Chapter 1

SUMMARY

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Chapter 1

SUMMARY

INTRODUCTION

The U.S. Air Force is developing a new intercontinental ballistic missile (ICBM) known as the MX (fig. 1). Because the hardened "silos" in which existing ICBMS are based are considered increasingly vulnerable to a Soviet attack as a result of the improving accuracy of Soviet m issiles, Congress and the Department of Defense (DOD) have agreed that a more survivable mode than hardened silos should be found for basing any new missile. OTA has examined a variety of ways in which such a missile could be based,

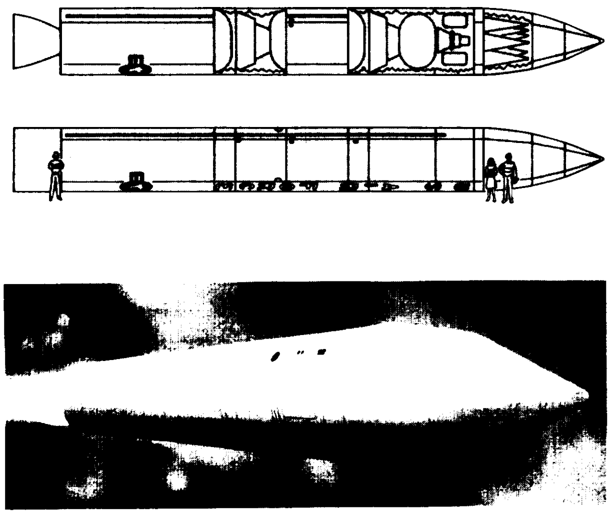
The purpose of this study is to identify MX basing modes and to assess the major advantages, disadvantages, risks, and uncertainties of each. At the outset of this study, OTA reviewed all the basing modes that could be identified, including those addressed in past DOD studies. On the basis of criteria of technical feasibility and the likely ability of each basing mode to provide survivability against a range of plausible Soviet threats, the list was narrowed to 11 basing modes that were analyzed in detail, This report presents these analyses, and also states briefly why other possibilities were rejected. Detailed analyses narrowed the range to five possibilities:

1. multiple protective shelter (MPS) basing in several variants,
2. antiballistic missile (ABM) defense of MPS basing,
3. launch under attack,
4. basing on small submarines, and
5. basing on large aircraft.

There is a variety of criteria against which these basing modes can be evaluated, though there is no general agreement about their relative importance. Indeed, since no basing mode ranks highest against all the commonly used criteria, deciding how to choose and weigh the criteria of evaluation is the essence of choosing a basing mode. To help Members of Congress assign the most weight to those criteria they consider most important, OTA has compared these five basing modes separately against these criteria in the last section of this summary chapter.

OTA was requested by the Technology Assessment Board to examine only basing modes for the MX missile. For this reason, the analysis does not address the questions of whether and why the missile itself is needed, or the relative merits of deploying additional numbers of existing Minuteman III or Trident I missiles. During the course of the study the Board requested that an analysis of rebasing the existing Minuteman i i i missiles in MPS to increase their survivability be included. Since the large size of the MX missile limits the ways in which it could be based, OTA surveyed bas-

Figure 1 .—MX Missile Characteristics



Missile Description

Length	71 feet
Diameter	92 Inches (7 feet 8 Inches)
Gross weight	1$2,000 lbs
Number of reentry vehicles	10

SOURCE Off Ice of Technology Assessment

ing modes that might be used for smaller missiles, but found none so attractive as to lead us to seek a change in our terms of reference. It is important to note that much of OTA'S analysis is premised on the accuracy of U.S. intelligence about the capabilities and growth of Soviet strategic forces. Due to the study boundaries, OTA'S criteria of analysis and comparison tend to use, rather than critically evaluate, conventional wisdom about how strategic nuclear forces support U.S. national security.

OTA does not have a recommendation as to which basing mode, or combination of basing modes, Congress should choose. OTA is therefore able to present the relevant technical information regarding each possibility without the need to make and defend a choice. This study provides data, analyses, and explanations that will assist Congress to understand and evaluate the forthcoming Reagan admin istration proposal, whether this proposal turns out to be a reaffirmation of the existing program as shaped by the Carter administration, a relatively minor mod fication, or a major change in direction.

PRINCIPAL FINDINGS

1. There are five basing modes that appear feasible and offer reasonable prospects of providing survivability and meeting established performance criteria for ICBMS. They are: 1) MPS basing of the type now under development by the Air Force or in one of several variants. MPS basing involves hiding the missiles among a much larger number of shelters, so that the Soviets would have to target all the shelters in order to attack all the missiles. If there were more shelters than the Soviets could effectively target, then some of the missiles would survive. This approach was the choice of the Carter administration, and one variant of MPS is now under engineering development by the Air Force. 2) MPS basing defended by a low-altitude ABM system known as LoADS (Low Altitude Defense System); 3) reliance on launch under attack so that the missiles would be used before the Soviets could destroy them; 4) basing MX on small submarines; and 5) airmobile basing in which missiles would be dropped from wide-bodied aircraft and launched while falling. As described below, each of these alternatives has serious risks and drawbacks, and it is believed that choosing which risks and drawbacks are most tolerable is a judgment that cannot be made on technical grounds alone.

2. No basing mode is likely to provide a substantial number of survivable MX missiles much before the end of this decade. While some basing modes would permit the first missiles to be operational as soon as 1986 or 1987, these missiles could not be considered more survivable than the existing Minuteman missiles until additional elements of the basing system were in place.

3. **MPS basing would preserve the existing characteristics and improve the capabilities of land-based ICBMS, but has three principal drawbacks.**

- **MX missiles based in MPS would provide better accuracy and endurance, and comparable responsiveness, time-on-target control, and retargeting capability, when compared to other feasible basing modes.**
- Survivability depends on what the Air Force calls "preservation of location uncertainty" (PLU), that is, preventing the Soviets from determining which shelters hold the actual missiles. PLU amounts to a new technology, and while it might well be carried out successfully, **confidence in PLU will be limited until prototypes have been successfully tested.** Even then lingering doubts might remain.

- MPS basing cannot ensure the survivability of the missiles unless the number of shelters is large enough relative to the size of the Soviet threat. **The "baseline" system of 200 MX missiles and 4,600 shelters would not be large enough if the Soviets chose to continue to increase their inventory of warheads.** If the trends shown in recent Soviet force modernization efforts continue into the future, an MPS deployment of about 350 missiles and 8,250 shelters would be needed by 199o to provide survivability. Although the number of missiles and shelters needed depends on what the Soviets do, the leadtimes for construction are so long that decisions on size must be made before intelligence data on actual, as distinct from possible, Soviet programs are available.
- **MPS would severely impact the socioeconomic and physical characteristics of the deployment region.** At a minimum, the deployment area would suffer the impacts generally associated with very rapid population growth in rural communities; but larger urban areas would also be affected by economic uncertainties regarding the size of the MPS construction work force and its regional distribution. The physical impacts of MPS would be characteristic of the impacts of major construction projects in arid regions; but because the grid pattern of MPS would mean that a very large area would be close to construction activities, it is possible that thousands of square miles of rangeland could be rendered unproductive.

4. **None of the variants of MPS would reduce the risks and uncertainties associated with PLU or significantly alter the number of shelters required. However, split basing or the selection of a different deployment area would mitigate the regional impacts.** The variants that OTA examined include changes from horizontal to vertical shelters, from "individual cluster" to "valley cluster" basing, and from Utah/Nevada basing to basing divided between Utah/Nevada and west Texas/New Mexico. A further variant would be to construct additional silos in the existing Minuteman basing areas to create a Minuteman/MPS system. This construction would be substantially cheaper than the proposed MX/MPS system, but would not be significantly quicker to construct.

5. **A LoADS ABM system could effectively double the number of shelters in an MPS deployment provided two conditions were met.** A LoADS system would have a high probability of shooting down the first Soviet warhead aimed at each MX missile, forcing the Soviets to attack each shelter with two warheads. The conditions for LoADS' effectiveness are: 1) PLU both for the MX and for the LoADS defense unit, and 2) survival and operation of the defense in the presence of nearby nuclear detonations. Since the LoADS defense unit must be concealed in a shelter and must be indistinguishable from the missiles and the decoys, LoADS deployment would compound the difficulties of PLU. These difficulties would be greater still if the LoADS addition were not planned at the time the MPS system was being designed. The LoADS defense unit would be required to endure nuclear effects of a severity unprecedented for so complex a piece of equipment.

A LoADS deployment would require the United States either to seek amendment of, or to withdraw from, the ABM Treaty reached at SALT 1.

6. **Basing MX missiles in silos and relying on launching the missiles before a Soviet attack could destroy them (launch under attack, or LUA) would be technically feasible, but it would create extreme requirements for availability of, and rapid decisionmaking by, National Command Authorities.** A substantial upgrading of existing warning and communications systems would be required to ensure this capability against a determined Soviet attempt at disruption, Reliance on this capability wou Id, however, impose extremely stringent requirements that the President be in communication with both the warning systems and the forces, and that an unprecedentedly weighty decision be made in a few minutes on the basis of information sup-

plied by remote sensors. Finally, there would always be concern about whether the system was really immune to disruption or errors.

7. MX **missiles based on small submarines would be highly survivable. Submarine-based MX would not be significantly less capable than land-based MX, but submarine-basing would involve a reorientation of U.S. strategic forces.** An MX force based on small diesel-electric or nuclear submarines operating 1,000 to 1,500 miles from the U.S. coast could offer weapon effectiveness (i. e., accuracy, responsiveness, time-on-target control, and rapid retargeting) almost as good as land basing and would probably be adequate to carry out any strategic mission. A command, control, and communications (C^3) system to support submarine basing would be different from that used for landbasing but would not necessarily be less capable. However, submarine basing of MX would change the relative importance of land- and submarine-based strategic forces. Although OTA could find no scientific basis for predicting such an occurrence, the possibility cannot be excluded that an unexpected Soviet capability in antisubmarine warfare that threatened the U.S. force of Poseidon and Trident submarines might also threaten a force of MX missiles on small submarines. The cost of providing 100 MX missiles on alert at all times on a small submarine force would be roughly comparable to the cost of the baseline MPS system, and would be less than the cost of an MPS system sized to meet a larger Soviet threat. A significant problem is that such a force of small submarines could not be constructed quickly; existing U.S. submarine construction programs are already behind schedule, and delays might arise from using shipyards which are not now building submarines. It is therefore unlikely that initial MX deployment on small submarines could take place before 1990. However, the first MX missiles deployed would be survivable even before the rest of the deployment was complete.

8. **An air-mobile MX-carried on wide-bodied aircraft and launched in midair—would be survivable provided the aircraft received timely warning and took off immediately.** Its dependence on prompt response to timely warning of submarine-launched ballistic missile attack would give such a force a common failure mode with the bomber force. (Removing dependence on warning by means of continuous airborne alert would be prohibitively expensive; acquisition and "1O years of operation for such a force Could cost $80 billion to $100 billion (fiscal year 1980 dollars).) On the other hand, an air mobile force could not be threatened by the Soviet ICBM force unless the Soviets deployed man}' more ICBM missiles than they now possess and used them to barrage the entire Central United States. The outcome of such an attack would be insensitive to Soviet improvement in the fractionation and accuracy of their ICBMS. An air mobile MX force could not endure long after an attack if the Soviets attacked every airfield on which such planes could land to refuel, In this case, the National Command Authorities would have to "use or lose" the MX missiles within 5 to 6 hours of a Soviet attack. Providing endurance by increasing the number of airfields at which the planes could refuel would be enormously expensive ($10 billion to $30 billion for up to 4,600 airfields), and growth of the Soviet threat to plausible levels for the 1990's would require so many airfields that they would essentially fill the continental United States. The aircraft would have to take off to launch their missiles, which could mean slow response time, longer warning for the Soviets of a U.S. strike, and the possibility that the Soviets would mistake dispersal during a crisis for preparation for a U.S. first strike. Warning, communications, and guidance systems for an air-mobile force could be complex.

9. **The problems associated with other basing modes studied by OTA appear more substantial.** An ABM defense of MX missiles based in fixed silos against a large Soviet threat would require the use of a complex system based on frontier technology and potentially vulnerable to Soviet countermeasures. The technical risks appear too high to support a decision today to rely on such a system for MX basing. Basing MX on surface ships appears to offer no serious advantages and significantly less survivability than submarine basing. Basing MX in

"superhardened" shelters (e. g., very deep underground) would likely involve a period of several days between a launch order and the actual launch of the missile. Rail mobile MX would involve problems of force management and vu lnerabiity to peacetime accidents or sabotage Road-mob i l e basing appears infeasible because of the size of the missile; off-road mobile basing appears to offer few advantages and several drawbacks compared to MPS.

10. In comparing MPS, MPS with LoADS, LUA, small submarine basing, and air mobile, it is found that:

- All offer reasonable prospects for feasibilit y and survivability MPS depends for surrevivability on concealing its location (PLU) which creates a degree of technical risk, and which would be become still more cliff i cult if LoADS is used to defend MPS
- All are compatible with high weapon effectiveness for the MX missile, although MPS, MPS with LoADS, and LUA would provide slightly better accuracy than submarine basing or air mobile.
- MPS would endure in an operational condition for a long time if it survived; small submarines would endure for several months; air mobile might endure for only a few hours, depending on the nature of the Soviet attack; the endurance of LoADS would depend on the speed and effectiveness of surviving Soviet reconnaissance and retargeting capabilities; LUA would have no endurance at all.
- All are compatible with adequate C^3, but obtaining such C^3 for any of them would require time, effort, and money.
- MPS could complicate future arms control. MPS with LoADS would require amending or withdrawing from the ABM Treaty reached at SALT 1. LUA, small submarines, and air mobile appear compatible with existing arms control concepts.
- MPS, or MPS with LoADS, would have an impact on both the socioeconomic and physical environment in the deployment region that would be so great as to be different in kind from the impacts of any of the other systems. LUA would have virtually no environmental impact. Impacts from submarine basing and air mobile would be relatively small and limited to the areas of the operating bases,
- Assuming a requirement for 100 surviving MX missiles, costs of baseline MPS, submarine basing, and air mobile would be roughly comparable: costs of acquisition and 10 years of operations for nominal designs are estimated to be roughly $40 billion (fiscal year 1980 dollars). Rebasing Minuteman III in an MPS mode would cost 10 to 20 percent less. Growth in the Soviet threat would require increases in the costs of MPS systems, but not in the others. If the Soviet threat grew to a level OTA considers plausible for 1990, the United States could assure survivability of the MX/MPS either by adding LoADS (at an additional cost of $10 billion to $15 billion) or by expanding the number of shelters and MX missiles (at an additional cost of $15 billion to $20 billion). Continued growth of the Soviet threat into the 199o's would drive the cost of survivability as high as $80 billion. Costs of LUA would be the lowest: procurement of the MX missiles, modification of existing silos, and upgraded C^3 and warning systems could be $20 billion cheaper than the alternatives.
- MPS could provide a small, nonsurvivable force by 1986 or 1987, and a large, survivable force by about 1990 MX deployment relying on launch under attack could begin in 1986, but completion of necessary upgrading of warning and C3 systems would require several years longer. Air mobile could be deployed near the end of the decade. MPS with LoADS could be available around 1990, Small submarines could be deployed beginning around 1990, and would be survivable immediately, Thus, none of the basing modes could close the so-called "window of vulnerability" before the end of the decade,

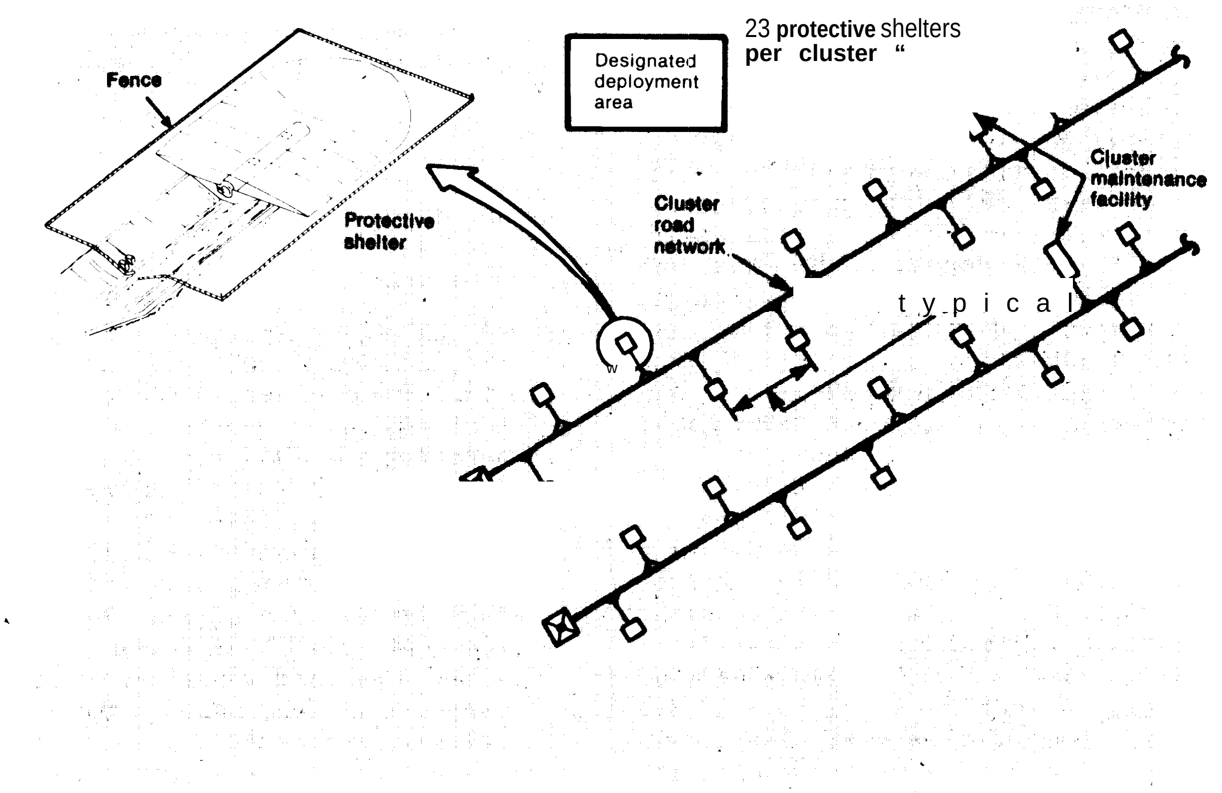
ELEVEN POSSIBLE BASING MODES

1. MX/MPS—The Current Baseline System

In the fall of 1979, the Carter administration selected a basing mode for MX and decided to proceed with full-scale engineering development. This design envisages the deceptive deployment of 200 MX missiles in 4,600 hardened concrete shelters. If the Soviets could not know which shelters contained the actual MX missiles and which contained missile decoys, they would have to target all 4,600 shelters in order to attack all 200 missiles. The baseline system would be located in the Great Basin area of Nevada and Utah and could be expanded by building additional shelters, additional missiles, or both.

The shelters would be spaced roughly 1 mile apart, and arranged in a linear grid pattern. (Fig, 2 illustrates the schematic layout of a single cluster.) Each of the 200 missiles would be based in separate clusters of 23 shelters. The missiles would be transportable within each cluster but could not be moved from one cluster to another without removing large earthen barriers. Each shelter would resemble a garage or loading dock; the truck transporting a missile or decoy would back up to the shelter entrance, and insert the missile or decoy horizontally. Each cluster would thus contain 1 MX missile, 22 decoys, 23 shelters, 1 large transporter truck, and 1 maintenance facility. The truck would shuffle the missile and the decoys among the shelters in such a

Figure 2.—Conceptual Cluster Layout



SOURCE U S Air Force

way that the Soviets would be unable to determine which shelter contained the missile. Missiles would also be transported for maintenance or, possibly, to faclitate arms control verification.

The MX missile in MPS basing has been designed to set a new standard in military capability. Its accuracy would be unprecedented, It could be rapidly retargeted in a variety of ways, and would have precise time-on-target control. MPS basing would give MX a very high alert rate and a long postattack endurance. As a system, MX/MPS would perform its military function providing that two conditions were met: 1) preservation of location uncertainty for the missile, and 2) adequate size to meet the Soviet threat.

Preservation of Location Uncertainty (PLU)

The multiple shelters cannot ensure survival of the requisite number of missiles if the Soviets find out which shelters contain the missiles. PLU therefore involves making certain that the observable characteristics of missiles and decoys are so nearly identical that an outside observer cannot distinguish them, This design entails a major new engineering task, driven by the high sensitivity of present-day and future sensors and by the many observable signs of the missile's presence. As an example of PLU engineering, the missile decoy might contain an appropriate quantity and distribution of high-permeability metal to help make it impossible to distinguish the missile from the decoys by means of a metal detector.

Dealing with this and dozens of other potentially observable signatures makes PLU the equivalent of a new technology, which is wide in scope and intensive in detail. It would require the integration of administrative, operational, and technical considerations. One cannot have confidence in the success of this "new technology" before equipment prototypes are field-tested, because even fine details of missile signatures are important for adequate missile concealment. Furthermore, after the system is fully designed, tested, and deployed, lingering doubts could remain that would limit confidence in the system. Even small doubts could be important, since a catastrophic breakdown in PLU (e. g., a technique whereby the Soviets could determine the exact location of the missiles by satellite observations) would make it relatively easy to attack all the MX missiles; a more limited breakdown, while not imperiling the entire system, could improve the effectiveness of a Soviet attack and reduce the weight of a U.S. retaliation. On the other hand, the Soviets' task of "breaking" PLU could be difficult as well. For the Soviets to attack the system on the basis of their own counter-PLU efforts might entail considerable risk and uncertainty on their part.

Except during missile transport, the proposed baseline system would not restrict public activities outside the 2.5-acre sites surrounding each shelter, While barring the public from a larger area might be infeasible, restrictions on public activities, including mineral exploration and development, could be necessary. From a technical standpoint, the nature and extent of these restrictions depends on the degree of success of the Air Force PLU program.

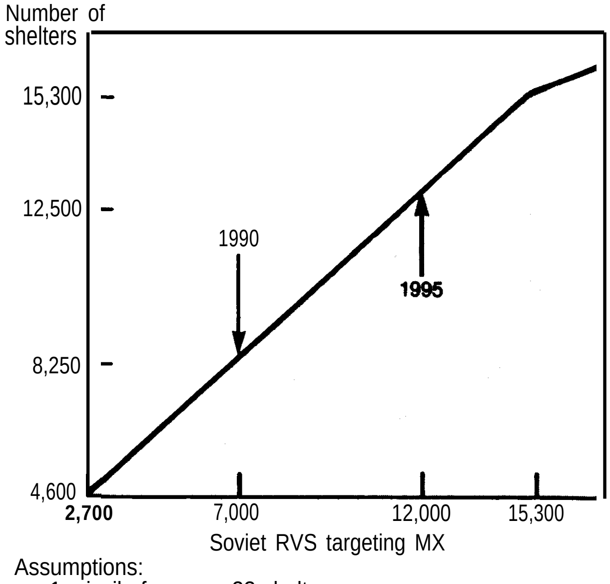
Adequate Size in the Face of Threat Growth

The principle of an MPS system is that survivability is maintained by having more shelters than the enemy is able to target. It is therefore necessary to estimate the number of RVS (reentry vehicles carrying a nuclear warhead) which the Soviets could use to attack the MX/MPS system, and to ensure that the number of shelters is sufficiently large. Since the Soviets have other high-priority targets (bomber bases, submarines in port, etc.) and presumably want to retain a force in reserve, the number of RVS available to attack MX would be somewhat less, perhaps several thousand RVS less, than the total number of Soviet RVS.

Any effort to estimate the size of and composition of future Soviet forces is highly uncertain — U. S. intelligence is far from perfect, and in some cases the Soviet leaders themselves may not yet have made key decisions. OTA has sought an approximation of the threat by making a series of conservative assumptions, most notably that the trends of the 1970's in the rate of Soviet development and deployment of their ICBM force continue through the 1980's and the 1990's. On this assumption, it is estimated that the Soviets could have 6,000 to 7,000 RVS available to attack MX/MPS by 1990, and 11,000 to 12,000 RVS available by 1995. By the year 2000,15,000 or more Soviet RVS could be aimed at an MX/MPS deployment. This assumes that approximately 3,000 additional Soviet RVS would be reserved for other counterforce targets, such as Minuteman silos, and that an additional force of Soviet strategic weapons would be allocated to attack or threaten U.S. cities, industry, and conventional military forces.

One can calculate the approximate number of shelters needed to ensure the survival of 100 MX missiles against the projected Soviet threat (fig. 3). For example, if we assume the 1990 threat of 7,000 RVS targeted against MX, an 85-percent probability of RVS reaching their targets, a deployment of 1 missile for each 23 shelters, and no ballistic missile defense, then this would require a deployment of 360 missiles among 8,250 shelters. Similarly for the 1995 threat of 12,000 RVS, the same survival requirement could be met with 550 MX missiles among 12,500 shelters.

Figure 3.— MPS Shelter Requirement (100 Surviving Missiles)



Assumptions:
. 1 missile for every 23 shelters
• Damage expectancy 0,85
Feasible Soviet threat growth

SOURCE Office of Technology Assessment

An alternative assumption is that, faced with the threat that MX would pose to their silos, the Soviets would devote their efforts to providing survivable basing for their existing ICBM force, rather than to expanding their RV inventory in order to attack MX/MPS.

The existing schedule for the baseline case calls for completion of 4,600 shelters by 1989, although it does involve some optimistic assumptions. Continuation of the planned construction rate (roughly 100 shelters per month) would mean that it would be 1992 before the level of 8,250 shelters was approached, and by then 8,250 could be insufficient. By 1995 the number of shelters constructed (at a rate of 100 per month) would be just under 12,000 — still somewhat less than the number of available Soviet RVS. Clearly, a response to a Soviet effort to overwhelm MX calls for either an ABM system (discussed below) or a higher construction rate.

A large MPS system which was too small to retain survivability could still have some value as a means of limiting Soviet options. It would still oblige the Soviets to use a large fraction of their strategic forces to destroy a somewhat smaller fraction of U.S. strategic forces. However, if the Soviets "fractionate" – i.e., put a larger number of smaller warheads on their large missiles —then the Soviets might be willing to accept an unfavorable exchange ratio because they could "afford" to expend a large number of RVS in order to destroy a smaller number of RVS that constituted the entire U.S. ICBM inventory. I n any case, it is clear that an MPS that was far too small, say half as many shelters as available Soviet RVS, could not be considered at al l survivable, and would be of little greater value than single shelter basing.

With the same reasoning, an MPS system that requires a number of years to build would not reach survival value until the number of operational shelters exceeded the number of Soviet RVS available to attack them, If one assumes that the number of available Soviet RVS may grow from year to year, then the time when U.S. MPS construction actually began and the rate at which shelters were constructed would both be critical. Since building additional shelters would require time, including time to plan the additional building program, the United States would require a prediction several years in advance of the size of the Soviet threat against MX.

The Air Force has estimated that a construction rate of 2,000 shelters per year (about 165 per month) would not exceed projected construction resources, although there would be an additional $400 m i l l ion in front-end costs (e.g., additional cement factories). Assuming this construction rate, to start construction in 1986 would bring the United States to the required shelter level sometime in 1991, and it might not be difficult to stay ahead thereafter. However, it would be necessary to decide by 1983 (or 1984 at the latest) that a 2,000 shelter per year construction rate would be needed, and it is not clear that by 1983 the United States will have a reliable estimate of the path that Soviet ICBM deployment will have taken by 1990. Furthermore,)the United States could not first build a 4,600-shelter system and then decide to expand it if it proved to be too small, unless the United States were prepared to defer survivability into the mid-1990's. Therefore, the completion date, size, regional impact, and cost of an MPS system would all depend in part on what the Soviets chose to do, and on the accuracy of the U.S. estimates of future Soviet programs.

It is possible that the Soviet decision about whether to attempt to overwhelm MX/MPS with large numbers of RVS would depend on Soviet estimates of their chances for success. U.S. construction of MX/MPS at the baseline rate might tempt the Soviets to deploy more RVS in order to "stay ahead, " while a U.S. decision to build a larger deployment at an accelerated rate might persuade the Soviets that deploying many more RVS was pointless. In this case, the expansion of the program would make itself unnecessary, but the United States would probably realize this only after incurring the greatly increased costs and regional impacts of expansion

Regional Impacts

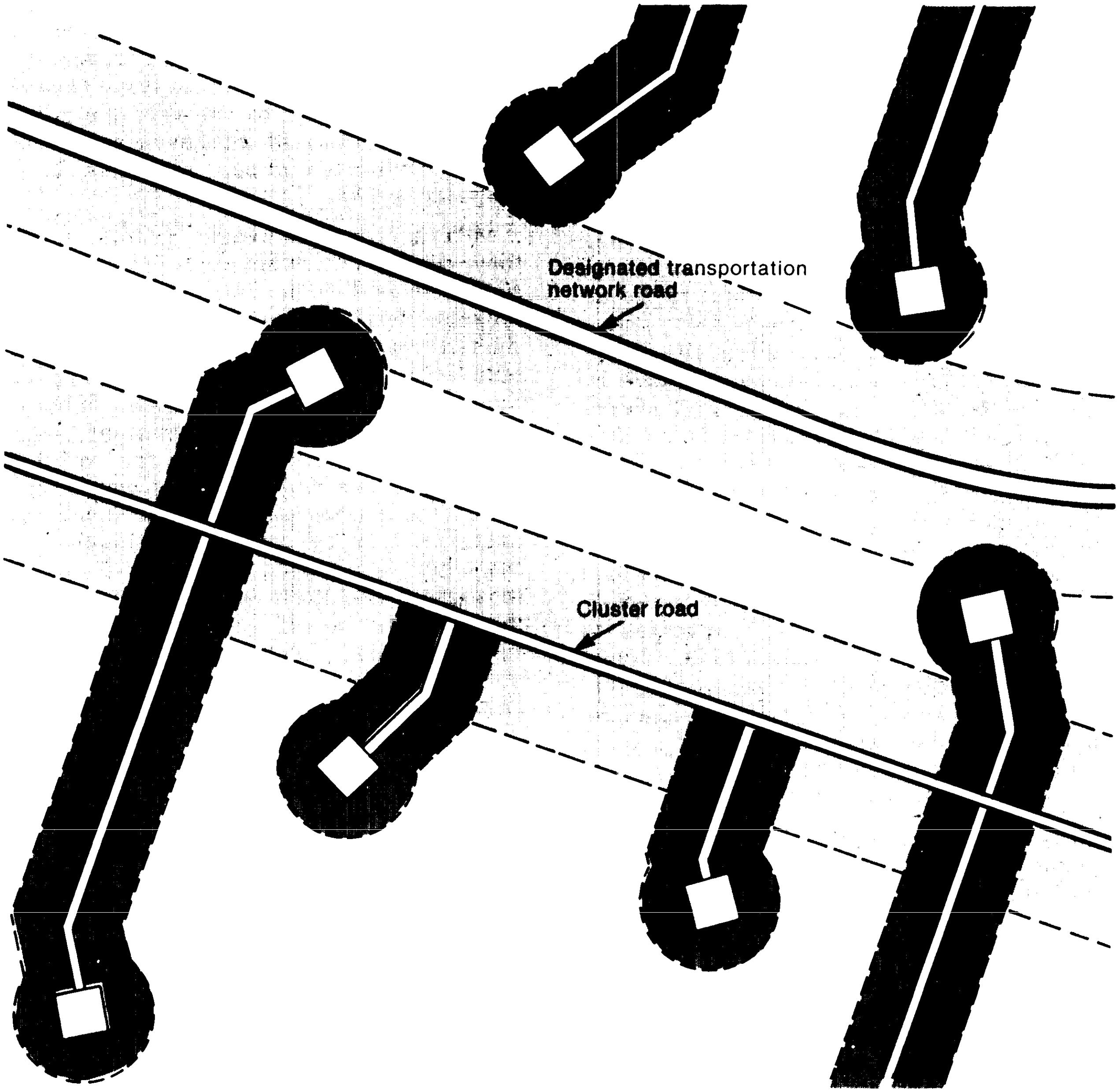
The regional impacts of the proposed MPS basing system would be severe and could include the long-term loss of thousands of square miles of productive range lands, However, the severity of these impacts would result as much from the site selection criteria as from the nature of the basing system and could be mitigated, in part, by variants of the proposed system.

MPS construction would require a work force ranging in size anywhere from 25,000 to 40,000, depending on construction techniques, program decisions, and the total number of shelters required by 199o. The total associated population could be as high as 250,000 people. Because MPS siting criteria require minimum population densities, this influx of people would necessarily overwhelm the social infrastructure and severe impacts would result within the deployment area. The overall impacts would include potential economic benefits; but experience with rapid growth throughout the West suggests that most of these benefits would go to in-migrants with specialized skills, while unemployed residents of the deployment area, women, minorities, and Indians would be least likely to benefit. At the same time, the economic restructuring of the region would adversely impact many local businesses. The cultural values of isolated communities with integrated social structures would also be subject to severe disruption.

In the larger urban areas on the periphery of the deployment area, MPS would have different effects. Although these areas might have sufficient social infrastructures to absorb rapid population growth, uncertainties regarding the potential size of the MPS related population increase and their geographic distribution would preclude effective growth management. As a result, investment planning in both the public and the private sectors would probably fail to minimize the adverse impacts or maximize the potential benefits of MPS deployment. Finally, smaller communities affected by planned energy developments in surrounding areas could be impacted by MPS if the resource and manpower requirements contribute to delays in energy project schedules.

l-he physical impacts of MPS would necessarlly involve the disruption of 200 square miles of land area for construction of shelters, roads, and support facilities (fig. 4). In a

Figure 4.— Potential Vegetative Impact Zone



SOURCE Off Ice of Technology Assessment

deployment area with moderate rainfall and agricultural productivity, the major impacts of construction might be confined to the loss of those lands and related wildlife habitat, but other lands temporarily disturbed by construction activities probably could be revegetated. In "least productive" agricultural lands such as the Great Basin, however, the arid environment would inhibit revegetation and effects could spread to adjacent lands. I n the absence of irrigated revegetation, or if subjected to continued disruption from PLU surveillance activities and random off-road vehicles, these lands would not recover. Consequently, thousands of square miles of productive rangeland could be desolated and the ecology of the entire region irreversibly degraded,

Institutionally, the use of Federal lands would raise many complicated questions of landrights, oil and gas leases, mining claims, grazing permits, and Indian land claims, resulting primarily from potential conflicts between PLU requirements and economic activities such as mineral exploration and development. If private lands are used, most of these questions could be circumvented by negotiation of easements with explicit provisions for PLU, definitions of compatible land uses, and covenants regarding the resale of properties and rights, although the process of negotiation might delay the project schedule.

Civilian Fatalities

OTA arranged for calculations of the number of civilian fatalities due to radiation fallout that would result from a Soviet nuclear attack on an MPS deployment in Utah and Nevada. The results depend to a very large degree on windspeed and direction, causing calculated fatalities to range from less than 5 million to more than 20 million. However, it seems quite probable that a Soviet nuclear attack on MX would be likely to include Minuteman and Titan missile fields, strategic bomber bases, and submarines in port. Because these existing targets are distributed over a large area, the added fallout-related fatalities due to the additional targets in the MPS fields would have a likely range from less than 1 million to 5 million. Total fatalities for this general attack have been estimated to range from 25 million to 50 million people.

Fatalities due to fallout would be a major part, but not the only measure, of damage caused by a nuclear attack. For a discussion of other consequences, and of the uncertainties involved, see OTA'S earlier study, The *Effects of Nuclear War.*

cost

All present cost estimates must be qualified; apart from the usual uncertainties of estimating future costs of unprecedented programs (which means that all estimates have at least a 10-percent error factor), there are some design decisions that have not yet been made that would have an impact on costs. Nevertheless, OTA reviewed the Air Force cost estimates and prepared an independent estimate using a comparable methodology. OTA'S estimate of $37.2 billion (fiscal year 1980 dollars) for acquisition costs of the system is within 10 percent of the Air Force estimate of $33.8 billion (fiscal year 1980 dollars) and is within the accepted range of uncertainty. I n order to permit fair comparison with other possible basing modes, an estimate was made for the cost of: (a) acquisition plus (b) operating costs between initial operating capability (IOC) and final operating capability (FOC), plus (c) the cost of operating the full system for 10 years after FOC. This 10-year lifecycle cost was $43.5 billion (fiscal year 1980 dollars). Note that neither the Air Force estimate nor the OTA estimate includes the costs of mitigating regional impacts. The socioeconomic impacts could amount to several billion dollars, which would be divided in some way among the Air Force, local and State governments, and individuals and firms in the area. The costs of irrigation to permit revegetation, if this were undertaken, could be several billion additional dollars.

OTA also estimated the cost of an expanded system. The estimated cost of a system of 8,250 shelters and 360 missiles, completed by 1990 is $62.4 billion (fiscal year 1980 dollars).

The cost of a system of 12,500 shelters and 550 missiles, completed by 1995, was estimated at $82.6 billion (fiscal year 1980 dollars).

At the request of the Senate Appropriations Committee, the Congressional Budget Office (CBO) made similar estimates. Their assumptions were coordinated with OTA, but they made use of an Air Force parametric cost model. CBO estimates of system acquisition costs for 325 missiles in 8,570 shelters (the least costly mix for the 1990 threat) were $49 billion (fiscal year 1980 dollars), compared to OTA'S estimate of $52.9 billion for acquisition costs. For the 1995 OTA projected threat, CBO estimated a system acquisition cost for 410 missiles and 13,510 shelters (the least costly mix) of $66 bill ion (fiscal year 1980 dollars), compared to OTA'S estimate of $71.1 billion for acquisition costs. CBO further estimated that if a LoADS ABM system were deployed to meet the 1990 threat, system acquisition costs for 225 missiles, 5,370 shelters, and 225 LoADS defense units (the least cost mix) would be about $44 billion (fiscal year 1980 dollars), or about 10-percent less than an undefended system for the same threat level.

Schedule

The present Air Force schedule calls for IOC in mid-1986, and FOC by the end of 1989. OTA reviewed the milestones which this schedule would require, and believes that the schedule for IOC, while possible, is quite optimistic. Any unforeseen delays, including delay in a firm administration decision on MX basing mode after July 1, 1981, would almost certainly result in slippage in IOC. On the other hand, a delay of some months in IOC need not lead to a corresponding delay in FOC. Slippage in IOC by 1 year, without significant change in FOC, would increase acquisition costs by about $1 billion (fiscal year 1980 dollars). OTA considers this a likely scenario.

2. MX/MPS: Vertical Shelters

There is technical disagreement over whether MPS should have horizontal or vertical shelters. On the one hand, if missiles need to be quickly relocated, it appears that missile relocation takes less time with horizontal shelters than with vertical shelters because missile insertion for horizontal shelters is somewhat simpler. On the other hand, the United States has more experience with, and understanding of, vertical shelters; and pound for pound of concrete, vertical shelters are more resistant to nuclear weapon effects than horizontal shelters. As a result, less land area might be required for a given number of shelters. Still, it appears that with adequate field tests, horizontal shelters could be built to withstand the expected nuclear environment with confidence.

There is no particular reason to believe that PLU, arms control verifiability, or addition of an ABM system would be significantly easier or more difficult if a shift were made from horizontal to vertical shelters. However, about a year of intensive engineering development has taken place on the basis of a decision to use horizontal shelters. Much effort has gone into design of PLU and ABM components, and this effort would have to be done over. Apart from the loss of time, real confidence in vertical shelter PLU or vertical shelter ABM would have to await the results of this design effort.

OTA estimates that the lifecycle costs for a 4,600 vertical shelter system with a 1989 FOC would be reduced by about $1.5 billion (fiscal year 1980 dollars) if the shift were made to vertical shelters now.

3. Valley Cluster Basing

A variant of the baseline system, that has received serious consideration within DOD during the first part of 1981, is to replace "individual clusters" with "valley clusters. " This change would mean creating a single large cluster i n each valley, establishing the roads so that it would be possible to move a missile between any two shelters in the same valley. This approach is in contrast to the baseline arrangement in which only 1 missile has access to each group of 23 shelters, and each missile can be placed only in one of its "own" 23 shelters. Valley clustering would not alter the design of the missiles, shelters, or transporter trucks.

This change would have the following effects:

1. It would require fewer maintenance facilities. Instead of 1 facility per cluster of 23 shelters (required because the transporter trucks could not carry missiles from one cluster to another), there could be only one or two facilities per valley. This would save money in both construction and operation.
2. It would require fewer transporter trucks. Instead of one transporter per missile, it would be possible to have one transporter for several missiles. This would save money, but it would mean that reshuffling all the missiles and decoys would take longer, and it would limit the possibility of "dash to shelter" as a fallback mode if PLU were broken.
3. It would have only marginal effects on PLU.
4. It could make arms-control verification more difficult. While it would probably not affect the difficulty of clandestinely introducing additional missiles into the deployment area (i.e., putting missiles in shelters that are supposed to contain decoys), it would make it most difficult to verify after the fact that such cheating had or had not taken place. Since this drawback is the same as the drawback of saving money by eliminating the so-called "SALT ports" (openable hatches in the tops of shelters designed to facilitate verification), valley clusters and elimination of SALT ports (which would save money) appear to some as an attractive combination.
5. Valley clusters would not change the principal regional impacts.

On balance, shifting to valley clusters, if combined with the elimination of SALT ports, might save close to $2 billion (fiscal year 1980 dollars), at the cost of slower reshuffling and more difficult verification.

4. Split Basing MPS: Nevada/Utah and West Texas/New Mexico

Split basing would locate half of the shelters in the Great Basin of Nevada and Utah, and half in the Southern High Plains of west Texas and New Mexico. The rationale would be to mitigate the adverse regional impacts— both socioeconomic and physical — by making the deployment in each region smaller.

Split basing would mitigate some of the adverse impacts of MPS. The mitigation would arise from the likelihood that the rapid changes created by MX/MPS construction could be below thresholds where they become difficult or impossible to manage in the available time. However, if the baseline shelter number (4,600) and construction rate (roughly 1,200 per year) proved inadequate, then split basing would probably not mitigate the impacts, but might make system expansion easier because plenty of suitable land would be readily available. Split basing could complicate issues of land acquisition, since the land to be used in Nevada and Utah is largely public land, while the land in west Texas and New Mexico is largely in private hands.

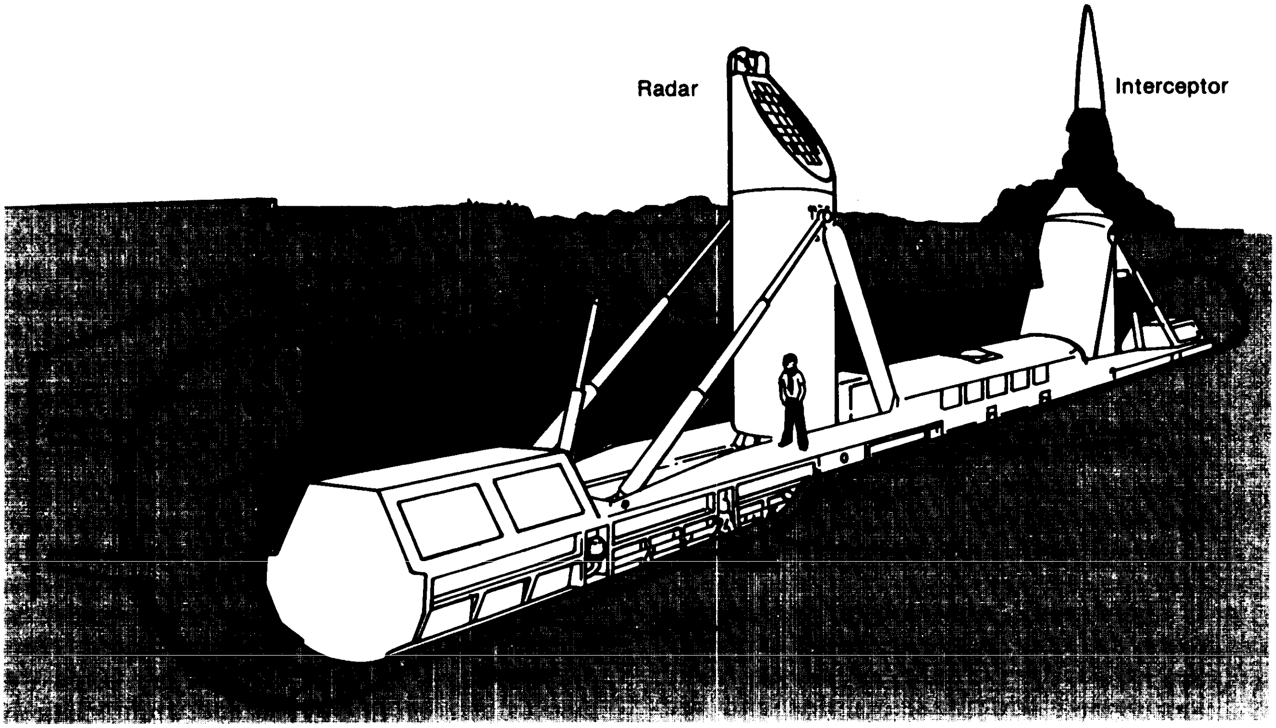
Split basing would increase the costs of both construction and operation by about 7 to 10 percent.

5. MX/MPS With a LoADS ABM System

An alternative to increasing the number of shelters in the face of an expanded Soviet threat would be to provide the MPS system with a ballistic missile defense. The Army's LoADS has been proposed for the role of defending an MPS system.

The LoADS defense unit (DU) (fig. 5), consisting of a tracking radar and nuclear-armed interceptor missiles, would be designed to fit in the shelters and appear just like an MX missile or a decoy to outside observers or sen-

Figure 5.— LoADS Defense Unit After Breakout (human figure indicates scales)



SOURCE. Off Ice of Technology Assessment

sors. A DU would be hidden in each cluster of shelters and programed to defend the shelter containing the MX missile. The DU might also have to defend itself. When it became apparent that a Soviet attack was on the way, the DU would break through the top of the shelter and prepare to fire.

The Soviets would have to target two warheads at the shelter containing the MX missile, since the first one would be intercepted by LoADS with high probability. Since the Soviets would not know which shelter contained the MX, they would have to target two RVS against each of the shelters in the cluster. Thus, addition of LoADS to the baseline MPS system would double the price the attacker would have to pay to destroy an MX missile from 23 to 46 RVS. The effect would be the same as doubling the number of shelters while keeping the number of missiles the same.

It is possible to have high confidence that LoADS would exact a price of 2 RVS per shelter *if* the locations of LoADS DUS and the MX missiles could be concealed and if the DU could be hardened to survive the effects of nearby nuclear detonations. This confidence, conditional upon successful deception and nuclear hardness, results both from advances in ballistic missile defense (BMD) technology in the last decade and from the relatively modest goal of exacting from the Soviets one more RV per shelter.

Successful deception would be essential for LoADS defense, since if the Soviets found out which shelter contained the DU, they could attack. that shelter first, force the DU to use up all its interceptors in self-defense, and then attack. the remaining shelters using one RV per shelter. The situation would be far worse if detection of the DU somehow made it feasible for the Soviets to locate the MX missile as well. Since the DU would be a functional object– not just a decoy that could be designed in any way that would make it indistinguishable from a missile to Soviet sensors— PLU would become considerably more complex if LoADS were added to MX/MPS, It would probably be necessary to alter some features of the MX missile canisters and the decoys to mimic distinctive features of the LoADS DU. Because of this possibility, a deferred decision to deploy LoADS (made after the dimensions of the future Soviet threat became clearer) would entail more risk and cost unless the MPS system had been designed with the LoADS addition in mind.

The LoADS DU would have to survive and operate in a nuclear effects environment unprecedented for so complex a piece of equipment. Measures taken to protect the DU would furthermore have to be consistent with the severe design constraints imposed by PLU. It is not possible to have confidence that the goals of PLU and nuclear hardening can be met — separately, much less simultaneously— until detailed design and testing are done.

There is a variety of ways in which the Soviets might respond to deployment of LoADS, involving both special attack strategies and new weapon systems, which could pose a threat to the defense's effectiveness. These so-called "reactive threats" are discussed in chapter 3 of this report and its classified annex. The risks to LoADS' effectiveness (in forcing the Soviets to target each shelter twice) from these threats appear to be moderate.

Because LoADS would be integrated into the MPS system, the environmental impacts would be essentially the same as for baseline MX/MPS.

LoADS DUS that were mobile or that contained more than one interceptor missile per DU could not be developed outside of the laboratory, tested, or deployed within the terms of the ABM Limitation Treaty reached at SALT 1. Pursuing this option from the present technology development stage into prototyping or deployment would require amendment or abrogation of the Treaty. The diplomatic and political consequences of seeking amendment or unilaterally withdrawing from the Treaty are beyond the scope of this study. Amendment or abrogation would give the Soviets the legal right to develop and deploy an ABM system of their own. A Soviet ABM deployment might create a situation in which the United States felt it needed more surviving MX missiles, and hence a larger deployment, to be sure of destroying defended Soviet targets.

6. MPS Deployment of Minuteman Ill

A related possibility would be to construct additional silos or shelters in the existing Minuteman I I I fields, and modify the Minuteman I I I missiles to permit them to be moved around deceptively and concealed among the available shelters. The rationale for such an option would be to use the MPS concept to make the existing Minuteman I I I missile survivable, thereby saving time and money. Such a system might replace MX altogether, or it might serve as a precursor system, with MX gradually replacing Minuteman III missiles in the new MPS field. It could also serve as an interim measure, providing survivable land basing until some other mode of MX basing was read y.

Such a system appears to be technically feasible. The existing Minuteman III missiles and launch-support equipment would be canisterized separately to facilitate movement among protective shelters. New transporters for the Minuteman missiles and associated equipment would have *to* be procured, and roads in the deployment area would have to be upgraded. It would also be necessary to design a system for maintaining Minuteman PLU similar to but not identical to the system of maintaining PLU for the MX. Minuteman PLU would have similar technical risks and uncertainties, although the institutional problems would be altered by the predominance of private lands. The regional impacts would be similarly altered, and OTA'S analysis suggests that both the range of likely impacts and the probability of extremely severe impacts would be reduced. It would be possible, at additional cost, to replace the existing guidance system with the new AlRS (advanced inertial reference sphere) guidance system being designed for MX; this would upgrade the military capability of Minuteman I I I to the level of the MX missile, except that since each missile would carry fewer warheads, more missiles would be required for an equivalent capability.

Cost and schedule are of particular interest in considering an MPS rebasing of Minuteman I II, since this basing mode was originally proposed as a "quick fix." Assuming a firm decision in july 1981, it appears that Minuteman MPS could not be deployed on a faster schedule than MX/MPS. Because of the need to replicate for Minuteman the design work already done on PLU for MX, and the need to begin the environmental impact statement and land acquisition processes, construction for Minuteman rebasing probably could not begin before the spring of 1985, and FOC for a survivable 5,800-shelter Minuteman MPS system would probably be in the spring of 1989, Cost of a Minuteman MPS would be less than the cost of MX/MPS, OTA estimates that Minuteman MPS system composed of 5,800 shelters and 667 missiles, which would have roughly equivalent survivability to baseline MX/MPS and existing silo-based Minuteman, could be built and operated for about $36 billion, or roughly $7 billion less than MX/MPS (fiscal year 1980 dollars). This figure would include reopening the Minuteman production line to provide test missiles and spares, but would not include the cost of retrofitting the MX guidance system (AIRS) on to the Minuteman Ill missiles. If the systems had to be augmented (whether by expansion, by adding LoADS, or both) to meet an expanded Soviet threat, the cost advantage of Minuteman III MPS would diminish somewhat.

Expanding a Minuteman MPS system to maintain survivability against an expanded threat would require a substantial increase in the total number of U.S. multiple independently targeted reentry vehicle ICBMS. This would run counter to the approach to offensive arms control which both the United States and the Soviets have espoused during the last decade of SALT negotiations.

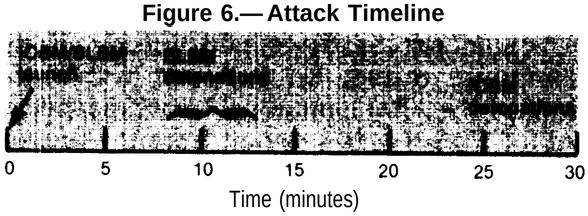
7. Launch Under Attack

Another approach to MX survivability (or, for that matter, Minuteman survivability) is to base the missiles in fixed silos, accept the vulnerability of these silos, and resolve to launch the missiles before Soviet RVS could arrive to destroy them (fig. 6 gives the attack timeline of LUA.). Such a posture is known as launch under attack (LUA). Adopting this approach to basing MX would mean choosing to rely on LUA.

To have high confidence in the technical aspects of LUA, the United States would have to begin by substantially upgrading the systems that provide warning of an attack and emergency communications. OTA'S analysis indicates that providing sensors and communications I inks that were highly reliable in the face of Soviet efforts to destroy or disrupt them is feasible but would require time, money, and continued effort. Almost all improvements in this area could be deployed by the end of the decade at a cost of several billion dollars. The total cost of this basing mode, including the MX missiles, might be about half that of baseline MPS. Some of the systems required for LUA would be desirable, or perhaps even necessary, for other basing modes as well.

Once this were done, we could have high confidence that LUA was technically feasible provided that National Command Authorities (i.e., individuals empowered to order the launch of the MX missiles) were in communication with a command post at the moment the Soviet attack was detected so that they could assess its meaning, decide how to respond, and

Figure 6.— Attack Timeline



SOURCE Office of Technology Assessment.

communicate a launch order to the forces in a short period of time. Whether the President would be available at al I times for this purpose, or delegate his most awesome authority to someone who was, is clearly not a matter of technology but of decision at the highest level of government.

Apart from this question, LUA has several attractive features as an MX basing mode. Because existing silos could be modified for use by MX missiles, there need not be any major environmental or societal impact. The cost would be lower than for any other MX basing mode, and deployment could take place as soon as MX missiles were produced. LUA would preserve familiar features of silo basing, including weapon effectiveness as measured by accuracy, time-on-target control, retargeting capability, and the like; familiar force management procedures; and familiar arms control verification procedures. The same targets (and perhaps more) would be available in the first few minutes of a war as in the first few hours or days. An LUA force could therefore participate in U.S. war plans in any role except that of a secure reserve force.

Reliance on LUA also has some serious drawbacks. Decision time would be very short. Depending on the circumstances, decisionmakers could lack crucial information regarding the extent and intent of the Soviet attack — e.g., information about targets which the Soviets had chosen not to attack. Such information could be necessary to gauge the proper response. Decisionmakers would also lack an interval between attack and response during which an effort could be made to assess intelligence information, consider diplomatic measures, and signal the intent of the U.S. response.

No matter how much money and ingenuity were devoted to designing safeguards for the U.S. capability to launch under attack, and even if these safeguards were very robust indeed, it would never be possible to eradicate a lingering fear that the Soviets might find some way to sidestep them.

Finally, despite all safeguards, there would always remain the possibility of error; depending on the nature of the error, it could mean a successful Soviet first strike against MX or it could mean a nuclear war started by accident.

8. Silo-Basing With an ABM Defense

For defending a relatively small number of targets such as MX silos, an ABM system that operates outside the atmosphere is preferable in theory to a low altitude defense system. This is because an exe-atmospheric (or "exe") defense could intercept many RVS headed for a single silo, whereas after a small number of intercepts an endo-atmospheric ("endo") system would find further defense precluded by the effects of its own and attacking nuclear weapons. A combination of exo and endo — a so-called layered defense — is an attractive concept because the principal limitation of each layer could be alleviated by the presence of the other: the exo defense would break up the dense and structured attacks which could otherwise overwhelm an endo defense, while an endo defense could cope with the relatively few enemy RVS that would almost certainly "leak" through the exo defense.

The Army's concept of exo defense, called the "Overlay," is in the technology exploration stage. No detailed design is available, such as exists for LoADS. In outline, the concept consists of interceptor missiles roughly the size of offensive missiles, equipped with infrared sensors, and carrying several kill vehicles, also equipped with infrared sensors. The interceptors would be launched into space, where the infrared sensors would detect approaching RVS as warm spots against the cold background of space. The kill vehicles would be dispatched to destroy the RVS either by colliding with them directly or by deploying a barrier of material in their path.

Because no specific system based on the Overlay concept has been worked out, it is not possible to analyze in detail the effectiveness of the Overlay in various attack scenarios. It is clear that high efficiency would be required if it were to be able to defend a small number of MX missiles against a large Soviet attack. There are at present many uncertainties about whether the Overlay could achieve the high performance it would require to satisfy the needs of MX basing. These uncertainties concern both the underlying technology and the defense system as a whole. The technical risk associated with layered defense based on the Overlay is therefore high–substantially higher than the risk associated with LoADS.

In addition to uncertainties and consequent risk associated with the Overlay, there is a potential "Achilles' heel" in the vulnerability of infrared sensing to decoys and other penetration aids. Unlike the LoADS radar, which could measure the weight of approaching objects after they entered the atmosphere, the Overlay's infrared sensors would measure their temperature characteristics. Lightweight decoys could be made which resembled in their temperature characteristics the heavier RVS.

The Overlay is not a system that is developed and ready for the role of defending silo-based MX. As the concept matures, it will have to deal with the fundamental problem of decoy discrimination as well as with the design of a specific working system. For the moment, it would be quite risky to rely on the Overlay, or on layered defense, as the basis for MX basing.

As in the case of LoADS, development or deployment of an Overlay or layered defense would require amendment or abrogation of the ABM Treaty reached at SALT 1.

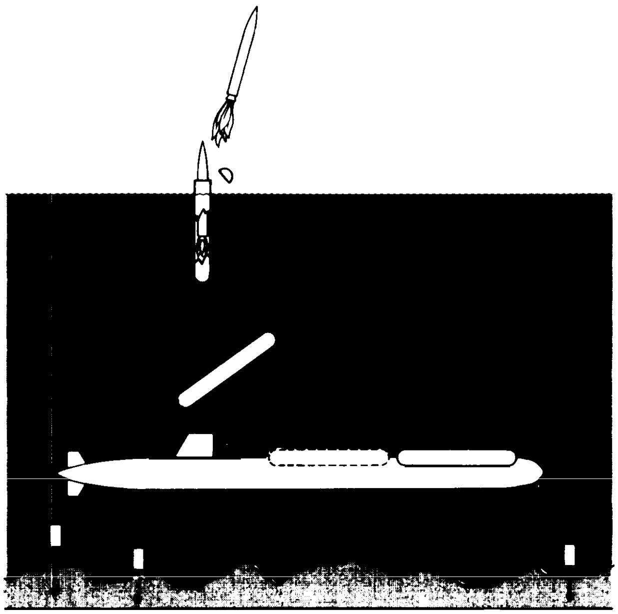
9. Basing on Small Submarines

It would be technically feasible to build, deploy, and logistically support a fleet of small MX-carrying diesel-electric-powered submarines. These submarines could operate within 1,000 to 1,500 nautical miles of three bases, located on the east and west coasts of the continental United States and on the coast of Alaska. These submarines would be highly survivable against all existing antisubmarine threats, and against all future antisubmarine warfare technologies which OTA was able to project. An alternative means of propulsion, using inexpensive low-powered nuclear reactors, is also possible.

At present, no detailed design exists for a submarine force specifically optimized to have flexibility, responsiveness, and accuracy comparable to that of the ICBM leg of the Triad. In order to provide a basis for analyzing the degree to which these attributes could be achieved in a submarine-based MX, OTA has postulated a system optimized for this purpose. The system postulated uses proven technologies and existing U.S. Navy operational practices wherever possible, and therefore differ:; in some respects from the "SUM" concept developed by Sidney Drell and Richard Garwin.

I-he system assessed by OTA would consist of 51 moderate-sized diesel-electric submarines, each of which carries 4 MX missiles (fig. 7). The missiles in their capsules would be carried horizontally outside the pressure hull. During normal operations about 28 submarines would be at sea at all tiroes, while the remainder would be in port for refits or over-

Figure 7.—Conceptual Submarine-Launch MX Missiles



SOURCE. Off Ice of Technology Assessment hauls, The submarines would have pressure hull displacements comparable to those of existing U.S. and Allied diesel-electric submarines. If an operational need arose, the submarines would have sufficient size, speed, and endurance to operate at distances in excess of the proposed 1,000 to 1,500 nautical miles from bases.

Small submarine basing raises two quite different kinds of issues. The first class of issues relates to whether or not small submarine basing is appropriate for MX; the second class of issues are technical questions about the extent to which such a basing mode would enable X to meet the requirements for which it is being designed.

Placing the MX missile on board submarines would mean that well over half of the U.S. strategic force of the 1990's would be submarine-based. This would obviously exacerbate the problems that would develop if–contrary to expectations —the Soviets were to develop an antisubmarine warfare capability that was effective against ballistic missile submarines. It would not be possible to build a new fleet of submarines without an expansion of U.S. submarine shipbuilding capacity. It would be necessary for three shipyards that do not now build submarines to learn how to do so. Submarine construction is complex, and involves more exacting quality control than surface ship construction. Delays could occur if the shipyards have difficulties in implementing the necessary quality control and construction techniques, or if the industrial base supplying certain critical materials is not expanded fast enough. Problems could be encountered in recruiting and retaining enough skilled and dedicated personnel to man such a fleet.

There is no particular reason why the existing Minuteman force would have to be taken out of service as soon as MX was deployed on submarines, and so the land-based ICBM leg of U.S. strategic forces would continue to exist. (Existing plans for, and OTA analyses of, other basing modes assume the continued operation of Minuteman after MX deploy merit.) However, its relative weight would be diminished, and this could have political significance. There is a school of thought which holds that basing a major portion of U.S. strategic forces on U.S. soil (so-called "sovereign basing") makes a significant contribution to deterrence. Moreover, changing the relative weight of land- and sea-based forces would create institutional problems for both the Air Force and Navy.

On the other hand, submarine basing of MX could lend an element of stability to the arms race, since a Soviet counter would involve increasing their already high level of effort in the apparently unpromising area of strategic antisubmarine warfare rather than increasing the number of their nuclear weapons. Submarine basing would be fully compatible with existing arms control concepts and verification procedures. The technical risks would be low.

OTA'S analysis focused on those aspects of submarine basing where it is possible to make comparisons with other basing modes: survivability, accuracy, responsiveness (including the effectiveness of command, control, and communications), environmental impact, cost, and schedule.

Chapter 5 contains an extensive discussion of the issue of submarine survivability. In brief, OTA could find no existing technology, and no technology believed to be on the horizon, which offers any promise for permitting an effective Soviet attack on a fleet of small MX-carrying submarines. However, the possibility that the Soviets may discover and deploy some antisubmarine warfare technology which cannot be foreseen cannot be excluded. If this were to happen, the differences between the Trident fleet (a small number of high-speed boats operating in an enormous deployment area) and the MX fleet (a large number of slower boats operating relatively close to the United States) could make it more difficult, and perhaps impossible, for the Soviets to deploy an antisubmarine warfare force capable of attacking both U.S. ballistic missile submarine forces.

"Endurance" is defined as the ability to survive for weeks and months *assuming* that a system has survived for a few days. The small submarines which OTA envisaged would have to return to a port (or conceivably an at-sea tender) 1 to 4 months after an attack, depending on how long each submarine had already been at sea when the attack took place.

Submarine-based MX missiles could achieve accuracies close or equal to the engineering-design requirements for the land-based MX missile. While it appears likely that land-based MX accuracies would exceed these requirements, submarine-based systems may well have such high damage expectancies against very hard targets that further improvements in accuracy would not have military significance.

OTA could find no reason to believe that the construction of three new submarine bases would have environmental impacts unlike those associated with comparable construction projects in coastal areas. In this case, the impacts would be confined to the immediate areas surrounding the three operating bases, and should be manageable.

Any estimate of the cost of small submarine basing can only be approximate, since no detailed design exists. Acquisition cost of the system described here is estimated to be about $32 billion (fiscal year 1980 dollars), with another $7 billion to operate the system until 2000.

Construction of submarines is a complex and specialized task, involving rigorous quality control and specialized materials not normally required for shipbuilding. At present there are only two shipyards in the United States capable of building submarines, and both are backlogged. Bringing additional shipyards to the point where they could build submarines, and obtaining the necessary parts and materials, could perhaps involve substantial delays. OTA estimates that the first such submarine could not be operational before 1988 at the very earliest, with 1990 a more realistic date. Four more years would be needed before the force reached the number of 51. Efforts to accelerate this schedule (or, if things went wrong, to maintain this schedule) could delay other, existing submarine construction programs. However, the first MX missiles deployed on small submarines would be highly survivable, in contrast to other basing modes which would attain survivability only after most or al l of the force was operational.

10. Surface Ship Mobile

Another approach to seeking survival by mobility at sea is to base the MX missiles on a fleet of surface ships. Such a fleet would be designed to have an appearance similar to merchant shipping, and to hide itself either in broad expanses of the ocean or among the other ships in crowded shipping lanes. The techniques for lowering missiles over the side of a ship and launching them from the water are well-established, although other launching modes might prove preferable.

Most of the points noted in the previous section about shifting the weight of U.S. strategic forces from land to sea apply. Unlike submarines, the surface ships would have a security problem in making certain that third parties did not attempt to seize the MX missiles. The ships would have to have a considerable capability for self-defense. The need for defensive weaponry could make it more difficult to disguise the ships.

An examination of the way in which such a force of surface ships might operate reveals numerous operational problems, which interact with the task of assuring survivability. Briefly, the Soviets could destroy any MX-carrying surface ship which they could locate or, having located, trail. OTA'S analysis (ch. 7) assumes that by the 1990's the Soviets would deploy a large force whose purpose was to locate and trail such ships, and finds that in such a case the proportion of a fleet of such ships which would be located and under trail might fluctuate greatly from day to day. Hence, although attacking such ships would be a formidable task for the Soviets, the United States could not have confidence in the survivability of surface-ship mobile MX.

While cost and schedule estimates cannot be precise for a system that has never been designed in detail, it is estimated that surface-ship acquisition costs would be comparable to those of a fleet of small submarines. Annual operating costs would be Slightly higher than those of small submarines. These differences are within the range of expected error A surface ship fleet might be operational a year or two before a submarine fleet. Given the greater survivability of submarine basing, it would seem to be preferable to surface ship basing if sea mobile basing is chosen.

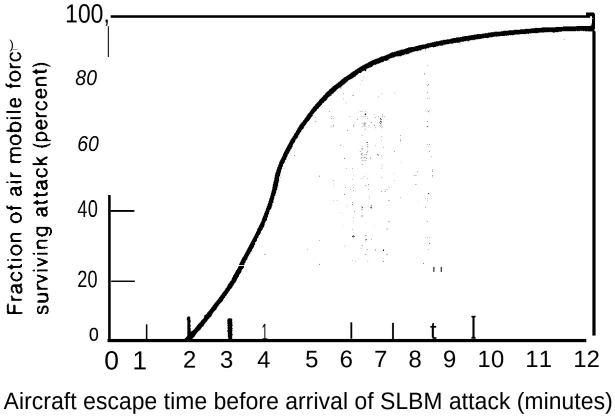
11. Air Mobile

Air mobile MX would be a system of great operational complexity, and therefore there is a corresponding wide choice of specific concepts. The lowest cost concept would consist of 75 or so wide-bodied aircraft, each carrying two MX missiles, maintained on strip alert at airfields located in the Central United States.

Such a "dash-on-warning" air mobile force could be highly survivable. The principal threat to the force would be submarine-launched ballistic missiles (S LBMS) launched from positions near U.S. coasts. Such an attack could arrive in the vicinity of the alert airfields within 15 minutes of launch and seek to destroy the aircraft before they could take off and escape. However, if a high-alert posture were accepted for the force, meaning that the aircraft took off *immediate/y upon time/y warning* of SLBM attack, almost the whole force would survive even if a large number of SLBMS were launched from positions near U.S. coasts (see fig 8). The Soviet SLBM force is presently incapable of such an attack. Air-mobile basing could therefore stress Soviet strategic forces where they would be least able to respond in the short term.

Nevertheless, the difference between survival and destruction of the force would be a very few minutes, depending on timely tactical warning. In this respect an air mobile ICBM force would replicate a significant failure mode of another leg of the strategic Triad — the bomber force.

Figure 8.—Survivability v. Escape Time (8 EMT on Each Airstrip, 2 PSI Aircraft)



SOURCE Off Ice of Technology Assessment

ICBMS, arriving later than the SLBMS, could not threaten the survivability of the force as a whole, since by that time the aircraft would have been in flight long enough to be dispersed over a wide area. Effective barrage attack of this area would require the Soviets to build many more large IC BM *missiles* than they now possess and use them to barrage a m i l l ion or so square miles. The outcome of such an attack would be insensitive to both the fractionation (the apportioning of the missile payload among a small number of large-yieldt[ge-yield RVS or a larger number of smaller yield RVS) and to the accuracy of Soviet ICBM forces.

The principal disadvantage of a dash-on-warning force—the need for reliable, timely warning—could in principle be removed by having the aircraft maintain continuous airborne patrol. However, even with a new aircraft designed for low fuel consumption, the cost of operating such a force would be prohibitive. A continuously airborne force of 75 aircraft (1 50 MX missiles) could cost $80 billion to $100 billion (fiscal year 1980 dollars) to acquire and to operate for 10 years after full deployment (FOC).

A second crucial problem for an air mobile force concerns the question of postattack endurance. After a few hours of flight, the aircraft would have to land and refuel. Since their home airfields would be destroyed, they would have to find other places to land and await further instructions. This problem could be avoided completely if the United States were willing to adopt a policy of “use it or lose it” for the few hours of unrefueled flight. There are also several hundred civilian and military airfields in the United States capable of servicing large aircraft. Many of these airfields are located close to urban areas. If the Soviets wished to deny postattack endurance to an air mobile fleet—tantamount to forcing the United States to “use it or lose it” –they would have to attack these airfields. A serious effort to build more austere recovery airstrips throughout the country than the Soviets possessed ICBM RVS to destroy them would be enormously expensive, would have substantial environmental impact, and would be completely impractical if the Soviet threat grew large. For instance, 4,600 airfields spaced 25 miles apart would fill the entire 3 million square miles of the continental United States.

There could conceivably be some value in having more airfields suitable for air mobile operations than the Soviets had SLBM RVS. These could be useful if the United States doubted the reliability of its SLBM warning sensors and wished to relax the force’s alert posture (since, in a crisis, false-alarm takeoff might be mistake~ by the Soviets for preparation to launch the MX missiles), or if the fleet were somehow “spoofed” into taking off (thus making a portion vulnerable as the aircraft were forced to land). A force with this dispersal option could cost $10 billion to $20 billion (fiscal year 1980 dollars) more than a wide-bodied jet force with no recovery airfields beyond existing large civilian and military airfields.

Thus, the lowest cost air mobile system would exclude extra recovery airfields beyond those large civilian and military airfields which exist at present. Although OTA has not performed detailed cost and schedule analysis for such an air mobile option, it appears that the cost of a force with 75 aircraft (150 MX missiles) on alert would be comparable to the cost of the baseline MPS system and could be deployed in a comparable time.

An air mobile force would also require several supporting systems. First and foremost would be reliable sensor systems for timely warning of Soviet attack. Providing such systems would be technically feasible but would require time, money, and continued effort. The complex force management needs of the air mobile force after attack would require a comparably complex communications system. Last, providing for missile accuracy comparable to land basing would require use of the Global Positioning Satellite system or a Ground Beacon System.

COMPARISON OF BASING MODES

As we have indicated above, OTA’S technical analysis of MX basing modes does not support a clear or simple choice, All of the basing modes reviewed have strengths and weaknesses. This section presents the criteria OTA has identified for the purpose of analysis, and uses them to compare the five most feasible options. Since no basing mode ranks high against all criteria, choosing among them depends on the relative weight attached to each.

Technical Risk

Technical risk refers to the level of confidence that one can have ***at this time*** that the system will perform the way it is supposed to.

There are significant risks associated with two of the five basing modes considered. PLU will represent an area of significant technical risk for MPS basing until prototypes have been tested, and could be a subject of lingering doubts even afterwards. The use of LoADS with MPS would compound this risk. An additional technical risk for LoADS concerns the requirement that LoADS operate in a nuclear environment of unprecedented severity, inducting high-yield nuclear donations roughly a mile away.

The risks of LUA arise not from technically difficult problems, but from the uncertainties of the interface between men and machines.

Survivability y

A force is "survivable" if its destruction by a Soviet first strike is infeasible, Some basing modes aim at protecting the entire force while others accept some attrition and size the system to assure an adequate number of survivors Survivability would be of critical importance to deterrence in either of two scenarios. The first is that the Soviets considered an all-out war inevitable, and were considering whether striking first would limit the damage such a war would cause to the Soviet Union. The second is that the Soviets sought to control the outcome of a crisis by partially disarming the United States while deterring the United States from responding. In either case, it would be important that the United States could feel confident that the Soviets would doubt their ability to destroy a relatively large proportion of U S. strategic feces All the MX basing modes are designed to provide this assurance, but they do so in different ways. For this reason, they create somewhat different risks,

A timely decision to launch under attack would prevent the Soviets from destroying the missiles before they were used Air mobile MX would become vulnerable if the United States failed to receive and act on adequate warning, a failure mode which it would share with the bomber leg of the Triad. The MPS systems (including the MPS/LoADS combination) would become vulnerable if PLU broke down, and wou ld a l so become vu l nerable whenever the size of the MPS system was too small relative to the Soviet threat. This latter occurrence is not so much a question of technology as it is a question of the judgment and optimism of U. S policy makers: a rapid growth in the Soviet threat could make MPS vulnerable unless the United States had decided to expand the system *before* Soviet intentions had become clear. Small submarines do not appear to be vulnerable, either now or in the foreseeable future, However, if an unforeseen Soviet breakthrough in antisubmarine warfare occurred, it is possible that it would threaten both small submarines and the Trident/Poseidon leg of the Triad.

LUA would become progressively less vulnerable as improved warning and communications systems were brought online. MPS (with or without LoADS) would become survivable only after the n u mber of shelters deployed surpassed the number of Soviet RVS available to attack them Small submarines. would be highly survivable when first deployed

Endurance

En durance is defined as the capabil ty to survive as an integrated system — both m ss i les and the communications needed to use them — for an extended period after a nuclear attack, *assuming* that the system survives the attack itself. An LUA system would clearly have no endurance,

An air mobile system would not endure longer than 5 to 8 hours unless the Soviets chose not to attack the airfields at which the MX-carrying aircraft could land and refuel. LoADS could be ineffective against a second attack. Small submarines with diesel-electric propulsion wou ld endure from 1 to 4 months at sea, and longer if provisions were made for replenishment Nuclear-electric propu ls ion could provide longer endurance for small submarines. MX,' M PS is designed to endure i n a low-power mode for many months after an attack.

Weapon Effectiveness

This criterion addresses the question of how well MX in the various basing modes could support those aspects of U.S, nuclear weapons employment policy which have previously been the specialty of the ICBM leg of the Triad, including ability to destroy hardened Soviet targets (accuracy and time-on-target control), strike rapidly on command (responsiveness), and support a doctrine of flexible response (retargeting capability),

Land-based systems (MPS, MPS with LoADS, and LUA) will continue to set the standard for accuracy, time-on-target control, responsiveness, and rapid retargeting. MX based on small submarines would be almost as good, and in-

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deed would most probably be close to or equal the design requirements for MX. There would be few if any military missions of importance for which a submarine-based MX (given feasible upgrades in guidance systems, navigational aids, and C^3 systems) would be significantly less capable than land-based MX. Air mobile basing would sacrifice a degree of responsiveness because of the need for the aircraft to takeoff before launching the missiles, would require external navigation aids to achieve high accuracy, and management of a dispersed air mobile force could be very complex.

Command, Control, and Communications (C^3)

Reliable communications impervious to Soviet attempts at disruption are needed for commanders to assess the status of the MX force, retarget the missiles if desired, and transmit launch commands. The technical means to accomplish these tasks, as well as the tasks themselves, could be very different in the preattack, transattack, and postattack periods.

There are distinct and important differences from basing mode to basing mode regarding both the technical means to support effective C^3 and potential vulnerabilities. In each case, it appears that with adequate funding and effort, acceptable technical solutions are available, though it would be extremely difficult to secure any C^3 system against any and all contingencies. On balance, OTA has found no clear technical reason for preference among the basing modes on the basis of C^3.

Arms Control Considerations

The choice of basing mode could affect arms control in several ways. First there is the question of whether a given basing mode conflicts with U.S. obligations under a treaty now in force. Also of interest are possible conflicts with treaties signed but not ratified. Apart from specific treaty provisions, the United States has a longstanding policy that strategic systems should be amenable to verification. The impacts of MX basing on future arms control negotiation are speculative. They involve not only the negotiability of future arms control agreements, but also incentives which might be created for increasing or reducing the level of strategic armaments.

Deployment of a LoADS ABM system in defense of MPS would require amendment of, or U.S. withdrawal from, the ABM Treaty reached at SALT 1, though much predeploy - ment work could be done within the terms of the Treaty. In general, the five basing modes we are comparing appear compatible with the provisions of SALT 11. MX/MPS has been designed specifically to be compatible with this proposed Treaty.

A future arms control agreement that permitted MPS basing but limited the number of missiles could be verified if the system were designed from the outset with this in mind. An agreement permitting the deployment of the MX missile on small submarines or aircraft could be verified using established procedures and national technical means.

MPS basing could complicate future arms control negotiations. Detailed understandings about deployment procedures and peacetime operations, not previously included in arms control agreements, could be required for the United States to verify limits on a Soviet MPS deployment. Because MPS deployments must be large in order to be survivable, MPS basing could tend to provide incentives for continuing increases in numbers of strategic arms, and comlicate efforts to seek agreements limiting or reducing these numbers. Moreover, MPS would necessarily focus attention on numbers of RVS.

Institutional Constraints

The Navy has shown little interest in small submarine basing of MX, and the Air Force opposes it. The LoADS ABM concept would not challenge existIng roles and missions, but it would require early and close Army/Air Force cooperation, MX/MPS would strain the ability of Federal, State, and local jurisdictions to plan and coordinate adequate provision of social services and environmental protection.

Impacts on the Physical Environment

MPS systems would have considerably greater physical impacts than the other basing modes considered In the Great Basin of Nevada and Utah these impacts would be particularly severe and could include the long-term loss of thousands of square miles of productive rangelands. Although the qualitative impacts of both split basing and Minuteman MPS would be essentially the same, the magnitude of these impacts would be significantly reduced by split basing and could be reduced further by basing in the northern Minuteman fields Impacts of air mobile basing would re sult from airfield construction, but severe impacts would be unlikely The impacts of submarine basing would be site-specific and confined to the areas where operating bases would be built, but could be significant within these areas The i m pacts of LUA as a basing mode would be minimal

Socioeconomic Impacts

The magnitude of MPS construction would have major impacts on the socioeconomic structure of any deployment area selected on the basis of minimum population criteria Furthermore, uncertainties regarding the size and the distribution of the work force population would make advance planning so difficult that effective mitigation of adverse impacts would be unlikely These impacts would be most severe in the case of MPS in Nevada and Utah, but would also accompany split basing or rebasing of Minuteman I I I

The impacts of air mobile and submarine basing would be confined to the areas where operating bases were built, and might be positive or negative depending on the characteristics of the areas chosen LUA would have no impact

costs

OTA has compared costs on the basis of "lifecycle" cost, which includes both the cost of acquiring the system and the cost of opera t-ing it until 2000

The baseline MX MPS system of 200" missiles and 4,600 shelters was sized to provide adequate survivability against a particular Soviet threat For costing purposes OTA has sized the other systems to provide equivalent survivability against a comparable threat. If the Soviet threat should grow, MPS systems (including MX defended by Lo ADS and Minuteman,MPS) would have to grow accordingly. Submarine basing, air mobile basing, and reliance on LUA would not

Table 1 summarizes OI" A cost estimates for the basing systems The lifecycle cost of baseline MPS (4,600 shelters with 200" missiles),

Table 1 .—Summary, Lifecycle Cost Estimates for Basing Options
(billions of fiscal year 1980 dollars)

	MX/MPS baseline	MX/MPS expanded 1990 threat	MX/MpS expanded 1995 threat	MX/M PS vertical shelters	MXIMPS spilt basing	Small submarine	MM III MPS	MM III expanded 1990 threat	MM III expanded 1995 threat
Number of shelters	4,600	8,250	12,500	4,600	4,600	51*	5,800	10,400	15,500
IOC/ FOC (calendar year')"	87/89	87189	87194	87/89	87/89	89/95	87/90	87/91	87/94
Number of deployed missiles	200	359	544	200	200	204	667	900	1,100
Development	$ 9172	$ 9.372	$ 9.572	$ 9.172	$ 9.172	$ 7.225	$ 2.527	$ 2500	$ 2.500
Investment.	27999	43,557	61.512	26.500	30109	24862	28,037	43200	60400
Total acquisition ...	$37171	$52.929	$71.084	$35.672	$39,281	$32.087	$30.564	$45700	$62.900
Operating and support to year 2000	$ 6.308	$ 9482	$11486	$ 6.308	$ 6.526	$ 7160	$ 5907	$ 7.700	$ 9500
Lifecycle cost to 2000	$43479	$62411	$82570	$41.980	$45807	$39247	$36471	$53400	$72400

'Submarines

SOURCE Of office of Technology Assessment small submarines, and air mobile are all about $40 billion (fiscal year 1980 dollars) OTA estimates that split basing would cost about 7 percent more. Rebasing Minuteman I I I would be about $7 billion less expensive than the baseline MX/MPS systems LUA would be considerably less expensive than the others, even after very su stantial upgrading of warning and communications systems.

Against an increased Soviet threat, the cost of MPS would grow. If the Soviets devoted substantial effort to threaten MPS, and if the U.S. response was to increase the number of shelters and missiles, then the lifecycle cost to the year 2000 of $43 billion for the baseline system (OTA estimate in fiscal year 1980 dollars) might have to grow to $58 billion to $62 billion by 1990 and to $78 billion to $83 billion by 1995. Adding LoADS instead of increasing the number of shelters could cut costs: a Congressional Budget Office study estimates that using an optimal mix of LoADS, additional shelters, and additional missiles would save about 10 percent against the 1990 threat and about 18 percent against the 1995 threat.

Note that efforts to make the survivability of air mobile independent of warning by means of airborne alert, or to give air mobile some endurance by building additional dispersal airfields, would drive its cost u p very sharply.

Schedule

The advocates of each of these basing modes project initial operating capabilities in the mid- to late 1980's. These projections are based on rather optimistic assumptions, and the record of U.S. development of weapon systems in the recent past suggests that schedule Slippages are likely.

In considering schedule it is necessary to distinguish among three dates for each possible basing mode.

1. Initial operating capability (IOC) refers to the date at which the first missiles would enter the active strategic force This date is sign if i cant from the viewpoint of the overall strategic balance, and concern with how perceptions of this balance may affect U S. diplomacy
2. FuI I operating capability (FOC) refers to the date when the last missiles and bassing facilities would become active
3. Survivability refers to the date when the deployed system is judged to be adequately survivable against the then-existing Soviet threat. This date is significant from the viewpoint of reversing the effects of the growing Soviet capability to destroy the Minuteman force in a first strike.

Depending on the basing mode and the growth in the Soviet threat, survivability could coincide with IOC, could coincide with FOC, or could come at a date between them.

Because considerable engineering development has been accomplished for MX/MPS, it could probably achieve IOC in 1987. Minuteman MPS could not have an IOC before 1986, even though the missiles already exist, because of the need for an environmental impact statement, site selection, land acquisition, and the need to design a PLU system before starting construction. FOC dates for MPS systems would depend on the size of the Soviet threat. Reasonable FOC dates are 1989 or 1990 if 200 missiles and 4,600 shelters prove to be enough, and a Minuteman MPS of comparable size could be completed at about the same time. So long as the threat kept growing, the system could never be completed in the sense that costruction could stop. However, survivabilty could be achieved before Soviet threat growth and U.S. construction stopped, For example, a 1990 threat of 7,000 Soviet RVS cou Id be met by an MX/MPS system of some 8,250 shelters and 360 missiles. These could be completed by 1990 *provided* that a firm decision to build at that rate were made in late 1982 or ealrly 1983— before firm evidence of Soviet building plans is likely to be available. To retain survivability after 1990 would require a building program that kept pace with any continuing growth in the Soviet threat.

LUA could begin, in principle, as soon as MX m i ssiles could deployed, but upgraded warning and communication systems might not be developed until the end of the decade.

Adding LoADS to MPS would probably not affeet FOC significant I y Submarine-based MX IOC could be as early as 1988, but 1990 seems more likely. An FOC for submarines appears achievable as early as 1992, but OTA believes that 1994 would be more realistic However, since submarine basing would achieve survivability at the IOC date rather than the FOC date, submarine basing might well achieve survivability sooner than any of the other basing modes despite the fact that its IOC could well be the latest

While OTA has not performed schedule analyses for air mobile, it appears that an air mobile system might also be deplo yed by the end of the decade

Stability

MX basing could affect stability n three dif - ferent senses In the first, survivability (which is treated separately above) enhances stability by avoiding a situation in which the Soviets might start a war because they expected to obtain an advantage by destroying vulnerable U.S. forces. Second, MX basing should, if possible, minimize the risks that a war might start because of accident or miscalculation during a crisis. Finally, MX basing could affect the incentives which shape future nuclear weapon deployment decisions: this is called arms race stabi I it y

MPS basing introduces the prospect of an increasing number of U S. shelters and missiles in response to an increasing number of Soviet RVS. From the U.S. point of view, keeping pace with a growing Soviet threat could be costly and would put a premium on determining and projecting the number of Soviet RVS For their part, the Soviets would be tempted to expand their RV inventory, taking advantage of their existing throwweight to overwhelm the U.S. MPS deployment On the other hand, the Soviets would be concerned about the effects of a growing MX deployment on the survivability of their own ICBMS.

LoADS ABM deployment could permit an MPS deployment to attain survivability against a given threat level with a smaller number of MX missiles; in this sense it would contribute to arms race stability. On the other hand, it could reopen the qualitative arms race in ABM technologies and offensive penetration techniques (including larger numbers of offensive weapons) which the 1972 A BM Limitation ion Treaty sought to foreclose,

Small submarine basing would be survivable and might force the Soviets to redirect their efforts from building offensive weapons to intensify antisubmarine warfare research. Since strategic antisubmarine warfare appears very unpromising, this would be stabilizing. However, if the Soviets did achieve an antisubmarine warfare “breakthrough,” it would be highly destabilizing.

LUA poses the risk of failure during peacetime or during crisis which could lead to accidental war. U. S deployment of a new missile in a nonsurvivable basing mode could also create a Soviet perception that in a crisis the United States might choose to strike first rather than wait to launch under attack.

Air mobile would be survivable and would therefore not create incentives for the Soviets to expand their ICBM force. However, its dependence on timely warning could create tension in a crisis.