Chapter 10

Alternative R&D Programs

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INTRODUCTION

In previous chapters, this report has addressed the potential contributions and liabilities of ballistic missile defenses, and it has primarily discussed the long-term issues associated with developing and deploying BMD. However, technologies now within the state of the art are capable of providing only limited BMD capability. More effective BMD systems cannot be developed without further research and technology development.

This chapter discusses research programs to investigate the possibilities for acquiring more advanced BMD systems. It presents a number of different potential strategies for pursuing BMD research, describes some characteristics by which alternative R&D programs can be compared, and outlines some of the issues Congress must face in the near-term.

There is general agreement that BMD technologies merit investigation. Support for BMD research, however, does not necessarily imply support for the Strategic Defense Initiative (SDI). Possible BMD research programs can differ greatly from the SDI in emphasis, direction, and level of effort. Moreover, research programs having different perceived and intended purposes—even if they have similar technical content—can have very different consequences.

Decisions to be made by Congress in the very near future and in the years to come will have a major impact in ratifying, or in redirecting, major changes which the Reagan Administration has initiated in the U.S. BMD research program. These changes include:

- Urgency: Research under the SD I is intended to proceed at a "technology-limited' pace to permit an informed decision to be made at the earliest possible date on whether to enter full-scale engineering development. Proceeding past that point would clearly be inconsistent with ABM Treaty constraints. The pre-SDI program had no such mandate for an early decision on maintaining the ABM Treaty.
- Visibility: The SDI has much higher visibility, and a much higher level of Presidential attention, than the previous program of research in BMD-relevant technologies. The decision to spotlight BMD has already been made, and its consequences are already being felt. These consequences certainly include a decision by the Soviets to at least explore their options to respond to the increased probability of a U.S. BMD deployment.
- Direction: Under the SDI, emphasis has shifted away from fairly mature technologies, which generally include use of nuclear interceptors, towards nonnuclear defenses which would use much more speculative but potentially more effective technologies.
- Budget: Over the next decade, much more is proposed to be spent on ballistic missile defense research than would have been allocated in the absence of the SDI. Large budget increases start with the $3,722 million fiscal year 1986 request, which is almost four times the fiscal year 1984 total and is more than twice what would have been spent within the Department of Defense in fiscal year 1986 under the pre-SDI budget. Subsequent increases proposed for the SDI are even greater, and by fiscal year 1990 are projected to reach a level over eight times the fiscal year 1984 total.
- Arms Control Policy: Instead of the pre-SDI approach of seeking deep *reductions* of offensive forces along with maintenance of the ABM Treaty ban on defenses against ballistic missiles, current arms control policy seeks "greatly reduced

levels of nuclear arms and an *enhanced ability to deter war based upon an increasing contribution of non-nuclear defenses against offensive nuclear arms.*"[1]

BMD R&D Options

Near-term decisions by Congress will determine our approach to BMD research. These near-term decisions will not completely determine our longer term policy approach, in part because many factors influencing long-term policy are not under our direct control (e.g., Soviet activities and U.S. progress in technology development). However, decisions made in the short term can significantly affect, or rule out, options for long-term policy. The research options discussed below correspond roughly to the long-run policy approaches discussed in chapter 9, as is shown in table 10-1.

Different approaches that can be taken towards ballistic missile defense research proceed from different sets of basic assumptions about the value and feasibility of BMD and from differing assessments of the consequences of pursuing BMD research. Three such approaches can be distinguished and are presented below. These approaches differ primarily in emphasis and urgency, rather than in which technologies are to be studied. Most BMD-relevant technologies would be investigated, at some level, in all three.

The first approach is the SDI as proposed by the Reagan Administration. The second approach would proceed to BMD deployment faster than the SD I would be able to, and the third approach would conduct BMD research and development at a slower rate than the SDI. Each of the last two approaches is further broken down into two suboptions which differ in the emphasis given to existing versus near-term technologies (in the second approach) or near-term versus far-term technologies (in the third). The five research suboptions are defined as follows:

1. SDI approach: Vigorously investigate advanced BMD technologies with the

[1] Quoted from "The U.S. Strategic Concept, " enunciated by Paul Nitze in "The Objectives of Arms Control, " address before the International Institute of Strategic Studies, London, Mar. 28, 1985. (Emphasis added.)

Table 10.1 .—Correlation Between the Near-Term Research Approaches Discussed in This Chapter and the Longer-Term Policy Approaches Discussed in Chapter 9

	Long-term policy approach (ch. 9)				
Near-term R&D approach (ch. 10)	SDI	Early deployment	Intermediate deployment	Silo defense	Non-BMD, arms control
1. SDI	Compatible	Must add near-term deployment	Must commit to deployment	Eventually becomes incompatible	Eventually becomes incompatible
2a. Early deployment, . .	Not very compatible	Compatible	Compatible but not optimal	(see note [a] below)	Incompatible
2b. Intermediate deployment	Conditionally compatible (see note [b] below)	Need to add near-term deployment	Compatible	(see note [a] below)	Incompatible
3a. Funding-limited	Would delay but not rule out	Incompatible	Incompatible	Eventually becomes incompatible	Compatible
3b. Combination	Would delay but not rule out	Incompatible	Incompatible	Compatible	Compatible

[a] Both early development and intermediate deployment R&D approaches might be compatible with a "silo defense" long-term policy approach, since defending hardened targets such as missile silos, a technically easier task than defending other types of target, could probably be Implemented earlier than other types of BMD. However, to the extent that the early and intermediate deployment R&D approaches are Intended to support widespread area defenses, probably including boost-phase weapons, those R&D approaches may be incompatible with the "silo defense" policy approach in which defenses would be limited to specific sites, and where the appearance that nationwide area defenses were being implemented would be avoided.

[b] If the technologies slated for initial deployments in the "intermediate term" research approach cannot be successfully developed, or If their development triggers offensive countermeasures which render the defense largely Ineffective, pursuit of the long-term "SDI" policy approach would be greatly complicated or prevented Successful deployment of intermediate term technologies, on the other hand, could then be followed by pursuit of more capable BMD technologies and would be compatible with the goals of the Iong term SDI policy approach This path would take longer and would cost more than pursuit of the "SDI" research approach from the beginning, which would not necessarily Include deployments in the intermediate term

intent to decide in the early 1990s on whether or not to enter full-scale engineering development and subsequent deployment. This approach assumes that while technology now within the state of the art is not good enough to be worth deploying, the long-term potential of advanced BMD technologies is sufficiently promising that a "technology-limited" (i.e., not constrained by lack of funds) effort is warranted to develop that potential. It also assumes that if successfully developed, such technologies could make possible a national security regime (weapon systems and arms control) preferable to the current one and to other alternatives.

2a. Early deployment approach: Emphasize early and incremental deployment of currently available BMD technology. This approach places high strategic value on the modest levels of defensive capability which can probably be obtained with existing technology. Although the ABM Treaty permits the United States to defend some ICBMs with a single, highly constrained defensive deployment, most early deployment proposals go well beyond these constraints and could not be pursued under the existing treaty regime.

2b. Intermediate deployment approach: Emphasize research on BMD technologies which are beyond the present state of the art, but which, unlike many SDI technologies, might be applicable to deployments in the early to mid-1990s. This approach assumes that investigation of longer run technologies should not delay deployments in the nearer term.

3a. Funding-limited approach: Investigate advanced BMD technologies at a funding level well below that requested for the SDI and with a much reduced sense of urgency. Like the SDI, this approach would focus mainly on advanced technologies that may make a highly capable defense possible. Unlike the SDI, however, it does not assume that we will know in a few years whether we can achieve that goal. The program would not aim towards facilitating a development decision at a particular time, nor would it include tests or demonstrations which would raise questions of compliance with the ABM Treaty.

3b. Combination approach: Balance research in advanced B-MD technologies with the development of near-term deployment options which would include "traditional" BMD technologies (nuclear-armed, radar-guided interceptors) of the sort specifically mentioned in the ABM Treaty. This program, conducted at a funding level well below that requested for the SDI, would aim to deter Soviet abandonment of the ABM Treaty, to hedge against future Soviet BMD developments, to prevent technological surprise, and to investigate the long-term potential of advanced BMD technologies. Like the funding-limited approach, it would not include demonstrations or development work which would raise questions of compliance with the ABM Treaty.

These research options will be described and discussed in detail later in this chapter.

Hedges Against Near-Term Soviet ABM Treaty Breakout

One of the functions of a U.S. BMD research program is to deter or respond to a near-term Soviet ABM Treaty "breakout" (sudden initiation of nationwide BMD deployments) or "creepout" (gradual implementation of nationwide BMD capability without overt Treaty abrogation). A U.S. response to either of these actions would most likely consist of deployment of a near-term U.S. defense, deployment of offensive countermeasures which would ensure that our strategic forces could penetrate Soviet defenses, or some combination of the two.

Near-Term U.S. Defensive Deployment

The SDi approach has largely discontinued investigation of "traditional" BMD technologies in favor of nonnuclear technologies which would make intercepts at altitudes high enough to protect soft targets as well as hardened ones.[2] Although protecting soft targets with nonnuclear interceptors is technically much more demanding than defending only hardened targets with nuclear interceptors, advocates of the SD I approach are confident that the technical requirements can be attained within a few years if required. In principle, "traditional" BMD technologies could be restored to the SDI as a hedge against inability to develop other near-term defensive options. However, doing so would require reevaluating SDI's emphasis on nonnuclear technologies, and it would also require additional funds if work on other BMD technologies were not to be impeded.

The *early deployment* and *intermediate deployment* approaches would not wait for a Soviet breakout before deploying defenses. Different versions of these approaches would stress differently the deployment of "traditional" BMD technologies as opposed to nonnuclear ones which have yet to be demonstrated but are nevertheless thought by some to be capable of providing high-confidence deployment options.

The *funding-limited* approach would deemphasize near-term defensive deployments, concentrating on longer term research which could lead to a highly capable defense. It stresses offensive countermeasures (see below), rather than near-term defensive counterdeployments, to respond to near-term Soviet breakout. The *combination* approach would be intended to deter a near-term Soviet breakout by putting more emphasis on improving our ability to deploy a near-term U.S. defense, in addition to developing offensive countermeasures. This approach would pursue research and development of "traditional" BMD technologies (within ABM Treaty constraints) to eliminate the technical risks of depending on yet-to-be demonstrated near-term defensive technologies.

Offensive Countermeasures

The U.S. response to Soviet breakout need not be limited to defense. Offensive countermeasures intended to penetrate, counter, or evade Soviet defenses are at least as important in deterring or responding to a Soviet defensive deployment as U.S. defensive options are. Offensive countermeasure research would accompany any of the BMD research options above.

The U.S. program responsible at present for developing offensive BMD countermeasures is the Air Force's Advanced Strategic Missiles Systems (ASMS) Program.[3] These countermeasures include maneuvering reentry vehicles, which evade terminal BMD interceptors by flying unpredictable trajectories, and other penetration aids which would help U.S. warheads defeat Soviet defenses. According to the fiscal year 1982 Arms Control Impact Statement on the ASMS Program,

> Maneuverable re-entry vehicle (MaRV) and penetration aid R&D is expected to provide a high-confidence, low-risk option for timely deployment on current or future ballistic missile systems if needed to offset improved rapidly deployable nationwide Soviet ABM defenses (which would violate the ABM Treaty).
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> * * *
>
> The present MaRV and penetration aids programs are a hedge against the possibility of such a situation . . .[4]

[2]Even if a defensive interceptor does not use a nuclear warhead, a nuclear explosion can result if the attacking warhead is salvage-fused to detonate when intercepted. Therefore, nonnuclear interceptors (as well as nuclear ones) must intercept at high altitude if soft targets are to be defended.

[3]The U.S. capability to penetrate existing Soviet defenses was not mentioned in the White House January 1985 pamphlet on *The President Strategic Defense Initiatitve*. That pamphlet asserts that the Soviets will be able to deploy a nationwide ABM defense system within the next 10 years. Should they decide to do so, it continues, "deterrence would collapse, and we would have no choices between surrender and suicide'" (p. 4).

Although any defense deployable by the Soviets in the next 10 years would certainly complicate U.S. targeting, the available offensive countermeasures technologies make it extremely unlikely that we could be forced to choose between ' 'surrender and suicide. "

[4]*Fiscal Year 1982 Arms Control Impact Statements*, Statements Submitted to the Congress by the President Pursuant to Section 36 of the Arms Control and Disarmament Act, printed for the use of the Committee on Foreign Affairs and Foreign Relations of the House of Representatives and Senate respectively, Joint Committee Print, 72-434 (), U.S. Government Printing Office, Washington, DC, February 1981, p. 28.

Such offensive countermeasures, of course, would no longer be required were the United States to agree to eliminate its offensive arsenal. However, defenses good enough to permit eliminating offensive nuclear forces are not envisioned for the foreseeable future, even by proponents of strategic defense.[5]

In addition to providing the United States with options to respond to Soviet defenses, investigation of potential offensive countermeasures to BMD systems must also be an integral portion of our own defensive research. Defensive technologies which can be shown to be easily countered will not be as promising as those for which countermeasures cannot be found so readily.

Offensive countermeasure research options differ in their choice of which defense technologies are to be countered and in how far countermeasure and penetration aid research should be taken into advanced development, production, and deployment. Unlike defensive research, there are no treaty constraints banning testing and development of offensive countermeasures.[6]

Soviet BMD Research and Comparison With U.S.

"Traditional" BMD Technologies

The United States and the Soviet Union have conducted research and development activities in BMD both before and after the ABM Treaty was signed. Each has acquired considerable experience with "traditional" BMD technologies, such as the nuclear-armed, radar-guided interceptors of the sort specifically mentioned in the ABM Treaty. However, although the state of Soviet "traditional" BMD technology probably does not exceed our own, the Soviets are almost certainly better positioned in the near-term to deploy a limited-capability ballistic missile defense system than we are.

The Soviets have deployed and maintained an ABM system around Moscow utilizing "traditional" BMD technologies. They have also extensively upgraded and modernized that system. Ever since the United States decided that its own similar system was not effective enough to justify maintaining it, the Moscow ABM has been the world's only operational ABM system.

In addition to the Moscow system permitted under the ABM Treaty, the Soviets have built a large radar in Siberia which violates the siting restrictions on such radars in the ABM Treaty. Furthermore, according to the DOD publication *Soviet Military Power, 1985,* the Soviets are "developing a rapidly deployable ABM system to protect important target areas in the U.S.S.R. That report concludes that "the aggregate of [their] ABM and ABM-related activities suggests that the U.S.S.R. may be preparing an ABM defense of its national territory. ' CIA officials, however, have testified before Congress that they have not judged it likely that the Soviets would in fact move to such a deployment in the near term.[8] They point out that while the Soviets could expand their presently limited ABM system by the early 1990s,

> In contemplating such a deployment . . . [they] will have to weigh the military advantages they would see in such defenses against the disadvantages of such a move,

'When asked by Senator Sam Nunn whether they could "envision our having a [defensive] system that would avoid the necessity of deploying our offensive forces, " Reagan Administration officials Dr. Robert Cooper (Director of the Defense Advanced Research Projects Agency), Dr. Richard DeLauer (Under Secretary of Defense for Research and Engineering), and Dr. Fred Ikle (Under Secretary of Defense for Policy) responded negatively. They held out the hope that such a condition might someday be achieved, but said that at present there can only be an "optimistic view that that will be possible at some time in the future. "

—"Hearings Before the Committee on Armed Services, United States Senate, on Department of Defense Authorization for Appropriations for Fiscal Year 1985, " S. Hrg. 98-724, Part 6, Strategic Defense Initiative, Mar, 8, 1984, pp. 2924-2925 and 2939.

'However, testing offensive countermeasures which involved nuclear detonations in the atmosphere or in space would violate the Limited Test Ban Treaty and possibly the Outer Space Treaty.

"130th quotes from *Soviet Military Power, 1985*, p. 48.

'Testimony of National Intelligence officer Lawrence K, Gershwin before a joint session of the Subcommittee on Strategic and Theater Nuclear Forces of the Senate Armed Services Committee and the Defense Subcommittee of the Senate Committee on Appropriations, June 26, 1985.

particularly the responses by the United States and its Allies.[9]

Advanced Technologies

The Soviets are also undertaking a vigorous research program in advanced BMD (laser and particle beam) technologies.[10] It has been estimated that the total Soviet effort in directed-energy research is larger than that in the United States. However, the quality of that work is difficult to determine, and its significance is therefore highly controversial. In large part, we are limited to observing what goes *into* their efforts (e.g., the amount of floor space at various Soviet research laboratories, the observable activity at test sites) and what does *not* come out (e.g., absence or cessation of publication on topics known to be under investigation, indicating that the activity has been classified).

In terms of basic technological capabilities, however, the United States remains ahead of the Soviet Union in key areas required for advanced BMD systems, including sensors, signal processing, optics, microelectronics, computers, and software. The United States is roughly equivalent to the Soviets in other relevant areas such as directed energy and power sources. According to the Under Secretary of Defense for Research and Engineering, the Soviet Union does not surpass the United States in any of the 20 "basic technologies that have the greatest potential for significantly improving military capabilities in the next 10 to 20 years."[11]

[9] Written testimony of Robert M. Gates and Lawrence K. Gershwin, op. cit.

[10] *Soviet Military Power, 1985,* U.S. Department of Defense, pp. 43-44.

[11] *The FY 1986 Department of Defense Program for Research, Development, and Acquisition,* Statement by the Under Secretary of Defense, Research and Engineering, 99th Cong., 1st sess., 1985, pp. 11-3 and 11-4.

ALTERNATIVE R&D PROGRAM DESCRIPTIONS

The alternative R&D program options presented in this chapter are described in terms of basic rationales and objectives, rather than in terms of which technologies would be investigated at what level. The overall effects of conducting BMD research depend on much more than the technical content of the research program-a point which will be returned to below in the section which describes "Political Attributes" (p. 251).

Approach 1: The Strategic Defense Initiative

The goal of the SDI is to advance the state of the art of BMD-relevant technologies to the point where an informed decision could be made on whether to enter full-scale engineering development and subsequent deployment of ballistic missile defenses. The program focuses on resolving those critical technological issues on which a highly effective defense system might rest but which at present are not adequately understood.

The SDI is based on the "technology-limited" research plan formulated by the Defensive Technologies Study Team (DTST), or Fletcher Panel. It is therefore intended to proceed as rapidly as possible, with further progress waiting not for more money but for previous results. Funding requests reached the DTST technology-limited profile with the fiscal year 1986 request.[12]

The SDI research program is intended to comply with all U.S. treaty obligations. However, tests that have been viewed as being ambiguous with respect to treaty compliance are proposed.[13] At any rate, if the research is successful, it would lead to systems for which development and testing would clearly be inconsistent with ABM Treaty constraints.

In addition to developing key BMD technologies, SDI is directed by its charter to "protect U.S. options for near-term deployment of

[12] Report to Congress on the Strategic Defense Initiative, 1985; p. 4.

[13] See app. A.

limited ballistic missile defenses."[14] These options are either to be implemented or held in reserve as a hedge against Soviet defensive breakout. SDI is also specifically instructed to "place principal emphasis on technologies involving nonnuclear intercept and destruction concepts. " As a result, development of "traditional" nuclear-armed, radar-guided interceptor technologies has been almost completely discontinued. Research on nuclear directed-energy weapons continues in order to understand their potential and to hedge against Soviet developments in that area.

SDI activities have been grouped into five program elements: Surveillance, Acquisition, Tracking, and Kill Assessment; Directed-Energy Weapons; Kinetic-Energy Weapons; Survivability, Lethality, and Key Technologies; and Systems Concepts/Battle Management Technology (see box). Each program is designed to advance the technology base, to conduct demonstrations that experimentally validate the technology, and to provide direction to focus the technology development on those critical issues which must be resolved before feasibility can be determined.[15]

SD I also attempts to encourage innovation in the U.S. scientific community to aid in identifying new approaches. The Directed-Energy Weapons program element, for example, has set aside 1.5 percent in fiscal year 1985 (1.7 percent is requested for fiscal year 1986) to support high risk, highly innovative approaches which would not otherwise be undertaken. SDI is soliciting advanced technology proposals for these funds from small businesses and the academic community.

Approach 2a: Early Deployment

Advocates of the early deployment of strategic defense systems attach a high strategic value to the modest levels of effectiveness that can be provided with presently available BMD technology. They believe that early and incremental deployments are required to address serious problems with existing U.S. strategic capability, and that delaying such deployments until more research has been done may be dangerous. They believe that the ABM Treaty prohibiting such defenses is not in the best interests of the United States, and in embarking on this approach would withdraw from or abrogate it. Although BMD systems effective enough to counter a responsive Soviet threat are not available at present, early deployment advocates are confident that U.S. technological superiority will enable it to prevail should an offensive v. defensive military technology competition ensue.

The research and development program supporting an early deployment approach would have two largely distinct aspects. In the first, those technologies now within the state of the art would have to be engineered into operational status and deployed; in the second, more advanced and presumably more capable concepts would have to be investigated in order to increase defensive capability and to counter responses by the Soviets.

There are many forms that early deployment of BMD technology could take, and their cost and effectiveness depend on what technologies are utilized, what targets are defended, and the nature of the Soviet response. Some have advocated that hardened targets be defended with "traditional" technologies of the type developed prior to the ABM Treaty in 1972, or with more recently proposed nonnuclear, low-altitude interceptors. Others have proposed deployment of space-based chemical infrared lasers or kinetic-kill vehicles. Of these technologies, we have significant experience only with the "traditional" ones, and even their performance in an environment of many nuclear detonations is poorly understood.

The most publicized proposal for early BMD deployment is the one presented by High Frontier.[16] That study recommended near-term deployment of both a terminal defense of hardened targets and a space-based boost-

[14] Caspar Weinberger, "Strategic Defense Initiative Organization (SDIO) Charter, " Apr. 24, 1984.

[15] Report to Congress on the Strategic Defense Initiative, 1985; p. 23.

[16] Daniel Graham, High *Frontier: A New National Strategy* (Washington, DC: High Frontier, Inc., 1982).

SDI *Program* Descriptions (reproduced from *Report* to the *Congress* on the Strategic *Defense* Initiative, 1985, pp. 23-25)

The Surveillance, Acquisition, Tracking, and Kill Assessment (SATKA) Program Element includes a mixture of some of the most and least mature technologies being developed by the SDIO. It includes technology base efforts to support surveillance, acquisition tracking, and kill assessment that provide: 1) data on the observables from ballistic missiles and their warheads; 2) new radar and optical sensors capable of obtaining detailed imagery of warheads and warhead deployment; and 3) on-board signal and data processing capable of performing necessary computations right at the sensor. The experiments include three general classes: boost-phase surveillance, midcourse tracking, and terminal-phase tracking and discrimination. Space-based surveillance experiments are planned for the early 1990s to demonstrate survivable means of detecting and tracking boosters from very high altitudes m space. Other space-based sensor experiments are to be conducted in the same time frame to explore our ability to track tens of thousands of objects during midcourse flight. Such platforms may ultimately include active sensors to aid in discrimination. A sensor experiment will determine the feasibility of using optical sensors to aid in target discrimination. A terminal imaging radar experiment is planned to demonstrate rapidly evolving ground-based radar capabilities.

The Directed Energy W_ (DEW) Program Element is advancing t e state-of-the-art in the technologies for: 1) high-powered laser and particle beam generation; 2) optics and sensors for correcting and controlling the high power beam; 3) large, lightweight mirrors and lightweight magnets for focusing the beam on the target; 4) Precision acquisition, tracking, and pointing to put and hold the beam on target; and 5) fire control to capitalize on those unique features of directednergy weapons such as the ability to measure and control the energy delivered to the target. The DEW technology program includes major experiments at the subcomponent level in the four concepts currently being examined: - - - lasers, ground-based lasers, space-based particle beams, and nuclear-driven directed energy. These concepts are candidates for boost and post-boost phase intercept and for discrimination functions in the other phases. In addition, selected subcomponents for these concepts will be integrated in on-the-ground experiments designed to teat interface approaches and resolve technical issues arising from the integration. The work on nuclear-driven directed energy is largely pursued by the Department of Energy and is designed to establish its technical feasibility. Equally important, the work ensures that the U.S. understands the potential impact of these emerging concepts if they were to be used against it by an adversary. It should be reiterated that emphasis in the SDI program is being given to nonnuclear weapons for defense.

The Kinetic Energy Weapons (KEW) Program Element is a collection of related research that would make use of the very high velocity of a small mass to render a ballistic missile or its warhead ineffective. The KEW program contains some of the more mature technology be- *investigated in the SDI. Efforts include interceptors and hypervelocity gun systems for boost-phase intercept, midcourse intercept, terminal intercept, and defense of space platforms. Both space-based and ground-based kinetic kill vehicles (KKV) are being investigated The technology thrusts for the space-based KKV include research into a high performance multiple kill vehicle (MKV), fire control/guidance, and booster propulsion. Ground-launched interceptor studies involve both exo- and endo-atmospheric kill. Both space- and ground-based electromagnetic (EM) gun investigations are included. Space based EM gun investigations include critical technologies such as high-g propulsion, high-g compact structures, long-range high resolution tracking, and multiple MKV tracking. AU experiments will be designed and conducted to conform to ABM Treaty constraints.

The Survivability, Lethality, and Key Technologies (SLKT) Program Element provides critical supporting R&T [research and technology]. Understanding the vulnerability of ballistic missiles to the various kill mechanisms is fundamental to assessing their effectiveness against current and responsively hardened targets. Survivability to mission completion, particularly of any defense space assets, is fundamental if defensive options are to be viable. Economical space transportation, on-orbit logistics and maintenance, kilowatt/megawatt sources of power, and multi-megajoule energy storage and conversion are potentially key needs in an affordable defense deployment.

Lethality and target hardening efforts will provide the basic theory underlying kill mechanism/target interactions, the resulting damage and response of the target to damage, and fundamental limitations in hardening countermeasures. The survivability problem includes substantial technology development, particularly in the case of space-based components. It also includes identification and assessment of innovative survivability hardware and tactics and evaluations of the survivability of conceptual designs. Space transportation, logistics, and space power efforts are designed to take advantage of existing DoD and NASA definition efforts and to expand them into the definition phase and satisfaction of the more demanding requirements of a defense-in-depth.

The Systems Concepts/Battle Management Program Element is designed to allow intelligent choices among competing approaches to defense architectures and to develop the technologies necessary to allow eventual implementation of a highly responsive, ultra reliable, survivable, endurable, and cost-effective battle management/command, control, and communications (C^3) system. Threat analyses, mission analyses, conceptual design of defensive architectures and performance requirements definition, and system evaluation for all levels of a layered defense against ballistic missiles will be performed. The battle management/C^3 efforts will provide the tools, methods, and components 1) for development and eventual implementation of the system and 2) to quantify risk and cost of achieving such a system.

Innovative Science and Technology (IS&T)[1] encourages the innovation of the U.S. scientific community to aid SDI research in identifying new approaches. To this end, the Strategic Defense Initiative Organization is soliciting innovative, advanced technology proposals from small businesses and the academic community.

[1]Deleted material was a cross-reference to another section of the SDI Report to Congress not cited above.

phase area defense (Global Ballistic Missile Defense System I) which would use rocket-powered kinetic-kill vehicles. More effective space-based defenses (GBMD II) would be deployed when developed.

Since High Frontier provided a candidate system architecture, including cost estimates and timelines, more detailed analyses can be done on that system than can be performed for other concepts. However, studies by several groups have shown that High Frontier severely underestimated the cost and overestimated the capability of the GBMD I system. These studies are discussed in appendix G.

Approach 2b: Intermediate Deployment

Intermediate deployment supporters, like those favoring early deployment, disagree with the SD I premise that a decision to deploy nearer term BMD should be contingent on the successful development of longer term, advanced BMD technologies. They believe that strategic benefits of BMD can be realized in the intermediate-term even without confidence that long-term, highly effective systems can subsequently be deployed. Unlike early deployment supporters, however, backers of intermediate deployment do not believe that deployments should be started now, but rather that those BMD technologies which could lead to deployments in the early to mid-1990s be pursued. They believe that existing technology is inadequate, and they may also seek to leave open the possibility of discussing and negotiating defensive deployments with the Soviets before deployment starts.

The technologies investigated by an intermediate deployment R&D program would be similar to those studied in an early deployment program. In both programs, technologies slated for initial deployments would have to be brought into operational status at the same time that more advanced technologies were investigated.

Approach 3a: Funding-Limited

A BMD research program might share the SDI program's focus on advanced defensive technologies that in the long run may make a thoroughly reliable defense possible, without also sharing the SDI program's premise that we can know in a very few years whether we have any assurance of reaching that goal. A funding-limited approach would conduct a systematic program of laboratory research on technologies which might have potential for leading to highly capable defenses, and it would investigate most of the topics which the SDI proposes to study. This research, however, would not proceed as rapidly as it would under the SDI; it would investigate the potential of these technologies without preparing to decide in the near term whether to exploit that potential.

Adherents of such an approach would want to maintain the ABM Treaty in the near term. Should a new approach to effective national defense be successfully developed–whether by breakthroughs in defensive technology which made defense-dominant strategies clearly viable, or by implementing constraints in offensive forces so stringent that existing defensive technology could bring about defense dominance-the ABM Treaty would have to be reexamined, and the United States would have to consider an arms control/weapons acquisition approach that integrated offensive and defensive forces. However, advocates of the funding-limited approach would expect such an eventuality to occur well into the future, if at all. Although they might disagree on exactly which criteria should be met before moving defensive research into full-scale engineering development, they would agree that such a decision either should not or cannot be made as early as the SD I approach implies.

In the meantime, the intent of this approach would be to signal that the United States supports the ABM Treaty and wants to deter the Soviet Union from rejecting its own ABM Treaty commitment. The prominence of U.S. BMD research would be reduced from what it would have (and has already had) under the SDI approach, and that research would take on a character more similar to other military R&D programs. Field testing and major technology demonstrations which appeared to be aimed more towards developing a BMD system than towards researching technology would be deferred.

A Soviet near-term ABM Treaty breakout would be deterred primarily by the development of U.S. offensive countermeasures. Unilateral Soviet BMD deployment in the long run would be discouraged by the prospect that the U.S. funding-limited program could be accelerated if the Soviets were to abandon the ABM Treaty regime.

Approach 3b: Combination

The combination approach would balance serious study of advanced BMD technologies with the development of high-confidence, near-term options to deploy BMD systems based on "traditional" technologies. The advanced technologies would be investigated to understand their potential, especially if used against us, and to prevent technological surprise, so that no unanticipated Soviet technological developments would permit them to threaten an ABM Treaty breakout in a way we could not counter. In addition, study of advanced BMD technologies could advance their applications in other military (and possibly civilian) uses.

Near-term deployment options, developed within ABM Treaty constraints, would help to deter a near-term Soviet defensive breakout, and they could provide a response if that contingency occurred. Perhaps more importantly, a prototype "traditional" BMD system would also provide a test-bed for offensive countermeasures which we might have to deploy against nationwide Soviet defenses of the sort already deployed around Moscow.

Like the funding-limited approach, the combination approach would be intended to strengthen rather than to threaten the existing ABM Treaty regime in the near term; it would therefore defer tests or technology demonstrations which appeared to pose questions of compliance with the ABM Treaty. In the long run, advocates of both the combination and the funding-limited approaches believe that it might or might not be desirable to modify the ABM Treaty and our overall strategic arms control approach in the future to incorporate defensive systems, depending on how BMD technology develops and how the U. S.-Soviet strategic relationship evolves.

ALTERNATIVE R&D PROGRAM CHARACTERISTICS

The alternative R&D programs differ in a number of individual characteristics which can be grouped into three categories:

- Technical attributes characterize which technologies are to be investigated and which deployment options are to be made available. Each of the alternative R&D programs would produce deployment options, but those options differ widely in what they would consist of, how effective they would be, and how long they would take to implement.
- Economic attributes include most directly the cost of a given R&D approach, but also include an R&D program's impact on other activities which compete with it for the same resources (financial, material and facilities, and technical talent).
- Political attributes include the effects that a U.S. program to investigate BMD technologies might have on other countries' actions or relationships with us, and the constraints such a program might place on arms control possibilities, They also include the effects that such a program might have on ourselves. In both cases, perceptions may have a greater political impact than either announced intentions or demonstrated capabilities.

Technical Attributes

The technical outputs of a BMD research program will be advances in BMD-relevant technologies which might provide options for deploying ballistic missile defenses. Nearer term options using technologies which are now fairly mature can be developed with relatively high confidence; much more speculative but potentially more powerful technologies might also be developed, but at present there is much less confidence that those technologies will lead to BMD options. If they do, those options would be longer term ones.

None of the alternative R&D approaches described here would abandon research on technologies relevant to long-range BMD concepts. However, the approaches do differ in the relative emphasis put on near-term options as opposed to the longer term ones. The SDI *approach* stresses longer range options. Even though the SDI maintains an active effort in technologies it considers near-term, SD I officials have stated that it could be counterproductive to deploy near-term technologies without also demonstrating that even more effective longer term technologies are feasible and can later be deployed. [17] The experimental technology demonstrations included within the SD I program are not intended to be engineering prototypes of operational BMD components, but they must nevertheless be relevant to the mission and advanced enough to provide a meaningful basis for determining their utility in BMD applications.

Although the early *deployment approach* calls for investigation of longer term possibilities, unlike the SD I it stresses primarily the development of available technologies for near-term deployment. The *intermediate deployment* approach similarly stresses technologies for intermediate-term deployment. The *fund-*

[17] For example, General Abrahamson's testimony before the Strategic and Theater Nuclear Forces subcommittee of the Senate Committee on Armed Services, Feb. 21, 1985.

ing-limited approach would emphasize longer term options; the *combination approach* would develop near-term deployment options in addition to conducting longer range research.

Related to the choice between near- and far-term options is the balance that should be struck between basic research, on the one hand, and development geared towards more immediate application, on the other. The appropriate balance for a given technology depends on the status of the research, the perceived promise of its applications, and the urgency of the task. The first of these depends on the results of the research to date; the latter two also depend in part on the overall approach taken towards BMD research and development.

Prematurely advancing a research program into the development and testing phase can have two major disadvantages: the technologies under investigation can get frozen at an immature level, and the greater expenses of advanced development and testing can absorb resources which would otherwise be devoted to improving the basic technologies or finding better ones. On the other hand, failing to advance a program into development and testing at an appropriate stage delays possible application of newly developed technologies should it become necessary or advantageous to do SO.

Economic Attributes

cost

One obvious characteristic for comparing R&D programs is their respective costs. BMD research will generally yield more results with higher funding until either: 1) the nation's R&D capacity cannot efficiently absorb additional resources, or 2) research reaches a *technology-limited* funding level. Although some of the approaches discussed above will be clearly more expensive than others, in most cases it is not possible to associate a given level of expenditure with a particular approach; most of the approaches are compatible with a range of funding levels.

The SDI *approach,* intended to proceed at a technology-limited pace, will be the most expensive of the research-only approaches—the definition of "technology-limited' means that additional money will. not speed up the research, and that therefore budgets larger than those requested for the SDI will not necessarily yield greater results. Furthermore, the SDI approach calls for substantial year-to-year increases, since each year's progress is intended to make possible increasing amounts of follow-up research in subsequent years.[18]

Adding deployment to research would, of course, cost more than research alone. However, limited deployments of existing technologies may be less expensive than ambitious research of more advanced technologies, so approaches which include deployment—the *early deployment* and the *intermediate deployment approaches—would* not necessarily cost more than the SDI approach.[19]

The *funding-limited approach* would probably cost considerably less than the SDI, although in principle it could be carried out at almost any level of funding short of the SDI's technology-limited level. Such a program would also be amenable to a growth rate much slower than that of SDI, in that much follow-on research made possible by technical progress to date would be deferred.[20] The *combination approach* would likewise be compatible with a wide range of funding levels; annual increases would probably also be modest.

Impact on Other R&D

Just as important as the total amount of money which is spent on a research program

[18] Budget requests for the SD I in fiscal year 1986 and future years are presented in app. F, along with the projected requests which the SD I Organization has estimated would have been made for the previously existing BMD programs had SD I not been formed.

[19] The High Frontier study, advocating early BMD deployment, is discussed in app. G. That study contains cost estimates, but others believe that the estimates given for its first space-based deployment should be considerably higher.

[20] A hypothetical range for such a program might be $1.5 to $2.0 billion per year, with annual increases at, or a few percent above, the inflation rate. The modest annual increases, more so than the funding level for any individual year, distinguish the funding-limited approach from the SD I approach.

is the way in which it is spent, and in particular the things on which it is not spent. Choices made at the research and development stage constrain the range of possible outcomes, and the opportunity costs of forgoing certain investments in order to make others can have a great impact on future BMD developments as well as on other areas. Since resources such as R&D facilities and talent are limited, other military and civilian R&D will suffer to the extent that they are unable to compete against BMD research for those scarce resources. True opportunity costs are difficult to measure, since what would actually have been accomplished had some given amount of money been invested elsewhere cannot be predicted in detail.

"Spinoffs" in a sense are the opposite of opportunity costs—they might be described as "opportunity benefits" which have applications in areas other than those of direct interest for BMD research. Spinoffs may be more important in the long run than a research program's direct applications. However, they seldom constitute a justification for pursuing a defined objective that cannot otherwise be supported.

By nature serendipitous, spinoffs are even harder to predict than opportunity costs. However, some generalizations can be made. The more broad-based and basic a research program is, the wider its results are likely to be applied; the further advanced its development, the less its results are likely to be utilized outside of their intended application. For example, basic laser physics has applications throughout the civilian economy as well as in many defense areas; a multi-megawatt, space-qualified chemical laser would have little utility outside a BMD or ASAT system.[21]

Estimates of the impact that a vigorous BMD research and technology development program might have on the civilian sector vary widely. An editorial in an aerospace industry trade journal notes that "there is a school in industry that takes the view that even if the U.S. falls short of its defensive strategy goals, the research program will be the biggest stimulant to technology in this country since the Apollo program."[22] Others are of the opinion that BMD research will be so specialized to military applications that spinoffs for the civilian sector would be better described as "dripoffs."[23]

Political Attributes

The technical and the political aspects of a BMD research program, although related, are quite distinct. The Strategic Defense Initiative, for example, is much more than a cataloged set of technology development programs. Officially described as "The President Strategic Defense Initiative,"[24] it receives unprecedented attention from the highest levels of government. It has been described by the Secretary of Defense as "the only thing that offers any real hope to the world,"[25] and it is meant to set the groundwork for a fundamental shift in national strategy. It featured prominently in the 1984 Presidential election campaign, and it has become the focus of an ideological battle fought in the public pronouncements and private negotiations of the United States, the Soviet Union, our NATO allies, and other nations. Although more difficult to quantify than the technical or even the economic attributes of BMD research and development, the political aspects are nonetheless important and very real.

[21] Plus whatever role it might have for other purposes of war such as space-to-air (e. g., anti-aircraft) or space-to-ground attack, as discussed in the "Non-BMD Applications" section of ch. 7.

[22] William Gregory, "Spark for Technology," *Aviation Week and Space Technology*, May 27, 1985, p. 11.

[23] For example, Lewis Branscomb, vice-president and chief scientist of IBM, and Dieter von Sanden, until recently head of the communications division of Siemens, Germany's largest electronics company, as quoted in "The Diplomatic Round" by John Newhouse, *The New Yorker*, July 22, 1985, p. 49.

[24] White House pamphlet, *The President Strategic Defense Initiative*, January 1985, GPO : 19850-465-450 : QL 3 (emphasis added).

[25] Secretary of Defense Caspar Weinberger; interviewed on ABC TV's "This Week With David Brinkley" (quoted in Cass Peterson, "U.S. Won't Abandon 'Star Wars'," *The Washington Post*, Dec. 21, 1984).

Political Impact on Others

One way in which other countries will respond to our research will be by anticipating its possible outcomes. They cannot predict, any more than we can, how successful our research program will be or what future Congresses and Administrations will decide. They must instead consider a range of possibilities—and their reactions may start long before we have decided on or initiated BMD deployment.

Our policy pronouncements, implicitly as well as explicitly stated, will also affect their decisions. Their actions will be based on their perceptions of what we might do—perceptions which depend on their analyses of American political processes as well as their estimates of American technological capabilities. Decisions to be made by both the Soviet Union and our NATO allies regarding force modernization (conventional and nuclear), arms control strategy (see the following section), alliance relations, and international affairs will depend in part on their estimates of our own *future* decisions.

Reactions can be stimulated to some extent even when no clear link is drawn between a research program and BMD deployment. However, the likelihood and gravity of allied and Soviet responses will generally depend on how strongly the U.S. BMD research program *appears* to lead to deployment. In this respect, the SDI *approach* presents an ambiguous set of signals. It is intended to proceed as rapidly as possible[26] towards the decision point on whether to enter full-scale development and subsequent deployment, but it is explicitly not committed to crossing that threshold. Regardless of U.S. statements, however, the Soviets may believe that a decision to deploy BMD has already been made provided the technology development proceeds favorably; it would be surprising if they have not already started to analyze their possible options for responding to U.S. defensive deployments.

Adoption of an *early deployment* or *intermediate deployment* research strategy makes the connection between research and deployment explicit, and either one would certainly be expected to stimulate prompt Soviet reactions. On the other hand, the *funding- limited* and *combination approaches,* by relaxing the sense of urgency and minimizing the extent to which technology experiments challenged ABM Treaty restrictions, might lessen much of the political impact that would be generated by the other approaches.

Nothing in this section is intended to suggest that the United States should abandon a course of action judged to be in its own best interest because other parties-either allied or adversarial-might misinterpret our purposes. In determining what is in our best interest, however, the reactions of others must be taken fully into account.

Effect on Arms Control

The political impact of the U.S. BMD research program will perhaps be most strongly felt in the area of arms control, where alternative approaches to BMD research can have very different implications. The most direct effect on arms control of conducting BMD research concerns the compatibility of that research with the ABM Treaty. Most BMD *systems* or *components* based on advanced technologies cannot be developed, tested, or deployed under the ABM Treaty regime.[27]

Since the distinction between *technology* development and *component* development is highly controversial, the SD1 approach raises questions concerning the compatibility of certain technology experiments with Treaty constraints on development and testing.[28] Moreover, with its sense of urgency and its high visibility, the SD I also raises political questions concerning the degree to which the

“E. g., at a “technology-limited” pace.

“While laboratory research into any type of BMD system is permitted under the ABM Treaty, there are severe limitations on field testing and development of ABM systems. Only fixed, land-based systems or components can be developed or tested, and only one specified fixed, land-based system can be deployed. See app. A.

‘These compliance issues are specifically addressed in app. A.

United States is committed to maintaining the ABM Treaty regime. If the Soviets perceive that this U.S. commitment has indeed diminished, the probability that they will act in compliance with the Treaty is reduced.

Although the United States is permitted a very limited BMD deployment under the ABM Treaty, many advocates of the early *deployment approach* find value in going beyond Treaty constraints and favor abandonment of the Treaty. The *intermediate deployment approach,* by deferring deployment for a number of years, provides some time for negotiations between the United States and the U.S.S.R. which could lead to ABM Treaty modifications to permit more extensive, but nevertheless limited, defensive deployments. However, should such an agreement be impossible to reach by the time deployments could be made, intermediate deployment advocates (like early deployment supporters) would probably favor abandoning the Treaty and proceeding with BMD deployments.

On the contrary, advocates of the *funding-limited* and the *combination approaches* would strive not to damage the Treaty regime, at least not until we had identified a preferable alternative that we had confidence could be attained. In their view, mutual U.S. and Soviet adherence to the ABM Treaty would be worth the restrictions that such compliance might impose on our exploitation of BMD technologies. These approaches would relax the urgency of BMD research, easing the political questions; to the extent that technology demonstrations were deemphasized, the questions of treaty compliance would be relaxed as well.

Possible effects of the alternative BMD research approaches on arms control go beyond their impact on the ABM Treaty. These effects on other aspects of arms control are highly controversial, and they may arise even before the ABM Treaty issues do.

Supporters of the Sill *approach* say that the Strategic Defense Initiative has already succeeded in bringing the Soviets back to the bargaining table to discuss offensive arms, and that meaningful reductions in nuclear arsenals can be obtained only after the Soviets come to believe that effective defenses will make offensive forces less useful.

The role of arms control under the SD I approach would be to facilitate a safe transition to a state of highly constrained offenses coupled with effective defenses. However, making BMD deployment contingent on prior agreement with the Soviets in effect gives them a “veto” over U.S. BMD deployment, which the Reagan Administration has emphatically stated will not be permitted. This results in an inherent paradox: U.S. BMD developments will continue even if the Soviets refuse to negotiate a cooperative transition, but such a cooperative agreement is necessary if the long-term SDI goals are to be attained. Moreover, such an agreement would certainly have to be negotiated before deployments start if those deployments are to be regulated in an orderly manner.

The feasibility of any such transition agreement is still very much in question. In addition to regulating offensive and defensive deployments, it might have to regulate offensive and defensive development and testing as well in order to restrict preparations for prohibited deployments. Nobody has yet suggested how the problems of measuring, comparing, and monitoring disparate nuclear forces, problems which have plagued past arms control negotiations, could be satisfactorily resolved in the far more difficult situation in which both offensive and defensive forces are to be closely regulated.

Critics of the SD I point out that the SDI, rather than having driven the Soviets back to arms control negotiations, might instead merely have provided them with a face-saving excuse for reversing their previous decision to walk out—a decision they now regret. The Soviets now say that reductions in their offensive forces will be impossible as long as force increases might be needed to counter a U.S. defense. These statements may be only propaganda, but they may also accurately describe the initial Soviet reaction to a U.S. defensive deployment. A logical response by the Soviets to a U.S. near-term defense would indeed be the addition of penetration aids and other offensive countermeasures, the proliferation of nuclear warheads, or both. Although the U.S. defensive deployments that such a Soviet decision would anticipate might not be initiated for a number of years, if ever, the consequences of that Soviet decision for the military balance and for arms control prospects would start to be felt immediately. Potential early Soviet reactions therefore affect our choice of near-term BMD research approach, as well as our longer term policy decisions.

By deploying BMD in excess of ABM Treaty limits without waiting for the establishment of a replacement arms control regime, most early *deployment approaches* imply abandonment not only of the ABM Treaty but of the entire strategic arms control process. Not content with the condition of strategic parity prerequisite to arms control, or alternatively believing that the Soviets are not willing to settle for such a state, supporters of this approach would instead attempt to attain and maintain strategic supremacy. *intermediate deployment approaches* may provide time for negotiation before BMD deployments start. However, should negotiations not be pursued, or should they not be satisfactorily concluded, proceeding to deployment anyway could denote abandonment of the strategic arms control process.

Many supporters of the *funding-limited* and the *combination approaches* believe that long-term improvement of the political relationship between the United States and the Soviet Union, assisted by arms control agreements, would be the most promising way to reduce the risk of nuclear war. They oppose the SDI approach as focusing all U.S. efforts on arms control and conflict avoidance into a single, dubious direction. By lessening the emphasis placed on BMD research, their approaches would leave open other arms control options, such as the ones described in chapter 9. On the other hand, if some SD I supporters are correct in asserting that only U.S. defenses can compel the Soviets to agree to force reductions, then these alternative approaches to offensive arms control will not succeed.

Under the funding-limited and combination approaches, negotiations with the Soviets which attempted to establish the boundaries of permitted versus proscribed BMD research would be desirable for the purposes of clarifying activities by both sides. If the prospect of the United States' developing advanced technologies under the SDI approach sufficiently concerns the Soviets, U.S. proposals for constraining BMD research and technology development by clarifying or extending provisions of the ABM Treaty might have considerable bargaining leverage. Such an agreement would almost certainly have to permit laboratory research, which would be extremely difficult to ban verifiably, but it might constrain more observable activities such as demonstrations of ABM "subcomponents" and other field experiments which the Department of Defense argues are currently not prohibited by the ABM Treaty (see appendix A). Although it might be difficult to construct a verifiable and equitable agreement of this sort, the task would appear easier than reaching agreement on the mutual introduction of strategic defenses.

Political Impact on Ourselves

A multibillion dollar U.S. program to study ballistic missile defense technologies will have a political impact not only on other countries, but also on our own subsequent policy decisions. Creating any large institution also generates constituencies which benefit from that institution's continued existence. This is especially true if the institution, like the Strategic Defense Initiative Organization, exists primarily to spend money for a particular purpose. However, quantifying this "institutional momentum" is difficult and controversial. Complex decisions are rarely documented with itemized breakdowns specifying how influential each input criterion was.

Should ballistic missile defense research be greatly accelerated, it would become one of our largest military programs. While some point to precedents for terminating large military programs, such as the cancellation of programs for the DynaSoar lifting body, the Manned Orbiting Laboratory, and the nuclear-powered airplane, others question how easily

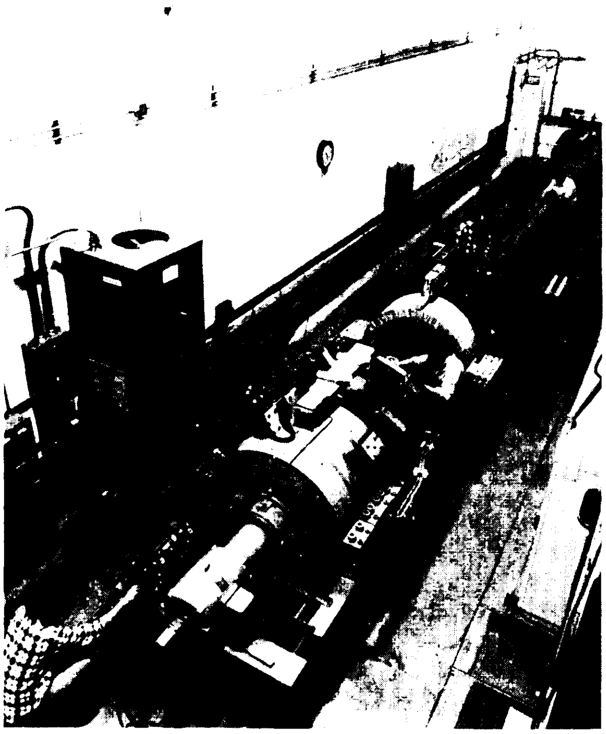

Photo credit: Westinghouse

Westinghouse EMACK electromagnetic launcher during assembly and test, February 1982. BMD research conducted with experimental apparatus of this size, easily contained within a building, would be very difficult to control under an arms control agreement.

Congress and the executive branch would be able to terminate a future BMD program, even if the technology advances did not meet initial expectations or requirements.[29]

Since the full effects of "institutional momentum" are poorly understood, it is difficult to predict precisely how much each of the alternative research programs will suffer from it. Relevant factors, however, might include total program budget and the number of people supported by it, along with less tangible items such as visibility and level of attention. The more high-level interest there is in a program, and the more money and prestige that has been committed to it, the harder it will be to make decisions which revise or reverse earlier ones without "losing face."[30]

[29] During a floor debate on the MX missile, Senator Dale Bumpers (D-Ark.) told the Senate that he had been "trying to think . . . when the last time a weapons system was defeated here. Weapons systems have gotten where they are just like Rasputin–you cannot kill one." *(Congressional Record,* Mar. 20, 1985, p. S 3269.)

[30] Along these lines, one observer has noted that "the program manager who will admit that 5 years of research and more than $20 billion have been wasted on an unworkable system probably has yet to be born."

—William E. Burrows, "Ballistic Missile Defense: The Illusion of Security," *Foreign Affairs*, spring 1984, p. 855.

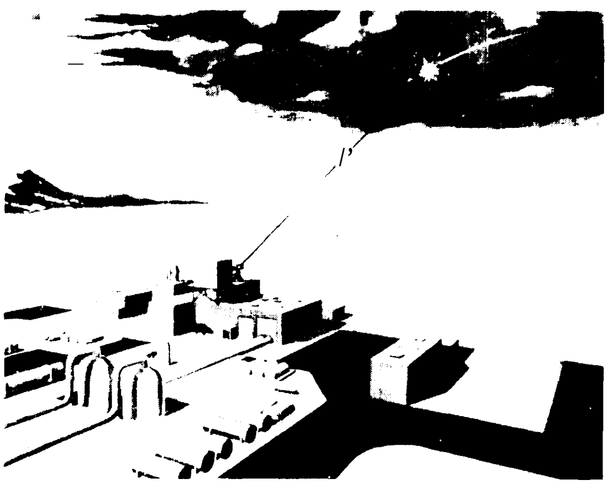

Photo credit U S Air Force

Artist's conception of the existing U.S. High Energy Laser System Test Facility (H ELSTF) at White Sands Missile Range, New Mexico.

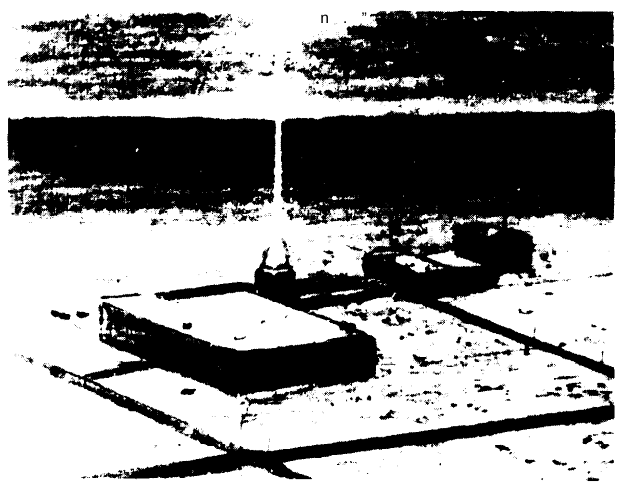

Photo credit: U S Department of Defense

U.S. Defense Department drawing of the Soviet directed-energy research and development site at Sary Shagan proving ground.

Compliance with arms control agreements regulating research, field development, and testing using facilities of the size shown here would be more easily verified than agreements attempting to regulate activities within laboratories.

ISSUES

Other chapters of this report have dealt primarily with issues concerning ballistic missile defense *deployment,* for which decisions are at least several years off (unless the early deployment approach is adopted). Before then, Congress will need to address issues concerning the U.S. program for BMD *research and technology development.*

One set of issues concerns our choice of overall approach to pursuing BMD research. Another group involves specifically those BMD research programs which would prepare options for deployment, or which were intended to permit a decision as to whether deployment options were sufficiently promising to enter full-scale engineering development. A final set of issues pertains to any research and technology development program in areas relevant to ballistic missile defense.

Issues Concerning Choice of Research Approach

The ABM Treaty

Most BMD systems based on advanced technologies which would be investigated by the alternative R&D programs discussed above could not be developed, tested, or deployed under the ABM Treaty regime. One issue is whether or not our program of BMD research is compatible with the ABM Treaty. A more fundamental issue, however, is whether or not the ABM Treaty continues to be compatible with our national interest. One's attitude towards that Treaty, or more precisely one's attitude towards the concepts of national security which it embodies, will in large part determine which of the BMD research approaches described above one would choose.

Our current choices are to plan for revision of or withdrawal from the ABM Treaty, to attempt to make it more effective, or to attempt to find a middle ground. That middle ground–bolstering the effectiveness of the ABM Treaty in the short run (thereby preventing near-term Soviet BMD testing and deployment) while explicitly and publicly preparing to decide whether to abandon it later, when we are ready—may be the most difficult to attain.

The testing of new technologies on both sides could, in a few years, undermine the confidence of each that the other was not on the verge of abandoning the Treaty. Therefore, maintaining the BMD limitation regime may require new treaty provisions or other forms of agreement to reduce technical ambiguities (see discussion above on "Effect on Arms Control").

If the Treaty regime is to be sustained, questions of Soviet compliance must be resolved (see discussion of Soviet work on "traditional" BMD technologies, p. 243).

On the other hand, if we decide to revise or withdraw from the ABM Treaty to permit U.S. BMD deployments, our goals should be well-defined and our course of action well-planned. There may be a serious timing problem in carrying out a research program which will not violate the ABM Treaty, but which will give us enough information to decide with confidence that BMD deployment can meet our criteria. If we were to allow the ABM Treaty regime to erode prematurely, and then learn from our BMD research that the new BMD technologies will not fulfill our requirements, we could end up with the worst of both worlds: no arms control to limit Soviet BMD, no effective U.S. BMD, and, quite possibly, proliferated Soviet offensive forces intended to overcome an anticipated U.S. BMD.

An important issue for Congress to consider is how we can carry out our BMD research program so that it does not either prematurely compromise the ABM Treaty through technical ambiguities, or stimulate the Soviets to begin testing and deploying BMD at a time more advantageous to them than to us. At the same time, charges of Soviet noncompliance with the Treaty must be addressed as well. If they cannot be satisfactorily resolved, the United States would effectively have adopted stricter standards of compliance than those observed by the Soviets, which would put us at a competitive disadvantage.

Congress may wish to review the standards and the procedures by which U.S. and Soviet activities are judged to comply with existing treaty commitments—perhaps by requiring the establishment of an independent, nonpartisan commission to review Soviet activities and to advise Congress and the President on compliance issues associated with tests proposed by the Defense Department.

Anti-Satellite Weapon Arms Control

In the 1985 U.S.-Soviet arms control negotiations in Geneva, the Soviets emphasized the importance they attach to limiting weapons deployed in or directed at space. As both this report and its companion *Anti-Satellite Weapons, Countermeasures, and Arms Control* indicate, anti-satellite weapon technologies are closely related to BMD weapon technologies. Therefore, those favoring uninhibited research on ballistic missile defense would find arms control measures limiting anti-satellite weapon testing to be highly constrictive. Indeed, to attempt to remain compliant with the ABM Treaty, some experimental technology demonstrations proposed under the SD I will be conducted as anti-satellite tests. On the other hand, those interested in strengthening the testing provisions in the ABM Treaty would find anti-satellite weapons test restrictions a useful tool in further constraining BMD development.

Offensive Weapons Arms Control

The long-term objective of deploying defenses–enabling deep reductions to be made in offensive forces by lessening their utility—directly conflicts with one of the most probable near-term reactions to a defensive deployment—strengthening offensive forces to overwhelm defenses. This strengthening might take the form of adding penetration aids or other countermeasures, deploying additional offensive weapons, or both. Although these changes might turn out to be a waste of resources if the defense could overcome them at lesser cost, the final cost-exchange balance might not be evident in the early stages of deployment, let alone in the research stage. The effect that our choice of BMD research approach can have on future arms control possibilities is highly significant, as was discussed in the section above on "Effect on Arms Control."

Near-Term Soviet Breakout Potential

Each of the research approaches needs to account for the possibility of a Soviet breakout or ''creepout from the ABM Treaty. The major issues in deterring or responding to a Soviet defensive breakout are how important an ability to deploy "traditional" nuclear-armed BMD technologies would be, whether more advanced but still near-term technologies could be relied on, or whether offensive countermeasures alone would suffice. The SDI *approach* relies on a combination of U.S. ability to penetrate Soviet defenses and an ability to deploy as-yet-untested nonnuclear defense options; it has largely discontinued investigation of the "traditional" ballistic missile defenses of the sort once deployed by ourselves and now deployed by the Soviets. The *early* and *intermediate deployment approaches* handle the threat of Soviet breakout essentially by preempting it. The *funding-limited approach* would emphasize offensive countermeasures to counter a near-term breakout; this approach also holds out the option of accelerating research in advanced technologies up to a technology-limited pace in response to Soviet defensive deployments. In addition to offensive countermeasures and the prospect of acceleration, the *combination approach* would maintain options to deploy a near-term U.S. defense in response to Soviet near-term breakout.

Long-Term Soviet Breakout Potential

The Soviets will almost certainly continue their investigations of advanced BMD technologies. All the U.S. research approaches described here require as a minimum that sufficient U.S. research be done to understand Soviet capabilities. (Some approaches go well beyond that.) The level of U.S. research in long-term BMD technologies should depend on a decision as to whether understanding potential

Soviet developments is deemed sufficient, or whether the existing U.S. advantage in advanced BMD technologies can and should be exploited. It should also depend on evaluating the likelihood that valuable capabilities will be forgone by the United States if it does not pursue a more active BMD research program. Giving up what might be valuable options could disadvantage the United States even if the Soviets do not develop those options either.

Issues Concerning Preparation of Deployment Options

R&D/Deployment Coupling

There is an inherent conflict between seeking the ability to make deployment decisions in the near term and seeking to keep control over whether and when such a deployment might be made. Vigorous U.S. R&D programs could lead the Soviets to infer an intent to deploy, and might possibly stimulate them to preempt such a deployment. Therefore, proposals for vigorous R&D programs should demonstrate the ability to cope with a Soviet defensive breakout and associated Soviet offensive actions in a timely way. Offensive countermeasures probably contribute more than defensive actions towards our ability to deter or respond to Soviet defensive breakout.

The Strategic Defense Initiative Organization (SDIO) has the primary responsibility both for directing BMD research and technology development, and for making the case to Congress and to the public that this R&D effort deserves support. It will be the principal source of information about the quality, cost, and adequacy of the technologies which are thought to be ready for full-scale engineering development, but at the same time it will have a large psychological and organizational stake in an affirmative answer to the deployment question. This may create a problem when the time comes for the Secretary of Defense, the President, and Congress to decide whether BMD deployment is appropriate.

There is nothing unusual about this situation, which occurs to a greater or lesser extent when all Department of Defense programs reach their major development milestones. However, even if not peculiar to the SDI, this potential problem may be more acute in the case of SDIO because of the novelty of the technologies involved, the lack of a base of historical experience to serve as a benchmark, the possibility that a "streamlined" program will bypass some of the stages of review that most Defense Department programs must pass through, and the unusual amount of political prestige which both proponents and opponents of SDI will have staked in advance upon the outcome.

If our research program is not to be presumed to be a prelude to deployment, there must be a clearly perceived threshold which requires a positive decision—not merely the lack of a negative one—to cross. The limitations posed by the ABM Treaty provide such a threshold.

Also required, however, is a set of clear decision criteria that must be met before BMD development continues past the point requiring ABM Treaty renegotiation or abrogation. As the level of effort devoted to BMD research increases, a momentum or constituency will be created that will press for continuing and enlarging the research effort, and then for moving from research to demonstrations to deployment. For this reason, it would be easier to establish clear decision criteria before a few more years of BMD research growth have occurred, and before the time comes to begin the actual decision process.

Cost Estimates

It is not possible to estimate the cost of BMD deployments in the absence of either a system architecture or cost estimates for candidate system elements. However, reliable overall cost estimates must exist before an informed development decision can be made. Cost information, required to determine whether a possible BMD deployment will be affordable, is part of any realistic system design. It is not possible to optimize a system unless there is some way to measure whether a given approach is better or worse than another; the criterion usually utilized for this purpose is minimum cost for various levels of effectiveness.

Any research program leading up to a development or deployment decision must have as a principal priority the determination of credible cost estimates for various levels of defensive capability. Those managing such a program must be able to show whether any proposed defenses can be both affordable and cost-effective.

Relative Pace of Technology and Systems Studies

In an investigation of advanced ballistic missile defense intended to produce deployment options or to facilitate development decisions, technology development and systems studies must proceed in parallel. Without some understanding of technological potential, effective systems cannot be designed. However, without some conception of how it might be applied, technology development may not be effective and may not even be meaningful. Such a research program needs to decide how to correlate technology development with system studies, and needs to develop a policy regarding how far either should be allowed to progress should unforeseen problems crop up in the other.

Technology Transfer

The ABM Treaty prohibits the "transfer to other states' of 'ABM systems or their components, " or of "technical descriptions or blue prints" worked out for their construction.[31] These provisions prohibit the signatory nations from using their allies to circumvent ABM Treaty constraints. As a result, allied participation in a treaty-compliant research program would have to be limited to research which had not reached the "system" or 'component" level. Allied participation would also be affected by restrictions which the United States itself might impose, as it does now, on the transfer of military technology to its allies for fear that such technologies may eventually reach the Soviet Union.

[31] Article IX and Agreed Statement G, ABM Treaty. (See app. B.)

In some discussions of BMD research or deployment, it has been suggested that the United States might intentionally transfer BMD technologies to the Soviet Union to prove that the United States did not seek military superiority.[32] Any such transfer would raise very significant issues. If BMD plans or devices are transferred, potential adversaries might be able to discover vulnerabilities, enabling them to circumvent or destroy our own BMD systems. If technological capability is transferred, rather than specific devices, the American advantage which had enabled us to develop that technology first would necessarily be compromised. Furthermore, many BMD-relevant technologies have applications in other military areas that we may not want to help the Soviets develop. Approaches towards BMD which assume that we can and should maintain technological supremacy over the Soviets would not be consistent with transfer of U.S. BMD technology to them.

Issues Pertaining to any BMD Research Program

Technology Experiments

Technology demonstration experiments are the most expensive and one of the most controversial aspects of a BMD research program. Demonstrations may be useful to measure technical progress or to provide public evidence that the technology effort in general is succeeding. Moreover, demonstrations are sooner or later needed to determine whether some system components are feasible. On the other hand, advancing our understanding of basic principles and technologies may be preferable to demonstrating the existing state of the art. There is a risk that demonstrations may "lock in" suboptimal levels of technology and divert resources which would otherwise go towards developing improved options.

Demonstrations of BMD technology are particularly complicated by ABM Treaty constraints on developing and testing ABM components or systems. Experiments that raise

[32] For example, see footnote 36, ch. 6.

treaty compliance questions run the risk of provoking a Soviet reaction that could eliminate the option of deferring BMD deployment until technology had advanced further. One possible way to assess whether this risk is worth taking might be to require that before such demonstrations are approved, there should be developed both a plausible system architecture that would use the particular technologies to be demonstrated and a corresponding arms control approach. Congress may wish to satisfy itself beforehand that, if the technologies are proven feasible, such an architecture and arms control regime appear likely to meet satisfactorily whatever criteria are established for proceeding with BMD.

Diversion of Other R&D Efforts

Acceleration of BMD programs affects other military R&D by changing the emphasis of some of those other programs to support the BMD mission. Many BMD programs had originally been pursued for other applications, such as tactical weaponry (particle beams and lasers) or space surveillance (longwave infrared detection). For example, a system designed to provide early warning of missile launch would be similar in many ways to a system providing coarse pointing information to BMD boost-phase weapons. However, the two will not be identical. If plans to upgrade early warning satellites are subsumed within a longer range effort to develop a BMD tracking system, the original early warning mission may suffer. The alternative, however, would probably be duplication of effort.

Even R&D in nominally unrelated areas can be affected if it competes with BMD research for limited resources, such as highly trained personnel or specialized technical facilities, which cannot be readily increased in the short run.

Allied Relations

Beyond its effects on the ABM Treaty, the U.S. BMD research program can have other foreign policy consequences which should be taken into account in evaluating options. Most of our allies support U.S. BMD research as a counter to Soviet research, and some have inquired how they can participate in this research. However, for the most part they have deep reservations about the wisdom of deploying a strategic defense. Whether the U.S. BMD research program now, and any BMD deployment in the future, can be conducted so as to avoid endangering the cohesion of our alliances will be an important issue.[33]

Research and Development of Offensive Forces

There will be a role for U.S. strategic offensive nuclear forces for the foreseeable future in the absence of an agreement to forgo or drastically reduce them. To ensure their effectiveness in the event that the Soviets deploy defenses, the United States will need to continue its development of penetration aids and other countermeasures against defenses. By minimizing the potential effectiveness of Soviet defenses, the existence of such countermeasures would help deter the Soviets from abrogating the ABM Treaty or any subsequent agreement limiting defenses.

However, prudence dictates that we should assume any offensive countermeasure that can be developed by the United States could also be available to the Soviets, and we therefore must consider what such countermeasures would do if deployed against *our* defenses. Development by either side of powerful offensive countermeasures conflicts with the long-term goal of minimizing the role for offenses—a problem which is exacerbated if *defensive* technologies have applications in *offensive* roles (e.g., attacking satellites or aircraft, or particularly attacking enemy defenses).

[33] Alliance issues in particular are discussed in Paul E. Gallis, Mark M. Lowenthal, and Marcia S. Smith, "The Strategic Defense Initiative and United States Alliance Strategy, Congressional Research Service Report No. 85-48 F, Feb. 1, 1985.