similarly, by devoting more resources to antisubmarine warfare research, the Soviets might increase their chance of developing a system for locating U.S. submarines. An important question in this context is whether the Soviet system for allocating resources to various branches of the military would allow such reallocations.

In addition to providing insurance against unexpected Soviet threats, a Triad of three survivable parts provides insurance against the possibility that some U.S. weapons might experience unexpected reliability or aging problems. If the United States were heavily dependent on one or two weapons systems, unexpected problems of this nature might jeopardize the security of the U.S. retaliatory capability.

A strategic force posture composed of three survivable parts gives the United States time to respond to a problem experienced by any one of the parts. Indeed, the United States has had time to consider an appropriate response to the projected vulnerability

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2/ Transcript of news briefing by Dr. William J. Perry, Under Secretary of Defense for Research and Engineering (November 14, 1978; processed).

of the Minuteman ICBM force precisely because of the diversity provided by the existing Triad. If a new, more survivable ICBM system is not deployed in response to the growing Soviet capability to destroy silo-housed missiles, the appearance in the future of a threat to the submarine fleet or the strategic aircraft force would pose a much more serious problem.

Diversity in basing is also a desirable attribute to seek in the U.S. strategic force posture because programs designed to ensure the survivability of one part of the U.S. arsenal may enhance the survivability of the other parts. One of the most important such "synergistic" relationships may be that between the survivability of the strategic aircraft force and an MPS basing system for ICBMs. In the absence of an MPS basing system, the Soviets could conceivably destroy the bulk of the silo-housed Minuteman and Titan missile force with only a fraction of their own large ICBM force. The remaining Soviet warheads might then be used to attack large areas around U.S. air bases, perhaps destroying in the air a significant portion of U.S. strategic aircraft in the area surrounding the bases. Countering such a possibility might require the United States to construct additional air bases and to procure strategic aircraft capable of more rapid take-off in order to escape a Soviet attack. Deployment of a U.S. MPS basing system would require the Soviets to use most or all of their ICBM weapons in order to destroy a large number of U.S. shelters and missiles. Thus, the existence of an MPS basing system might contribute to the survivability of U.S. nuclear weapons based in aircraft.

SPECIAL RETALIATORY CAPABILITIES PROVIDED BY LAND-BASED ICBMS

Survivable land-based ICBMs enjoy several attributes that are not all found in missile-carrying submarines or strategic aircraft. The most important attributes include:

- A potential to deliver large numbers of powerful nuclear warheads with high accuracy;
- Short missile flight time;
- Reliable, continuous, high-speed two-way communications;
- Rapid retargeting capabilities;
- Flexibility to launch a small number of missiles; and

- The ability to withhold weapons from use over an extended period of nuclear conflict.

Several of these attributes would be particularly worth having if the United States wished to maintain retaliatory capabilities that would be useful in a nuclear conflict not confined to the massive destruction of Soviet cities in an all-out and immediate spasm response. Specifically, these would contribute to U.S. capabilities to retaliate against military targets of all kinds--especially hard targets such as ICBM silos--and to execute other nuclear response options designed to avoid the destruction of Soviet cities. They would also contribute to a U.S. capability to wage nuclear war over a period of days or weeks, rather than just hours.

Capabilities to Attack Military Facilities and Other Targets Isolated from Cities

The United States might wish to maintain a force that: could absorb a large-scale first-strike attack and then retaliate against Soviet conventional military facilities or other targets isolated from Soviet cities in order to maintain a Soviet incentive to avoid direct attacks on U.S. cities should deterrence fail and nuclear war begin. Indeed, such a capability might be considered a more credible retaliatory threat than the threat to destroy Soviet cities, since the United States would be reluctant to destroy Soviet cities as long as U.S. cities remained intact to serve as Soviet hostages. In addition to enhancing the credibility of U.S. strategic deterrent forces, a capability to destroy Soviet conventional military targets might also be an effective deterrent to a Soviet leadership contemplating war with the United States, because the destruction of Soviet military targets might deny the Soviets their ability to achieve whatever war objectives they might have established.

Submarine-launched ballistic missiles and cruise missiles launched from aircraft could, of course, also be used to attack Soviet conventional military facilities and other targets isolated from Soviet cities. Yet, neither missiles deployed aboard submarines nor weapons based in strategic aircraft share all the attributes of land-based ICBMs. The latter have better communications than the other two forces. Submarine-launched ballistic missiles have short flight times, but it might be difficult to launch a small number of missiles from a submarine without revealing the location of the ship. Cruise missiles take several hours to reach their targets, and their ability to penetrate Soviet air defenses in small numbers may, in the future, be uncertain.

Many of the attributes of land-based ICBMs would be especially useful if the United States wished to acquire an improved capability to destroy Soviet hard targets, including Soviet ICBM silos, nuclear weapon storage bunkers and other weapons depots, and underground command centers. Particularly important in this role would be the potential of land-based missiles to deliver large numbers of powerful nuclear warheads with high accuracy and the reliable, continuous, high-speed two-way communications enjoyed with land-based missile systems. If the United States wanted a capability to respond promptly, the short flight time of an ICBM would also be an important attribute.

The Hard-Target Controversy. Whether or not the United States should acquire an improved capability to destroy Soviet hard targets has been a controversial issue. The United States might want such a capability in order to expand its available retaliatory options. Some believe that a capability to destroy Soviet silo-housed ICBMs would provide a more credible and effective deterrent than the threat to attack Soviet cities or Soviet conventional military facilities. It might be more credible because the United States, knowing that the Soviets could destroy U.S. cities and U.S. military targets, might be reluctant to strike Soviet cities or Soviet conventional military targets. It might be a more effective deterrent because a capability to destroy any Soviet missiles remaining after an attack on U.S. forces could ensure that the Soviet Union would be relatively less powerful in terms of surviving strategic forces at the end of an exchange. Seeing such a disadvantage in initiating a nuclear exchange, the Soviets might be more effectively deterred than if their ICBMs were not vulnerable to a U.S. counterattack.

A U.S. capability to destroy Soviet silo-housed ICBMs might also force the Soviets to consider reducing their reliance on fixed-base missiles and to adopt instead a mobile ICBM basing system of their own. If compelled to follow the United States on this expensive course, the Soviets might be forced to allocate fewer resources to weapons programs threatening to U.S. land-based missiles and other U.S. strategic forces. In addition, they might be more willing to reach the kinds of mutually beneficial strategic arms limitation agreements that would contribute to the survivability of future land-based ICBM systems.

Many arguments have also been advanced against U.S. acquisition of an improved capability to destroy Soviet silo-housed ICBMs. For example, such a capability would be of little use if the Soviets launched all of their ICBMs in an initial attack against the United States; in that case, there would be nothing but empty silos remaining to be destroyed. 3/ An actual U.S. counterattack against any Soviet ICBMs that did remain after a Soviet first strike might even be a counterproductive tactic, because such an attack could cause the Soviets to launch their remaining missiles before they could be destroyed. In addition, the United States might have little use for a capability to counterattack against Soviet ICBMs if deployment of an MPS basing system eliminated the Soviet capability to destroy the bulk of U.S. land-based ICBMs with only a fraction of their own missiles. And such a capability might be unnecessary if a judgment were made that the ability to destroy most of the Soviet industrial targets and conventional military facilities would be sufficient to deter Soviet attack.

U.S. acquisition of a capability to destroy Soviet silo-housed ICBMs has also been criticized on the grounds that such a U.S. capability could increase the chance that a Soviet leadership believing war to be likely would feel compelled to strike the first blow. If the Soviet land-based ICBM force were vulnerable, the Soviets would know that a possible U.S. first-strike attack would leave them at a severe disadvantage, especially since the bulk of Soviet intercontinental nuclear strike capabilities are deployed in the land-based missile force. Soviet incentives to strike first in a crisis would be particularly strong if the U.S. missiles capable of destroying Soviet ICBMs were deployed in vulnerable fixed-base silos. In this case, the Soviets could eliminate the threat to their own missiles by striking first. U.S. missiles with a capability to destroy Soviet ICBM silos that were deployed in a basing system less vulnerable to a Soviet attack would provide less tempting targets.

Acquiring a capability to destroy Soviet ICBM silos would also be an expensive task. If the United States could not

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3/ Preventing the Soviets from reloading their ICBM silos would probably not require missiles with high accuracy and powerful warheads, since reloading equipment and operations would be vulnerable to less accurate and less powerful warheads.

determine which Soviet silos had launched their missiles in a first-strike attack, all the Soviet missile silos would have to be targeted in a U.S. retaliatory strike. Some 2,000 to 3,000 warheads deployed on highly accurate missiles would be necessary to provide a capability to target two warheads on each Soviet missile silo. If this capability were to be added to other U.S. retaliatory capabilities, the cost would be very high. Moreover, a capability to destroy Soviet land-based ICBMs might become increasingly expensive if the Soviets responded by deploying a new, more survivable mobile basing system of their own. There is also the risk that Soviet deployment of a less vulnerable mobile missile system might complicate U.S. efforts to verify Soviet compliance with future SALT limits because it would probably be harder to count the number of Soviet mobile ICBM launchers deployed than it has been to count silo-housed missiles.

The value attached to acquiring a capability to destroy Soviet ICBM silos would be an important factor to consider in deciding whether or not to deploy a new, more survivable land-based missile system. It would not, however, necessarily be a decisive factor. If a capability to destroy Soviet silo-housed missiles is highly desired, deployment of a new, more survivable land-based ICBM system would be an attractive option. Still, other options, possibly less effective, might be available, including the development of a new Trident II missile for the Trident: submarines or the deployment of a large force of accurate air-launched cruise missiles. 4/ Likewise, if the United States wished to avoid the acquisition of an improved capability to destroy Soviet ICBM silos, construction of an MPS basing system might still be considered an attractive option, because missiles without sufficient accuracy to threaten Soviet hard targets could be deployed in the system.

Trident II missiles could significantly improve the capability of the submarine-launched ballistic missile force to attack Soviet hard targets. Thus, they might be considered an alternative to deployment of land-based MX missiles. It would be difficult, however, to develop a submarine-launched missile as accurate as a new land-based ICBM such as the MX missile, because

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4/ For an examination of these options, see Congressional Budget Office, Planning U.S. Strategic Nuclear Forces for the 1980s, Budget Issue Paper (June 1978).

the initial information about position and velocity provided by a moving submarine is less precise. It would also be difficult to develop a system for communicating with submarines comparable to the communications systems for land-based missiles.

Air-launched cruise missiles are highly accurate and would have a high probability of destroying Soviet hard targets. If deployed in large numbers, they might provide a capability to attack Soviet ICBM silos. Because cruise missiles would take several hours to reach targets in the Soviet Union, they could be used for a second-strike counterattack against Soviet missile silos without posing the threat of a surprise first-strike capability. There are, however, two potential disadvantages in assigning cruise missiles the task of destroying Soviet hard targets. First, it might be possible for the Soviets to develop air defense systems capable of intercepting cruise missiles attacking important hard targets. 5/ Second, the United States might want a capability to destroy Soviet ICBM silos within minutes of a Soviet first strike, rather than within hours, or to strike first against Soviet missiles. 6/

It should also be noted that a decision to forego acquisition of an improved U.S. capability to destroy Soviet ICBM silos would not be inconsistent with the deployment of an MPS basing system. Rather, a decision made about whether or not the United States wanted a capability to destroy Soviet missile silos would affect the choice of the missile deployed in an MPS basing system. If the United States wished to avoid the acquisition of a capability to destroy Soviet silo-housed ICBMs, existing Minuteman III missiles or a new missile without improved accuracy could be deployed.

5/ Existing Soviet air defense systems are not regarded as a serious threat to U.S. cruise missiles. Improved future systems, however, might provide a cause for concern. Improved surface-to-air missiles might be especially effective in defending small "point" targets such as Soviet ICBM silos. See transcript of news briefing by Dr. William J. Perry, Under Secretary of Defense for Research and Engineering (November 14, 1978; processed).

6/ For a discussion of the possible advantages of a U.S. first-strike capability, see Carl H. Builder, "Why Not First-Strike Counterforce Capabilities?" Strategic Review (Spring 1979).

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Survivability in an Extended Nuclear Conflict

A survivable land-based ICBM system would also provide an ability to withhold weapons from use over an extended period of nuclear conflict. After absorbing a Soviet first-strike attack, survivable land-based missiles could remain safely in their shelters until their emergency batteries no longer supplied sufficient electricity or until a critical piece of equipment malfunctioned. In an MPS basing system, missiles might have a power source sufficient for a two-week period of extended survival. 27 During this period, the survivability of those missiles that were not destroyed by an initial Soviet attack would not be dependent upon the continued availability of sensor systems designed to detect the launching of Soviet missiles.

An ability to hold weapons in reserve for an extended period of time is considered by many to be one of the most desirable characteristics of survivable land-based ICBMs, as well as of strategic submarines. In the event of a Soviet attack, American leaders would have days, or even weeks, to consider an appropriate response. A retaliatory strike would not have to be launched on the basis of incomplete information. There would be an opportunity for negotiations. In addition, a U.S. ability to wage nuclear war over an extended period of time might prevent the Soviets from believing that they could prevail in such a conflict.

Like survivable land-based ICBMs, missile-carrying submarines provide the United States with a capability to withhold weapons from use over an extended period of nuclear conflict. In fact, a nuclear-powered submarine can remain at sea for months as long as food is available for its crew. Weapons based in aircraft, on the other hand, may not share this capability. Strategic aircraft, once airborne, may face a situation in which their ability to survive over an extended period would depend on the continued availability of air bases and the continued survivability of the satellite and ground-based sensor systems designed to detect the launching of Soviet missiles. Without the continued

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7/ Fiscal Year 1977 Authorization for Military Procurement, Research and Development, and Active Duty, Selected Reserve and Civilian Personnel Strengths, Hearings before the Senate Committee on Armed Services, 94:2 (March 1976), Part 11, p. 6365.

availability of air bases and warning systems, American leaders would, within a matter of hours, have to decide whether to order an attack or lose the aircraft. 8/

LAND-BASED ICBMS AND INTERNATIONAL PERCEPTIONS

Some observers worry about the political consequences of the projected Soviet capability to attack the U.S. silo-housed ICBM force. They postulate that other countries see ICBMs as a primary symbol of strategic nuclear power. 9/ The large size and growing capability of the Soviet ICBM force may affect the perception of the strategic balance shared by U. S. allies and by the Soviet Union itself. Moreover, they argue, Soviet development of a capability to destroy U.S. silo-housed Minuteman and Titan missiles represents an international challenge that must be met in order to demonstrate American resolve. If the United States appears to be abandoning land-based ICBMs under Soviet pressure, other countries may see this as a sign that the United States is unwilling to compete with the Soviet Union.

For all these reasons, some observers believe that international stability and U.S. security require that a condition of perceived equality between the strategic power of the United States and the Soviet Union be maintained. In particular, some judge that the maintenance of such a condition, often referred to as "essential equivalence," requires that the United States develop and deploy a survivable land-based ICBM system.

8/ The crucial issue with regard to the long-term endurance and survivability of all U. S. strategic forces relates to the survivability of communications systems and command and control centers. Submarines and land-based missile systems share this potential problem because of their dependence on airborne launch control centers for communications after a Soviet attack. Thus, possible limitations on the enduring survivability and viability of communications systems could limit the effectiveness of all U.S. strategic forces in an extended nuclear conflict.

9/ U.S. Department of Defense, Annual Report, Fiscal Year 1980, p. 118.

An alternative view is that there is no intrinsic reason why land-based ICBMs should always be seen as the primary symbol of strategic power. In this view, whether or not land-based ICBMs remain a special political symbol may depend largely upon the statements of American officials and on the other strategic programs undertaken by the United States. For example, an American declaratory policy that emphasized the advantages enjoyed by the United States in ballistic missile submarine and strategic cruise missile technology might have as positive an effect on international perceptions of the strategic balance as the deployment of a new land-based ICBM system.

QUESTIONS RAISED ABOUT MPS BASING FOR ICBMS

The previous sections of this chapter have outlined some of the characteristics that U.S. strategic forces might possess if the United States included an MPS basing system in its strategic force modernization programs. Weighed against these considerations are several specific questions as to the effectiveness and desirability of MPS basing for ICBMs. These include questions about whether an MPS basing system would actually provide survivability for ICBMs over the long run, doubts about the willingness of the public to support the construction of a new basing system for ICBMs that would include several thousand underground shelters and a large network of roads or underground trenches, and several questions about the arms control implications of deploying a multiple-shelter system for mobile land-based missiles.

Would an MPS Basing System Be Survivable?

As discussed in Chapters II and III, the survivability of an MPS basing system would require the United States to build more shelters than the Soviets could destroy and to prevent the Soviets from determining in which shelters the U.S. missiles were housed. Soviet responses to U.S. deployment of an MPS basing system and U.S. uncertainties about the size of the Soviet ICBM force could affect the ability of the United States to meet these requirements for survivability. Whether the requirements could in fact be met would depend in large part on the strength of the U. S. commitment to maintain a survivable land-based ICBM system. For example, *a* willingness to add shelters to an MPS basing system could be particularly important in maintaining survivability.

Some consider an MPS basing system to be unsuited to the realities of the political environment in the United States. Thus, they question the willingness of the American people to support the construction of additional shelters in response to potential increases in the number of warheads in the Soviet ICBM force or in response to U.S. uncertainties about whether the Soviets possess large numbers of extra missiles that could rapidly be made ready for launch in a crisis. Some may judge that the likelihood of such Soviet responses and U.S. uncertainties is high and that this is not an avenue of strategic competition in which the United States would fare particularly well. Some may also judge that, over time, the United States would have difficulty maintaining secrecy about the location of the U.S. missiles deployed in an MPS basing system.

In this view, other kinds of basing systems--in particular, submarines and aircraft--may appear to be more attractive alternatives. An important possible advantage currently enjoyed by strategic submarines, for example, is that their ability to survive an attack is not sensitive to the number of warheads in the Soviet missile force. As long as submarines remain undetectable while on patrol at sea, sea-based mobile missiles cannot be targeted by Soviet missiles.

Public Acceptance of MPS Basing for ICBMs

There may also be doubts as to public acceptance of a system requiring thousands of shelters and a large network of connecting roads or trenches. Public opposition could develop from three major sources. First, there might be concern about the environmental impact of an MPS basing system. Second, opposition could arise because of possible restrictions on land use even if only small areas around each shelter were fenced off. (For example, safety regulations would prohibit the construction of buildings within certain distances of the missile shelters; there could also be restrictions on the use of the roads while missiles or decoys were being transported among the shelters and the maintenance facilities.) Third, concern could arise that the deployment area would become an important Soviet target in a nuclear war.

If serious opposition developed, it is conceivable that the United States could find itself in the early or middle 1980s with a new missile and components for a new basing system but no place to put them. Then several billion dollars would have been wasted and few alternatives for expanding the size of the U.S. submarine and strategic aircraft forces would be immediately availble. As discussed in Chapter IV, one way to hedge against uncertainties of this kind would be to develop a common missile that could be deployed in Trident submarines if an MPS basing system were not constructed.

Several approaches might minimize the risk of serious public opposition to the deployment of an MPS basing system. For example, the Air Force proposes insofar as possible to use public lands that are not needed for farming, with adverse effects on as few people as possible. Only small areas of land around the protective shelters that would house the missiles would be fenced off from public access. An extensive environmental impact analysis and land acquisition process would be undertaken. Another important factor in minimizing the risk of public opposition would be a strong commitment from the Congress and the Administration to the deployment of an MPS basing system.

Arms Control Considerations

A major source of opposition has been concern about the arms control implications of an MPS basing system. In particular, questions have been raised about the ability to count the number of missiles deployed in an MPS basing system and the compatibility of MPS basing with SALT launcher restrictions. Also at issue is the effect of deployment of an MPS basing system on efforts to prevent increases in the number of nuclear weapons.

There are two major reasons why it is important that a U.S. MPS basing system be compatible with SALT provisions. First, U.S. deployment of a system for basing missiles that was not compatible with SALT verification or SALT launcher restrictions might cause the Soviet Union to abrogate an existing SALT treaty or to refuse to accept a future agreement. Without SALT limits on the number of Soviet multiple-warhead ICBM launchers and on the number of warheads that may be flight-tested on an ICBM, the Soviets could greatly increase the number of warheads in their ICBM force. As shown in Chapter III, this would require the United States to construct a large number of additional shelters and to deploy additional missiles in its MPS basing complex, thereby increasing its costs.

Second, the United States must ensure that its MPS basing complex be designed to be verifiable and in accordance with SALT launcher restrictions in order to set the proper precedents for a future Soviet mobile ICBM system, should the Soviets choose to deploy such a system. If the United States constructed a basing system for ICBMs that made it difficult to count the number of missiles deployed, the Soviets could deploy a similar system, thereby hindering the U.S. ability to assess accurately the number of Soviet ICBMs deployed. Thus, a U.S. MPS basing complex must be designed so that it would place pressure on the Soviets to make any similar system that they might deploy verifiable by the national technical means of verification available to the United States. In this regard, Secretary of Defense Brown has stated that the United States will not deploy a mobile ICBM system that would prevent adequate verification of the number of launchers deployed and will insist that any Soviet system meet the same standards. 10/

Compatibility with SALT Launcher Limits. One SALT concern is that the protective shelters constructed for an MPS basing system, especially vertical shelters, might be indistinguishable from the existing silos that house ICBMs. Because the construction of additional fixed ICBM launchers would be prohibited by the proposed SALT II agreement, the construction of several thousand vertical shelters would be a violation of SALT limits if shelters were indistinguishable from existing silos.

If the United States deployed an MPS basing system, its position in the SALT negotiations would be that the missile canisters, rather than the vertical shelters, would constitute the launchers. The canisters themselves would contain the equipment necessary to support and to launch the missiles--and would hence be "launchers"--while the shelters would be little more than concrete holes in the ground with communications and power supply lines.

The Soviets have reportedly drawn a distinction between deployment of missiles in a complex of vertical protective structures and deployment of mobile transporter/erector launchers in horizontal protective structures. According to this report, the Soviets have stated that a system of vertical shelters would

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10/ Ibid., p. 40.

involve additional fixed ICBM launchers, which are prohibited by the proposed SALT II agreement. On the other hand, horizontal shelters, if associated with transporter/erector launchers, might be considered by the Soviets to be a permissible system. 11/

Verification. An MPS basing system would complicate the task of verifying compliance with SALT limits on the number of missiles that may be deployed. Because the concept of MPS basing involves the deployment of many more shelters than missiles, the number of missiles deployed could not be verified simply by counting the number of underground shelters. Indeed, the need to prevent the Soviets from determining in which shelters the missiles were located would require that the United States actively counter Soviet efforts to observe the missiles once deployed within the MPS basing complex.

Counting the number of missile canisters or other types of mobile launchers deployed within an MPS basing complex would be more difficult than counting fixed-base silos, whose construction can be verified with high confidence both because of the long time needed to construct a silo and because of the size of the operation. The Arms Control and Disarmament Agency regards the verification problems associated with mobile ICBM systems to be "difficult" but "not insurmountable." The degree of confidence that could be gained in efforts to verify the number of mobile ICBM launchers deployed would depend upon the design, construction, deployment, and operating practices of the side deploying the system. 12/

The basic verification concept identified by the Air Force for an MPS basing system would involve designing the system so that the Soviets could count the missiles and missile canisters or other types of mobile launchers as they were brought into the shelter complex. In a vertical shelter system, for example,

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11/ See statement of Paul H. Nitze on the future of the land-based leg of the strategic Triad in hearings before the House Committee on Armed Services, 96:1 (February 6, 1979; processed), p. 10.

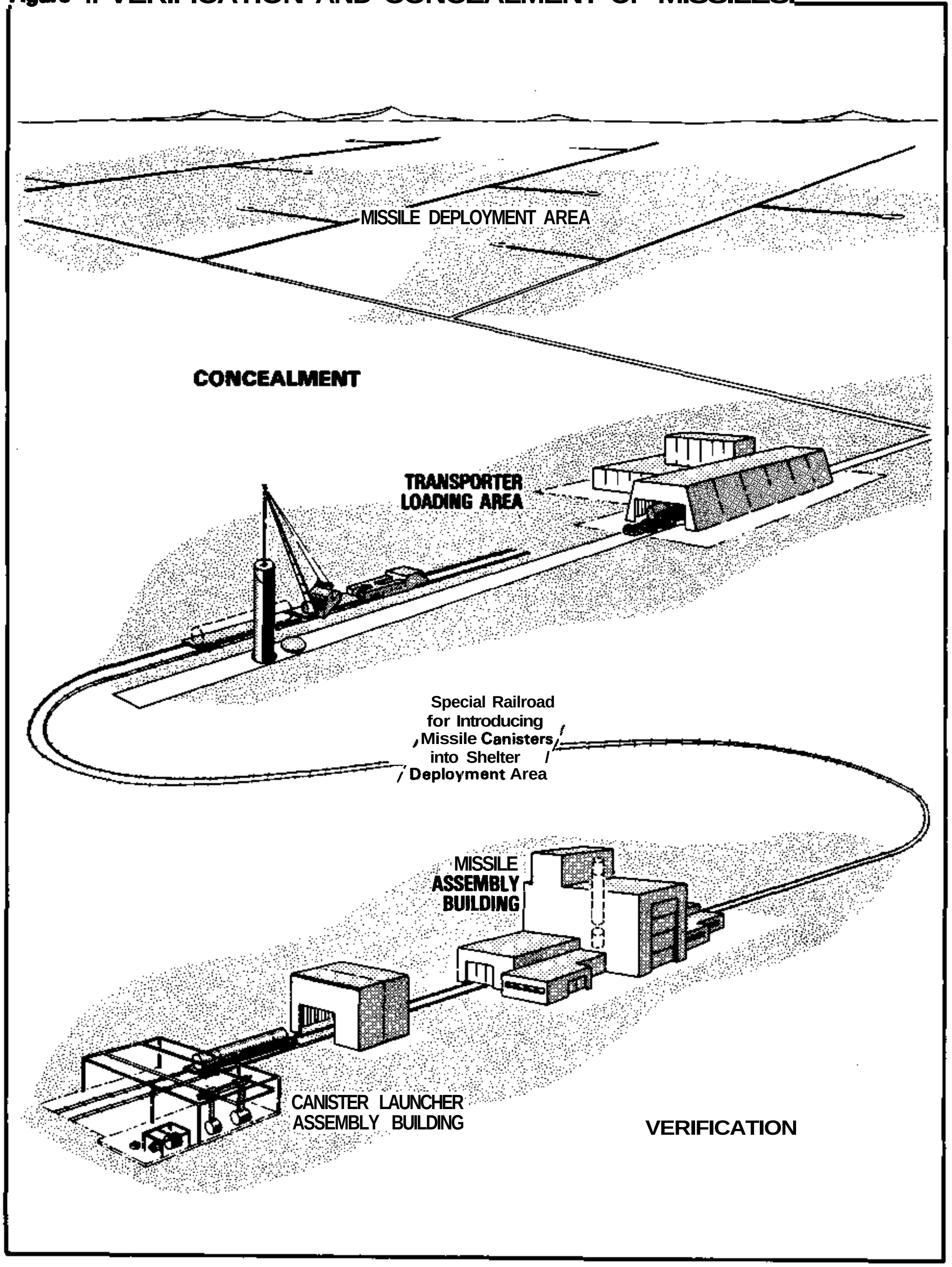
12/ Fiscal Year 1980 Arms Control Impact Statements, Senate Committee on Foreign Relations and House Committee on Foreign Affairs, Joint Committee Print, 96:1 (March 1979), p. 23.

the assembly of the canisters and missiles and the insertion of the missiles and their support equipment into the canisters would be done in a time-consuming and observable way in a special assembly area located several miles from the shelter deployment area. The assembled missile canisters would then enter the shelter deployment area over a special railroad track that would take a significant amount of time to traverse. Such an arrangement would create a "choke point" that would cause the process of introducing missile canisters into the shelter deployment area to take several days. Presumably, Soviet reconnaissance satellites would then be able to count the number of missile canisters introduced into the shelter complex (see Figure 4).

Several other design features would contribute to the effectiveness of this verification plan for a complex of vertical shelters. The metal rods, or "mass simulators," would be assembled within the deployment area and inserted into the shelters at the time of their construction, thereby avoiding the possibility of confusing simulators for missiles at the shelter complex entry point. Likewise, the large transporter vehicles that would move missile canisters and simulators among the shelters and maintenance facilities would be assembled within the shelter deployment area. No buildings that could provide an ability to assemble canisters and missiles would be constructed within the deployment area. Two additional measures would minimize the chance that missile canisters could be smuggled into the shelter deployment area from places other than the designated canister and missile assembly area. First, no roads capable of carrying the large transporter vehicles would be constructed outside the shelter deployment area. Second, the fields of shelters would be located at significant distances from any large buildings in the area that could potentially be used to assemble canisters and missiles.

The Administration apparently considers a choke-point verification plan, by itself, to be insufficient to provide an adequate ability to monitor the deployment of missiles in an MPS basing system. An ability to inspect the system from satellites might provide a complement to the choke-point arrangement. There is, however, concern that reconnaissance satellites might have difficulty in seeing to the bottom of a vertical shelter. Thus, it might be difficult to verify that a particular shelter did not contain a missile. For this reason, a system of horizontal protective structures, either a complex of individual horizontal shelters or a network of unburied trenches, is being examined.

Figure 4. VERIFICATION AND CONCEALMENT OF MISSILES.



The idea is to design a system that would make it easy for satellites to distinguish with high confidence a protective structure that housed a missile from one that did not. The vehicles that would be required to raise the missiles to the vertical position for launch would also be larger than the canisters used in a vertical shelter system. This might make it easier to observe their entry into the deployment area through the choke-point system.

There may be questions about the practical details of any system intended to allow the monitoring of missiles deployed in an MPS basing complex. Some tough bargaining may be required in order to work out with the Soviets the details of a cooperative verification scheme. There are, however, several precedents for cooperative SALT verification arrangements, 13/ and a scheme of this kind might well succeed in its aim. Just as important, it might establish a precedent that would put pressure on the Soviets to design any mobile missile system that they might deploy in a way that would allow U.S. verification of the number of Soviet missiles deployed.

Other, more general concerns related to the verification of mobile land-based missile systems may remain. By making the ability to launch a missile independent of an underground silo launcher, mobile systems may create or exacerbate concerns about the potential ability to produce a large number of extra missiles and mobile launchers that could rapidly be made ready for use in a crisis. In a vertical shelter system, for example, the canister, rather than an underground shelter, would provide the ability to launch a missile. If extra canisters could be covertly produced, large numbers of extra launchers would be available to launch any missiles that might have been produced and stockpiled.

Covertly producing extra canister launchers and stockpiling them in warehouses might be a less difficult task than secretly

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13/ For example, the proposed SALT II agreement includes a special rule used to distinguish multiple-warhead missiles from those armed with single warheads. Any missile of a type ever tested with multiple warheads must be counted as a multiple-warhead missile, whether it actually carries multiple warheads or just one warhead. See speech of George M. Seignious, Director of the Arms Control and Disarmament Agency, in "SALT II and the National Security," Congressional Record (May 24, 1979), pp. S6755-58.

constructing large numbers of extra underground silos. It might also be a more reliable tactic than undertaking efforts to develop a capability to launch missiles from expedient aboveground launchers, since canisters for mobile missiles would provide a tested method for launching extra missiles. While the open nature of the U.S. political system makes it unlikely that the United States could produce large numbers of extra canisters and missiles in secrecy, such fears might be justified if the Soviet Union developed and deployed a new mobile launcher system. 14/

At least two approaches to the problem of assuring that extra mobile launchers could not be produced and stockpiled might be considered. First, the deployment or stockpiling of mobile launchers outside a designated deployment area could be banned. Although detection of a single launcher outside this area would indicate a violation of SALT restrictions, it is possible that extra launchers could secretly be produced and stockpiled within buildings. This worrisome possibility makes a second approach seem the best way to assure that extra mobile launchers could not be stockpiled. The second approach would involve the regulation of production activities in a way that would allow the observer nation to assure itself that extra mobile launchers were not being produced and stockpiled in secrecy. Although the regulation of production practices might be the optimal approach, it might be difficult to obtain Soviet agreement to such an intrusive verification scheme, if they deployed a mobile launcher system of their own.

It: is important to remember that the potential difficulties in counting the number of mobile launchers produced apply to all mobile land-based missile systems, not just to MPS basing systems. Thus, a unilateral U.S. decision not to deploy an MPS basing complex would not in itself solve the verification difficulties associated with mobile launchers, since the Soviet Union may decide to deploy a mobile missile system in any case. In fact,

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14/ The Soviets previously developed the SS-16 missile, believed to have been designed for a mobile basing system, but they have agreed not to deploy this system during the effective period of the SALT II agreement. See Fiscal Year 1980 Arms Control Impact Statements, Senate Committee on Foreign Relations and House Committee on Foreign Affairs, Joint Committee Print, 96:1 (March 1979), p. 20.

the proposed SALT II agreement explicitly permits deployment of mobile ICBM launchers after the expiration of the temporary protocol period. 15/

Soviet Responses to U.S. MPS Basing. A final arms control concern is that U.S. deployment of an MPS basing system might cause the Soviets to increase the number of warheads in their ICBM force. 16/ If the Soviets wished to maintain a disarming first-strike threat against U.S. ICBMs, they might decide that the increase in the number of protective shelters for U.S. missiles associated with U.S. deployment of an MPS basing system required an increase in the number of their own warheads available to attack the U.S. ICBM force. Such arguments are necessarily somewhat speculative, since their validity hinges on a number of unknown factors. For example, future SALT limits may restrict the ability of the Soviets to increase the number of warheads in their ICBM force. In addition, it is not clear how strongly Soviet missile programs are influenced by U.S. programs. The Soviets may seek to increase the number of warheads in their ICBM force whether the United States deploys an MPS basing system or not. For example, the Soviets might consider additional weapons useful for attacking the U.S. strategic aircraft force.

If the Soviets do seek to develop disarming first-strike capabilities against the various elements of the U.S. nuclear arsenal, and if there are no SALT limits on the Soviet missile force in the future, it is possible that deployment of an MPS basing system might be a better way to maintain the survivability of U.S. strategic forces than some of the other alternatives. It might, for example, be cheaper to proliferate shelters in an MPS basing system than to increase the number of air bases for the U.S. strategic aircraft force as a counter to an increase in the number of Soviet missiles and warheads.

If the Soviets were to agree to reductions in missile ceilings in a future SALT agreement, the survivability of an MPS basing system would be improved because a smaller Soviet missile force would allow the targeting of fewer U.S. shelters. This could be considered a positive characteristic of an MPS basing system from the standpoint of arms control.

15/ Ibid., pp. 12-13.

16/ Ibid., p. 20.

APPENDIXES

APPENDIX A. THE MX COST EFFECTIVENESS MODEL

The cost estimates for MPS basing systems presented in this paper have been derived from the MX Cost Effectiveness Model developed by the MX System Program Office of the Air Force's Space and Missile Systems Organization (SAMSO). The model is capable of determining costs for a variety of U.S. missile options and for several specific MPS basing systems. When it is provided assumptions as to the number and characteristics of future Soviet ICBMs and the desired number of surviving U.S. warheads, it can determine the combination of U.S. missiles and shelters that would minimize the cost to deploy and operate any given MPS basing system with a particular type of missile deployed in that system.

All assumptions about the future Soviet ICBM force and about the desired number of surviving U.S. warheads were supplied by CBO. Because CBO's assumptions may differ from those used by the Air Force, the cost estimates given here may be different than those provided by the Department of Defense. Differences in costs costs are the result of differences in the number of shelters and missiles that might be deployed. CBO examined the model, and its calculations seem to produce reasonable results. CBO did not, however, undertake a comprehensive review of Air Force estimates of the costs to develop, deploy, and operate an MPS basing system with a given number of shelters and missiles. Such a review was undertaken by the Air Force Office of Independent Cost Analysis (ICA), and the cost estimates calculated by ICA were within about one percent of the Air Force MX System Program Office estimates. 1/

MODEL INPUTS

Several inputs must be provided to the model. The assumed number of Soviet ICBMs and the accuracy, reliability, and warhead yields of the ICBMs in the Soviet force at the time the United

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1/ Information supplied to CBO by U.S. Air Force (January 12, 1979).

States would complete deployment of its MPS basing system must be specified. As shown in Chapter III, the costs of an MPS basing system would be highly sensitive to the number of Soviet warheads available for an attack on it. A desired number of surviving U.S. warheads must also be provided. In addition, the characteristics of the U.S. missile to be deployed in the MPS basing system must be specified. The number of warheads carried on each U.S. missile is an especially important variable, because that number determines how many U.S. missiles must survive a Soviet attack in order to provide the desired number of surviving U.S. warheads. The type of MPS basing system to be examined--whether vertical shelter system, horizontal shelter system, or trench system--must also be specified. Finally, cost estimates must be attached to the various MPS basing system components. All cost estimates for the system components were supplied by SAMSO.

MODEL CALCULATIONS

To start the model's calculations, the user provides a preliminary estimate of the total number of missiles to be deployed in the MPS basing system and a preliminary hardness specification for the individual shelters.

Shelter Hardness and Design

After being given a preliminary shelter hardness specification, the model determines the shelter dimensions, the thickness of the concrete walls and shelter door, and the type of shock isolation system required to provide the shelter hardness specified. These shelter design specifications are provided to the model's cost program, and a cost estimate for an individual shelter is determined for use in a later part of the model's calculations.

In another part of the model, the shelter design specifications are used to assess independently the degree of protection from nuclear blast and shock effects that would be provided to a missile in such a shelter. Given this hardness estimate, along with the preliminary estimate of the total number of U.S. missiles to be deployed in the MPS basing system, the model then determines the number of shelters and the spacing between them required to ensure that the desired number of U.S. missiles could survive a Soviet attack of the specified magnitude.

Spacing Between Shelters

The spacing between the shelters is designed to ensure that each Soviet warhead exploding in the MPS basing system deployment area could destroy no more than one U.S. shelter. Spacing should be large enough so that this condition would hold even if the Soviets armed their missiles with somewhat more powerful warheads. In addition, the spacing is designed to be large enough to prevent each Soviet warhead from destroying more than one U.S. shelter, even if the shelters proved to be significantly less resistant to nuclear blast and shock effects than estimated or the nuclear environment proved to be more severe than anticipated.

The spacing between shelters is an important variable because it affects the number of miles of road required for an MPS basing system, the size of the total MPS basing system deployment area, and, hence, the required number of maintenance and security personnel. In general, the more protection against nuclear blast and shock effects provided by the shelters, the smaller the spacing need be. Thus, hard shelters are a desirable attribute in an MPS basing system. At some point, however, it becomes more expensive to make the shelters harder than to increase the spacing between the shelters.

The Number of Shelters

The number of shelters required to provide the desired number of surviving U.S. warheads can also be determined once the preliminary shelter hardness has been estimated and a preliminary estimate of the total number of U.S. missiles to be deployed in the MPS basing system has been specified. For example, the United States might want to ensure the survival of 1,000 warheads in an MPS basing system. If the United States deployed missiles that were each armed with 10 warheads, 100 missiles would have to survive a Soviet attack in order to provide 1,000 surviving warheads. To start the model's calculations, the user might specify that, as a preliminary estimate, 200 missiles would be deployed in the MPS basing system.

Given this information, the model would determine the number of shelters required to ensure that half of the 200 missiles to be deployed in the MPS basing system could be expected to survive a Soviet attack. For example, assume that the Soviets would have 4,000 warheads available to attack the U.S. MPS basing system and that 3,400 of these, or 85 percent, would function reliably. If the preliminary shelter hardness estimate indicated that a reliable Soviet warhead exploding in the area of an individual U.S. shelter would have a 95 percent chance of destroying that shelter, then the Soviets would possess a capability to destroy 3,230 (95 percent of 3,400) of the shelters in a U.S. MPS basing system. To ensure that half of the U.S. shelters--and, hence, half of the 200 deployed missiles--could survive a Soviet attack, the model would determine a requirement for an MPS basing system with 6,460 shelters, twice the number that the Soviets could destroy.

Finding the Minimum-Cost Combination of Missiles and Shelters in an MPS Basing System

A combination of 200 missiles and 6,460 shelters constitutes one U.S. MPS basing system that could provide 100 surviving missiles with 1,000 surviving warheads after a Soviet attack of 4,000 warheads. This combination would not necessarily represent the minimum-cost MPS basing system, however. To determine the minimum-cost combination of missiles and shelters, the model must estimate the cost of this MPS basing system and compare it to the costs of systems with, on the one side, relatively fewer missiles and more shelters and, on the other side, relatively more missiles and fewer shelters. For example, it might be cheaper to deploy 300 missiles and 4,843 shelters, another combination of missiles and shelters that would provide 100 surviving U.S. missiles. Likewise, the preliminary hardness specification for the shelters, and hence the spacing between them, is also varied in order to find the minimum-cost combination of shelter hardness and spacing between shelters.

In estimating the cost of an MPS basing system with a particular combination of missiles and shelters and a particular shelter hardness and spacing, dozens of system components are taken into account. In addition to the costs of the missiles and the shelters themselves, estimates are given for the costs of missile canisters, missile-support equipment, transporter vehicles, simulators, roads, underground communication and power cables, maintenance and security buildings, and base facilities.

The costs of maintaining all of these system components are also considered. The number of personnel required for these maintenance tasks is affected by the number of shelters, the spacing between them, the number of missiles, the frequency of missile and missile-support equipment failure, and the time required to repair such malfunctions. The operating and support costs estimated by the model are based on the assumption that the missiles would be moved only for maintenance purposes and that they would not have to be moved frequently in order to prevent the Soviets from determining their location.

In addition, the personnel required for maintaining the security of the missiles are included in the costs. The number of required security personnel is affected strongly by the spacing between the shelters and the size of the MPS basing system deployment area.

Finally, the costs for an MPS basing system assume that one silo-housed Minuteman III missile would be retired for each missile deployed in an MPS basing system. The savings in operating costs realized from the retirement of Minuteman missiles is subtracted from the costs to operate an MPS basing system.

Once the model has estimated the cost of an MPS basing system with a particular combination of missiles and shelters and with a particular shelter hardness specification and spacing, it then looks to see if a less expensive MPS basing system can be found. To undertake this search, the model starts the calculations again with a lesser or greater number of missiles deployed in the system and with a different shelter hardness specification.

Typically, the minimum-cost MPS basing system is found at a combination of missiles and shelters such that 50 percent or less of the missiles deployed in the system would be assumed to survive a Soviet attack. This tendency of the model can be altered in two important ways. On the one side, a limit on the number of missiles that can be deployed in an MPS basing system, imposed by either a SALT constraint or a physical constraint, can force the model to solutions in which a large number of shelters would have to be constructed so that a high percentage of the limited number of deployed missiles would be able to survive a Soviet attack.

On the other side, an MPS basing system with a very large number of missiles but with a relatively low percentage of missiles surviving a Soviet attack--as low as 25 percent--often represents the minimum-cost combination of missiles and shelters if it is assumed that the Soviets would have a very large number of warheads available to attack a U.S. MPS basing system. In these high-threat cases, the cost of adding missiles rises much less rapidly than the cost of adding shelters; thus it is cheaper to add a large number of missiles and a relatively small number of shelters to the MPS basing system. This is because the unit cost of missiles and of missile-support equipment tends to fall as larger numbers are procured, while the cost of constructing additional shelters remains relatively constant.

INFLATION ASSUMPTIONS

The model provides cost estimates for MPS basing systems that are based on expenses that would have been incurred if the system had been developed and deployed in March 1978. CBO converted all the estimates into fiscal year 1980 dollars, using the assumptions about inflation between 1978 and 1980 shown in the following table.

TABLE A-1. ASSUMED INFLATION RATES IN VARIOUS MILITARY ACCOUNTS, FISCAL YEARS 1978 TO 1980

Account Number	Title	Inflation Rate 1978-79	Inflation Rate 1979-80 a/	Inflation Rate 1978-80
3600	Research and Development	7.3	7.7	15.6
3020	Procurement	7.2	6.9	14.6
3300	Military Construction	8.1	8.2	17.0
3400	Operations and Maintenance	6.7	6.8	14.0
3500	Military Personnel	5.4	5.6	11.3

a/ Assumes 5.5 percent federal pay raise in 1980.

APPENDIX B. ESTIMATED SOVIET MULTIPLE-WARHEAD ICBMS IN THE POST-1990 PERIOD: POSSIBLE VARIATIONS IN THE THREAT TO A U.S. MULTIPLE PROTECTIVE STRUCTURE BASING SYSTEM

TABLE B-1. SALT II-CONSTRAINED SOVIET THREAT WITH NEW TEN-WARHEAD MISSILE: ESTIMATED SOVIET MULTIPLE-WARHEAD ICBMS IN THE POST-1990 PERIOD

Type of Missile a/	Number b/	Warheads per Missile c/	Total Warheads	Yield in Megatons d/	Circular Error Probable e/	Reliability f/
SS-18	308	10	3,080	0.6 to 1.5	500 feet	0.85
New 10-Warhead ICBM	512	10	5,120	0.335	500 feet	0.85
Total	820		8,200			

a/ The missile types include both existing Soviet multiple-warhead ICBMs and replacement missiles that may be developed in the future.

b/ SALT II multiple-warhead ICBM limit of 820, assumed to be extended through the 1980s and into the 1990s.

c/ Proposed SALT II limit of 10 on the number of warheads that may be flight-tested on an ICBM, assumed to be extended into the 1990s.

d/ For the lower end of the range of estimates for the yield of warheads carried on SS-18 missiles, see Walter Pincus, "U.S. Downgrades Soviet ICBM Yield," Washington Post (May 31, 1979), p. A-1. For the upper end of the range, see Clarence A. Robinson, Jr., "MX Deployment Urged for Parity," Aviation Week and Space Technology (December 5, 1977), pp. 12-15. The yield for the new 10-warhead missile is assumed to be the reported yield of the MK-12A warheads that may be deployed on U.S. MX missiles. See Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978), pp. 20-22.

e/ This is the reported current U.S. advanced technology capability and the reported limit of accuracy for purely ballistic reentry vehicles. See Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978), pp. 20-22.

f/ See Hon. Thomas A. Downey, "How to Avoid Monad and Disaster," Foreign Policy (Fall 1976), pp. 180-81.

TABLE B-2. SOVIET DEPLOYMENT OF 820 MULTIPLE-WARHEAD ICBMS WITH LARGER NUMBERS OF SMALLER WARHEADS: ESTIMATED SOVIET MULTIPLE-WARHEAD ICBMS IN THE POST-1990 PERIOD

Type of Missile a/	Number b/	Warheads per Missile c/	Total Warheads	Yield in Megatons d/	Circular Error Probable e/	Reliability f/
SS-18	308	25	7,700	0.2	500 feet	0.85
SS-19	400	14	5,600	0.2	500 feet	0.85
SS-17	112	14	1,568	0.2	500 feet	0.85
Total	820		14,868			

a/ The missile types include both existing Soviet multiple-warhead ICBMs and replacement missiles that may be developed in the future.

b/ SALT II multiple-warhead ICBM limit of 820, assumed to be extended through the 1980s and into the 1990s.

c/ See Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978), pp. 20-22.

d/ See Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978), pp. 20-22; and Edgar Ulsamer, "Ominous Soviet ICBM Testing," Air Force Magazine (November 1978), p. 12.

e/ This is the reported current U.S. advanced technology capability and the reported limit of accuracy for purely ballistic reentry vehicles. See Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978), pp. 20-22.

f/ See Hon. Thomas A. Downey, "How to Avoid Monad and Disaster," Foreign Policy (Fall 1976), pp. 180-81.

TABLE B-3. SOVIET DEPLOYMENT OF 1,400 MULTIPLE-WARHEAD ICBMS WITH EXISTING MISSILE PAYLOADS: ESTIMATED SOVIET MULTIPLE-WARHEAD ICBMS IN THE POST-1990 PERIOD

Type of Missile a/	Number b/	Warheads per Missile c/	Total Warheads	Yield in Megatons d/	Circular Error Probable e/	Reliability f/
SS-18	308	10	3,080	0.6 to 1.5	500 feet	0.85
SS-19	853	6	5,118	0.55 to 0.8	500 feet	0.85
SS-17	239	4	956	0.6	500 feet	0.85
Total	1,400		9,154			

a/ The missile types include both existing Soviet multiple-warhead ICBMs and replacement missiles that may be developed in the future.

b/ This corresponds to the number of ICBM silos that the Soviets were allowed under the SALT I agreement negotiated in 1972.

c/ The number of warheads currently deployed on Soviet ICBMs.

d/ For the lower end of the range, see Walter Pincus, "U.S. Downgrades Soviet ICBM Yield," Washington Post (May 31, 1979), p. A-1. For the upper end of the range, see Clarence A. Robinson, Jr., "MX Deployment Urged for Parity," Aviation Week and Space Technology (December 5, 1977), pp. 12-15.

e/ This is the reported current U.S. advanced technology capability and the reported limit of accuracy for purely ballistic reentry vehicles. See Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978), pp. 20-22.

f/ See Hon. Thomas A. Downey, "How to Avoid Monad and Disaster," Foreign Policy (Fall 1976), pp. 180-81.

TABLE B-4. SOVIET DEPLOYMENT OF 1,400 MULTIPLE-WARHEAD ICBMS WITH LARGER NUMBERS OF SMALLER WARHEADS: ESTIMATED SOVIET MULTIPLE-WARHEAD ICBMS IN THE POST-1990 PERIOD

Type of Missile a/	Number b/	Warheads per Missile c/	Total Warheads	Yield in Megatons d/	Circular Error Probable e/	Reliability f/
SS-18	308	25	7,700	0.2	500 feet	0.85
SS-19	853	14	11,942	0.2	500 feet	0.85
SS-17	239	14	3,346	0.2	500 feet	0.85
Total	1,400		22,988			

a/ The missile types include both existing Soviet multiple-warhead ICBMs and replacement missiles that may be developed in the future.

b/ This corresponds to the number of ICBM silos that the Soviets were allowed under the SALT I agreement negotiated in 1972.

c/ See Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978), pp. 20-22.

d/ See Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978), pp. 20-22; and Edgar Ulsamer, "Ominous Soviet ICBM Testing," Air Force Magazine (November 1978), p. 12.

e/ This is the reported current U.S. advanced technology capability and the reported limit of accuracy for purely ballistic reentry vehicles. See Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978), pp. 20-22.

f/ See Hon. Thomas A. Downey, "How to Avoid Monad and Disaster," Foreign Policy (Fall 1976), pp. 180-81.

TABLE B-5. FUTURE SALT REDUCTIONS AND EXISTING MISSILE PAYLOADS: ESTIMATED SOVIET MULTIPLE-WARHEAD ICBMS IN THE POST-1990 PERIOD

Type of Missile a/	Number b/	Warheads per Missile c/	Total Warheads	Yield in Megatons d/	Circular Error Probable e/	Reliability f/
SS-18	150	10	1,500	0.6 to 1.5	500 feet	0.85
SS-19	400	6	2,400	0.55 to 0.8	500 feet	0.85
Total	550		3,900			

a/ The missile types include both existing Soviet multiple-warhead ICBMs and replacement missiles that may be developed in the future.

b/ U.S. SALT II proposal of March 1977.

c/ The number of warheads currently deployed on Soviet ICBMs.

d/ For the lower end of the range, see Walter Pincus, "U.S. Downgrades Soviet ICBM Yield," Washington Post (May 31, 1979), p. A-1. For the upper end of the range, see Clarence A. Robinson, Jr., "MX Deployment Urged for Parity," Aviation Week and Space Technology (December 5, 1977), pp. 12-15.

e/ This is the reported current U.S. advanced technology capability and the reported limit of accuracy for purely ballistic reentry vehicles. See Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978), pp. 20-22.

f/ See Hon. Thomas A. Downey, "How to Avoid Monad and Disaster," Foreign Policy (Fall 1976), pp. 180-81.

TABLE B-6. FUTURE SALT REDUCTIONS AND NEW TEN-WARHEAD MISSILE: ESTIMATED SOVIET MULTIPLE-WARHEAD ICBMS IN THE POST-1990 PERIOD

Type of Missile a/	Number b/	Warheads per Missile c/	Total Warheads	Yield in Megatons d/	Circular Error Probable e/	Reliability f/
SS-18	150	10	1,500	0.6 to 1.5	500 feet	0.85
New 10-Warhead ICBM	400	10	4,000	0.335	500 feet	0.85
Total	550		5,500			

a/ The missile types include both existing Soviet multiple-warhead ICBMs and replacement missiles that may be developed in the future.

b/ U.S. SALT II proposal of March 1977.

c/ Proposed SALT II limit of 10 on the number of warheads that may be flight-tested on an ICBM, assumed to be extended into the 1990s.

d/ For the lower end of the range of estimates for the yield of warheads carried on SS-18 missiles, see Walter Pincus, "U.S. Downgrades Soviet ICBM Yield," Washington Post (May 31, 1979), p. A-1. For the upper end of the range, see Clarence A. Robinson, Jr., "MX Deployment Urged for Parity," Aviation Week and Space Technology (December 5, 1977), pp. 12-15. The yield for the new 10-warhead missile is assumed to be the reported yield of the warheads that may be deployed on U.S. MX missiles. See Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978), pp. 20-22.

e/ This is the reported current U.S. advanced technology capability and the reported limit of accuracy for purely ballistic reentry vehicles. See Clarence A. Robinson, Jr., "MX Basing Delay Threatens SALT Ratification," Aviation Week and Space Technology (November 20, 1978), pp. 20-22.

f/ See Hon. Thomas A. Downey, "How to Avoid Monad and Disaster," Foreign Policy (Fall 1976), pp. 180-81.

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