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THE SECRETARY OF DEFENSE

WASHINGTON, THE DISTRICT OF COLUMBIA

(2)

1 MAY 1986

Honorable Barry Goldwater
Chairman, Committee on Armed Services
United States Senate
Washington, D.C. 20515

373.24

Dear Mr. Chairman:

In conjunction with submission of the FY 1987 budget, I am required to submit an updated version (in classified and unclassified form) of the 1985 Report on the Strategic Defense Initiative submitted to the Congress pursuant to Section 1102 of the Department of Defense Authorization Act, 1985 (Public Law 98-525; 98 Stat. 2580) and House Report 98-1086. The enclosed report is intended to fulfill these requirements.

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Sincerely,

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REVIEW-DATE: 1/22/07
AUTHORITY: DC DD
NAME: T McDonald
REVIEW-DATE: 03/20/07
AUTHORITY: DD
NAME: Billy W. Hannis
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~~BY: Betty Harris (DR-80-70)~~
~~Date: 1/22/07~~

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THE SECRETARY OF DEFENSE

WASHINGTON, THE DISTRICT OF COLUMBIA

1 MAY 1986

Honorable Jamie L. Whitten
Chairman, Committee on Appropriations
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

In conjunction with submission of the FY 1987 budget, I am required to submit an updated version (in classified and unclassified form) of the 1985 Report on the Strategic Defense Initiative submitted to the Congress pursuant to Section 1102 of the Department of Defense Authorization Act, 1985 (Public Law 98-525; 98 Stat. 2580) and House Report 98-1086. The enclosed report is intended to fulfill these requirements.

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Cap Weinberger

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THE SECRETARY OF DEFENSE

WASHINGTON, THE DISTRICT OF COLUMBIA

1 MAY 1986

Honorable Richard G. Lugar
Chairman, Senate Foreign Relations Committee
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

In conjunction with submission of the FY 1987 budget, I am required to submit an updated version (in classified and unclassified form) of the 1985 Report on the Strategic Defense Initiative submitted to the Congress pursuant to Section 1102 of the Department of Defense Authorization Act, 1985 (Public Law 98-525; 98 Stat. 2580) and House Report 98-1086. The enclosed report is intended to fulfill these requirements.

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THE SECRETARY OF DEFENSE

WASHINGTON, THE DISTRICT OF COLUMBIA

1 MAY 1986

Honorable David Durenberger
Chairman, Select Committee on
Intelligence
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

In conjunction with submission of the FY 1987 budget, I am required to submit an updated version (in classified and unclassified form) of the 1985 Report on the Strategic Defense Initiative submitted to the Congress pursuant to Section 1102 of the Department of Defense Authorization Act, 1985 (Public Law 98-525; 98 Stat. 2580) and House Report 98-1086. The enclosed report is intended to fulfill these requirements.

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THE SECRETARY OF DEFENSE

WASHINGTON, THE DISTRICT OF COLUMBIA

1 MAY 1986

Honorable Don Fuqua
Chairman, Committee on Science and
  Technology
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

In conjunction with submission of the FY 1987 budget, I am required to submit an updated version (in classified and unclassified form) of the 1985 Report on the Strategic Defense Initiative submitted to the Congress pursuant to Section 1102 of the Department of Defense Authorization Act, 1985 (Public Law 98-525; 98 Stat. 2580) and House Report 98-1086. The enclosed report is intended to fulfill these requirements.

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THE SECRETARY OF DEFENSE

WASHINGTON, THE DISTRICT OF COLUMBIA

1 MAY 1986

Honorable Lee Hamilton
Chairman, Permanent Select Committee
on Intelligence
Washington, D.C. 20515

Dear Mr. Chairman:

In conjunction with submission of the FY 1987 budget, I am required to submit an updated version (in classified and unclassified form) of the 1985 Report on the Strategic Defense Initiative submitted to the Congress pursuant to Section 1102 of the Department of Defense Authorization Act, 1985 (Public Law 98-525; 98 Stat. 2580) and House Report 98-1086. The enclosed report is intended to fulfill these requirements.

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WASHINGTON, THE DISTRICT OF COLUMBIA

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Honorable Les Aspin
Chairman, Committee on Armed Services
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

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THE SECRETARY OF DEFENSE

WASHINGTON, THE DISTRICT OF COLUMBIA

1 MAY 198[illegible]

Honorable Dante B. Fascell
Chairman, House Foreign Affairs Committee
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

In conjunction with submission of the FY 1987 budget, I am required to submit an updated version (in classified and unclassified form) of the 1985 Report on the Strategic Defense Initiative submitted to the Congress pursuant to Section 1102 of the Department of Defense Authorization Act, 1985 (Public Law 98-525; 98 Stat. 2580) and House Report 98-1086. The enclosed report is intended to fulfill these requirements.

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THE SECRETARY OF DEFENSE

WASHINGTON, THE DISTRICT OF COLUMBIA

1 MAY 1986

Honorable Mark O. Hatfield
Chairman Committee on Appropriations
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

In conjunction with submission of the FY 1987 budget, I am required to submit an updated version (in classified and unclassified form) of the 1985 Report on the Strategic Defense Initiative submitted to the Congress pursuant to Section 1102 of the Department of Defense Authorization Act, 1985 (Public Law 98-525; 98 Stat. 2580) and House Report 98-1086. The enclosed report is intended to fulfill these requirements.

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REPORT TO THE CONGRESS ON THE STRATEGIC DEFENSE INITIATIVE (U)

March 1986

Prepared by the Strategic
Defense Initiative Organization

~~RESTRICTED DATA~~

~~This material contains restricted data as defined in the Atomic Energy Act of 1954. Unauthorized disclosure subject to administrative and criminal sanctions.~~

Classified by the SDIO

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March 1986

Prepared by the Strategic Defense Initiative Organization

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TABLE OF CONTENTS

CHAPTER I

(U) INTRODUCTION

A. (U) PURPOSE OF REPORT

(U) This report describes the coordinated Department of Defense (DoD) research and technology program efforts needed to meet the goals of the President's Strategic Defense Initiative (SDI). This report responds to Section 1102 of the Department of Defense Authorization Act, Fiscal Year 1985, (Public Law 98-525, October 19, 1984).

B. (U) SCOPE

(U) The scope of this report encompasses the plans for ongoing and future efforts by the DoD to achieve the goals of the SDI. This plan describes the basic program execution by DoD Services, Agencies, and the Strategic Defense Initiative Organization (SDIO). The basic program comprises all SDI supported research and technology efforts leading to decisions on whether or not to implement a defensive strategy and develop promising systems for defense against ballistic missiles. This report is designed to serve as a basic tool in communicating a broad overview of the SDIO Program to non-SDIO agencies and groups. As such, it is a top-level program description that can be used as the basis for describing the program to those who need access to its classified aspects.

C. (U) PROGRAM GENESIS

(U) In March 1983, the President called for an intensive and comprehensive effort to define a long term research and development program with the ultimate goal of eliminating the threat posed by nuclear ballistic missiles. Two study teams were established, the Future Strategic Strategy Study (FS^3) Team and the Defensive Technology Study (DTS) Team. The DTS, commonly referred to as the Fletcher Study, called for the structuring of a broad-based research and technology development effort focused on establishing technical feasibility, as opposed to initiating system-level development. The recommended effort was structured to permit a decision in the early 1990s on whether to proceed to system-level development. The FS^3, which paralleled the Fletcher Study, concluded that it was essential that options for the deployment of advanced defenses against the ballistic missile be established and maintained. Such defenses, if feasible, would offer an entirely new concept of deterring nuclear war based on defense against attack rather than solely relying on retaliation.

(U) In January 1984, the Strategic Defense Initiative was established as a research program based on the Fletcher Study. In the same time frame, the Strategic Defense Initiative Organization (SDIO) was formed as a defense agency to manage the DoD efforts. Specifically, a comprehensive SDI program was defined to explore key technologies associated with concepts for defense against ballistic missiles. The SDIO was directed to place principal emphasis on technologies involving nonnuclear kill concepts. (Research on nuclear directed energy weapons is being undertaken by the Department of Energy separately from the efforts of the SDIO to develop an understanding of the potential of this technology and as a hedge against Soviet work in this area.) At the same time, the SDI program protects options to deploy a limited defense against ballistic missiles (nonnuclear if possible) as one possible early response to particularly threatening Soviet deployments.

(U) Specific research efforts were organized in five areas:

- (U) Surveillance, Acquisition, Tracking, and Kill Assessment (SATKA)
- (U) Directed Energy Weapons (DEW) technologies
- (U) Kinetic Energy Weapons (KEW) technologies
- (U) Systems Analysis and Battle Management (SA/BM)
- (U) Survivability, Lethality, and Key Technologies (SLKT)

CHAPTER II

(U) THE DIRECTOR'S OVERVIEW

A. (U) INTRODUCTION

(U) Fiscal Year 1985 was a challenging and exciting year for the Strategic Defense Initiative Organization. Efforts were most inventive and innovative, and events moved very quickly. That challenge and movement have extended into FY 1986. The following themes best characterize these early and formative years:

- (U) The shaping of the program to a better understanding of the ultimate needs and the likely fiscal constraints plus our ability to formulate an investment strategy that allows us to reach our goals in the light of those needs and constraints.

- (U) The emergence of new opportunities and the beginnings of important progress in our technical program that provide the foundations for the major decisions we see in the future.

- (U) The beginnings of a convergence of the key concerns and issues in the important national debate on the Initiative.

(U) My overview will concentrate on these three points. They provide the basic evidence to the Congress, the nation, and our Allies that the Strategic Defense Initiative has passed through the usual turbulence associated with the formative years of any major new endeavor. We have plotted a course and are now well underway. The SDIO is proceeding with a focused, goal-oriented program to support critical national decisions about the future thrust of the nation's strategy, policy, and tactics in the presence of nuclear weapons. The details that follow in this Annual Report to the Congress describe the technical and programmatic aspects of our program and present key discussions on cooperative efforts with our Allies, arms control, and responsive threats.

(U) We are committed to the President's policy to conduct our program within the bounds of existing treaties and international agreements to which the nation is a party. We have, therefore, chosen to describe the program in terminology compatible with the use and interpretations of language appearing in those treaties, particularly the Anti-Ballistic Missile (ABM) Treaty. In doing so, we preempted the lexicon of the research and development community in favor of the terminology found in international agreements. This has been done not only to underscore our commitment to existing treaties and agreements, but also to promote understanding by confining the discussion of SDI to one "word set". The differences in meaning between technical and political language are often great. For example, the ABM Treaty refers to a component as "currently consisting of" an ABM radar, ABM launcher, or ABM interceptor missile. The R&D community uses "component" to describe any part, constituent or ingredient including one of the smallest elements (such as a switch) that makes up a subsystem that in turn makes up a system such as a radar, etc. (Appendix H contains a more detailed discussion of terminology.)

B. (U) <u>SHAPING THE PROGRAM</u>

(U) At the beginning of FY 1985, we were in the midst of starting this major new effort with three basic tasks. First, we needed to ensure continuity in those programs inherited from the Services that were appropriate and relevant to the Initiative. Second, we had to tailor other inherited programs to better fit the needs of our endeavor. Third, we had to initiate important new programs that both expanded and accelerated the pre-SDI efforts in ballistic missile defense and related technologies. We had a basic sketch of the program from the studies done in the Summer of 1983, a well-established goal, and an investment strategy that pushed promising technologies across a broad front and at a pace that was limited, not by funds, but by the pace at which that technology could be developed in an efficient program that controlled risk.

(U) Section IV states our program goals and technical objectives, describes how we have constructed our program in reaction to the realities of budget allocations by the Congress and outlines our evolving understanding of the technology needed to realize our goal. We have made substantive changes in the program as the result of these pressures, so here I would like to give you a brief overview of the structure of our program, our current investment strategy and the changes made to the program.

(U) Although our budget requests for FY 1985 and FY 1986 were reduced by the Congress by about 25 percent, we have made adjustments without changing our basic goal. Although we now have to accept higher risks and more austere research, we still seek to provide the basis for informed decisions in the early 1990s on whether or not to develop and later deploy a defense of the United States and its Allies against ballistic missiles. The mission of the SDIO is to provide the widest set of technical options that time and the resources allocated will permit. We seek the technology that can support a decision to pursue defensive options that would provide an effective defense of critical assets, of our nation and our Allies. But most importantly we seek to lessen the possibility of nuclear war. In essence, we seek to provide strategic defense options that could:

- (U) Support a better basis for deterring aggression;
- (U) Strengthen strategic stability;
- (U) Increase the security of the United States and our Allies; and
- (U) Eliminate the threat posed by ballistic missiles.

We have established our goal in the belief that technological progress can yield the results we seek in the time frame set. We also believe that a program that does not aim toward providing the basis for a development decision at a particular time is likely to lose its focus, its dedication to its goals, and its support.

(U) To accomplish our mission, the SDIO has established a program that has three basic building blocks:

- (U) A technology base program that includes over 50 percent of the scientific work of the SDIO. It is comprised of both basic and applied research intended to foster the birth of many innovative ideas, provide the needed framework of knowledge to pursue large projects, and build opportunities for program growth.

- (U) Technology integration (proof-of-feasibility) experiments are intended to show the feasibility of key technologies. Emphasis is on the early resolution of major issues that, if resolved favorably, can have a substantial impact on the success of ballistic missile defenses over the long term.

- (U) Demonstration-of-capabilities projects involving technology that has already been demonstrated as feasible and must now be integrated with other subsystems to show that desired performance levels can be achieved. These projects emphasize integration of constituent elements and the performance of functional tests to bring feasible technology into engineering proof-of-principle. Full defensive capability need not be tested to prove feasibility.

(U) Given these three basic thrusts within the SDIO research program, the establishment of an investment strategy for the SDIO has been of major importance.

(U) The large budget reductions imposed by the Congress have forced us continually to reevaluate our priorities. Our current investment strategy:

- Protects the technology base,
- Increases the emphasis on proof-of-feasibility experiments with increased investment in the high risk-high payoff approaches, and
- Decreases the number and scope of capability demonstration projects.

This strategy seeks an end product that gives the U.S. the kind of leverage necessary to make SDI work and work effectively at a reasonable cost. Admittedly, this involves a higher element of risk, and we need to maintain a constant vigil over the priority settings between the technology base and feasibility experiments. The program can afford neither to pursue "science for the sake of science" nor to proceed with risky experiments having an inadequate technology base.

(U) The impact of the budget cuts has been pervasive at a time when technology is moving forward rapidly and there is a need to emphasize certain technical areas originally underemphasized or overlooked.

(U) The demonstration-of-capabilities activities are configured into an experimental mode emphasizing key technology issues rather than the integration aspects:

- Space Surveillance Tracking System (SSTS),
- High Endoatmospheric Defense Interceptor (HEDI),
- Exoatmospheric Reentry Vehicle Interceptor Subsystem (ERIS),
- Terminal Imaging Radar (TIR), and
- Integration Test and Demonstration Project (ITD).

(U) On the other hand, the following areas have been selected for greater emphasis in achieving proof-of-feasibility at an early date:

- Ground-based free electron laser technology integration experiment,
- Space-based neutral particle beam technology integration experiment,
- Space-based kinetic energy technology experiments, and
- A set of space pointing and tracking and experiments.

These experiments upgraded into projects are a natural outgrowth of the SDIO's emphasis on critical path programs. They are oriented toward resolving the key issues needed for possible development decisions in the early 1990s. They will also provide a timely, visible, and understandable set of milestones to measure program progress and accomplishment.

(U) The key to the success of this approach is to incorporate multiple paths to successful operation and thus avoid single point failures. The reduction of the requested budget levels by Congress has not, as yet, had the effect of slowing project schedules for the present proof-of-feasibility experiments. It has had the effect, however, of not allowing the SDIO to fund the alternative or fall-back technologies at an adequate level to minimize program risk. In addition, it has caused us to reduce considerably the pace of many of our demonstration-of-capability programs.

(U) Thus, Congressional budget reductions have had an adverse impact on SDI research and forced major program changes. We have been forced to reduce the effort on certain major technologies such as space-based lasers prematurely. This will increase significantly program risk and could cause program slippage, thereby delaying completion and increasing total costs.

C. (U) NEW OPPORTUNITIES: THE BEGINNINGS OF PROGRESS

(U) One of our top priorities has been to examine multilayer defense architectures and define major factors affecting technology decisions, such as threat, survivability, lethality, and affordability. We need to have the best possible understanding of these issues so that we can chart a clear course for the program. Even though the resources devoted to this particular work are relatively modest, the importance of the results cannot be overstated. Nearly every element of SDIO's research is touched.

(U) By late FY 1985, Phase I of the System Architecture and Tradeoff Study was completed by ten industrial contractor teams. Classes of potential architectures for ballistic missile defense were identified and key issues in achieving those architectures explored. Phase II, with the number of contractors reduced to five, is examining the classes of architectures and issues in greater detail. While we have found a healthy diversity of opinion on how to resolve key issues, we also expect agreement on the key features of ballistic missile defense architectures. Points of major importance that have emerged are:

- (U) The most robust architecture would combine both space-and ground-based elements. The space-based assets would be configured to provide effective defense during the boost, post-boost, and midcourse phases of the threat trajectory. They also would provide self defense and protect against various defense suppression threats. The ground-based components would be used to engage the threat during the late midcourse part of the threat trajectory and within the atmosphere at both high and low altitudes. The large number of opportunities to engage the threat with this architecture leads to an expectation of achieving very low levels of defense leakage even if the enemy were to proliferate his offensive forces in response to our defense.

- (U) We must fully explore technologies that could provide systems to engage hostile ballistic missiles in the boost and post-boost phases. The leverage afforded by defensive action at these stages of a hostile ballistic missile's flight can be decisive. Conceivably, the highest payoff and the greatest return on defensive dollar investment would occur in these phases, before deployment of a missile's warheads and associated penetration aids.

- (U) ~~Data~~ handling, along with command and control technologies, for layered defenses must maintain a high priority within the SDI program. Clearly, this work is central to the concept of a layered defense against ballistic missiles. No matter what evolves from our research in other areas of the program, reliable, resilient and responsive ~~data~~ handling and command and control capabilities are requisite.

- (U) Beyond the boost and post-boost realm, a high priority is to conduct thorough examinations of potential capabilities in other layers. The capability to perform defensive engagements in the midcourse and terminal phases is critical to the full exploitation of the advantages of a layered defense. These capabilities would also make available to our future leaders the widest range of defensive options.

- (U) Good exoatmospheric discrimination is essential to effective midcourse defenses. In addition, midcourse defense with good discrimination capability can reduce the impact of fast burn boosters on the effectiveness of boost phase intercept. Cost-effective intercept in midcourse requires a capability to recognize light decoys (less than one percent of the weight of a warhead). Denying the use of light decoys exacerbates the difficulties that fast burn boosters have in deploying decoys. Thus, the impact of this countermeasure on boost phase intercept is mitigated by the increase in effectiveness of midcourse intercept. Then, a capability for heavy decoys (1 to 10 percent) that more closely resemble the warhead can tip the cost exchange heavily in favor of the defense.

- (U) It is hard to overestimate the importance of the generation of realistic threat models, the estimation of the vulnerability of targets to the numerous kill mechanism options being exploited, and the development of the strategies, tactics and technology to ensure system survivability to mission completion. These analyses and estimates will provide the boundaries for measuring success.

- (U) Success in nearly every element of the program is dependent on major advances in supporting technologies for space-based electric power, power conditioning, low cost devices, space transportation and logistics.

- (U) We must accelerate examination of potential applications to the short-range threat. Our security is inextricably linked to that of our Allies. We cannot confine ourselves solely to an exploration of technologies with promise against intercontinental range, land- and sea-launched ballistic missiles.

(U) The architecture studies reinforce our views on the role of boost phase intercept; discrimination of decoys from warheads; midcourse and terminal intercept; basing of defense assets in space; command, control, communications and battle management; and threat modeling, survivability, and target vulnerability. At the same time, our research has already yielded important results from efforts specifically addressing these issues. (The details are included in Section VII.)

- ~~(C)~~ In discrimination, we have seen outstanding progress in imaging, particularly through phased-array radar technology and signal processing improvements. Equally important, directed energy efforts have given us an approach to "interactive" discrimination where we possibly can induce signatures from objects in space that yield discriminants (such as the radiation released from the interaction of a particle beam and nuclear material in a warhead).

- (U) The surveillance and sensor program areas have witnessed impressive progress. Miniaturization and advances in optical sensors have provided rapid gains in surveillance technologies. Multispectral measurements of booster, post-boost vehicle, and reentry vehicle signatures have been obtained by both optical and radar devices. These measurements allow us to understand threat signatures and will be used in the development of sensor technology. Additionally, we have achieved significant progress in technologies for hardening of high density microelectronic processors and infrared (IR) focal plane arrays against the effect of nuclear radiation that would be experienced during a battle.

- (U) In the directed energy field, work with atmospheric compensation and free electron laser technologies has progressed to the point where it appears that the potential for large, effective ground-based laser systems is very real.

- (U) In electromagnetic accelerator or "rail gun" research we have shown the ability to input high levels of power to these devices far sooner than expected. This means that heavier projectiles could be used and/or higher speeds attained.

- (U) In space-based kinetic energy weapons for boost-phase intercept, we have defined a concept for a simple chemical rocket based on low risk attainable technology at an affordable cost that would be effective in a near term defense.

- (U) In kinetic energy weapons, the most significant accomplishment over the last 2 years has been the midcourse intercept of an actual reentry vehicle by an autonomous terminal homing interceptor. This experiment proved the capability of a nonnuclear interceptor launcher from a fixed ground position to demolish an incoming ballistic missile payload outside the earth's atmosphere at a closing speed of over 20,000 miles per hour.

- (U) In hardening electronic circuits and devices for computers against nuclear radiation, we have fabricated and tested radiation-hardened, large scale, integrated circuits that show the potential for incorporating significant onboard processing for spacecraft in high radiation environments.

- (C) In shipboard ~~data~~ collection on missile tests, we have developed and deployed a new radar that improves our capability for collecting detailed ~~data~~ on reentry vehicles.

- (U) A distributed computer that networks several standard commercial computers into a virtual memory system is now operational. It is providing test beds for battle management concepts.

- (U) In lethality and target hardening, we have conducted many tests to analyze and quantify damage effects and vulnerabilities to radiation and high speed projectiles. One of the more graphic tests involved destruction of a rocket body by a laser on a ground range. Other tests have examined the effects of x-rays on laser mirrors. Other effects tests have shown that small plastic projectiles travelling at 7 km/sec and impacting aluminum can create major damage.

(U) We can also show progress in our dealings with our Allies. Many of our Allies have indicated support for SDI research and in some cases interest in participating. On December 6, 1985, the Secretary of Defense and the British Defense Minister signed a government-to-government agreement concerning SDI research involvement, and other Allied governments appear interested in similar accords.

(U) U.S. and Allied security remains indivisible and we will continue to work closely with our Allies to ensure that, as research progresses, Allied views are carefully considered. In addition to direct Government participation in the research effort, Allied contributions could include innovative university research, individual exchanges, subcontracts from U.S. industry, or direct contractor arrangements. (Appendix G contains a more detailed discussion of the SDI and the Allies.)

D. (U) SETTING OBJECTIVES AND STANDARDS

(U) Earlier I characterized the events of the past year as the beginning of a convergence of the key concerns and issues in the important national debate on the Initiative and the promise of greater relevance in future discussions.

(U) The stack of press and periodical coverage of SDI is now nearly two yards high, but I am pleased to report that the debate is focusing on the achievements needed before decisions can be made. A U.S. decision about whether to incorporate defenses into our strategic posture will be based on those criteria that we apply to all important military system deployment decisions:

- Potential Role in U.S. Strategy,
- Deterrent to Surprise Attack and Enemy Escalation,
- Contribution to Our Arms Control Objectives, and
- Technical Feasibility.

The SDIO has the lead role in defining the feasibility and cost. We also have an active role in assisting those who are addressing the other criteria to ensure our results are useful and responsive. How we view the relative weights and priorities of these criteria cannot be fixed in time; the degree to which we are successful in defining feasibility and affordability will be a major factor in future decisions.

(U) In our role of defining feasibility and cost, we have structured our efforts to support an early 1990s decision on whether to proceed to the engineering development phase by ensuring the presence of several conditions. The technology needed to proceed with confidence along a development path should be sufficiently in hand. In other words, the majority of effort needed from that point on should be engineering in nature rather than experimental. The mission and performance envelopes should be adequately defined. The best technical approach should have been selected. Finally, cost and schedule estimates should be credible and acceptable. For these conditions to be present, concept formulation and technical feasibility studies would have to be favorably completed so that questions regarding prospects for achieving the desired goals and potential pay-offs could be answered with reasonable certainty.

(U) There is one other important point of agreement that needs to be stressed. There has been much discussion concerning the relationship between scientific objectivity and partisan politics. The scientists and engineers, both inside and outside the government, involved with the Strategic Defense Initiative have an obligation to hold their professions and their work to the highest standards; that is, scientific objectivity should rise above partisan political debate. Resolution of the technology ambiguities can anchor the political arguments and will ultimately lead to an informed decision.

E. (U) SUMMARY OBSERVATIONS

(U) In conclusion, several cogent themes in Secretary Weinberger's Posture Statement capture the direction and scope of the program. These themes bear repeating once again.

- (U) The aim of the SDI is to determine the feasibility of a thoroughly reliable defense against Soviet strategic and shorter-range missiles. Our research program to determine if we can do this is well under way;

- (U) Research will last for some years. Our research program is being conducted within ABM treaty limitations; despite Soviet violations of that treaty;

- (U) It is too early in our research program to speculate on the kinds of defensive systems -- whether ground-based or space-based and with what capabilities -- that might prove feasible and desirable to develop and deploy;

- (U) The purpose of the defensive options we seek is clear -- to find a means to destroy attacking ballistic missiles before they can reach their potential targets;

- (U) United States and Allied security remains indivisible. The SDI program is designed to enhance Allied security as well as U.S. security. We will continue to work closely with our Allies;

- (U) We are attempting to engage the Soviets in serious discussions in Geneva on how international security and stability could be enhanced through a greater reliance by both sides on advanced defensive systems;

- (U) SDI represents no change in our commitment to deterring war;

- (U) For the coming years, offensive nuclear forces and the prospect of nuclear retaliation will remain the key element of nuclear deterrence. Therefore, we must maintain modern, flexible, and credible

CHAPTER III

(U) PROGRAM IN PERSPECTIVE

A. (U) THE STRATEGIC CONTEXT

(U) The basic intent behind the Strategic Defense Initiative (SDI) is best explained and understood in terms of the strategic environment the United States faces for the balance of this century and into the next. This nation and those nations allied with it face a number of challenges to their security. Each of these challenges imposes its own demands and presents its own opportunities. Preserving peace and freedom is, and always will be, this country's fundamental goal. The essential purpose of its military forces is to deter aggression and coercion based upon the threat of military aggression. The deterrence provided by U.S. and Allied military forces in the past has permitted the American people and our Allies to enjoy peace and freedom.

(U) For the past 20 years, assumptions of how nuclear deterrence can best be assured have been based on one basic idea. That is, if each side maintains the ability to retaliate against any attack and impose on an aggressor costs that are clearly out of balance with any potential gains, this threat will suffice to prevent conflict. The estimate of what United States forces have had to hold at risk to deter aggression has changed over time. Nevertheless, the strategy of basic reliance on retaliation provided by offensive nuclear forces as the essential means of deterring aggression has not changed. This assumption served as the foundation for the U.S. approach to the Strategic Arms Limitation Talks (SALT I). At the time the process began, the United States concluded that deterrence based on the capability of offensive retaliatory forces was not only sensible but necessary. We believed that both sides were far from being able to develop the technology for defensive systems which could effectively deter the other side. However, the Soviet Union has failed to show the type of restraint, in both strategic offensive and defensive forces, that was hoped for when the strategy was implemented and the SALT process began.

(U) The U.S. response to the strategic threat has, out of necessity, undergone a period of evolution during the last three decades in order to adapt to the changing nature of the threat itself. The current strategic environment is characterized by (1) improvements in Soviet strategic offensive and defensive forces, (2) a longstanding and intensive Soviet research program in many of the same basic technological areas which the SDI program will address, and (3) a growing pattern of Soviet deception and noncompliance with existing arms control agreements.

B. (U) THE CHALLENGE TO U.S. SECURITY

(U) The Soviet Union remains the principal threat to U.S. security and that of its Allies. As part of its wide-ranging effort to increase further its military capabilities, the Soviet Union's improvement of its ballistic missile force has increasingly threatened the survivability of forces the U.S. and our Allies have deployed to deter aggression and of the leadership structure that commands them. It equally threatens many critical fixed installations in the United States and in Allied nations that support the nuclear retaliatory and conventional forces which provide the collective ability to deter conflict and aggression.

(U) Since 1969 when the SALT I process was just starting, the Soviet Union has built five new classes of intercontinental ballistic missiles (ICBMs) and upgraded these seven times. As a result, their missiles are much more powerful and accurate than they were several years ago. The United States, in contrast, introduced its last new intercontinental ballistic missile, the Minuteman III, in 1969, which has been upgraded once, and is now dismantling the obsolete Titan missiles. The alarming growth, both in quantity and quality, of Soviet ballistic missiles over the last decade is yielding a prompt hard target force capable of rapidly and significantly degrading our land-based retaliatory capability. The resulting asymmetry between Soviet and U.S. force structures has led to a destabilizing situation, one that the Reagan Administration believes strongly must be redressed.

(U) At the same time that it has worked to improve its offenses, the Soviet Union has continued to pursue strategic advantage through the development and improvement of active defenses. These active defenses provide the Soviet Union a steadily increasing capability to counter the retaliatory forces of the U.S. and its Allies, especially if those forces were to be degraded by a Soviet first strike. Even today, Soviet active defenses are extensive. For example, the Soviet Union possesses the world's only operational antiballistic missile system, deployed around Moscow. The Soviet Union currently is improving all elements of this system. The Soviets are also developing components of a new ABM system that apparently are designed to allow them to construct individual ABM sites in a matter of months rather than the years required for more traditional ABM systems. The Soviet Union also has the world's only operational anti-satellite (ASAT) capability. It has an extensive air defense network, which it is continuing to improve, and it is aggressively improving the quality of its radars, interceptor aircraft, and surface-to-air missiles. It also has a very extensive network of ballistic missile early warning radars. All of these elements provide them an area of relative advantage in strategic defense today and, with logical evolutionary improvement, could provide the foundation for a decisive advantage in the near future if the U.S. does not take steps necessary to counter these activities.

(U) The Soviet Union is also spending significant resources on passive defensive measures aimed at improving the survivability of its own forces, military command structure and national leadership. These efforts range from providing rail and road mobility for its latest generation of ICBMs to extensive hardening of various critical military and civil defense installations.

(U) For over two decades, the Soviet Union has pursued a wide range of strategic defensive efforts, including advanced ABM research and development. The resulting trends have shown steady improvement and expansion of Soviet defensive capability. Furthermore, current patterns of Soviet research and development on advanced defenses indicate that these trends will continue apace for the foreseeable future. If unanswered, continued Soviet defensive improvements will further erode the effectiveness of the United States' existing deterrent, based almost exclusively on the threat of retaliation by offensive nuclear forces. Therefore, this longstanding Soviet program of defensive improvements, in itself, poses a challenge to deterrence which must be addressed.

(U) Finally, the problem of Soviet noncompliance with arms control agreements in both the offensive and defensive areas, including the ABM Treaty, is a cause of very serious concern. Soviet activity in constructing the new phased-array radar near Krasnoyarsk, in central Siberia, has significant consequences. When operational, this radar, due to its location, and the location of others in the new network, will increase the Soviet Union's capability to deploy a territorial ballistic missile defense. Recognizing that such radars would make that contribution, the ABM Treaty expressly bans their construction at interior locations as one of the primary mechanisms for ensuring the effectiveness of the Treaty. The Soviet Union's activity with respect to this radar, due to its location and orientation, is in direct violation of the ABM Treaty.

(U) Against the backdrop of this Soviet pattern of noncompliance with existing arms control agreements, the Soviet Union is also taking other actions which affect this country's ability to verify Soviet compliance. Some Soviet actions, like their increased use of encryption during missile testing, are directly aimed at degrading the U.S. ability to monitor treaty compliance. Other Soviet actions, too, contribute to the problems that must be faced in monitoring Soviet compliance. For example, Soviet increases in the number of their mobile land-based ballistic missiles, especially those armed with multiple, independently-targetable reentry vehicles, and other mobile systems, will make verification less and less certain. If the United States fails to respond to these trends, there may come a point in the foreseeable future where the U.S. would have little confidence in its assessment of the state of the military balance or imbalance, with all that implies for the country's ability to control escalation during crisis.

C. (U) RESPONDING TO THE CHALLENGE

(U) In response to the long term pattern of Soviet offensive and defensive improvements, the United States is compelled to take complementary actions designed both to maintain security and stability in the near term and to ensure these conditions in the future. It must act in three main areas.

(U) First, offensive nuclear retaliatory forces must be modernized. This is necessary to reestablish and maintain the offensive balance in the near term and to create the strategic conditions that will permit the U.S. to pursue complementary actions in the areas of arms reduction negotiations and defensive research. In 1981, the U.S. embarked on a strategic modernization program aimed at reversing a long period of decline. This modernization program was specifically designed to preserve stable deterrence and, at the same time, to provide the incentives necessary to cause the Soviet Union to join the U.S. in negotiating significant reductions in the nuclear arsenals of both sides.

(U) In addition to the U.S. strategic modernization program, NATO is modernizing its longer-range, intermediate-range nuclear forces (LRINF). Our British and French Allies also have underway important programs to improve their own national strategic nuclear retaliatory forces. The U.S. SDI research program does not negate the need for these U.S. and Allied programs. Rather, the SDI research program depends upon collective and national modernization efforts to maintain deterrence today as options are explored for possible future decisions on how we might enhance security and stability over the longer term.

(U) Second, steps must be taken to provide future options for ensuring deterrence and stability over the long term and must be taken in a way that allows the U.S. both to counter the destabilizing growth of Soviet offensive forces and to channel longstanding Soviet propensities for defenses toward more stabilizing and mutually beneficial ends. The Strategic Defense Initiative is specifically aimed at achieving these goals. In the near term, the SDI program also responds directly to the ongoing and extensive Soviet anti-ballistic missile effort, including the existing Soviet deployments permitted under the ABM Treaty. The SDI research program provides a necessary and powerful deterrent to any near term Soviet decision to rapidly expand its anti-ballistic missile capability beyond that contemplated by the ABM Treaty. This, in itself, is a critical task. However, the overriding, long term importance of SDI is that it offers the possibility of reversing the dangerous military trends cited here by moving to a better, more stable basis for deterrence and by providing new and compelling incentives to the Soviet Union for seriously negotiating reductions in existing offensive nuclear arsenals.

(U) In our investigation of the potential of advanced defensive systems, the U.S. seeks neither superiority nor unilateral advantage. Rather, if the promise of SDI technologies is proven, the destabilizing characteristics of the current strategic environment can be rectified. And, in the process, deterrence will be strengthened significantly and placed on a foundation made more stable by reducing the role of ballistic missile weapons and by placing greater reliance on defenses that threaten no one.

(U) Third, the U.S. will continue its strong commitment to arms control. Our near-term objective is a radical reduction in the power of offensive nuclear arms, as well as a safer relationship between nuclear offensive and defensive arms. We are even now looking forward to a period of transition to a more stable world, with greatly reduced levels of nuclear arms and an enhanced ability to deter war based upon the increasing contribution of nonnuclear defenses against offensive nuclear arms. A world free of the threat of military aggression and free of nuclear arms is an ultimate objective to which the U.S., the Soviet Union and all other nations can agree.

(U) To support these goals, this country will continue to pursue vigorously the negotiation of equitable and verifiable agreements leading to significant reductions of existing nuclear arsenals. As it does so, it will continue to exercise flexibility concerning the mechanisms used to achieve reductions but will judge these mechanisms on their ability to enhance the security of the United States and its Allies, to improve strategic stability and to reduce the risk of war.

(U) At the same time, the SDI program is being conducted in full compliance with the ABM Treaty. If the SDI program yields positive results, the U.S. will consult with its Allies about next steps. The United States would also consult and, as appropriate, negotiate with the Soviet Union, pursuant to the terms of the ABM Treaty which provide for such consultations, on how deterrence might be strengthened through the phased introduction of defensive systems into the force structures of both sides. This commitment does not mean that the United States will give the Soviets any veto over a future U.S. decision on strategic defense. In anticipation of a possible future decision to deploy defenses, the U.S. has already begun the process of bilateral discussion with the Soviet Union in Geneva to address questions related to our objective of a jointly-managed transition integrating advanced defense into the forces of both sides.

D. (U) THE ROLE OF THE STRATEGIC DEFENSE INITIATIVE

(U) In summary, the President's Strategic Defense Initiative is an important effort to find a fundamental improvement in the long-term security of the U.S. and its Allies, and to provide a better response to the growing Soviet offensive and defensive threat. Recent advances in defensive technologies warrant a new evaluation of ballistic missile defense as a basis for a safer form of deterrence, more consistent with U.S. values. Possibilities for maintaining security by means of an enhanced ability to deter war through an increasing capability to defend against attack--rather than through sole dependence on the threat of nuclear retaliation--deserve, and are receiving, serious exploration.

CHAPTER IV

(U) GOALS AND TECHNICAL OBJECTIVES

A. (U) INTRODUCTION

(U) This section describes the basic guidance under which the SDIO program is executed and the basic thrusts of the resultant program. It discusses program goals, how these goals are being turned into program requirements, how these requirements can be met, and what the overall investment (funding) strategy is.

B. (U) GOAL OF THE STRATEGIC DEFENSE INITIATIVE

(U) The goal of the SDI is to conduct a program of vigorous research and technology development that may lead to strategic defense options that would eliminate the threat posed by ballistic missiles, and thus:

- Support a better basis for deterring aggression;
- Strengthen strategic stability; and
- Increase the security of the United States and its Allies.

The SDI seeks, therefore, to provide the technical knowledge required to support an informed decision in the early 1990s on whether or not to develop and deploy a defense of the U.S. and its Allies against ballistic missiles.

(U) Program success in meeting its goal should be measured in its ability both to counter and discourage the Soviets from continuing the growth of their offensive forces and to channel longstanding Soviet propensities for defenses toward more stabilizing and mutually beneficial ends. Furthermore, the SDI program provides in the near term a definitive response to the Soviets' vigorous advanced anti-ballistic missile (ABM) research and development effort. Thus, the SDI could act as a powerful deterrent to any near term Soviet decision to expand rapidly its anti-ballistic missile system beyond that contemplated by the ABM Treaty. Nonetheless, the overriding, long term importance of the SDI is that it offers the possibility of reversing dangerous Soviet military trends by moving to a better, more stable basis for deterrence. It could provide new and compelling incentives to the Soviet Union for serious negotiations on reductions in existing offensive nuclear arsenals.

(U) There are no preconceived notions of what an effective defensive system against ballistic missiles should entail. A number of different concepts involving a wide range of technologies are, therefore, being examined. No single concept or technology has, as yet, been identified as the best or most appropriate.

C. (U) THE BASIC REQUIREMENTS

(U) A strategic defense system developed following the Strategic Defense Initiative Program, like any other major military system, would have to meet three specific standards.

(U) Advanced defenses must be adequately survivable. They must not only maintain a sufficient degree of effectiveness to fulfill their mission even in the face of determined attacks on the defense, but also maintain stability by discouraging such attacks. Survivability means then that the defensive system must not be an appealing target for defense suppression attacks. The offense must be forced to pay a penalty if it attempts to negate the defense. This penalty should be sufficiently high in cost and/or uncertain in achieving the required outcome that such an attack would not be contemplated seriously. Additionally, the defense system must not have any "Achilles Heel." In the context of the SDI, survivability would be provided not only by specific technical "fixes" such as employing maneuver, sensor blinding and protective shielding materials, but also by such strategy and tactical measures as proliferation, deception, and self-defense.

System survivability does not mean that each and every element of the system need survive under all sets of circumstances; rather, the defensive force as a whole must be able to achieve its mission, despite any degradation in the capability of some of its components.

(U) The second requirement is military effectiveness. A defense against ballistic missiles must be able to destroy a sufficient portion of an aggressor's attacking forces to deny him confidence that he can achieve his objectives. In doing so, the defense should have the potential to deny that aggressor the ability to destroy a militarily significant portion of the target base he wishes to attack. Furthermore, if a deployed defensive system is to have lasting value, technology and tactics must be available that would allow the system to evolve over an extended period, in order to counter any plausible "responsive" threat. Such a robust defense should have the effect of deterring a strong offensive response and enhancing stability.

(U) Third, we will consider, in our evaluation of options generated by SDI research, the degree to which certain types of defensive systems, by their nature, encourage an adversary to overwhelm them with additional offensive capability while other systems can discourage such a counter effort. We seek defensive options -- as with other military systems -- that are able to maintain capability more easily than countermeasures could be taken to try to defeat them. This criterion is couched in terms of cost-effectiveness. However, it is much more than an economic concept.

D. (U) IDENTIFYING DEFENSIVE OPTIONS

(U) If the program is to support future decisions on defensive options, diverse efforts producing essential answers to critical issues must converge. Affordable ballistic missile defense architectures must be identified. The technical feasibility and readiness for development of survivable and cost-effective systems capable of meeting and sustaining the performance needs of the architectures must be established. The doctrine and concepts of operation for applying the system elements of the preferred architectures must be formulated. Practical paths for implementing the strategy and deploying defenses in the context of foreign relations and arms control must be defined.

(U) Since FY 1984, the SDIO has pursued efforts to identify the above requirements through the System Architecture Studies. The purpose of these studies is threefold. The first is to provide an initial definition and assessment of several alternative constructs of systems (architectures) that can detect, identify, discriminate, intercept and negate ballistic missiles in their boost, post-boost, midcourse and/or terminal phases. A second purpose is to provide a complete and balanced set of technological and functional requirements. This is accomplished by identifying the key trade-offs for sensors, weapons, command, control, communications, and supporting subsystems that can make the individual architecture viable and cost-effective. A third purpose is to define and prioritize critical technical issues that must be resolved before future decisions can be made on whether or not to implement a given defensive strategy.

(U) The task of identifying reasonable defense architectures is an ongoing one. The evaluation and analysis of SDI technologies and designs must <u>necessarily</u> evolve as research progresses. Two important elements are integral to this task--(1) the analysis of potential responsive threats with which a proposed defense would have to cope and (2) the development of appropriate scenarios for use in simulations and evaluations.

(U) The value of these studies, even at the generic level, should not be underestimated. The study of possible systems allows the SDIO to identify critical problem areas, develop measures of system effectiveness, and evolve new concepts. Without these steps the SDIO could not prioritize its investments. In addition, useful trade-off studies are performed that, among other outputs, may allow the SDI to discover possible synergistic relationships between subsystems, major system elements and strategies.

(U) The SDI Program will have a number of critical junctures. Clearly, the evolving description of emerging architectures will create several of these junctures. In the beginning simple constructs are being formulated and methodologies for evaluating systems concepts are being created. As more in-depth steps are taken, the constructs will become more complex and the various trade-offs and assessments of performance will become more detailed. Ultimately, the most sophisticated architecture, together with its evaluative process, might involve the simulation of the entire defense in a battle engagement. The simulation would assist the SDIO in analyzing the outcome of a hypothetical battle. It would provide a measure of how well the constructs performed, as well as estimates of how much it would cost to develop, deploy and operate the particular defensive options selected.

E. (U) ACHIEVING A TECHNICAL CAPABILITY

(U) If the SDIO is to offer a high confidence basis for decisions to pursue one or more defensive options, the program must do several things. First, it must conduct a broad-based effort that expands and accelerates the progress of technology in a manner that supports the relevant architectures. Second, it must provide the architect with conceptual designs of the system elements. Such designs are needed if the architect is to evaluate the potential effectiveness of candidate ballistic missile defenses that could be assembled and deployed from those technologies. Third, it must provide a basis for showing how those defense options can be operated and maintained to do the job. It must do this research in activities that are conducted in accordance with applicable U.S. treaty obligations.

(U) The SDIO must advance the technology in a logical and timely way in three experimental thrusts. First, the most mature technologies need to be validated in order to provide initial options for defense architectures that are affordable, survivable and effective. A decision in the future to proceed with a specific initial option would implement a defense against the threat the U.S. believes will be in place at least until early in the next century. Alternatively, the decision could be to reserve these options as a simple hedge against Soviet breakout and deployment of a defense against U.S. ballistic missiles. Second, the long term viability of future defensive options needs to be ensured by showing the feasibility and readiness of technologies to support more advanced defense options against an evolving and increasingly more capable threat based on the offensive technologies of the early twenty-first century. And third, research needs to be conducted that encourages innovation by the U.S. scientific community in response to the President's challenge to aid SDI in identifying and exploiting new approaches promising major gains in defense effectiveness.

F. (U) THE BASIC PROGRAM BUILDING BLOCKS

(U) To meet the requirements of an early 1990s decision milestone, the SDIO has established a program that has as its building blocks the following elements:

- A technology base program,
- Major experiments which include:
  - Technology integration experiments, and
  - Demonstration-of-capabilities projects.

(U) Well over 50 percent of the scientific work in the SDIO falls into the technology base category. It encompasses the large number of individual "small science" efforts, that is, programs with small to modest funding. The work is comprised of both basic and applied research. Some of this work involves relatively straightforward extensions of existing technology; it also includes high risk, but high payoff efforts. The technology base program is intended to foster the birth of many innovative ideas. The programmatic objective is to provide the framework of knowledge needed to pursue integrated experiments and to build opportunities for program growth, particularly in those disciplines that might have far reaching impact.

(U) In order to focus and integrate this evolving information, key projects have been chosen that are designed to provide the needed proof-of-feasibility of the critical elements of an SDI system. Examples of efforts that fall into this category are: scaling experiments for a laser device, development of new infrared (IR) sensor materials, study of lightweight shielding material to protect both boosters and spacecraft from laser attack, research into large structures to be used in space, and creation of advanced software engineering techniques to provide improved feasibility and testability.

(U) Proof-of-feasibility experiments tend to be moderately expensive and are driven (or selected to be driven) by time urgency. They are intended to show rapidly the feasibility of a key technology with high payoffs. These efforts often follow the concept of pursuing parallel technology paths when possible in order to lower the risk of these ambitious projects. The emphasis in these projects is on the early resolution of a major issue that, if resolved favorably, can have a substantial impact on the success of the long term SDI goal. Examples of such projects are: the integration of a high power free electron laser and beam director, a study of a space-based neutral particle beam accelerator and sensor package, a booster tracking and weapon platform pointing experiment, and an integrated study of kinetic energy intercept of a reentry vehicle in outer space similar to the Homing Overlay Experiment.

(U) Experiments to prove capabilities are the next step beyond showing technological feasibility and the last phase preceeding full scale development. Examples of these projects are the exercise of test beds to demonstrate capabilities in tracking missiles in the boost phase, discriminating decoys from warheads, and hit-to-kill exoatmospheric and endoatmospheric intercept. These experiments involve technology that has already been demonstrated as feasible and must now be integrated with other subsystem requirements. These projects are characterized by emphasis on integration of constituent elements and the performance of functional tests. They will bring feasible technology into engineering proof-of-principle. Experiments at this phase give some understanding of what are often called the "unknown-unknowns" that must be dealt with before any reasonable thought can be given to development and then deployment. These experiments are also expensive and time consuming. On the other hand, integration and further testing offer ways of avoiding more costly mistakes that often occur due to premature decisions to develop more complex integrated concepts. If the technology base is forced into an excessively lean posture, then the technical risk for these projects may become unacceptably high, that is, there will be limited flexibility with which to perform side-steps to assure ultimate project success. These programs can and should rely on the technology base program for help when the inevitable unknowns become apparent. These experiments are quite sensitive to and driven by fiscal and time constraints. These integration projects and functional tests have been structured to be carried out in conformity with the restrictive interpretation of the ABM Treaty.

G. (U) THE INVESTMENT STRATEGY

(U) Given the three basic areas of the SDI program, how are priorities being set? The establishment of a viable investment strategy for the SDIO has been of major importance since priorities have undergone constant reevaluation due to the large budget reductions imposed by Congress.

(U) The current investment strategy is to:

- Protect the technology base;
- Increase the emphasis on proof-of-feasibility experiments with increased investment in the high risk-high payoff approaches; and
- Decrease the number and scope of capability demonstration projects.

(U) The possible drawback of this approach is that the technology base program could turn into what has been termed in other cases "technological filibustering", that is, rejecting the "good enough" in search for something "better". The positive view, of course, is that SDIO would develop a better end product, one that gives the U.S. the kind of leverage necessary to make defenses work reliably, robustly, and at a reasonable cost. There will admittedly need to be a constant vigil stood over the priorities set between the technology base and feasibility experiments. The program can neither afford to pursue "science for the sake of science" nor to proceed with risky experiments having an inadequate technology base.

(U) The following examples illustrate the above points of new philosophy. The demonstration-of-capabilities activities have been intentionally reconfigured into an experimental mode emphasizing key technology issues rather than the integration aspects:

- Space Surveillance Tracking System (SSTS),
- High Endoatmospheric Defense Interceptor (HEDI),
- Exoatmospheric Reentry Vehicle Interceptor Subsystem (ERIS),
- Terminal Imaging Radar (TIR), and
- Integration Test and Demonstration Project (ITD).

(U) On the other hand, a number of areas have been selected for greater emphasis in achieving proof-of-feasibility at an early date. They are:

- Ground-based free electron laser integration experiment,
- Space-based neutral particle beam integration experiment,
- Space-based kinetic energy technology experiments, and
- A set of space pointing and tracking experiments.

(U) These upgraded projects are a natural outgrowth of SDI emphasis on critical path programs oriented toward resolving the key issues needed for the technical and programmatic inputs to the decision in the early 1990s. These experiments will also provide a timely, visible and understandable set of milestones with which to measure program progress and accomplishment. The key to the success of this approach is to incorporate multiple paths to satisfy key needs for successful defense architectures and thus avoid single point failures. The reduction of the requested budget levels by Congress has not, as yet, had the effect of slowing project schedules. It has had the effect, however, of not allowing the SDI to fund the alternative or fall-back technologies at a separate level to minimize program risk. The best example of this is in the Directed Energy Program where the technology is least mature and the number of potentially promising concepts large--only a few technologies can be emphasized.

H. (U) THE BASIC PROGRAM STRUCTURE

(U) With this priority-setting philosophy in hand, the program is logically divided into three basic elements. There are the "hardware" technology programs such as Directed Energy Weapons (DEW); Kinetic Energy Weapons (KEW); Surveillance, Acquisition, Tracking and Kill Assessment (SATKA); and Survivability, Lethality and Key Technologies (SLKT). There are the "software" programs such as Systems Analysis and Battle Management (SA/BM) and Countermeasures work. There are ancillary areas that address the threat and threat projections, in addition to an activity to stimulate innovative science and technology.

(U) The priority decisions that affect the "hard" programs are driven by systems requirements including possible Soviet responsive threats. These programs are described in Chapter VII, "The Technical Challenge", and Appendices B through G. The "soft" programs such as the "horse race" architecture studies and the Red Team/Blue Team countermeasures work should be viewed differently from the "hard" programs. These programs engage in studies to uncover problems and allow for definition of the critical issues. Such areas give the program general guidance and, when properly coupled through appropriate feed-back loops to and from the technical programs, provide a strong focus for the overall SDI program. These activities basically define the questions that the hardware programs must resolve and thus define the priorities in the face of limited resources.

(U) In the area of countermeasures, the SDIO has set up Red/Blue technical teams to provide interchange on SDI systems and possible countermeasures and counter-countermeasures, but we are attempting also to mimic the higher level Soviet Government response through the establishment of a mock "Politburo." This approach, hopefully, will provide some semblance of a "holistic" interpretation of possible Soviet responses to a defense deployment. Results in the form of predictions are yet to come forth, but will no doubt prove interesting, perhaps controversial, and clarifying.

I. (U) <u>THE TECHNICAL DEVELOPMENT PACE</u>

(U) A notional schedule for research and possible development and deployment would be comprised of four phases:

- (U) The research-oriented program, begun by the President in his 1983 Initiative, would run into the early 1990s when a decision could be made by a future President and Congress on whether or not to enter into full-scale system engineering development. This activity will be conducted within the constraints of our current treaty commitments.

- (U) The systems development or full-scale development phase could begin as early as the 1990s.

- (U) A transition phase would be a period of incremental, sequential deployment of defensive systems. This phase could be designed so that each added increment would further enhance deterrence and reduce the risk of nuclear war. Prefereably, this transition would be jointly managed by the U.S. and the Soviet Union, although such Soviet cooperation would not be a prerequisite.

- (U) The final phase would be a period of time during which deployment of highly effective, multilayered defensive systems would be completed and during which offensive ballistic missile force levels could be brought to a negotiated nadir, and hopefully, eliminated.

(U) Presently in its first phase, the SDI program is focused to bring defense options to the point where U.S. leaders, after consultation with the Allies, could make decisions on whether or not to proceed. The technology needed to proceed with confidence along a development path should be sufficiently in hand. In other words, the majority of effort needed from that point on should be engineering in nature rather than experimental. The mission and performance envelopes should be adequately defined. The best technical approach should have been selected by means of a thorough trade off analysis. This involves the identification of alternatives, examination of their feasibility, and comparison in terms of performance, cost, technical risk and development time. Last, cost and schedule estimates should be credible and acceptable. For these conditions to be present, concept formulation and technical feasibility studies would have to be favorably completed so that questions regarding prospects for achieving the desired goals and potential pay offs could be answered with reasonable certainty.

CHAPTER V

(U) KEY FUNCTIONS OF A DEFENSE AGAINST BALLISTIC MISSILES

A. (U) OVERVIEW OF THE DEFENSE ENVIRONMENT

(U) The critical requirement imposed on an effective ballistic missile defense system is the need to achieve low leakage of nuclear warheads when threatened by large, sophisticated attacks as well as attacks on the defense system itself. A strategic defense capable of engaging appropriate targets all along the ballistic missile flight path must perform certain key functions:

- (U) Detection: The rapid and reliable warning of an attack and the readying of defense assets to intercept appropriate targets. This includes the capability to provide full-time surveillance of ballistic missile launch areas (potentially worldwide) to detect an attack and identify its location; characterize the composition and intensity of the attack; determine the probable targeted areas for confident initiation of the battle; and provide track data to aid the defensive systems in acquiring the targets.

- (U) Tracking, Identification/Discrimination: The precise and enduring "birth-to-death" tracking of targets and other objects of interest associated with a ballistic missile attack. This also includes the effective discrimination of penetration aids and decoys; timely kill assessment; and efficient battle management, data processing and communications capabilities to coordinate the defensive battle and optimize the use of defense assets.

- (U) Interception and Destruction: The rapid, effective and discernible kill of ballistic missile boosters, post-boost vehicles, and reentry vehicles along the entire flight path of the ballistic missile. The defense must be capable of stopping an attack ranging from a single missile to massive, simultaneous launch that may require 10 or more kills per second by the defensive weapons in the battle. Defending against an attack while the ballistic missiles are still at the beginning of their flight path (the boost and post-boost phases) is attractive, for it maximizes the number of reentry vehicles killed and minimizes the deployment of decoys and penetration aids.

- (U) Battle Management, Coordination: The effective manipulation of information about the defensive battle, the generation of displays to inform the defense commander, and the transmission of his decisions to the defense elements.

(U) There are two basic approaches in designing a system to perform the necessary functions and achieve the goal of very low leakage. The first involves the use of extremely high performance system elements, and the second relies on redundant combinations of system elements performing at more modest levels. It is generally accepted that an efficient defense against a high level of threat would be a layered defense requiring all of the above capabilities. For example, with a single layer system, the failure of any function may result in overall failure. The defensive system would only be as strong as its weakest link. A target which is not detected would not be intercepted and thus would leak through the single defensive layer. [redacted] Clearly, very capable system elements would be required for a high confidence single layer ballistic missile defense.

(U) The second, and preferred, approach recognizes that near-perfect element performance is unlikely and, even if possible, might be too expensive. This approach envisions a multi-tiered defense with each tier capable of performing independently the basic functions of threat detection, tracking, identification, pointing and/or weapon guidance, destruction, kill assessment, coordination and self defense. If an element within a single tier fails, the target leaks through to the next tier where the defense has another chance to detect and intercept the target. Three independent tiers, [redacted] percent, are also likely to be less costly than a single tier that has the same total leakage since the performance requirements for each tier can be substantially lower than those required for a stand-alone tier.

(U) A typical trajectory of current ballistic missiles can be divided into four phases:

- (U) A boost phase when the missile's engines are burning and offering intense, highly specific observables;

- (U) A post-boost phase, also referred to as the bus deployment phase, during which multiple reentry vehicles (RVs) and penetration aids are being released from a post-boost vehicle (PBV);

- (U) A midcourse phase during which RVs and penetration aids travel on ballistic trajectories above the atmosphere; and

- (U) A terminal phase during which RV trajectories and signatures are affected by atmospheric drag.

Short-range submarine-launched ballistic missile (SLBM) and intermediate-range ballistic missile (IRBM) trajectories have similar boost and terminal phases but, in most cases, have less extensive busing and midcourse phases.

(U) For convenience, we have grouped the functions into three headings in the discussion which follows--<u>surveillance</u> (detection, initial identification), <u>acquisition</u> (tracking, identification/association/discrimination, kill assessment, coordination), and <u>intercept</u> (pointing/guidance, destruction, self defense).

(~~S~~) <u>Boost and Post-Boost Phases</u>. The ability to respond effectively to an unconstrained threat is dependent on the capability of a boost-phase intercept system. For every booster with multiple independently retargetable vehicle (MIRV) payloads killed, the number of objects to be handled by the remaining elements of a layered defense system can be reduced by 10 to 1000 or more. A very important additional feature is that such kills also disrupt the highly structured attacks that stress terminal systems. A boost phase system itself currently is constrained by the extremely short engagement times and potentially large number of targets [redacted] These constraints lead to the need for a surveillance and battle management system with weapons release authority based on predetermined, technically measurable conditions for engagement. They dictate a weapons system that can deliver enough energy to each target in the limited available engagement time to ensure booster kill.

(U) The post-boost phase is potentially rich in information that can be used for discrimination. As this phase of flight proceeds, the leverage decreases as decoys and RVs are deployed. On the other hand, the post-boost phase offers from 100 to 300 additional seconds for intercept by boost phase weapons and may be the predominant phase accessible after certain Soviet boost phase responses.

(U) Midcourse Phase. Intercept outside the atmosphere forces the defense to cope with decoys designed to deceive interceptors and exhaust the force. Fortunately, available engagement times are longer (approximately 1500 seconds) than in other phases. This freedom from the tight timelines in the boost (150 to 300 seconds), post-boost (300 to 500 seconds), or terminal (20 to 50 seconds) phases strongly argues that a midcourse intercept system is an important element in a comprehensive defensive capability. The midcourse system must, however, provide both early filtering of non-threat objects and continuing attrition of threat objects if the defense is to minimize the pressure on the terminal system. Failure to start the defense before midcourse could result in a tenfold to several hundredfold increase in objects in the threat cloud from multiple independently targeted reentry vehicles (MIRVs), decoys, chaff, and junk.

(U) Terminal Phase. The defended area of a terminal-defense interceptor is determined by how fast it can fly and how early it can be launched. Since terminal-defense interceptors fly within the atmosphere, their average velocity is limited. How early they can be launched depends on the requirements for discrimination of the target from penetration aids and accompanying junk and designation to the interceptor. A requirement for independent discrimination delays launch of the interceptor and reduces the "footprint" or defended area. Moreover, since the terminal defense of a large area requires many interceptor launch sites, the defense is vulnerable to saturation and preferential offensive tactics. Such structured, preferential attacks lead to a desire to complement the terminal defense with area defenses that intercept at long ranges and provide wider defense footprints. Such a complement is found in a system for exoatmospheric intercepts in the midcourse phase.

(U) The phenomenology and required technology for each of these phases of a ballistic missile trajectory are different.

While there is considerable technical overlap of systems between phases, it is useful to separate system concepts into these phases for the purpose of discussing top-level performance goals, identifying broad technical approaches to achieve those goals, and identifying key issues to be resolved. The remainder of this section discusses these topics in the context of boost, post-boost, midcourse, and terminal defense systems. These discussions establish the basis for an investment strategy and for an analysis of the technology development needed to realize defense-in-depth concepts.

B. (U) BOOST PHASE (BOOST IGNITION OF POST-BOOST VEHICLE OPERATIONS)

(U) Functional Needs

~~(S)~~ Functional needs and performance goals for defensive actions in boost phase operations are highly sensitive to assumptions about the number of targets to be engaged as a function of time and/or assumed target vulnerability. The first assumption bounds the performance of the surveillance and target acquisition system, the battle management and data processing system, and the fire-control or weapon-guidance sensors. The second assumption (target vulnerability) has a major impact on the performance of the weapon. Both dictate the number of weapons required. Survival and endurance of all boost phase systems are crucial.

- ~~(S)~~ Surveillance. The requirement to detect launches and associate target signatures with specific booster tracks is fundamental. A sensor resolution of the order of [redacted] is needed with current spacing of Soviet silos. Once launch is detected, the system must be capable of handling [redacted] individual targets during 300 seconds in the presence of natural interference from the sun and earth background, and, perhaps, active deception or countermeasure, including nuclear precursors. This same surveillance system would provide handover to the midcourse tracking system that must acquire and track the PBV during its maneuvers and initiate birth-to-death tracking.

- ~~(S)~~ Acquisition. Once the individual booster tracks have been identified, the battle management and command, control, and communication system must allocate individual targets or groups of targets to a weapon or weapon platform. A sensor or sensors on or closely coupled to that platform must then acquire and track the relatively cool booster body in the presence of the hot exhaust plume. The pointing accuracy required for this function may be [redacted] to support some directed energy concepts. It can be relaxed to a few tens of microradians for kinetic energy kill vehicles that have terminal homing and for some directed energy concepts.

- ~~(S)~~ Intercept. Directed energy kill mechanisms must, in general, deliver from a few to tens of mega-joules of energy to the booster or post-boost vehicle. Some weapons concepts attack targets serially using available battle time to move from target to target. In such systems, retarget time must be limited from a few seconds to a fraction of a second in order to achieve the high kill rates required. Other concepts engage targets in parallel and do not require rapid retargeting. Some concepts involve physically hitting the target with a homing warhead that must be terminally guided to within [redacted] of the aimpoint. Finally, one must sense, in near real-time, what-ever characteristic changes occur in the target that indicate that it has been successfully engaged (radical change in trajectory, premature thrust termination, fragments, etc.). This assessment may best be carried out by the surveillance and midcourse tracking sensor systems external to the weapon platform.

(U) <u>Candidate Technologies</u>

(U) The candidate technologies to perform these boost phase intercept functions are:

- ~~(S)~~ <u>Surveillance</u>. Ballistic missile boost phase surveillance has been performed operationally by Defense Support Program (DSP) satellites for more than a decade. An extensive data base exists for [redacted] This data is complemented by a number of simulation and analysis programs and limited observations at [redacted] These data and simulation programs provide high confidence that a space-based infrared (IR) sensor system can be developed to provide the sensitivity, clutter rejection, resolution, and booster trajectory accuracy to support boost-phase intercept requirements. Since, by design, these sensors are not sensitive to wavelengths that penetrate the atmosphere, ground-based countermeasures would be difficult.

- ~~(S)~~ <u>Acquisition</u>. For acquisition by directed energy weapons, [redacted] is applicable. Precision pointing and tracking of directed energy weapons may require active visible laser tracking. For kinetic energy kill devices, use of SWIR homing sensor technology appears feasible. Blinding the sensors with out-of-band lasers that can penetrate the atmosphere is possible but can be made extremely difficult with filters.

- (U) Intercept. Generic weapons concepts applicable to boost phase kill include:

  - (U) Thermal kill lasers--burn through of the booster skin resulting in breakup of booster--include continuous wave (CW) and repetitively-pulsed beams at wavelengths from IR to ultraviolet (UV).

  - ~~(SRD)~~ [redacted]

  - ~~(S)~~ In-depth energy deposition by particle beams--soft kill of electronics, detonation of high explosives, and melting of components and structures--include neutral and, possibly, charged particles. Atmospheric scattering and magnetic field effects limit target kill to altitudes above 100 km.

  - (U) Kinetic energy impact kill using homing projectiles propelled by chemical rockets or an electromagnetic gun.

Since a responsive threat might achieve boost-phase termination in the atmosphere, the need to propagate the kill energy through the atmosphere may limit the applicability of some of the candidates.

C. (U) POST-BOOST PHASE

(U) Functional Needs

(U) The post-boost vehicle's (PBV) dispensing phase begins at the end of booster burn and ends for each reentry vehicle (RV) or penetration aid as it leaves the PBV or "bus". Accordingly, acquisition, tracking, and discrimination between RVs and decoys and debris are key functions that begin in this phase and continue into the midcourse phase. Since the target is the PBV, the target engagement and energy delivery functions are similar to those for boost phase.

- ~~(S)~~ Surveillance. At booster burnout, the large massive and masking infrared signatures of the plume are replaced by the modest signatures of intermittent post-boost propulsion and the cool PBV body. Observations in this phase provide the opportunity to observe passively the RV and decoy dispersal processes. If these processes are imaged with sufficient resolution [redacted] it may be possible to see, for example, balloons being inflated, reentry vehicles being spun up, and masking clouds being deployed. If groups of objects can be classified, if a track file can be established for each group, and if the state vectors can be handed over to a birth-to-death tracker, the difficulty of discriminating RVs and masked RVs from other objects in later phases will be greatly reduced or the offense will be forced to use fewer, more complex decoys.

- ~~(C)~~ <u>Acquisition</u>. The functional needs are essentially the same as for boost phase with some differences. One no longer needs to find the target in a large masking signature. Precision pointing to a few tens of nanoradians now must be accomplished on bodies undergoing smaller but more frequently varying accelerations. While target signatures are much, much smaller than in boost phase, they should be large enough to support long-range acquisition and tracking.

- ~~(S)~~ <u>Intercept</u>. One would probably use boost phase kill mechanisms in the PBV phase. Although substantial differences in the vulnerability of PBVs and boosters are expected, there are no accurate assessments of PBVs that support even a preliminary estimate of their vulnerability. Since PBVs must perform some part of their functions above the atmosphere, propagation limitations no longer apply.

(U) <u>Candidate Technologies</u>

(U) Candidate technologies for performing the post-boost phase functions include:

- [redacted]

- (U) <u>Acquisition</u>. The boost phase candidates are also candidates for this phase.

- (U) <u>Intercept</u>. Here again, the boost phase candidates are the candidates for PBV phase.

D. (U) <u>MIDCOURSE PHASE</u>

(U) <u>Functional Needs</u>

~~(S)~~ Midcourse defense is the process of detecting and destroying RVs after their deployment from the PBV and before they reenter the atmosphere at altitudes of about 100 km. Acquisition or handover, tracking, and discrimination are the key functions in continuing defense against ballistic missiles during this phase. Assuming discrimination is possible, multiple engagement opportunities are available over the relatively long time of flight.

- ~~(TS)~~ Surveillance. An autonomous midcourse surveillance function requires sensors that detect all threatening objects in the midcourse regime, rapidly reject (bulk filter) lightweight decoys and debris that exist in large quantities, precisely track remaining credible objects (RVs and heavy decoys), discriminate the RVs from most of the heavy decoys, provide RV position and trajectory data of adequate accuracy for firing kill devices, and perform kill assessment. Against advanced decoy and PBV designs responsive to a PBV observation capability, active and interactive as well as passive measures will probably be essential to discrimination. As in the PBV phase, groups of objects must be classified, track files established, and state vectors handed over.

- ~~(TS)~~ Acquisition. Precision tracking of designated objects is required to provide the position of the target needed for intercept. This consists of trajectory predictions accurate to a few hundred meters over a 500-second prediction for battle management and handover to a midcourse hit-to-kill interceptor. In addition, position accuracy of about [redacted] is needed for handover to acquisition, tracking, and pointing subsystems of directed energy weapons if active discrimination is deployed. Homing interceptors must depend on cold body tracking or designation.

- ~~(TS)~~ Intercept. Since the targets (RVs) must be protected against the heat and forces of reentry, they are inherently hard to thermal and impulse kill mechanisms. Kill by neutral particle beams requires [redacted] depending on the kill mechanism (such as, electronics or structural kill). Kinetic energy weapons may be required to deliver [redacted] of impact energy depending on the impact geometry and projectile shape. For high confidence, kill mechanisms must deliver a few tens of megajoules of energy to the target. The long duration of the midcourse trajectory (1500 sec) offers opportunities for multiple engagements even with modest interceptor velocities.

(U) Candidate Technologies

(U) Candidate technologies for performing the midcourse functions include:

- ~~(S)~~ Surveillance. Midcourse surveillance needs may be provided by space-based platforms in low or medium earth orbit carrying multiple sensors for multiple functions. Passive [redacted] optics could provide long-range detection of cold bodies against the space background, rejection of simple lightweight objects, and birth-to-death tracking of designated objects. Either short-wavelength lasers or radar are candidates for imaging, measuring body dynamics, and precision tracking of objects as they continue through midcourse. Neutral particle beams are candidates for interactively discriminating reentry vehicles from decoys that cannot be effectively discriminated by other means. These sensor suites would be supported by communication, data-processing equipment, and signal processing.

- ~~(S)~~ Acquisition. Passive, active, and semiactive acquisition modes are candidate implementations for conventional chemical rocket-boosted interceptors.

Hit-to-kill interceptors using [redacted] homing or homing on illumination by [redacted] designators appear promising. As in boost phase, tracking and pointing for designation can be based on technologies now under development.

- ~~(S)~~ Intercept. The long time line available for midcourse intercept substantially reduces the relative payoff for extremely high velocity delivery of kill energies, and the geometry of the problem provides a wide variety of locations for basing of weapons with certain fundamental advantages for basing in the continental United States (CONUS). CONUS-based chemically-propelled interceptors using hit-to-kill warheads would defend CONUS from a single launch site with burnout velocities of [redacted] If deployed in several distributed sites, these interceptors would provide two full tiers of midcourse intercepts (shoot-look-shoot) over all of CONUS. Forward basing these midcourse interceptors to the north would also provide engagement opportunities just after the reentry vehicles reach apogee. [redacted] As mentioned previously, high performance directed energy weapons may also have considerable potential during midcourse phase.

E. (U) TERMINAL PHASE

(U) Functional Needs

(S) Unlike previous stand-alone, terminal defense concepts focused on defending hardened silos, a terminal defense is sought which protects both urban/industrial and military targets against the residue of an attack that has been engaged in all previous phases of its trajectory. This requirement and the resulting concept are very different from past requirements and concepts that were limited to defense of land-based ICBMs against a heavy attack in the absence of either boost phase defense or midcourse defense. Additionally, a terminal defense element of a total strategic defense system could serve three separate but similar functions. It could provide the final layer in a defense-in-depth system, stand-alone defense against depressed trajectory SLBMs, and stand-alone capability for defense of Allies against shorter-range threats. We have assumed in this discussion that terminal defense needs are defined to exploit the significantly major increase in capability possible from the attrition and discrimination in the boost and midcourse elements of the system.

~~(S)~~ The driving requirements for the terminal tier of defense are a survivable and affordable system that can defend the entire United States. Defense of soft targets demands a keep-out altitude above which all RVs must be killed to prevent damage to soft targets. We have selected a [redacted] keep-out, which corresponds roughly to [redacted] overpressure on the ground from a [redacted] detonation. The need to provide this keep-out over the entire United States requires that the defense elements have large footprints, that is, the area defended must be large in order to limit the number of elements needed for full coverage. Electromagnetic pulse (EMP) hardening of the terminal defense system would be required. Blast and thermal hardening are also required for effects outside the [redacted] keep-out zone.

~~(S)~~ Finally, mobility of both the interceptor launchers and the supporting surveillance would be an important objective, not only to avoid the survivability problems of fixed defenses but also to provide flexibility in allocation of defense forces.

- ~~(S)~~ Surveillance. The basic functions of the surveillance supporting the terminal-phase system are to acquire and sort all objects that have leaked through early defense layers and to identify the remaining RVs. Such actions will be based, where possible, on handovers from the midcourse engagements. Terminal defense must maintain, as an autonomous final line of defense, a separate surveillance capability while being able to use previous track files (if they are available) for efficiency. The system must be able to use atmospheric filtering to discriminate against junk, that is, buses, tankage, RV deployment hardware, and the debris created by destruction of the attack in the late boost phase and midcourse flight. Although only a small fraction of the lethal RVs will reach the terminal tier intact, junk from the entire attack may arrive over the United States. Implied is a terminal tier that can filter out [redacted] To accomplish these functions, surveillance should detect arriving targets above about [redacted] and continue tracking through the [redacted] altitude regime where [redacted] can be used to discriminate. Precise measurement of the position of each object (to accuracies of a few hundred meters) is required just before the interceptor is committed.

- ~~(S)~~ Acquisition. In the 110 to 75 km altitude region, an interceptor must be committed to each threatening object and given data to perform a "space-point intercept", that is, it flies under inertial control to its assigned point in space; on arrival at that point, the interceptor acquires its target on its seeker and homes to kill its target. Homing accuracies depend on the warhead used. For kinetic energy mechanisms, in a homing time of about [redacted] after sensor acquisition at [redacted] the interceptor must be guided to the order of [redacted] accuracy for the warhead pellets to be delivered to the target. In order to correct the seeker-handover error in the very short time available, the homing vehicles must have good maneuver capability and very fast control system response.

- ~~(S)~~ Intercept. The interceptor must have very high acceleration and burnout velocity on the order of [redacted] For targets that require the interceptor to fly a considerable distance, the intercept will take place below [redacted] but not below the keep-out altitude of [redacted] The high velocity of the interceptor permits it to have a relatively large footprint (defended area) of about [redacted] and since intercepts are above cloud cover, a lightweight passive optical seeker can be used. Kinetic energy warheads will have adequate lethality provided that the miss distance can be kept low.

(U) Candidate Technologies

~~(S)~~ The technology requirements for a terminal defense system which can meet a limited threat are well defined and relatively mature as a result of the ongoing research program. Both target acquisition and tracking and interceptor/kill vehicle requirements have been analyzed extensively. The candidate technologies emerging from such studies are:

- ~~(S)~~ Surveillance. A well-defined concept uses an airborne optical sensor that would detect arriving reentry bodies using [redacted] sensors and initiate angle-only tracking on those above an established threshold. The [redacted] sensor must be located above the clouds on a continuously patrolling, high-altitude platform that can carry enough sensors to detect and track, redundantly, all credible objects. This sensor could provide data necessary for discrimination. A laser or radar would precisely measure the position of each object and refine its track just prior to handover to a ground-based terminal radar. The footprint of an airborne optical sensor would be much larger than that of the interceptor. A goal of the research program is an AOS with a range capability beyond [redacted] on a target having an emissivity area as small as [redacted] A coherent radar capable of very high range resolution could provide high endoatmospheric discrimination of sophisticated decoys. The radar could track and image objects designated by the airborne sensor prior to interceptor commitment. This type of very narrow-beam radar would be inherently very resistant to jamming.

- ~~(S)~~ Acquisition. In nonnuclear intercepts, [redacted] tracking and laser fuzing are candidates to perform the required functions. The high interceptor burnout velocity requires that the seeker be protected by a fairing during flyout. After the fairing is jettisoned, the seeker window must be cooled until the intercept is completed. For short-range intercepts, the burnout velocity must be limited by thrust termination.

- ~~(S)~~ Intercept. The leading candidate for a nonnuclear warhead is one that weighs on the order of [redacted] uses pellets for kill, and is [redacted]

F. (U) SPECIAL CONSIDERATIONS--SHORTER RANGE BALLISTIC MISSILES

~~(S)~~ Slower reentry speeds, greater angle of reentry, less MIRVing, fewer penetration aids, plus potentially low apogees of depressed trajectory SLBMs and IRBMs pose a different set of defense problems. It is possible these factors may provide offsetting advantages in defending against shorter-range systems. An orbital boost phase intercept system of high-brightness lasers designed for ICBM kill appears to have substantial capability as a first tier against the IRBM and SLBM threats. The low apogees associated with some of the shorter-range classes of IRBMs or with depressed SLBMs make midcourse intercept difficult. However, the limited geographical area threatened by IRBMs would enhance the effectiveness of the terminal defense laser.

~~(S)~~ Defense against tactical ballistic missiles (TBM) also requires special consideration. However, the elements of the terminal tier of a defense system against longer-range missiles could be adapted to anti-tactical ballistic missile (ATBM) systems.

CHAPTER VI

(U) CONSIDERATIONS IN DEFINING DEFENSE ARCHITECTURES

A. (U) THE DEFINITION PROCESS

(U) To answer some basic questions concerning the SDI it is necessary to understand the technical requirements, define the technology issues and identify the systems issues which need resolution through either ground test or simulation. To shed light on these issues it is necessary to perform systems concepts studies. Such studies are trade and sensitivity investigations across a number of system design options involving architectures of the components of ballistic missile defenses--the surveillance, weapons, C^3, etc. In studying the purpose of a system, one naturally has to investigate the missions to be satisfied, which, in turn, are a function of the threats confronting it and the military strategy within which the system is operating. The architecture study, which is in the preliminary stage, and the individual conceptual designs of the various components of the system architecture developed in the other Program Elements attempt to deal with these questions.

(U) The systems analysis process starts with the definition of a defense system architecture (Figure VI.1). This establishes the context within which various technologies may be integrated into a system that will achieve the SDI mission. Once a candidate defense system architecture is defined, the performance requirements of the defense subsystems may be established and through that process the SDI program requirements for developing those technologies may be determined. In establishing the defense subsystem performance requirements, various tactics and strategies on the part of the offense and defense must be evaluated. On the offensive side, special consideration must be given to defense suppression attacks, defense avoidance, etc. On the defensive side, emphasis must be placed on configuring the candidate defensive subsystems in a manner to optimize the overall performance of the defense.

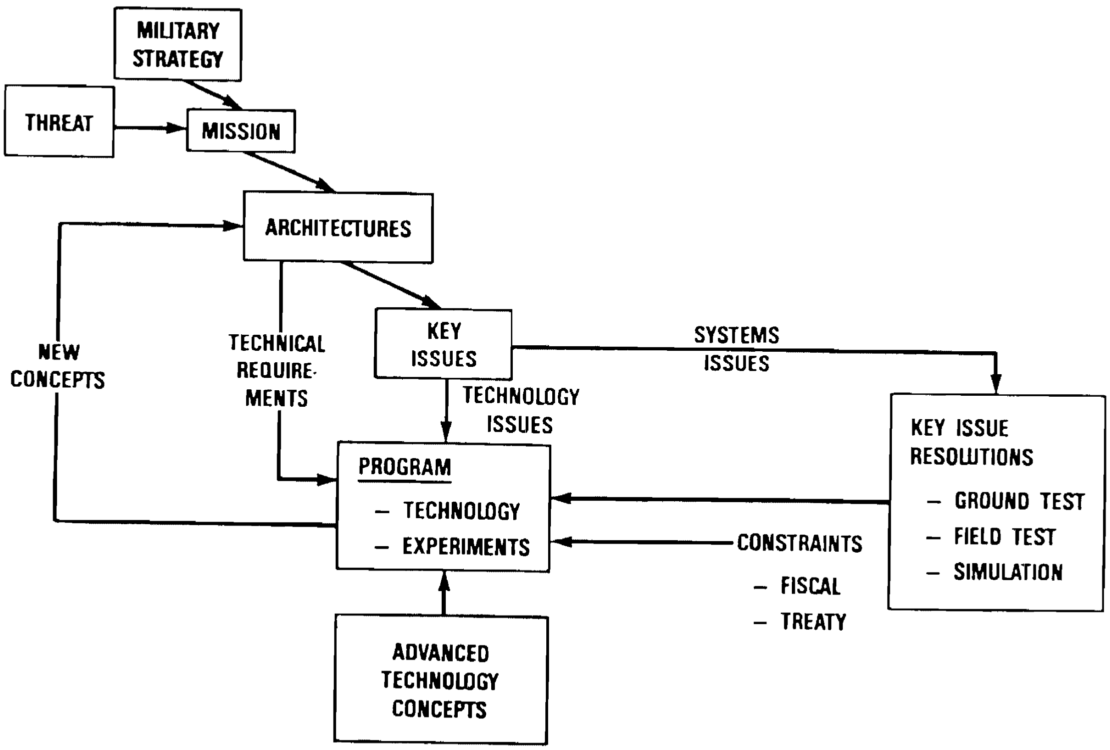

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Figure VI.1. (U) Systems Analysis and Program Requirements Process

(U) The analysis of the effectiveness of a candidate defense architecture leads to a definition of the technical requirements of the subsystems comprising the architecture and the identification of key issues that must be resolved to make that architecture viable. These key issues may be technology related or systems related, and their resolution is accomplished by some combination of ground test, field test, and simulation. The SDI, which combines research in relevant technology areas with selected experiments, must be structured to satisfy the technical performance requirements established by the architectures and resolve the identified key issues. This must be achieved within the programmatic, fiscal, and treaty constraints, and on a schedule compatible with a decision in the early 1990s whether to proceed to system development.

(U) An important objective of the SDI is the pursuit of several candidate architecture options and the promotion of advanced technology concepts which could form the basis for new architectural options.

B. (U) ARCHITECTURE CLASSES

~~(S)~~ Most architectures which have received serious attention during Phase I of the System Architecture Studies, including all thirty-odd architectures recommended by the study contractors, drew elements from three general, but not mutually exclusive, classes. First, architectures using space-based assets provide rapid access to the early phases of the threat trajectory and thus provide the defense with as many opportunities as possible to engage the threat. Hence these defenses tend to be robust, flexible and effective. A wide variety of space-based weapons and sensors were considered in the architecture studies, and architectures including space-based kinetic kill vehicles were recommended by all the architecture contractors. A critical issue associated with this architecture class is survivability.

~~(S)~~ Second, while likely to be less effective and flexible against large offensive threats, ground-based assets may have some advantages in survivability over space-based assets, though this is by no means certain. Ground-based assets also might be cheaper and easier to maintain. CONUS- or forward-basing may provide the ground-based system with effective access to the midcourse phase just after apogee of the trajectory and offer repeated attack through the midcourse phase. Access to earlier trajectory phases, which would be required for effective defenses against moderate to large threats, may be possible using pop-up directed energy weapons that deliver their energy at or near the speed-of-light. It should be noted that most defense architectures considered in SDI incorporate both space-based and ground-based elements.

~~(S)~~ Finally, defense against shorter-range ballistic missiles that threaten our Allies, an essential requirement of the Strategic Defense Initiative, has such unique constraints imposed by the threat trajectories as to warrant separate attention. The utility of space-based assets is diminished due to shorter burn times and shorter, lower trajectories of certain ballistic missile threats. But this might be offset to a degree by lower numerical threats and more extended time periods for [redacted] use in Allied defense situations. It is also likely that the characteristics of elements which can address the shorter range threat may be different from those of elements designed to face a threat to the continental United States (CONUS). This architecture class has characteristics which are unique. For example, the sequential operation of the various elements of the defense, typical of the first and second classes of architectures, may not be usable against all shorter-range threats. Instead, various types of parallel operations, taking maximum advantage of the small battle-space, may likely find utility in this architecture class.

C. (U) EXAMPLE ARCHITECTURES

(U) Nonnuclear Ground- and Space-Based Architecture

(U) Figure VI.2 describes this particular architecture class which uses a space-based directed energy weapon (DEW) as a discriminator.

~~(S)~~ System alert is provided by one or more of a small number of boost-surveillance satellites in high altitude orbit. These can provide initial boost track if they can be well enough protected against defense suppression attacks, but may otherwise have to be relegated to a purely alerting role. The space surveillance satellite provides the essential acquisition, tracking, and discrimination functions. These satellites must be located, proliferated and defended so as to make their function survive a defense suppression attack. This requirement suggests a high altitude basing. The need to view the depressed trajectory intercontinental and submarine-launched ballistic missile (ICBM and SLBM) threats (without looking too close to the hard earth) requires low altitude basing. It currently appears that basing a multi-spectral sensor at approximately [redacted] meets these requirements. Space-based System Architectures consist of mixtures of these sensors.

~~(S)~~ Space-based kinetic kill vehicles (SBKKVs) can engage the threat in the boost, post-boost or midcourse phases of its trajectory. The kill vehicles are required to attack substantially all of the boosters or to attack substantially all of the reentry vehicles (RVs) in midcourse if these were unaccompanied by large numbers of penetration aids. The kill vehicles are dispersed over many platforms to counter defense suppression attacks, such as ground-launched, direct-ascent ASATs. They must also defend themselves and other space assets from potential ground-and space-based threats.

~~(S)~~ In addition to defense suppression, a responsive offense can shorten the burntime of the ballistic missile booster or

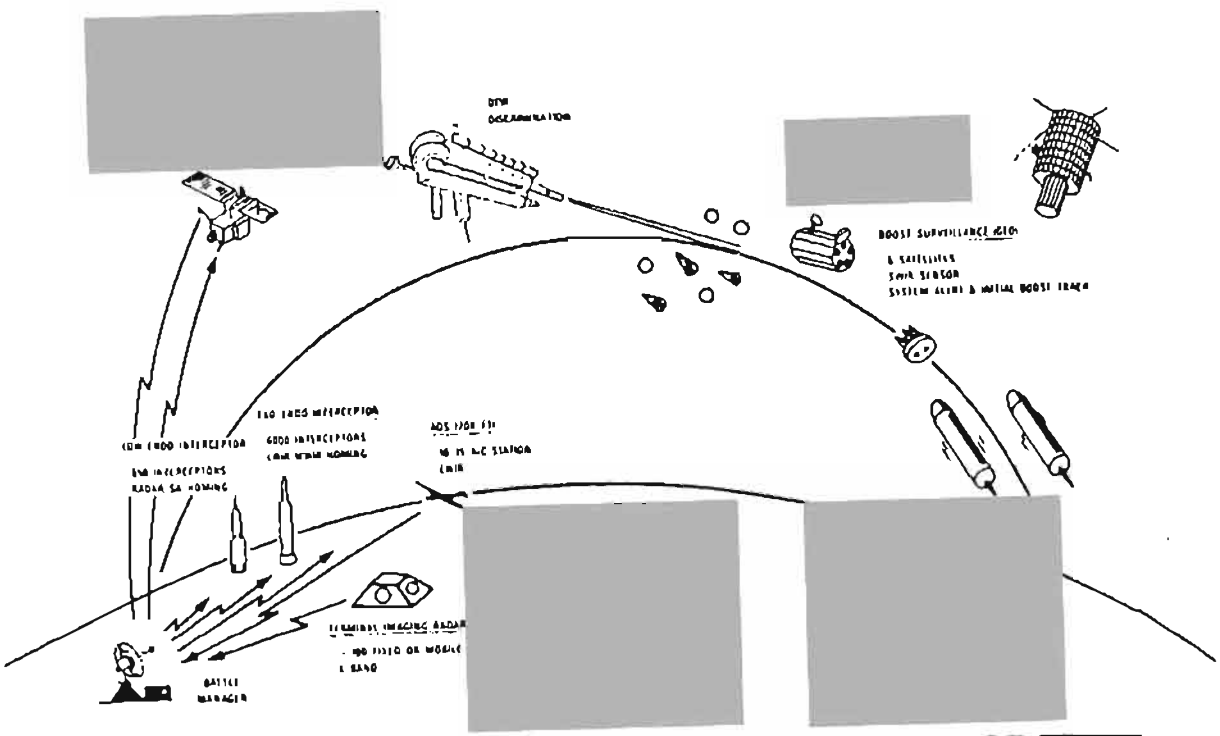

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Figure VI.2. (U) An Example of a Nonnuclear Ground- and Space-Based Architecture (DEW Discrimination) depress the trajectory to diminish the effectiveness of kinetic kill vehicles in the boost or post-boost phases and can proliferate penetration aids to attempt to overwhelm the defense during the midcourse phase. The desirability of achieving high confidence in effective midcourse discrimination has led to consideration of directed energy weapons (or even kinetic means) to modify the behavior or signature of the penetration aids and thereby identify them. The neutral particle beam is a promising device to engage in this interactive or intrusive discrimination, as are lasers of various types.

~~(S)~~ To achieve the low leakages, a terminal defense must effectively engage the RVs expected to leak through the space-based and midcourse engagement regimes. Two types of ground-based interceptors are envisioned for this purpose. One would operate against the threat in the exoatmospheric and high endoatmospheric regimes, [redacted] homing sensors, and the other would operate in the mid to lower endoatmospheric regime and typically use a radar semi-active or active homing sensor. Estimates of required inventory levels are shown. Airborne [redacted] platforms and terminal imaging radars are the sensors envisioned for operation of the terminal defense tiers.

~~(S)~~ The boost phase effectiveness of a near-term space-based kinetic kill vehicle (SBKKV) defense system may be augmented by adding directed energy weapons to the architecture to deal with offensive responses that shorten the engagement time available during the boost phase (Figure VI.3). Among the directed energy weapons, some high energy lasers have the advantage of being able to counter threats before they reach space, thereby increasing engagement time. Two alternative versions are shown, a space-based laser and a ground-based laser using space-based relay and fighting mirrors. In either case, the number of space-based DEW elements required is small. This would allow the offense to concentrate an attack on those assets in an attempt to destroy the

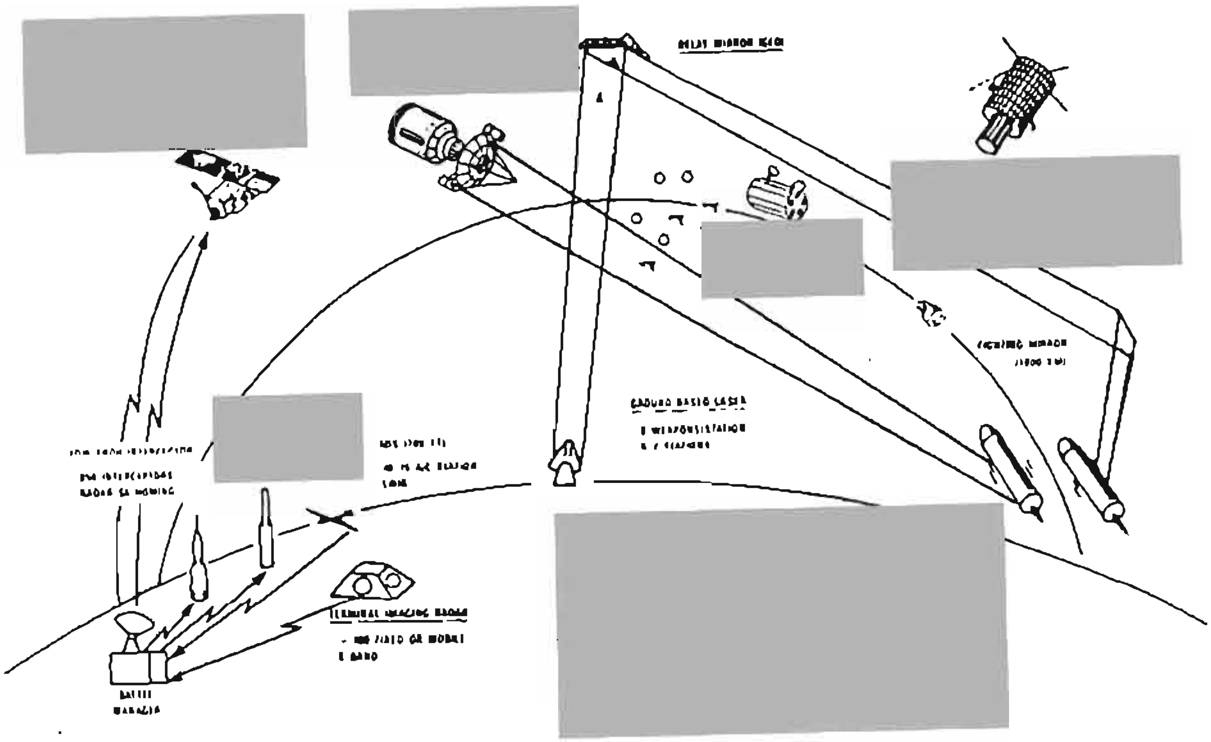

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Figure VI.3. (U) An Example of a Nonnuclear Ground- and Space-Based Architecture (Weapon DEW) boost phase defense capability of the system. The space-based kinetic kill vehicles play a critical role in protecting these space assets. When used in combination with the lasers themselves for self-defense, they constitute a formidable defense. The offense would have to pay a very high price to attempt to destroy it.

~~(S)~~ The brightness levels of the lasers required to achieve booster and post-boost vehicle (PBV) kill are more substantial than the levels required for performing the midcourse discrimination function described previously.

~~(S)~~ More detailed trade-off studies between space-based and ground-based laser weapons, especially in relation to survivability, have yet to be carried out.

(U) Ground-Based Weapons Architecture

~~(S)~~ The second architecture class of interest is one that considers ground-based assets consisting largely of midcourse and terminal kinetic energy weapons with a small number of surveillance satellites (Figure VI.4). The satellites would be used to provide early warning of offensive missiles detected in their boost phase. As previously pointed out, this class is being examined because it would rely on active defense elements not deployed in space and could be effective in cases where the offense is limited.

~~(S)~~ The midcourse tier of this class of systems, in the absence of space surveillance and tracking satellites, would employ high altitude probes to initiate exoatmospheric engagements at long range. The remaining components and terminal tier function are similar to the first architecture class. That is, the same airborne optical system (AOS), terminal imaging radar and interceptors are used, although they must be deployed in larger quantities to compensate for the large number of engagements that a SBKKV would have provided.

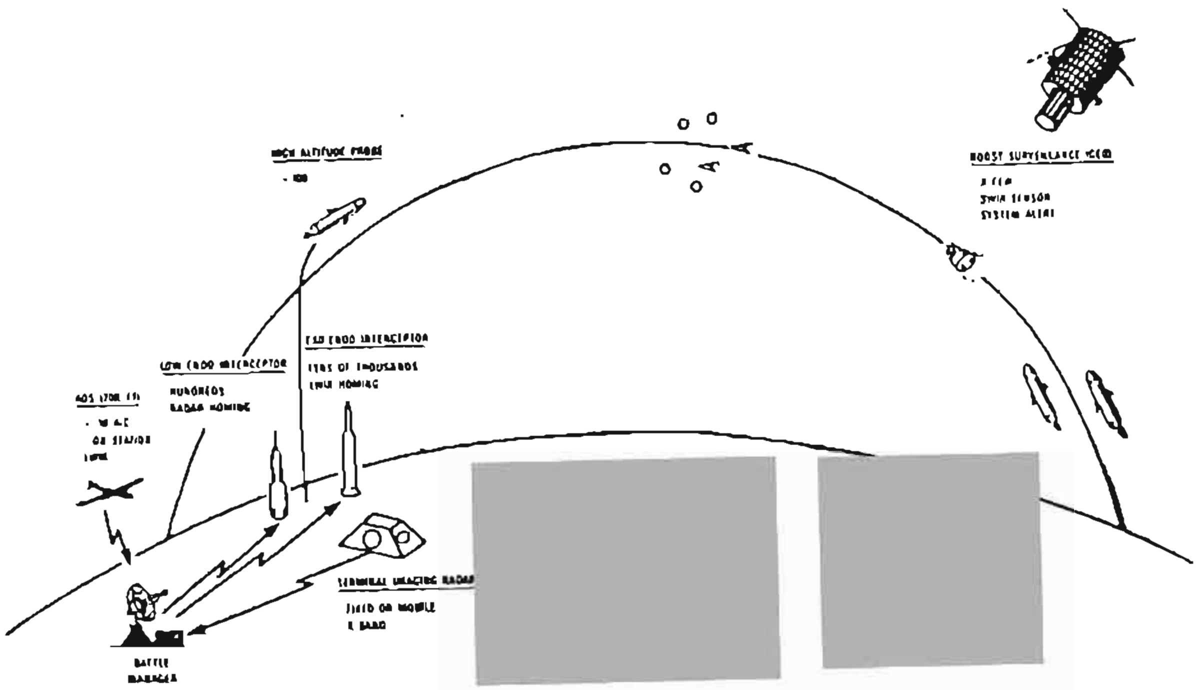

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Figure VI.4. (U) Ground-Based KEW Architecture

~~(S)~~ Recent technological developments show that DEW devices may be able to add performance growth potential to this all ground-based architecture by adding capability against earlier phases of the ballistic missile trajectory and beefing up the midcourse intercept capability. There is the prospect of being able to build DEW devices of considerably increased brightness.

~~(S)~~ Pop-up DEW such as a particle beam weapon might be able to assist in greatly alleviating the midcourse problem through effective discrimination by attacking (and destroying) penetration aids in their midcourse. With this substantial assistance, this class becomes a much more viable candidate in moderate threat levels.

~~(S)~~ The focus of the SDI research program is still non-nuclear; however, another option in this class might be the use of [redacted] With appropriate basing modes, [redacted] and pop-up DEW devices could be used to engage some boosters before burnout and PBVs early in their bus deployment phase. [redacted] could also be used to illuminate the entire decoy swarm. These interactive discrimination techniques could assist substantially in the midcourse defense tier.

~~(S)~~ Recent experiments on very high velocity [redacted] kinetic energy particles indicate that hypervelocity particles also may have promise as part of a strategic defense in this class. Particles travelling at such velocities could be used for attacking discrete missiles in their boost, post-boost and midcourse phases. Particles moving at very high velocities could have a mass much smaller than SBKKVs and achieve destruction of the target upon impact.

(U) <u>Defense Architecture to Counter Shorter-Range Threats</u>

~~(S)~~ The third architecture class addresses defense concepts in which the U.S. and its Allies are protected with existing and supplementary new deployments to provide coverage against shorter range threats comprised of SS-20s, SS-21s, SS-12/22s, SS-23s and SLBMs (Figure VI.5). Although the nature of the threat to all our Allies is being considered, the NATO-European theater was used to set the requirements.

(U) Unique architectural requirements for such a defense are determined by the different threat characteristics, the targets implicit in the mission(s) and the target value and geographic distributions.

~~(S)~~ The space-based early warning and surveillance systems play a key role in timely warning, track and support for the defense against most shorter range ballistic missiles. In addition, since the threat is much smaller, space-based kinetic kill weapons deployed for CONUS defense can be made available as needed, although the details of their use are scenario dependent.

[redacted]

~~(S)~~ The short ranges and abbreviated times of these engagements require additional fast acting tiers and shoot-look-shoot tactics on the part of ground-based defenses in order to achieve low leakage rates. One of the tiers will be able to use long-range exoatmospheric and endoatmospheric interceptors. The other must be deployed near the forward edge of defended regions exposed to SS-21s or shortened range SS-23s. A possible dual-mode interceptor capable of engaging these threats as well as air-breathing cruise missile threats is shown. While the exoatmospheric/endoatmospheric tier works most efficiently with infrared homing, the low-endoatmospheric tier works best with high frequency, semi-active radar homing. An airborne fire-control component is desirable to maximize the line-of-sight coverage, engagement performance and kill assessment for these engagements.

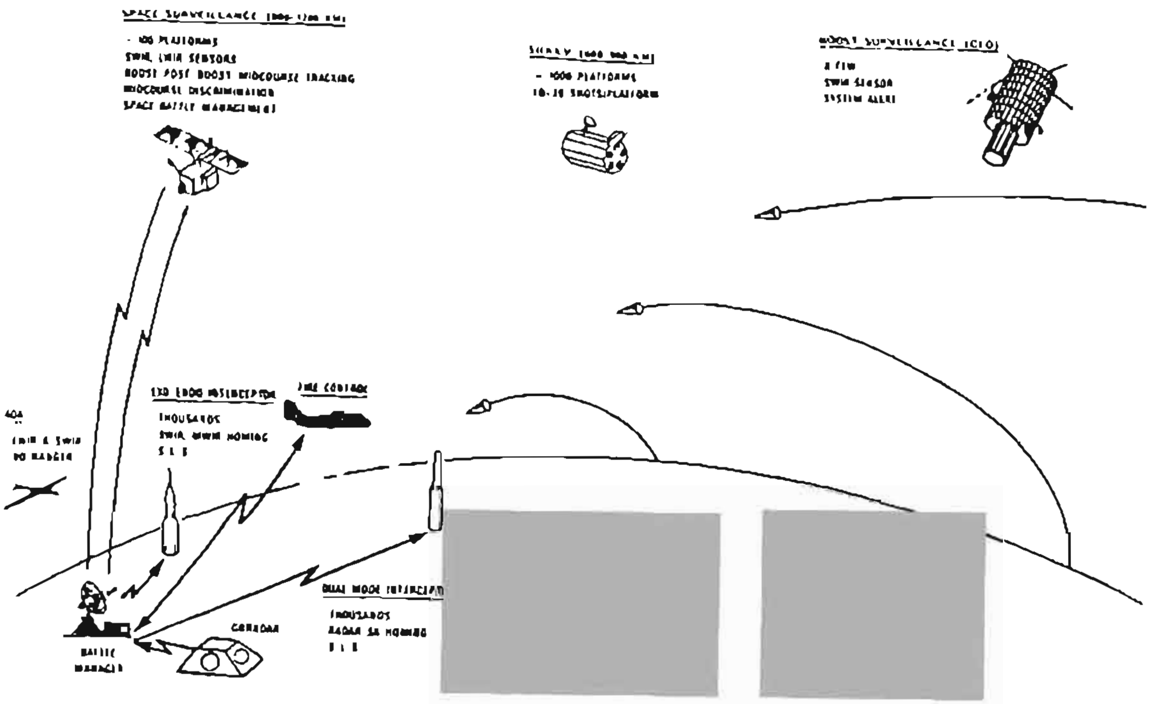

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Figure VI.5. (U) Defense Architecture to Counter Shorter-Range Threats

~~(S)~~ The dual-mode defense systems, which are capable of intercepting short-range ballistic missiles as well as cruise missiles, will drive the requirements for some of the deployed elements such as the AOS, airborne fire-control radar and ground-based radar. Dual-mode capability provides inherent leverage against threat tactics which could exploit and overwhelm single-mode defensive systems capable only of anti-tactical ballistic missile defenses or air-defense systems.

D. (U) KEY OBSERVATIONS

(U) General

~~(S)~~ The defense would benefit from the synergism resulting from multitier configurations. Boost and post-boost defenses facilitate the midcourse defense by removing a high proportion of the large MIRVed missiles from the threat environment and the traffic that otherwise would be encountered in midcourse. In addition, the boost phase defense forces the offense to deploy the RVs and penetration aids rapidly or run the risk of being intercepted before deployment is completed. This may facilitate the discrimination problem.

~~(S)~~ Similarly, midcourse defense can engage RVs that may either have been deployed early from a fast burn booster, or depressed trajectory, or may otherwise have been discriminated from accompanying penetration aids. Finally, terminal defense provides further reduction on overall defense system leakage and plays a critical role in the defense against depressed SLBM trajectories.

~~(S)~~ In some respects, terminal defenses are defenses of last resort. They may have design requirements based not on the fact that they are the last tier in a multitier defense system, but rather on the fact that they may be needed as a defensive system against specialized threats that other tiers in the system cannot address.

~~(S)~~ A defense system configured to operate in the limited battle space available in the late midcourse through terminal regions will only be able to accommodate a limited number of independent tiers. As a result, the ability to achieve low leakage with such a defense will be limited. This may be adequate for limited threats. However, it would not provide the very low leakage required for significant protection of U.S. and Allied societies from particularly large threats in the unlikely event deterrence might fail.

(U) Discrimination

~~(S)~~ Good exoatmospheric discrimination, especially against large numbers of [redacted] is essential to effective midcourse defenses. [redacted]

(U) A midcourse defense with good discrimination can offset the benefit an attacker would gain from fast-burn missiles. Fast-burn boosters are expected to have fewer RVs and penetration aids. Inexpensive ground-based midcourse interceptors could be proliferated to offset poor discrimination performance against heavy precision decoys.

~~(C)~~ Active laser or radar sensors that can measure body dynamics, size, and shape of objects during and after deployment appear to offer the best sensor-based solution for discrimination of responsive penetration aids. Discrimination by perturbation or kill of penetration aids with directed energy weapons offers the potential for a reliable backup to sensor-based discrimination, but requires a significant number of high-power directed energy weapons with very fast retarget times. Discrimination by neutral particle beams also requires a large number of adjunct radiation detection sensors in space. Furthermore, the kill of RVs surrounded by [redacted] would require either

(1) an area kill interceptor warhead or (2) removal of [redacted] by either a directed energy weapon or a preliminary intercept before intercept of the RV.

~~(S)~~ The SDIO is not convinced that the use of active laser/radar for precise measurement of object dynamics will meet all the requirements of discrimination of RVs from decoys. The prospect of interactive discrimination with high energy sweeper devices can impact the decoys by applying sufficient amounts of energy -[redacted] and a little energy can "go a long way". The problem is to find ways to expeditiously and inexpensively apply energy against objects (decoys and RVs) and measure observed signature changes of the affected objects. Thus, by "beating the penetration aids" the problem faced by the sensors can be simplified, which is a desirable goal.

(U) <u>Survivability</u>

(U) Assuming no change in Soviet goals and military doctrine, there may be a strong motivation for them to attempt to suppress U.S. strategic defense systems and to attempt to restore the effectiveness of their ballistic missile forces. The defense, in turn, must be designed to operate in any plausible environment the Soviets may create with countermeasures and still be assured of achieving required defense mission objectives.

~~(S)~~ Survivability of the defense against the suppression threat must be intrinsic to the design of the defense. Space-based defense components may be made to survive an intense ground-based, direct-ascent ASAT attack by a combination of platform hardening, maneuver, preferential self-defense and use of a highly distributed configuration of space assets. The survivability of space assets against high-brightness directed energy weapons may be enhanced by the use of advanced shields capable of withstanding multiple engagements of those weapons, combined with active countermeasures such as shoot-back, electronic warfare, and decoys. The Survivability Project, covered in Section VII.F is pursuing the critical survivability technologies and assisting the Systems Architect in performing the key trade studies necessary to make informed decisions on strategic defenses.

~~(S)~~ Special survivability problems are encountered if both the U.S. and Soviets simultaneously occupy space with an effective strategic defense system. Nonetheless, there do appear to be possible technical options in this case.

~~(S)~~ Consideration must also be given to the survivability of ground-based (mobile) and air-based defensive subsystems. These assets are potentially vulnerable to air attacks and sabotage and require redundancy, air defenses, ballistic missile defense (BMD) protection, dispersion of air bases, establishment of keepout zones, and physical protection against sabotage, which may be a serious problem. Special security protection measures will have to be taken to mitigate this danger.

(U) Space Logistics

(U) Several strategies may be considered for optimizing the SDI system design and configuration with respect to logistics, producibility and cost. One of the major costs of the overall SDI system, when configured with a robust space-based capability, is the launch cost associated with the initial system deployment. Another is the cost associated with the maintenance and replacement functions that will be required to maintain continuous operation.

(U) The development of very large, integrated launch vehicles capable of lifting 200 MT (Metric tonnes) into orbit appear to be unjustified unless substantial numbers of very large, integrated space assets are intended for launch. If on-orbit maintenance is considered, assembly in orbit from the payload of two 90 MT launch vehicles may be cheaper. The recovery and servicing options could make use of advanced technology in fully reusable launchers with a 70 MT capability for recovery operations and a 15 MT capability for performing on-orbit servicing.

(U) Production and Cost

(U) Reducing the production costs for space platforms, weapons, and sensors and for the large number of midcourse interceptors offers the greatest potential for improving the affordability of multilayer defenses. The existing cost ~~data~~ base for military space systems is derived from experience with programs in which small numbers of satellites, often of new design and at the leading edge of technology, are produced and tested largely by hand. A new way of producing space components that takes advantage of new technologies, new designs for producibility, more automated manufacturing techniques, and economies of scale is needed to significantly reduce space system costs.

(U) New cost models are needed to price the new designs and methodologies for high efficiency, high volume and low cost production of components for the defense systems. Current models are poor, because they are based on quite different ground rules, as noted above.

(U) Battle Management/Command, Control, and Communications (BM/C^3)

(U) The state-of-the-art in computer hardware is advancing very rapidly. It is expected that the requirements for the SDI procesing can be met in the early 1990s with radiation hardened processors. A strategy to emphasize processor hardware solutions rather than software solutions appears to offer potentially high payoff, especially when designed into the system architecture.

(U) Design simplicity and modularity result in simplified and more effective software development. Software modularity is the characteristic which allows the use of the same or derivative software in multiple applications. Modularity and simplicity also aid the development of reliable and fault-tolerant software.

(U) The initial space-based architecture led to a highly proliferated, distributed BM/C^3 architecture containing no identifiable critical nodes. This was to enhance survivability of the BM/C^3 function and to provide effective command and control of a globally distributed configuration of weapon and sensor platforms. Decentralizing BM/C^3 architecture and reducing interdependence results in a more resiliant system.

(U) Timely weapon release of the SDI defense system is important, especially for boost phase defenses under ASAT attack. Hence, special attention has to be paid to the interfaces between man and machine.

CHAPTER VII

(U) THE TECHNICAL CHALLENGE

A. (U) OVERVIEW

(U) Three years have passed since the President announced his defense initiative and called for an intensive and comprehensive effort to define a long term program. His confidence that it was time to pursue such a program was based on two major assumptions. First, that technology had reached a point that showed great promise, and secondly that the nation had the technological potential to bring the promise to reality.

(U) Building upon the foundation spelled out in the Fletcher Report, a sound technical program was defined and put into action, even though the SDIO had only been in existence in sufficient strength for little more than a year. Technical efforts have been structured into five program elements, each element examining equally crucial SDI technology. The material in this chapter is organized to describe each program element and the progress that has been made to date. A discussion of the major focus for FY 1987 and plans for the future including major milestones is also included. Detailed descriptions of these programs can be found in the FY 1987 Descriptive Summaries submitted to the Congress in February 1986.

(U) Recognizing the importance of innovation, the SDIO has organized an activity, in addition to the five program elements, to promote inventive ideas. A fixed fraction of each program element is set aside to fund promising concepts. Work on promising concepts is characterized by high risk, high payoff, low cost research that can be performed anywhere (laboratories, small business, industry, universities) and by anyone. The work involves unclassified fundamental research, and its results, once evaluated, will help create new opportunities for all the other program elements.

(U) The technical program has been organized to support future decisions on defensive options. To do this, diverse efforts producing essential answers to critical issues must converge. Among the more important critical issues requiring resolution to be recently identified are:

- (U) The need for "smart" high speed kinetic kill projectiles. That type of projectile will help assure the viability of a kinetic energy alternative for boost phase kill;
- (U) Good "windows" in the high-endoatmospheric regime and good discrimination for exoatmospheric interceptors;
- (U) Hypervelocity, repetitively-pulsed rail guns with "smart" bullets;
- (U) Active discrimination using RADAR and/or LADAR and interactive discriminators using lasers and neutral beams;
- (U) Hardening of passive sensors to hostile environments;
- (U) Booster "hardbody" identification in the presence of the rocket's "plume";
- (U) High brightness lasers, particle beams, and nuclear-driven technology for boost-phase intercept against "responsive" threats;
- (U) Battle management/C^3 software and hardware including a simulation and testing ground facility;

- (U) Survivability and countermeasure work by systems technologists;

- (U) Lethality experiments carried out at levels characteristic of realistic weapons on realistic targets.

- (U) Space-based power supplies and power conditioning equipment; and

- (U) Reduction in space transportation costs.

(U) Due to the complexity of the SDIO's research program, a number of issues must be resolved before a decision can be made to proceed to the development phase. The discussion in this chapter on the various accomplishments each facet of the program has made in the last several years points out that the answers to these issues are beginning to emerge.

(U) Typically, as a given technology matures, new questions arise as old ones are answered. Sometimes the more mature technologies appear less promising than other less well researched technologies that have not, as yet, encountered the tougher questions. Care has to be taken to avoid being overly critical of concepts well along in research or expecting too much from those not yet put to the test. The SDIO program as described in the following sections is designed to bring along the emerging technologies in a logical, timely way--that is the technical challenge.

B. (U) SURVEILLANCE, ACQUISITION, TRACKING AND KILL ASSESSMENT (SATKA) PROGRAM

(U) Technical Objectives - The Role of SATKA in the SDI

(U) The SATKA Program provides the research efforts necessary to identify and validate the various sensor concepts for performing surveillance, acquisition, tracking, discrimination and kill assessment of enemy ballistic missiles from launch to warhead reentry and detonation (birth-to-death). There are three basic sensor suites to accomplish these functions.

- (U) Rocket launch detection sensors that sense the initiation of the attack and provide the initial tracking data to assess the attack, bring boost phase interceptors to bear, and provide data to assist in kill assessment.

- (U) Midcourse surveillance and discrimination sensors that track the reentry vehicles, decoys, chaff and other debris that constitute the threat cloud released at the end of the boost phase. Sensors that provide data that can help discriminate decoys, chaff, and debris from the reentry vehicles carrying the warheads, provide the predicted positions of targets to bring the midcourse intercept weapons to bear, and assist in kill assessment.

- (U) Terminal phase surveillance that can--in the few tens of seconds it takes for the attacking warhead to enter the atmosphere and detonate--acquire, track, and collect data on the behavior of reentering objects in the atmosphere to support discrimination and predict intercept points and assess kills.

~~(S)~~ In the boost phase, sensors must provide rapid and reliable warning of attack as soon after launch as possible. This requires reliable full-time surveillance of ballistic missile launch areas (potentially worldwide) to detect an attack and define its location, order of battle, and intensity as a function of time; determine likely targeted areas for confident initiation of the battle; and provide track data for continuous hand-off to boost-phase intercept and post-boost (PBV) vehicle tracking systems. The sensors must also be capable of assessing the kill effectiveness of U.S. defensive intercept systems. One such concept is the Boost Surveillance and Tracking System (BSTS) shown in Figure VII.B.1. It must be highly survivable to direct attack during the battle and endure after the battle is finished, since this function is essential for warning, assessment, and handover to other defense elements.

~~(S)~~ In the post-boost and midcourse phase, sensors must provide accurate and efficient tracking and discrimination between reentry vehicles (RVs) and lightweight penetration aids and other debris. Midcourse surveillance systems must be capable of accepting track files from boost phase surveillance and provide track data for hand-off to post-boost and midcourse inteceptors as well as terminal phase tracking systems. One such concept is the Space Surveillance and Tracking System (SSTS) shown in Figure VII.B.2. This concept envisions 50 to 100 platforms in low earth orbit. Their long and short wavelength infrared sensors provide passive tracking of the cold reentry vehicles, decoys and debris as they travel through space on ballistic trajectories.

~~(S)~~ The current U.S. space surveillance network, the Space Detection and Tracking Systems (SPADATS), [redacted] The SSTS would provide a near real-time, fully responsive space-based system

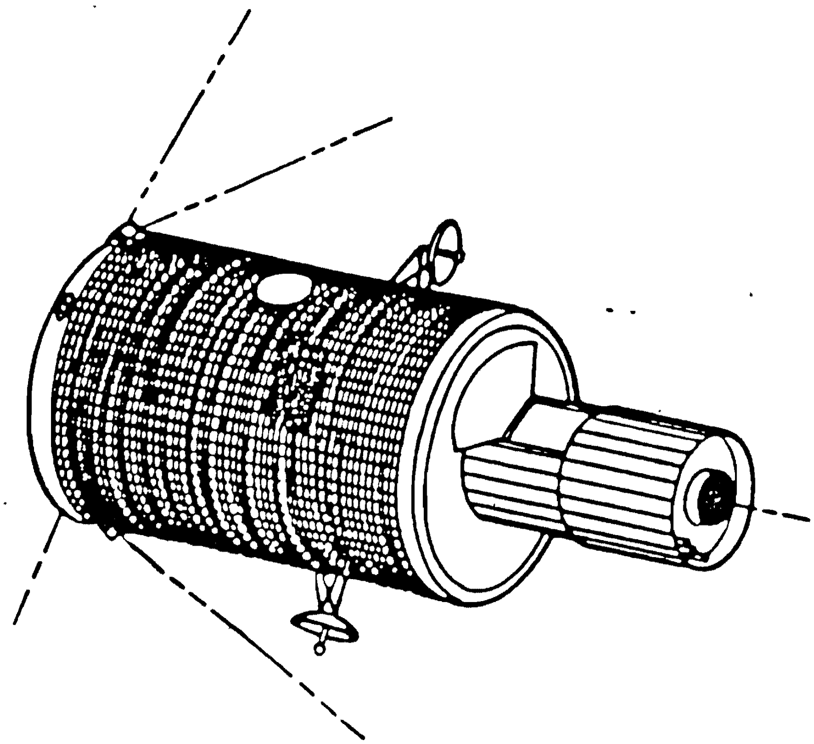

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Figure VII.B.1. (U) Boost Surveillance and Tracking System (BSTS)

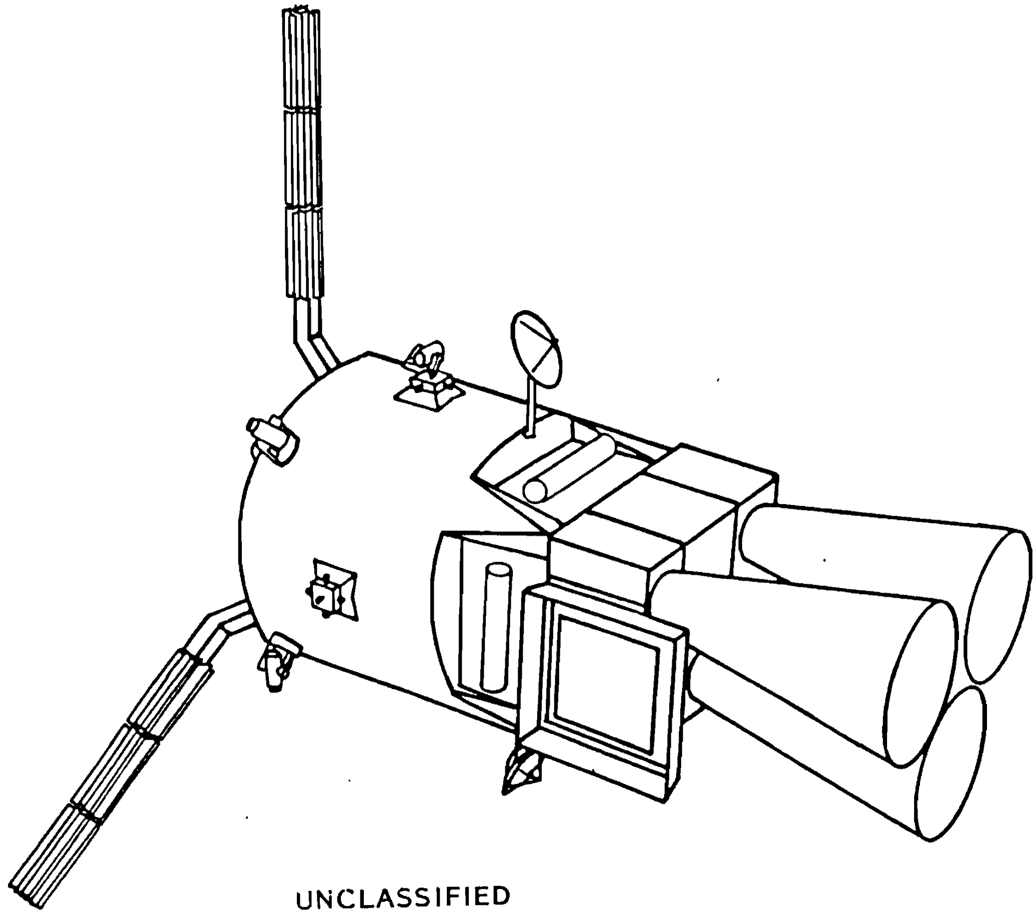

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Figure VII.B.2. (U) Space Surveillance and Tracking System (SSTS) for midcourse ballistic missile surveillance and tracking, and timely satellite attack warning and verification. Such a space-based system provides reduced dependence on overseas-based sensors for space surveillance with increased survivability and endurance.

~~(S)~~ In the terminal phase, sensors must provide efficient tracking and discrimination of RVs from penetration aids and other debris based on radiometric and ballistic information. Systems must be capable of receiving track information from midcourse sensors, tracking the target, processing the data, and passing commands to intercept vehicles. Two interactive concepts are being pursued.

~~(S)~~ The Airborne Optical Surveillance concept is shown in Figure VII.B.3. It is an aircraft-based, late midcourse and terminal phase acquisition, tracking and discrimination system capable of hand-off to a ground-based surveillance system for terminal intercept. Such a sensor system would have the wide field-of-view and high resolution essential for late midcourse and terminal phase detection, discrimination, and designation of ballistic missile reentry vehicles in conjunction with a ground-based, imaging radar. The concept is envisioned as employing long endurance, unmanned, high altitude aircraft.

~~(S)~~ The Terminal Imaging Radar could take the handover from an Airborne Optical Surveillance system and provide precision track information for high endoatmospheric terminal phase engagements of the most threatening objects. Unconstrained by aircraft weight and volume considerations, the ground-based radar could handle many more objects and can provide precise metric track data which minimizes the need for inflight maneuvers by the interceptor. The concept, which could also provide kill assessment and retargeting capability over a large area of terminal phase coverage, is depicted in Figure VII.B.4.

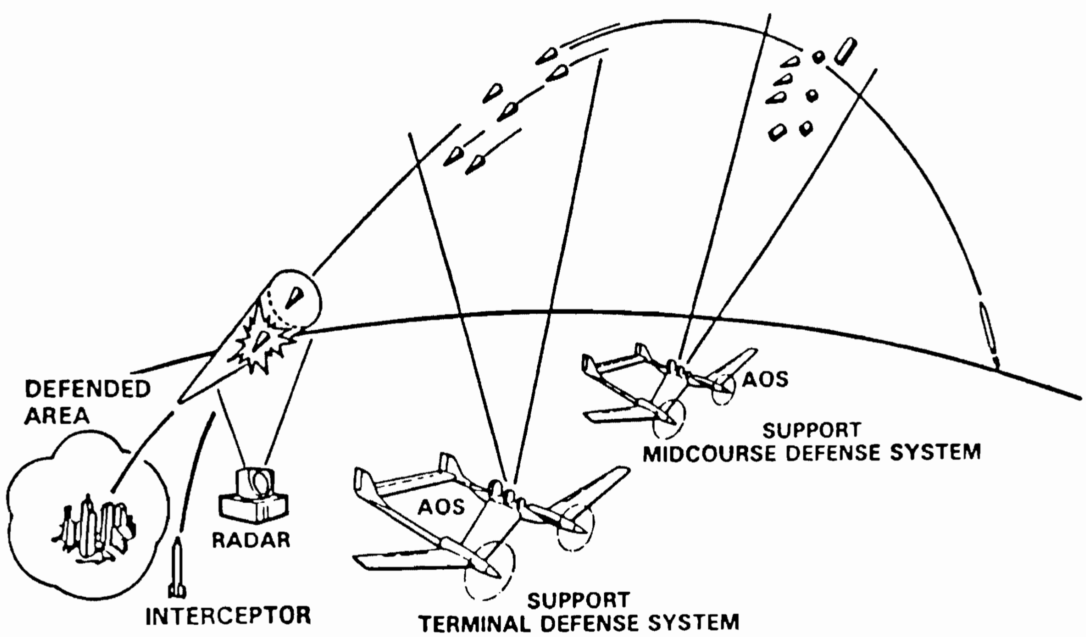

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Figure VII.B.3. (U) Airborne Optical Surveillance (AOS) Concept

(U) Significant Accomplishments (FY 1984-1985).

(U) Technologies

- ~~(S)~~ In the area of [redacted] sensors, [redacted] have been developed that are undergoing life testing that should increase sensor performance against [redacted] targets and should help reduce system costs. [redacted] component tests validated a new [redacted] sensor as superior to conventional sensors for survivable SDI surveillance systems.

- ~~(S)~~ In the area of large optics technology, two large, actively controlled, aspheric mirror panels have been edge matched and figure controlled.

- ~~(S)~~ Several high power, radar transmit/receive modules have been designed and built for [redacted] operation. The SDI Radar Discrimination Study has been completed.

- (U) In the area of signal processing, GaAs pilot production lines are now operational. A five node prototype Advanced Distributed Onboard Processor (ADOP) was delivered and installed at the Advanced Research Institute, Huntsville, AL.

- ~~(S)~~ In the area of interactive discrimination, analyses and laboratory tests have been completed that show the preliminary feasibility of using lasers and neutral particle beams as discrimination probes.

(U) Experiments

- (U) Requirements definition for Boost Surveillance and Tracking System (BSTS) and Space Surveillance and Tracking System (SSTS) have been completed.

- (U) Fabrication of Airborne Optical Adjunct (AOA) experimental hardware has been initiated.

- (U) Concept definition for Airborne Optical Surveillance Experiment and the Laser Ranger have been initiated.

- (U) Preliminary design contracts for Terminal Imaging Radar (TIR) have been initiated.

(U) <u>Measurements</u>

- (U) A rocketborne earthlimb viewing auroral experiment called SPIRIT I was completed and sent to Alaska.

- (S) In the area of [redacted] data collection system was completed.

- ~~(S)~~ In the area of optical discrimination, [redacted] Optical and Radar Effects codes for [redacted] emissions were developed. [redacted] and accepted. Primary mirror reflectance properties exceeded specifications by an order of magnitude. Laboratory measurements on [redacted] have been completed and analyzed to reduce Nuclear Effect code uncertainties. Successful joint SDIO/NASA Kuiper aircraft measurement programs provided UV and IR images [redacted] of high altitude third stage separations and plumes.

(U) <u>An Overview of the SATKA Program</u>

(U) In order to accomplish the stated technical objectives and to provide confidence necessary for an early 1990s decision, the SATKA Program has been structured with three basic thrusts: technology development, experiments, and ~~data~~ collection.

- (U) Technology Development. The SATKA Program performing research in those areas of the technology base which support the very high capability sensors required by SDI. These efforts are concentrated in five areas: Radar Technology (Project 3); Laser Radar Technology (Project 4); IR Sensor Technology (Project 5); Interactive Discrimination (Project 10); and Signal Processing Technologies (Project 11).

- (U) Experiments. The SATKA Program contains a number of experiments designed to validate the various concepts which have been proposed. Advanced sensor technology efforts determine the capabilities of such sensors and provide data necessary for future decisions. These include Boost Surveillance and Tracking Experiment (Project 6), Space Surveillance and Tracking Experiment (Project 7), Optical Airborne Surveillance Experiment (Project 8), and Terminal Imaging Radar (TIR) Experiment (Project 9).

- ~~(S/NF~~ [redacted]

C. (U) DIRECTED ENERGY WEAPONS (DEW) TECHNOLOGY PROGRAM

(U) Technical Objectives - The Role of Directed Energy in SDI

(U) The Directed Energy Program identifies and validates the technology for directed energy systems that can:

- (U) Destroy large numbers of enemy boosters and post-boost vehicles in the tens to a few hundreds of seconds that the missiles are in their boost phase; and

- (U) Discriminate decoys from warheads by probing them with a directed energy beam that interacts with the target and scatters radiation from the nuclear warhead or creates other identifying signatures.

Those two missions--boost phase intercept and midcourse discrimination--are the keys to achieving high levels of ballistic missile defense effectiveness against the most capable threats. Thus, the technological advances supported by this program element are critical to providing a wide selection of defense options for the President's Strategic Defense Initiative (SDI).

(U) In the earliest potential defense deployments, directed energy concepts could provide the primary candidates for interactive discrimination in the midcourse phase. In addition, they could provide alternatives to kinetic energy weapons for boost-phase intercept. Over the long term, directed energy weapons appear to hold the key to defeating some of the more stressing threats that might be deployed in response to U.S. defense deployments (such as the fast burn booster which could severely shorten the exposure time of enemy missiles in their vulnerable boost phase).

(U) The efforts in this program pursue directed energy weapon concepts that include not only those that have emerged since the start of the Initiative but also those that predate the

Initiative by several years and are more technically mature. The program also emphasizes innovative technology. New forms of directed energy weapons concepts are continually emerging and creating options that may offer significant system performance improvement and/or cost reduction. Four basic concepts are addressed with several potential variations identified within each concept. These concepts are: space-based lasers (SBL), ground-based lasers (GBL), space-based particle beams (SBPB), and nuclear directed energy weapons (NDEW).

(U) The space-based laser (SBL) concept (depicted in Figure VII.C.1) envisions self-contained laser battle stations. These battle stations are seen as modular assemblies of laser devices and optical phased arrays that grow in performance as the threat grows by adding additional modules. These stations are deployed in orbits that ensure the required number of weapons can be available to engage ballistic missile launches wherever they occur. Once deployed, such stations can engage ballistic missiles launched from anywhere on the earth including the broad ocean area for sea-launched ballistic missiles and Western Europe for intermediate range ballistic missiles. The same constellation of SBL battle stations could play other very significant roles. They can engage threat objects and destroy post-boost vehicles before all reentry vehicles are deployed; destroy decoys or penetration aids in the midcourse phase; and defend U.S. satellites. Furthermore, since the beam of some lasers could penetrate into the atmosphere down to the cloud tops, SBL weapons may be able to provide some capability against aircraft, cruise missiles, and possibly tactical ballistic missiles.

(U) The primary approach to the space-based laser concept uses hydrogen-flouride fueled chemical lasers of 2.7 micrometer wavelength. This concept has been in research since the late 1970s. As the first of the DEW concepts identified for application against ballistic missiles, it has the most mature

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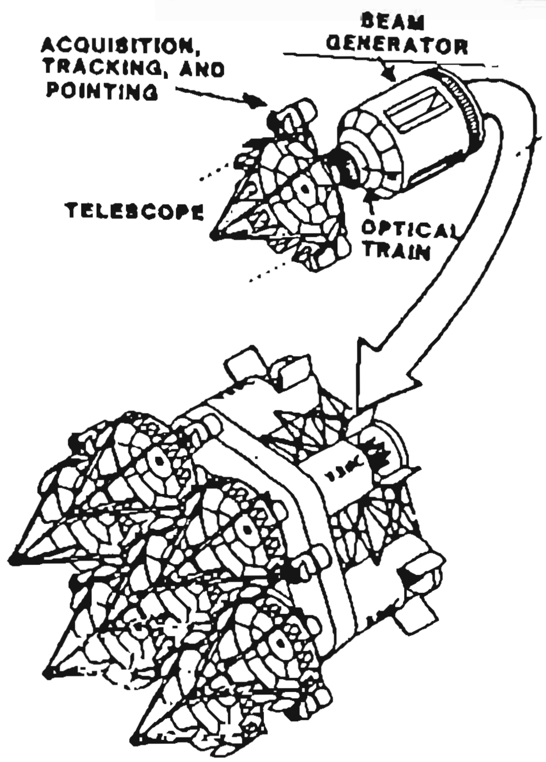

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Figure VII.C.1. (U) The Space-Based Laser Concept technology base. The efforts are well into the hardware fabrication phase for engineering proof-of-principle through ground-based tests.

(U) Other candidates for space-based lasers are based on devices that generate beams at short (one micrometer or less) wavelengths. Since brightness--a primary measure of performance--scales as the inverse of the wavelength squared, substantial increases in brightness can be realized if the quality of the optics and accuracy in pointing can be increased proportionately. The radio-frequency linac (RFL) free electron laser (FEL), for which high electrical efficiencies are projected, is one of the most promising alternatives. Another is the short wavelength chemical laser. Such an approach might be the most effective but, to date, no concept appears to be viable. Yet another approach is to use nuclear reactors to pump the laser.

(~~C~~) The ground-based laser (GBL) concept is depicted in Figure VII.C.2. Several ground sites are equipped with laser beam generators, target acquisition, tracking, pointing, and advanced beam control. These stations generate a short wavelength beam, condition it with the compensation necessary to transmit a useable laser beam through the atmosphere to space, and project the beam onto the space relay mirrors. These relays, perhaps at geostationary orbit (40,000 km), collect the beams from the ground and redirect them to mission mirrors at lower orbit. The mission mirrors collect the beam from the relay, acquire and track the target, point the beam at the target, focus the beam on the target and hold it there until the energy to kill the target is deposited. By this means, the ground stations located in the United States can engage targets worldwide. As in the case of SBL, such a weapon system has potential for application not only for defense against ballistic missiles but also for aircraft and satellite defense. Due to recent significant technical progress, the induction-linac free electron laser appears to be the most promising approach for this concept. The repetitively pulsed

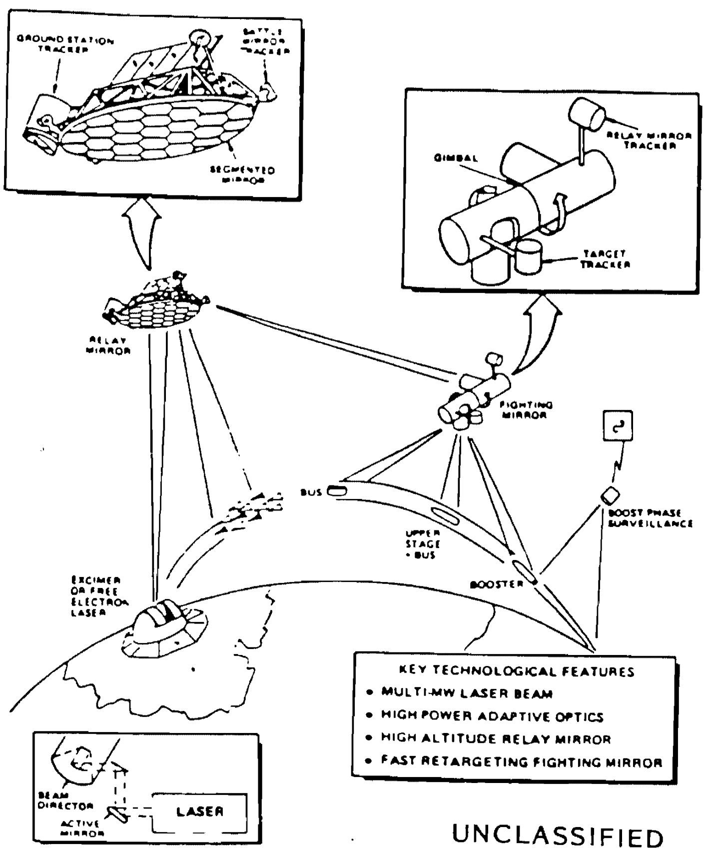

Figure VII.C.2. (U) The Ground-Based Laser Concept excimer laser serves as principal backup beam generator. Both approaches have been under investigation since the early 1980s in programs that were accelerated as a result of the Initiative.

(U) The space-based neutral particle beam (SBNPB) concept is depicted in Figure VII.C.3. In this concept, negative ions are accelerated by electro-magnetic fields in much the same way conventional accelerators do when used by particle physicists to explore the atom. Large numbers of these particles are accelerated to velocities near the speed of light creating a high energy beam which is steered toward the target by magnets at the front of the weapon. In the neutral particle beam concept, the particles are stripped of their charge as they leave the weapon. This neutral beam then will stay together as it leaves the accelerator. If the beam were not neutralized in the vacuum in space, the like charges of the individual particles would repel each other and break up the beam. In addition, the particles would be unacceptably deflected by the Earth's magnetic field. A second approach for targets at lower altitudes uses charged particle beams which follow an ionized channel created by a laser beam in the thin upper atmosphere, thereby forming a conducting path to the target.

(U) The neutral particle beam weapon concept, like space-based lasers, envisions stationing in space a configuration of battle stations that provides worldwide coverage. These stations could be capable of engaging ballistic missile boosters and post-boost vehicles as their trajectories bring them above the earth's atmosphere. Unlike lasers, the energetic particles or ions penetrate deep into the target. Thus a high brightness particle beam can penetrate the thermal protection provided to survive reentry and engage reentry vehicles in the midcourse trajectory. Such a weapon has two potential kill mechanisms. Electronics kill might be possible at relatively low beam fluence levels, but one might not be able to tell that the target has been killed. Hard or structural (readily observable) kill requires several orders of

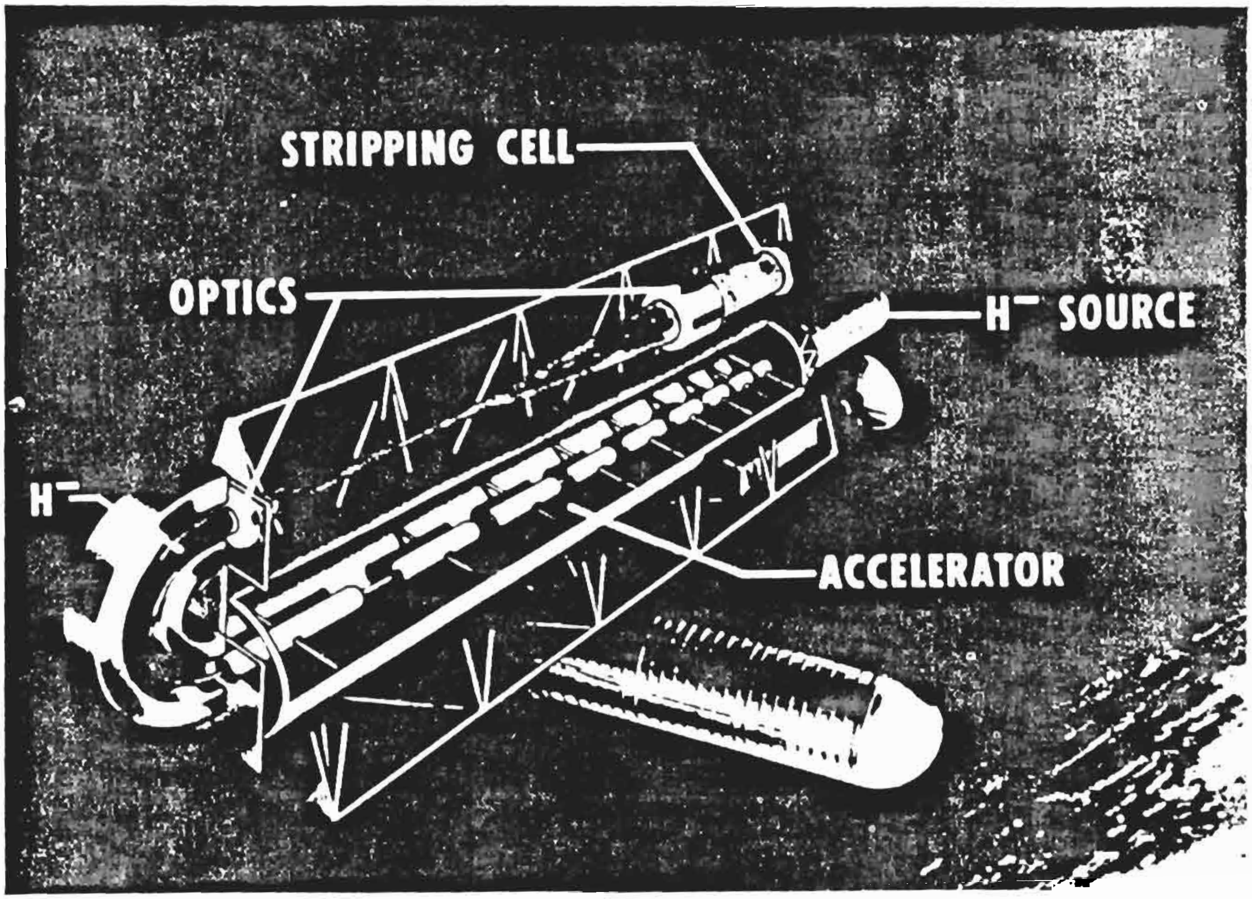

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Figure VII.C.3. (U) The Neutral Particle Beam Concept magnitude greater fluence than electronics kill. Efforts in this concept and its associated technology were proceeding at a fiscally-limited pace prior to the Initiative and were accelerated.

(U) The newest, and potentially the earliest, application of space-based particle beam battle stations could be to provide the discrimination function during the post-boost and midcourse phases. The primary targets would be decoys that are difficult to detect using passive means. The gamma-rays and neutrons emitted by an object when irradiated by an energetic particle beam are proportional to the mass of the object. Thus, these emissions can serve as a discriminant between the heavy reentry vehicles and the light decoys and/or penetration aids that may be encountered during an attack. Effective discrimination would decrease substantially the false targeting rate, thus conserving midcourse and terminal interceptor resources.

[redacted]

[redacted]

~~(S)~~ Finally, in applying the four basic directed energy concepts just described to a range of potential missions and threats, a wide range of performance is required. Figure VII.C.4 plots brightness and retarget times required for the various mission-target pairs. Brightness (a measure of power per unit solid angle of the beam), together with target hardness, provides a measure of how long one must dwell on the target to kill it. When combined with retarget time (how quickly one can switch between targets) the capability of the directed energy weapon is essentially defined. The basic technical objective, then, is to provide a proven set of technologies which, when assembled into a weapon system, can yield the high brightnesses [redacted] needed to meet specific BMD requirements.

(U) The overall program is paced by the SDI goal of an early 1990s decision on whether to develop and deploy advanced ballistic missile defenses. This decision will include whether to continue selected directed energy concepts for particular ballistic missile defense missions.

(U) Significant Accomplishments (FY 1984-1985)

~~(SRD)~~ Building on efforts that pre-dated the Initiative and new efforts started since the Initiative, the DEW program momentum is increasing and accomplishments multiplying. Major achievements in chemical lasers have "nailed down" that technology in experiments that have yielded [redacted] Precision optics fabrication processes for [redacted] These advances plus new proof-of-principle in combining chemical laser outputs and in optical phased arrays have

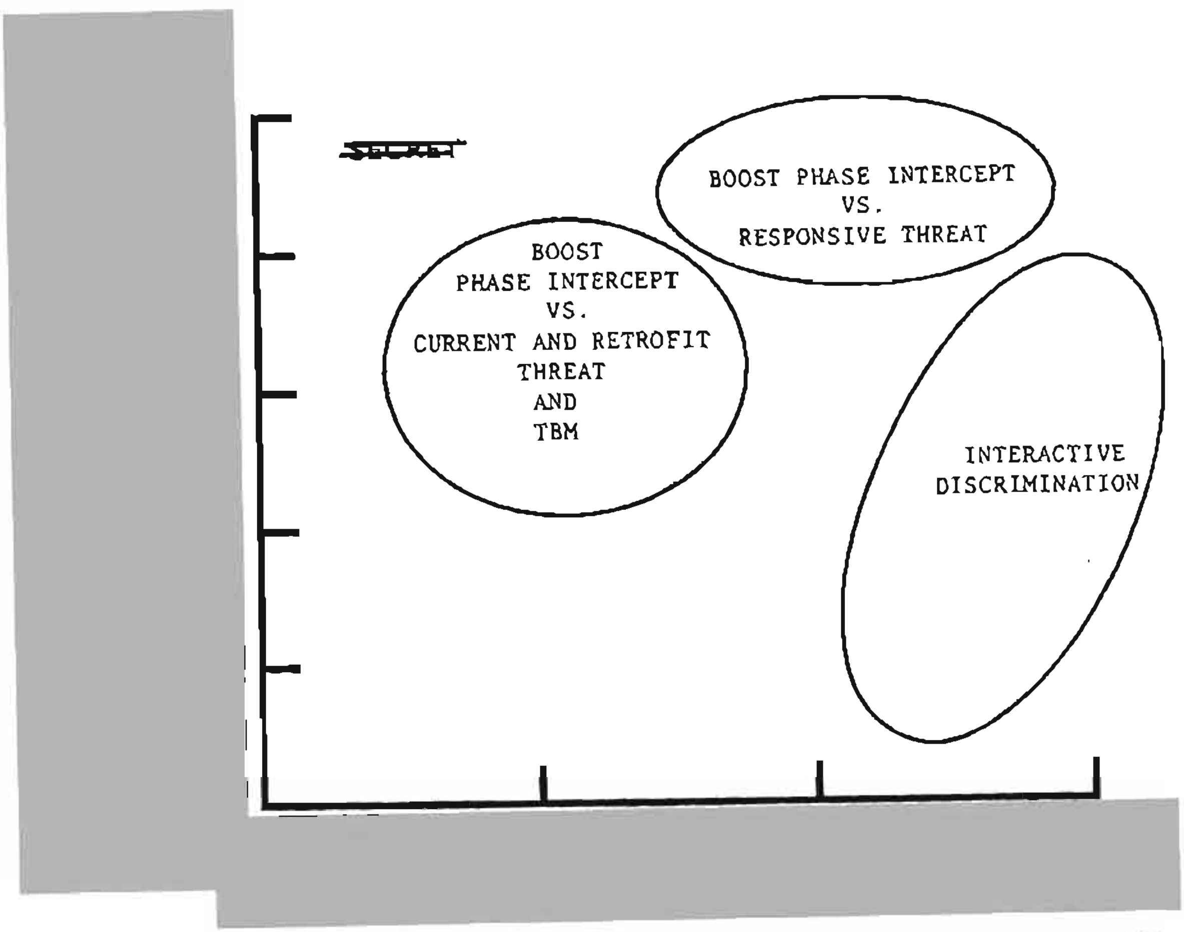

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Figure VII.C.4. (U) Top-Level DEW Performance Requirements provided substantial new evidence of the feasibility of achieving space-based lasers of very high brightness. For ground-based lasers, advances in free electron lasers (FEL) have opened the doors to initiation of a much more aggressive technical program to achieve high power levels. This FEL advance plus the low power atmospheric compensation successes have led to the formulation of a program leading to a [redacted] Dramatic advances in particle beam accelerators and the verification of a technique for determining the location of the particle beam in relation to the target have encouraged major new efforts for an early experiment to demonstrate interactive discrimination. [redacted]

(U) Some specific examples of recent technical accomplishments in the field of directed energy are:

- (~~C~~) The completion and test of the Mid Infrared Advanced Chemical Laser (MIRACL). This deuterium fluoride (DF) laser, located at White Sands Missile Range, is the Free World's first (and to date <u>only</u>) megawatt class, continuous wave laser. Completion of this device shows that the basic physics and engineering principles for "entry" level linear chemical lasers are understood.

- (U) The completion of the fabrication phase of the optical resonator and the demonstration that a high quality beam can be extracted from a cylindrical chemical laser. These experiments substantially increase our confidence in the success of the ALPHA project--the basic beam generator for space chemical laser concepts.

- (U) The ability to couple multiple lasers into one coherent output. These experiments under the advanced chemical lasers task are critical accomplishments in our efforts to show that small modular devices can be coupled together to yield very high power/high brightness chemical lasers.

- (U) The initial experiments on the hierarchical beam control using the laboratory brassboard of the Large Optics Demonstration Experiment (LODE). The results have markedly increased our confidence that baseline beam control architectures for space-based lasers are viable.

- (U) The validation of the fabrication process for the Large Advanced Mirror Program (LAMP). Validated at half scale, LAMP results give high confidence that the program will achieve a near order-of-magnitude reduction in areal density (kg/m^2) over that of the NASA Space Telescope, with segmented elements scalable to sizes that far exceed the diameter of the primary mirror in that NASA spacecraft.

- (U) The completion of a Large Optics Diamond Turning Machine (LODTM) facility that will permit precision fabrication of the complex mirror elements. Built to fabricate the cylindrical shapes for the ALPHA laser, this facility represents a major breakthrough in near IR optical fabrication technology amd a major step toward realizing space-based lasers.

- ~~(S)~~ The vacuum chamber demonstration of [redacted] and pointing in a realistic vibration environment. The Integrated Pointing Control Breadboard (IPCB) experiment exceeded the [redacted] by a factor of two. This ground experiment validates the concept for high accuracy beam stabilization and pointing of space-based SDI systems.

- (U) An order of magnitude improvement in beam emittance, new "magnetic modulator" power switches and confirmation of the basic electromagnetic theory of the induction linac FEL amplifier concept. Recent experiments have demonstrated laser gain and energy extraction efficiency at power levels that helped confirm the fundamental validity of this approach.

- (U) The experimental evidence of major advances in efficiency, beam quality, peak power and wavelength scalability of the radio frequency linac, free electron laser. Major achievements also include demonstration of diffraction limited beam generation with wavelength tuneability over a broad band. As in the case of the induction linac FEL, new insights in FEL theory and the resulting improved performance prediction have resulted.

- (U) The generation of a near diffraction limited beam in the excimer laser technology efforts on a single pulse basis. This excellent beam quality reduces the power required from the device for the GBL mission. In addition, advances in high power electrical pulse conditioning, high efficiency, large area electron guns, and acoustic damping also give increasing confidence in the excimer technology.

- (U) The proof-of-principle of the Raman conversion process on a laboratory scale. This process offers the potential of major reductions in the complexity (and cost) required to achieve high beam quality output from excimer lasers. This process also offers a practical approach for achieving the single aperture high power levels and beam quality required for excimer laser weapon applications.

- (U) The demonstration of atmospheric compensation in an extensive series of experiments involving propagation of a low power laser beam from a fixed ground site to an instrumented aircraft and sounding rockets that dramatically demonstrated our ability to reduce the deleterious effects of atmospheric turbulence on laser beam propagation.

- (U) The fabrication and testing of the radio-frequency quadrupole pre-accelerator section on the Neutral Particle Beam Accelerator Test Stand. This device, which both accelerates and bunches a charged ion beam, is considered a major step forward in ion beam accelerator technology. In addition, a pulsed negative ion source has produced a better ion beam quality than its design goal.

- (U) The demonstration of a technique suitable for precision boresighting of the neutral beam with respect to an optical tracker line-of-sight. These significant results and the accelerator advances cited above provide significant new evidence that neutral particle beams have practical applications in near-earth space for both interactive discrimination and weapons missions.

- ~~(SRD)~~ [redacted]

- ~~(SRD)~~ [redacted]

- ~~(SRD)~~ [redacted]

- ~~(SRD)~~ [redacted]

(U) <u>An Overview of the DEO Program</u>

(U) The DEW research efforts are consolidated into four principal projects under the program managed by the Directed Energy Office. These projects are Technology Base Development, Technology Integration Experiments, Concept Formulation and Technical Development Planning, and Support Programs.

(U) The Technology Base Development Project seeks to maintain an aggressive effort to expand the technological basis for directed energy weapons. Equally important, the project makes available other paths for achieving the critical functions of boost-phase intercept and discrimination alternative to those pursued in the Technology Integration Experiments. To achieve this goal, the technology base must advance the technologies that perform, within the directed energy weapon, the functions of (1) generating the beam; (2) conditioning the beam and delivering it to be propagated toward the target; (3) focusing and propagating the beam at the target along a prescribed path; and (4) acquiring the target to be engaged, establishing the line-of-sight to hit the target, holding the beam on the target, assessing the resulting damage, and then reinitiating the sequence to engage rapidly a new target. Thus, this project includes work on laser devices at various wavelengths, laser beam control and the associated optics, particle beam technology, acquisition, tracking, pointing and fire control (ATP-FC), and NDEW technology.

(U) Technology Integration Experiments are proof-of-feasibility efforts which integrate and validate technology for selected concepts. These projects include (1) Ground-Based, Induction Linac, Free Electron Laser; (2) Neutral Particle Beam (NPB) Interactive Discrimination; and (3) Space Pointing and Tracking Experiments. These major experiments leverage opportunities for realizing significant experimental gains in specific promising concepts for boost-phase intercept and midcourse discrimination. Their selection to receive emphasis as a major project with major resources applied places them on the leading edge of the SDI Directed Energy Program. In the case of space experiments in tracking and pointing, they are designed to have broad applicability across a range of SDI concepts--non-DEW as well as DEW.

(U) The other two projects under the Directed Energy Program are Concept Formulation and Technical Development Planning, and Innovative Science and Technology and Support Programs. Concept Formulation and Technical Development Planning funds activities that will guide the Directed Energy Weapons technology development efforts by reviewing and evaluating technical requirements and by providing conceptual designs of operational systems related to architectural structures emerging from efforts within the Systems Development Program Element. These planning activities will help identify and resolve critical DEW issues on a scale that establishes the technical feasibility of achieving weapon-level performance.

~~(S)~~ Support Programs partially fund activities at the DoD High Energy Laser Systems Test Facility (HELSTF) at White Sands Missile Range. This facility provides equipment and facilities for integrated high energy laser experiments and lethality and vulnerability testing of potential targets using a 2 megawatt deuterium fluoride (DF) laser. A second effort funded under this project, Targets supports planning, procurement, operations, and maintenance activities for the targets of DEW Major Experiments. This project also funds a DEW portion of the Innovative Science and Technology Program, described in Section VII-G.

D. (U) KINETIC ENERGY WEAPONS (KEW) PROGRAM

(U) Technical Objectives - The Role of KEW in the SDI

(U) Activities in this program support weapons options for all phases of a multitiered defense. As a relatively mature set of technologies, these efforts are not only a major candidate for providing the intercept and kill functions of any initial ballistic missile defense deployment but provide the major contribution to a hedge against a Soviet breakout of the ABM Treaty.

(U) Kinetic energy guided projectiles can be accelerated by chemically propelled boosters or, in the longer term, by hypervelocity electromagnetic means. In either case, projectiles rely on nonnuclear kill mechanisms. The kinetic energy program is developing technology for: (1) space-based, rocket-accelerated kinetic kill vehicles (KKVs) for ICBM intercept and satellite defense; (2) ground-launched, high-velocity, high endoatmospheric interceptors; (3) ground-launched, exoatmospheric interceptors; (4) advanced hypervelocity rail guns; and (5) support items, such as fire control components that cover all aspects of kinetic energy weapons.

(U) Key technology developments needed are seekers, divert (maneuver) propulsion, axial (booster) propulsion, fire control, guidance and control, warheads and fuzing. Proof-of-principle experiments are being designed to support a system level decision in the early 1990s time frame.

(~~C~~) A first-generation space-based boost phase and midcourse KKV would probably be based on an extension of the technology in which a small infrared homing projectile is accelerated by chemical propulsion (solid or storable liquid) to approximately 4 to 6 km/sec. Design goals for such a system include both low weight and low cost. These design goals are influenced by the key technologies mentioned above, by primary propulsion maneuver motor performance efficiencies, and by structural packaging. Such KKVs would be based in space on numerous platforms in a global pattern at orbital altitudes between 500 to 1000 km. The deployment configuration of these platforms would be based in part on the ability of the KKVs to reach booster targets before they release the post-boost vehicles which carry the warhead or decoy packages into their assigned trajectories. Survivability considerations also strongly influence the deployment pattern (mixed altitudes to complicate defense suppression attacks) and the number of interceptors per platform (that is, more platforms complicate any attempted defense-suppression attack). Figure VII.D.1 is a line drawing depicting one such concept for boost-phase intercept. Figure VII.D.2 depicts a midcourse interceptor concept. Current efforts are focusing on the commonality of boost and midcourse intercept requirements, and it is likely that a single chemical rocket can be configured which could be employed against both classes of targets in a cost-effective manner.

~~(S)~~ The terminal phase, ground-launched missiles are multistage (two or three) vehicles which can intercept reentry vehicles both above and within the atmosphere. These missiles are provided with intercept point prediction data and use onboard inertial guidance with possible updates during the initial parts of their trajectories. During the terminal phase, they home on their targets using internal guidance loops and sensors. For endoatmospheric intercepts, the terminal stage nosetip is shrouded during initial ascent, and active cooling is used for the optical homing seeker of the kill vehicle. Figure VII.D.3 depicts one such terminal interceptor concept.

(U) Chemical rockets are in a more advanced technological status than are hypervelocity, electromagnetic guns. The latter become favored over rockets for applications in which very large numbers of engagements must be accommodated. Hypervelocity guns are also attractive because of their ability to achieve shorter flyout times with minimal system weight impact. These advantages accrue since only the kill vehicle leaves the rail gun, as opposed

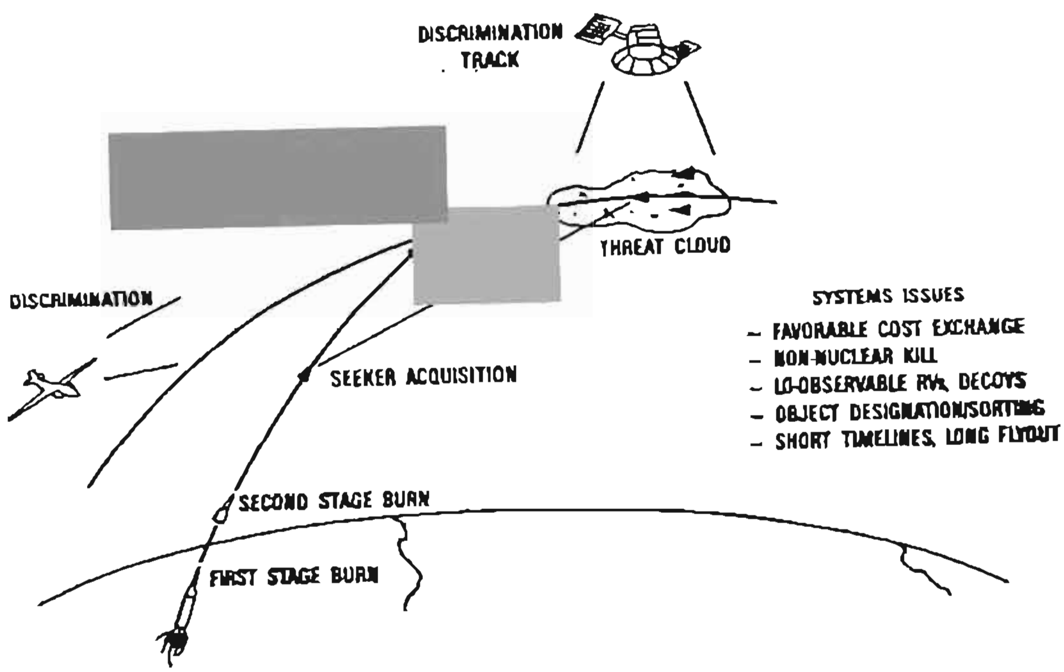

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Figure VII.D.2. (U) Midcourse Hit-to-Kill Interceptor Concept

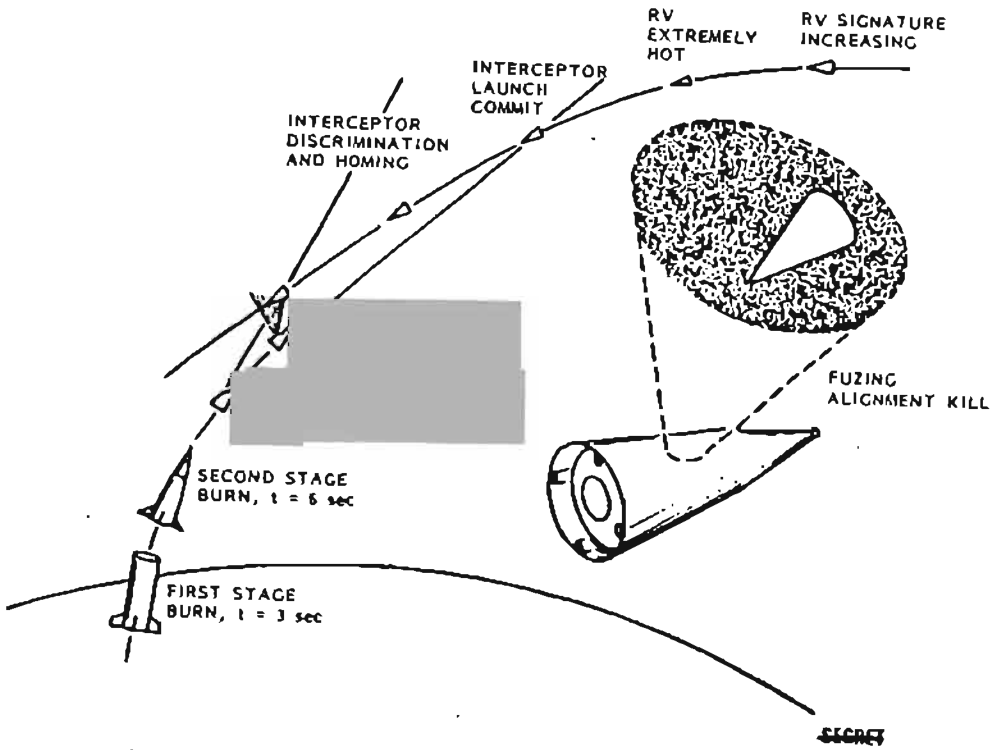

Figure VII.D.3. (U) Terminal Phase Kinetic Energy Interceptor Concept to the kill vehicle plus propellant in the case of a rocket. On the other hand, the electromagnetically-accelerated projectile experiences much higher g-forces than the rocket-accelerated projectile. One concept for an electromagnetic rail gun is depicted in Figure VII.D.4.

~~(S)~~ Boost phase intercept of current intercontinental ballistic missiles (ICBMs), long-range submarine-launched ballistic missiles (SLBMs) and post-boost vehicles (PBVs) requires propulsive velocities of at least [redacted] For engagement of faster burn boosters, propulsive velocities of approximately [redacted] may be required. Fast burn booster threats may require an electromagnetic gun, provided the terminally guided kill vehicle weight can be reduced to less than 1 to 2 kilograms to keep the total kinetic energy and associated launcher energy to an acceptably low level at these high velocities.

~~(S)~~ Midcourse intercepts can easily tolerate projectile velocities on the order of [redacted] since more threat flight time exists than in the boost phase. Low cost per engagement is a major objective to relieve performance requirements on exoatmospheric discrimination of decoys. Again the hypervelocity guns may have an advantage because of their large magazine potential.

~~(S)~~ Effective terminal intercepts with ground-launched rockets require maximization of the area coverage (footprint), intercepts above 15 km altitude, and commitment of the interceptor after atmospheric discrimination has occurred (approximately 100 km altitude). This equates to approximately 6 km/sec interceptor burnout velocity and capability to engage threats at between 15 and 40 km altitude. For engagement of intermediate-range ballistic missiles (IRBMs) and tactical ballistic missiles (TBMs) in Europe or elsewhere, lower performance levels would be acceptable.

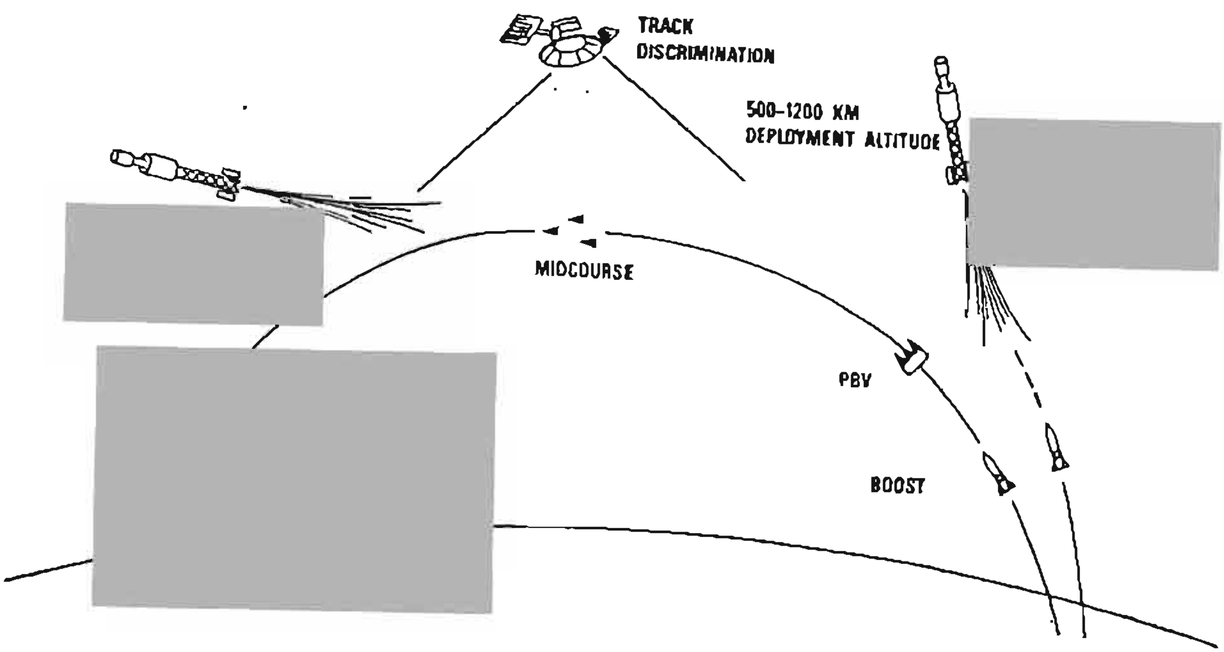

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Figure VII.D.4. (U) Electromagnetic Launcher Concept

~~(S)~~ It should also be noted that kinetic weapons are very useful in the defense of space platforms. Performance objectives are a function of the altitude and hardness of the space-platform orbit, threat yields and arrival rates, and threat numbers per platform. [redacted]

(U) Significant Accomplishments (FY 1984-1985)

(U) Over the last 2 years the kinetic energy weapon program has produced several accomplishments which are detailed in Appendix D of this report. The most significant of these is the demonstration of an actual reentry vehicle midcourse intercept in the Homing Overlay Experiment (HOE) conducted by the Army. This experiment was conducted with an interceptor which was initially given intercept point information and then switched to autonomous terminal homing, the same crucial functions most probably necessary for eventual weapons systems. Other major kinetic energy technology accomplishments include testing of elements such as divert propulsion thrusters and propellants necessary for lightweight interceptor fabrication. In addition, detailed analysis has been completed to define the performance requirements (for example, axial and lateral velocities) necessary for the various interception scenarios. In the hypervelocity launcher area, a number of laboratory devices have been utilized to test the feasibility of multiple shots with a single gun barrel and the feasibility of high-g survivable projectile components.

(U) An Overview of the KEW Program

(U) In order to accomplish the stated technical objectives and to provide the confidence necessary for an early 1990's decision, the KEW program is structured in six major thrusts--(1) space systems for boost phase intercept; (2) exoatmospheric nonnuclear kill interceptors; (3) endoatmospheric nonnuclear kill interceptors; (4) capabilities against shorter range threats; (5)

electromagnetic accelerators; and (6) testing and facilities support. The first five thrusts have an associated technology base activity and major experiments.

(U) In technology base activities, technologies relating to precision KKV projecties accelerated by rockets or hypervelocity guns will be explored to provide potential nonnuclear kill of ballistic missiles in all phases of flight--boost, midcourse, and terminal. Technology base efforts include:

- Smart seekers to acquire targets rapidly and provide highly accurate terminal homing;
- Advanced guidance and control techniques to control KKV maneuvers for direct impact with targets;
- Miniature rocket vehicles for boost and midcourse ballistic missile intercept, as well as for satellite defense; and
- Electromagnetic accelerators and smart hypervelocity gun projectiles.

E. (U) SYSTEMS ANALYSIS AND BATTLE MANAGEMENT (SA/BM) PROGRAM

(U) Technical Objectives - The Role of SA/BM in the SDI

(U) The diverse but related activities included in the Systems Analysis and Battle Management Program of the SDIO provide two key criteria that drive the other SDIO Programs. The systems analysis efforts define the performance regimes of the individual systems that make up the defense architecture that must be met if cost-effective defenses against responsive threats are to be realized. The battle management efforts define the operational environment of decisions, rules, constraints, and directions in which the individual systems must perform.

(U) Systems analysis provides the systematic approach that assists the managers of the SDI in choosing courses of action. Through a series of studies, analyses, and evaluations, the Director, SDIO and his subordinates are provided investigations of the full range of issues and problems, the identification of relevant objectives and alternatives, and analytical comparisons of those objectives and alternatives in light of their consequences. In the process an appropriate framework is created to bring expert judgment and intuition to bear on the choice among the promising approaches to achieving effective defenses and the design and development of the weapon systems that constitute those defenses.

~~(S)~~ Solutions to the command and control problems associated with the effective employment of a multitiered defense presents a significant technical hurdle. Surveillance satellites, airborne sensors and ground-based radars must locate targets and communicate the information to a battle management system where it would be processed and disseminated to space weapon platforms or ground-based interceptors for efficient target engagement. Surveillance and weapon satellites also must provide the kill assessment information so targets may be re-engaged, if necessary, in other phases of the defense. The activities and status of the space, air and ground elements of the system must be monitored and controlled by well-defined command levels, culminating with the National Command Authorities (NCA). Furthermore, a defensive system must be internetted with a robust, survivable communications systems to remain effective at all times.

(U) The four main thrusts of this Program are described in the following paragraphs.

(U) Systems Analysis

(U) Systems Analysis Technical Objectives

(U) The Systems Analysis project is comprised of several tasks which seek to establish system architectural alternatives based on defense missions and objectives, threat assessments and weapon/sensor technology integration. These candidate architectures will be used in the derivation of system component performance requirements. The efforts of this project will provide for technical program integration.

(U) Significant Accomplishments (FY 1984-1985). The emphasis in FY 1984-1985 was on defining the baseline threat and generating baseline SDI system requirements.

(U) In coordination with the intelligence community and other SDI programs, a time-phased expected strategic threat and attack scenario was defined. Strategy and policy issues and constraints were regarded as inputs and outputs. Architecture methodology and selection criteria were developed. There was a continuation of analyses and evaluation of boost, post-boost, midcourse, and terminal phase SDI concepts initiated in the previous year. Strawman system conceptual designs and iterated allocation of resources and constraints among defense phases were developed in sufficient detail to document initially perceived SDI system requirements. Architectural systems and cost models with interactive application and refinement to the architectures were chosen on a more generic level. Examination of the impact of future technologies and national resources on strategic defenses, strategy and policy was begun.

(U) Systems Analysis Project Description

(U) The specific tasks with the Systems Analysis Project include the Architecture task, the Threat Analysis task, the Technology integration task, and the Architecture Analysis Support task.

(U) The Architecture task is structured to define and evaluate candidate system architectures, system concepts and parametric trade-offs leading to the evaluation of preferred architectures and allowing assessment of key technologies and system functions. Developed by a team from Federal Contract Research Centers (FCRCs) and National Laboratories, the Pilot Architecture provided an early formulation of these system architectures and trade-offs. This Pilot Architecture also provided an initial reference to the SDIO for evaluation and comparison of alternative architectures developed by industry contractors as part of the SDI System Architecture and Key Trade-off Study.

(U) The Threat Analysis effort will provide projections of possible threat structures usable against the U.S. and its Allies. Analysis will also be performed to define responses which might be invoked to counter defense concepts.

(U) There are three broad categories under technology integration: affordability, logistics integration and technical integration. Within these categories, there are several tasks for accomplishment by the SDIO and the Services.

(U) Studies and analyses related to the affordability of the SDI program will be performed under the affordability task. In particular this task provides the affordability analyses, innovative cost analysis research and industrial base considerations, to include a production base analysis and manufacturing technology and producibility studies.

(U) The logistics integration task provides the means through which logistics and supportability elements will be addressed across the entire SDI program. Research and analyses to identify and quantify the essential elements of an SDI logistics support system; the basic supportability costs, schedules, and performance drivers in each project; and related supportability technology requirements will be performed. It is through early emphasis on supportability that desirable support characteristics are determined and considered in SDI research. Examples include appropriate levels of standardization and commonality, as well as reliability, maintainability, and system availability. This task is distinct from that managed by the SDIO/SLKT, previously entitled Space Logistics, which addresses space transportation and support.

(U) Achieving a systematic and coordinated relationship among the diverse technical elements of the SDI will be analyzed by the technical integration task. This task includes the development and implementation of an overall technical integration program plan, a work package directive data base, and a facilities assessment. These functions will be accomplished through a top-down analysis of technical requirements within system architectures, and a bottom-up analysis of actual technical capabilities existing or projected.

(U) The Architecture Analysis Support is structured to support the definition of boost, post-boost, midcourse, and terminal system performance requirements. Detailed trade studies will be used to determine lower level system performance requirements and support cost-effective systems context to ensure that risk is properly assessed. This task will also analyze cross-cutting system functions such as discrimination, track data base and weapons assignment. These functions are pervasive throughout a multitiered defensive concept and must be planned in an integrated manner. These functional requirements drive the battle management subsystem requirements, to which the BM/C^3 Technology and Experimental Systems projects must respond.

(U) Battle Management/Command, Control and Communications (BM/C^3)

(U) Battle Management/C^3 Technical Objectives

(U) The primary objectives of this project is to specify, design, develop, and verify the technologies required for battle management capabilities; command, control, and communications networks; and their interfaces. The goal is to provide effective capabilities to examine command control over a multitiered defense. Specific emphasis is on achieving the required battle management algorithms; reliable, fault-tolerant, high performance processing; communications; and software.

(U) Battle management for a multitiered defensive system employs a wide variety of algorithms performing such functions as situation assessment, damage assessment, defensive firing strategies, network management and many others. The algorithms must deal with complex engagement rules, multiple kinds of weapons, rapidly changing environmental conditions, and a large degree of uncertainty in the input data. While source specific algorithms must wait on a well defined system, the system constructs under consideration are comprised of many components (space, air and ground) which are widely distributed geographically. These individual components may have only limited data regarding the overall battle situation. A system such as this requires a class of algorithms which may be partitioned geographically, have distributed data bases and be required to operate effectively with partial loss of communication. The need for highly efficient computing algorithms in this environment presents a new and very strenuous challenge to the field of distributed computing.

(U) The objective is to synthesize algorithms applicable to specific SDI architectures. A further objective is to develop the algorithm data base necessary to produce a coherent, integrated, survivable, secure and interoperable distributed system to support ballistic missile defense command and control applications.

(U) Reliable fault-tolerant, high performance processing is essential for battle management of a future system based on SDI technologies. Much of this processing will be done onboard space vehicles where normal maintenance access is not available. The processing power required will greatly exceed what can be expected from even the highest performance single computing engine. Thus, a distributed processor will be required. In addition, multiple processor architectures, because of their built-in redundancy, provide a compelling approach to fault-tolerance. However, in order to achieve the required high performance and fault-tolerance, extensive work is required not only on the hardware elements but also on algorithms and software to effectively manage the computing resource while providing reliable computing. For example, extreme care must be taken to ensure that the operating system does not become a computation limiting overhead in multiple processor configurations.

(U) Communication networks are integral to the proposed Strategic Defense Initiative and are embedded in virtually every aspect of the ballistic missile defense capability. Communications network planning and design for SDI will be heavily influenced by the requirement for the most stringent survivability implementation measures. The objectives of the communications research tasks are to define communications network and technology requirements, to develop candidate network architectures to satisfy perceived system requirements, and to test the network robustness and technology solutions in simulated threat environments. This research will provide a high confidence basis for making the programmatic decisions necessary to realize future communications networks for ballistic missile defense.

(U) The battle management software to be developed for the SDI may be the most complex ever attempted. To be reasonably certain it will be developed on time, within schedule, and will correctly and safely implement the functionality of the system, the labor intensive aspects of the software development, test, and maintenance processes must be made more efficient and trusted. By automating significant parts of these processes, consistency, completeness and correctness can be better assured, and dependency on specific individuals lessened.

(U) Software for a multilayered ballistic missile defense will be very complex, not only due to the amount of software required, but also due to the functions to be carried out by software. The complexity will directly relate to requirements for large software systems that can be explicitly trusted to carry out mission requirements, which can be reliably modified and adapted to changing defense needs, and which can be guaranteed to have desirable behavior under all conceivable stressing conditions.

(U) The basic objective of software research is to provide the techniques, tools, facilities and methodology required to support the battle management software development. A major milestone of this program will be a software engineering system encompassing all high-payoff tools and methods in FY 1989.

(U) <u>Significant Accomplishments (FY 1984-1985)</u>. Requirements for a set of benchmark algorithms to be used to evaluate processor performance were developed. A consortium of universities has been established to evaluate the role of knowledge-based and artificial intelligence for BM/C^3. A distributed algorithm test bed has been established for BM/C^3 algorithms testing and evaluation. Network protocol requirements have been defined and techniques for network control are being assessed for BM/C^3 architecture alternatives. Alternatives for establishing network synchrony have been developed and tested. Architecture requirements have been specified for fault-tolerant, distributed processors and developed specifications for space-qualified, radiation-hardened components. Specifications have been developed for millimeter-wave elements for space-to-ground C^2 links. Communication link requirements characterization and definition has been produced. An initial set of automated software development tools that are being assessed for their efficacy in an integrated, automated software development environment also were developed.

(U) <u>Battle Management/C^3 Project Description</u>

(U) Five tasks are pursued in the battle management/C^3 project: battle management algorithms, network concepts, processors, communications and software engineering.

(U) The battle management algorithms task undertakes research on underlying technology, and, in parallel, of a candidate set of algorithms which will be required. The work will rely heavily upon previous and ongoing algorithm work in distributed systems, decentralized control and resource management (such as, Navy battle group defense). These technologies and algorithm studies will be integrated and the appropriate data base will be generated through experimentation in a battle management/command, control and communications (BM/C^3) test bed. Specific attention will be given to system level algorithms which are peculiar to SDI layered defense and which are not being addressed in other program elements or in other tasks within the SA/BM program element. These algorithms are: (1) discrimination decision making, based on data collected by the system of sensors, the available intelligence data base, and system resource constraints; (2) boost phase and midcourse weapon assignment algorithms accounting for multiple types of weapons in each phase, the presence of succeeding phases, and the existence of constraints such as illuminator availability for midcourse intercepts; [redacted] (4) kill assessment in all phases; (5) reconfiguration of the system when weapon, surveillance, and/or BM/C^3 resources are damaged; and (6) selecting the appropriate defense response when system elements come under attack.

(U) In the network concepts task, analyses and research also will be undertaken leading to the specification, design, development and verification of battle management/C^3 networks. These concepts of C^3 network asset (computers and communications) management, and their implementation in system software, will provide a high performance, fault-tolerant, secure and survivable C^3 network environment within which the battle management algorithms function. The specification, design, development, verification and validation of alternative BM system technologies resource allocation/network asset management (or control) algorithms, and network protocols will be pursued. Additionally, battle management/C^3 system interface design, engineering, and development of interface standards and configuration management guidelines will be accomplished.

(U) Simulations will be used extensively to evaluate the many variables that come into play during the computer system design process. The simulations will be of a quality to serve as effective tools for the final design and development of the actual computer. Following the design and simulation tasks, a demonstration computer will be implemented to verify the design specifications and to provide a real-time execution resource for fault-tolerant tasking and for executing the critical BM algorithms.

(U) In the fault-tolerant processors task, computer architectures, design methodologies and implementation technologies will be pursued to provide high availability, mission reliability and radiation survivability for complex battle management (BM) ~~data~~ processing systems onboard spacecraft or aircraft. The planned fault-tolerant research program will address: (1) definition of fault-causing phenomena at the component and system level; (2) development of fault-tolerant strategies, both in hardware and software; (3) incorporation of these strategies in computing architectures which will mitigate the effects of faults; and (4) development of a capability to validate and trade between the many fault-tolerant alternatives for a given system environment. In addition, nuclear radiation upset/mitigation will be treated as a class of fault which has peculiar and far-reaching system survivability impacts. The research will continue several ongoing projects and from this nucleus form a more encompassing fault-tolerant program. Work in definition and development of special purpose architectures such as dynamically reconfigurable computers and advanced distributed onboard processors will be used to gather ~~data~~ as to their effectiveness and to form the basis for a highly reliable architecture definition.

(U) The research will include studies to define the SDI processing functions and fault-tolerant requirements that must be performed, the information flow that exists between the functions and the response times required to meet the overall mission response time requirements. The system operating concept definition and the requirements specifications derived from the need to do autonomous secure fail-safe processing will be developed. Promising architectural approaches will be incorporated in a demonstration computer to further validate usefulness and performance. Failures will be induced to observe the system response to failures. Hardware/software fixes will be designed, implemented and tested. The final products will include a fault-tolerant computer system specification for a system which will meet the BM requirements including those peculiar to the space environment and which reflect the capabilities demonstrated on the development model of the fault-tolerant computer.

(U) In the communications task, research will pursue network planning and design, communication system designs and techniques, communication protocols, and candidate communication network architectures, development of critical communications technologies, and demonstration of the survivability of dynamic networks.

(U) In the battle management software task, research has been structured to obtain high confidence of satisfying the BM software development support requirements. Near term activity will concentrate on upgrading and tailoring existing and planned software development technology to support the SDI SA/BM program. This approach will maximize use of evolving automated techniques (such as, Program Design Language) for requirements specifications and analyses, program design and test. It will also permit integration with the DoD/DARPA high order language efforts, such as Ada, the DoD Software Technology for Adaptable Reliable Systems program, and other ongoing projects that are developing technology that may support part of the SDI BM software effort. The existing and evolving tools for definition of system requirements, software requirements, design, and implementation efforts will be combined into an integrated framework that will increase productivity of and reduce errors in the BM software development process.

(U) Emphasis will also be placed upon procedures which can verify the trustworthiness of the system being developed. These include software technologies for validating the effectiveness of the developed tools and techniques when used in realistic conditions. These new technologies include the use of design methodologies, rigorous inspection processes to provide correctness, and analysis tools to measure correctness. Another major activity will be concerned with applying innovative and advanced concepts to BM software development. For example, knowledge-based engineering and expert systems technology may have great potential for improving the development process and will receive in-depth evaluation. Also modern supervisory/control software (systems) will be evaluated for their potential to achieve significant increases in efficiency and reliability. Advanced techniques will be integrated into the SDI BM software development technology base as their feasibility and usefulness are verified.

(U) BM/C^3 Experimental Systems

(U) BM/C^3 Experimental Systems Technical Objectives

(U) The BM/C^3 Experimental Systems effort is one facet of the overall SDI Technology Verification Strategy that endeavors to provide the national leadership with the requisite technical information to decide whether to embark on development and/or later deployment of a strategic defense system. The SDI Technology Verification Strategy incorporates simulations, tests and demonstrations to evaluate the maturity of technologies required to support initial options for defensive systems. The performance of an SDI defense system will depend to a large extent on the performance of the battle management/C^3 system. Therefore, the architecture of the battle management/C^3 system must be developed as an integral part of the total defense system architecture.

(U) The objective of this task is to define and develop experimental versions of battle management/C^3 architectures that would lead to BM/C^3 systems which will coordinate and control the functioning of the diverse defense elements to provide maximum defense effectiveness and reliability. The experimental versions of these architectures must demonstrate the ability to survive and operate reliably even in the presence of failures caused by nuclear effects, severe electromagnetic threat or direct enemy threats.

(U) Significant Accomplishments (FY 1984-1985). Emphasis was on an initial definition of alternative architectures for BM/C^3 and evaluating them according to identified quantitative subsystem functional and technical requirements and trade-offs. This work concentrated on space-based systems.

(U) BM/C^3 Experimental Systems Project Description

(U) The Battle Management/C^3 Experimental Systems project develops BM/C^3 architectures, the resulting quantitative subsystem functional requirements, and technology trade-offs, which are responsive to the BM/C^3 requirements identified as a result of SDI Systems Analysis. This project also performs the analyses and research leading to and including the development of experimental versions of BM/C^3 systems. The demonstration of these experimental versions will validate the ability of technology to meet the requirements of the BM/C^3 component of a strategic defense. The BM/C^3 Experimental Systems research will use prototypical technologies selected from alternatives developed in the BM/C^3 Technology project assembled in experimental versions to evaluate system-level performance of technologies and architectural concepts.

(U) The demonstration of experimental versions and the conduct of BM/C^3 experiments will be through the National Test Bed (NTB), where their execution in a system-wide simulated environment is required to assess the achievement of required technical performance. Where appropriate, stand-alone experiments may be conducted, which are remote from the NTB, to assess the performance of BM/C^3 technology.

(U) The scope of the architecture is baselined on an SDI system to perform CONUS/Allied defense against ICBMs, SLBMs and IRBMs. [redacted] The selected BM/C^3 architectures will establish performance requirements for supporting technologies in data processing and communications, for high confidence weapons release and safety, and for system management and control algorithms.

(U) Since the BM/C^3 technology required to support SDI systems is significantly more complex than previous programs in this area, early emphasis will be on identifying candidate BM/C^3 architectures, assessing technical performance, and providing simulations to support engineering trade-offs among competing approaches. In order to incorporate realistic concepts of operation and weapon release procedures, inputs are expected from the Joint Chiefs of Staff and from field commanders.

(U) For the BM/C^3 Experimental System project, computer facilities will be needed to support experiments to evaluate BM/C^3 architectures and concepts to assess the performance of BM/C^3 technology prior to the development of the National Test Bed and when stand-alone experiments are appropriate. Initial BM/C^3 experiments will be undertaken as part of the incremental build-up to demonstrations of validated experimental versions of BM/C^3 systems in later years.

(U) National Test Bed

(U) National Test Bed Technical Objectives

(U) The National Test Bed (NTB) project will define, develop, build and integrate a number of geographically distributed development, experiment, simulation and support facilities that are interoperable. Collectively these resources will provide the capability to demonstrate key defensive technologies and subsystems necessary to support a SDI full-scale engineering development decision in the early 1990s. The NTB will consist of a dedicated central National Test Facility (NTF) and other geographically distributed test and demonstration capabilities such as Service development and evaluation facilities, DoE National Laboratories, and missile ranges. As an integrated set of resources the NTB will be a single national resource dedicated to the SDI, and will provide the focus for the many SDI simulations, demonstrations and experimental activities.

(U) Significant Accomplishments (FY 1984-1985). This effort was initiated late in FY 1985. The NTB was conceptually defined to consist of a central NTF connected to, and interoperable with, other geographically distributed development test and support facilities that either presently exist or are developed under other program elements. The project's major tasks were defined to be: concept and requirements definition, design and development; construction of facilities (or conversion of existing facilities); integration; and operation of the NTB/NTF.

(U) National Test Bed Project Description

(U) The NTB acquisition is envisioned as an evolutionary process, with subsystems and technology being developed and transferred into an initial capability at the core National Test Facility (NTF).

(U) The NTB/NTF will provide a capability of sufficient fidelity and extent to permit the comprehensive and specialized evaluation of alternative SDI systems and BM/C^3 technologies and architectures. It will be achieved through the use of flexible simulations and will include low-to-high fidelity algorithms and displays. Hardware-in-the-loop types also will be supported, including as a minimum, space-based, ground-based (including pop-up elements) and Allied anti-tactical ballistic missile architectures. Simulations of realistic threat scenarios and operational environments will support these architecture evaluations. The NTB/NTF also will provide the capability to support system and BM/C^3 experiments and tests from the minor subsystem level up through large-scale, realistic, system-wide, end-to-end experiments and demonstrations. Tests and demonstrations of generic and specific BM/C^3 technologies will be supported including networks, algorithms, processors, software engineering, communications, command and control, and man-machine interfaces. Realistic interfaces, representative of system architecture components, that is, weapons and sensors, will be provided as needed.

(U) The NTF will support the integration and control of interactive and stand-alone (autonomous) elements of Technology Verification Experiments (TVE). The integration functions will involve hardware-in-the-loop operations with actual or replica subsystems, such as signal processors, communications controllers, and message generators, and also real or emulated interfaces with other SDI and non-SDI national or Allied assets.

(U) Interim Assessment of Computing Requirements for BM/C^3 Technologies

(U) In pursuing the four projects just described, computing and computational capabilities will be required to accomplish the following:

Networks:	analysis of network configurations
	analysis of algorithms for network operations
	development of network concepts; evaluation using emulations of operating system software
Processors:	support the design and verification of hardware SDI/space applications
	circuit technology development and chip design
	algorithmically specialized processors
Communications:	analysis of communication system hardware requirements
	research and development of transmission technology
Software:	development of software engineering tools
	evaluation of software engineering tools and environments
	investigation of effect of massive computing power on software development and testing

F. (U) SURVIVABILITY, LETHALITY AND KEY TECHNOLOGIES (SLKT) PROGRAM

(U) Technical Objectives - The Role of SLKT in SDI

(U) Important factors in deciding whether or not to develop and deploy a strategic defense must be effectiveness, affordability and survivability. The SLKT program performs research in key technologies that are critical to that decision. Specifically, it funds research to:

- (U) Develop technologies and tactics to enhance the functional survivability of potential strategic defense force elements in hostile environments;
- (U) Reduce major uncertainties that exist in the DoD's capability to predict the vulnerability of enemy targets that are responsively hardened to U.S. directed and kinetic energy kill mechanisms;
- (U) Coordinate and stimulate the development of energy generation, conversion and power conditioning subsystems for deployed SDIO space and ground systems;
- (U) Develop the preliminary enabling technologies needed to improve significantly space logistics capabilities including transportation to orbit and repair and resupply on orbit; and
- (U) Identify, coordinate, and manage high payoff research into the development of materials and large-scale structures that meets SDI-unique requirements.

(U) The SLKT program element is organized into the following five projects: (1) System Survivability; (2) Lethality and Target Hardening; (3) Space Power and Power Conditioning; (4) Space

Transportation and Support; and (5) Materials and Structures Development. A sixth project, Countermeasures, has been added to the SLKT program element in FY 1987 to support the work planned by the SDIO Countermeasures Office.

(U) The System Survivability Project investigates concepts and technologies designed to assure defensive system functional survivability. The project is concerned with the system survivability for operational deployments of both initial strategic defenses and for follow-on defensive systems that are effective against a fully responsive defense suppression threat. The project is organized to: (1) assist the SDI Systems Architect in the development of candidate strategic defense architectures by ensuring survivability concerns are identified and addressed; (2) describe and update defense suppression threat descriptions to support survivability assessments; (3) investigate promising survivability concepts and initiate research into active and passive survivability technologies.

(U) Survivability in its broadest interpretation means sufficient defenses remain to destroy the ballistic missile threat after dedicated attacks have been made to suppress the defense. It is a measure of how well the defense functions after an enemy attack and does not depend solely on the survival of the individual elements of the defense. Functional survivability is a combination of system requirements, tactics and technology. The project concentrates on providing the systems architect with survivability technology options, but will also perform some of the trade studies and analyses that will assess tactics as well.

(~~S~~) The terms survivability, lethality and countermeasure are frequently confused, but refer to distinctly different phenomena. Lethality is concerned with the kill mechanisms to enemy targets caused by U.S. defensive weapons in a defense force. The SDIO is pursuing research in primarily nonnuclear concepts which involve sophisticated sure-kill techniques that may not produce dramatic results. Therefore, it will be important to know the kill mechanisms of weapons, the precise levels of damage required, and how to assess the damage U.S. weapons inflict on enemy targets. Survivability, on the other hand, refers to the capability of U.S. defensive forces being able to endure a hostile attack ranging from attempts at degradation through attempts at outright destruction.

(U) The term countermeasure as used here is defined as a specific response taken by the Soviets to negate the effectiveness of a defensive system. The countermeasure may be technical (directed specifically against the hardware of the defense system) or tactical (designed to get around or overcome the effectiveness of the defenses). Political "counters" designed to prevent full deployment of the defensive system through outside means are addressed in Appendix A. It is important that all types of Soviet countermeasures be anticipated and addressed if the United States is to have sufficient information to make decisions regarding deployment of a strategic defensive system.

~~(C)~~ The Lethality and Target Hardening (L&TH) Project addresses the important issue of the precise effectiveness of any strategic defense. It is a project designed to perform comprehensive research, addressing such areas as effects damage and vulnerability of enemy targets caused by conceptual kinetic and directed energy weapons. Because no such weapons exist, it is necessary to test at lower magnitudes and determine the scalability of results. The current tasks include the study of the effects of thermal/impulse/x-ray lasers, particle beams, kinetic energy projectiles, and high power microwaves on targets of interest. The effort includes a materials assessment program to ascertain theoretical hardening limits. The data, once developed, will provide performance requirements for the weapon system design teams.

(U) Some weapon concepts being considered by the SDIO will require large amounts of electrical energy. There are projected unique requirements for the spaceborne concepts. Some research has been performed to produce power in large amounts, but none at the levels needed for these weapons concepts. While there is research on power that might be scaled to the needs of SDI, extensive research is still required.

(U) The Space Power and Power Conditioning Project coordinates efforts to develop viable power generation and conditioning techniques capable of providing the large quantities of specially conditioned electrical power for space-based weapons, surveillance, communication, and battle management systems. The project requires funding in four tasks: (1) analysis and assessment of power requirements and candidate concepts; (2) development of the SP-100 nuclear power subsystem for continuous power generation for SDIO, NASA and other agency needs; (3) the multimegawatt (MMW) evaluation of a broad spectrum of innovative concepts from industry and laboratories; and (4) pulse power conditioning to demonstrate the technical feasibility of performance work as well as the feasibility of significant weight/volume reduction techniques.

(U) The economic feasibility of a multitiered ballistic missile defense system against a fully responsive threat may well depend on the capability to deploy, supply and maintain such a system. The Space Transportation and Support Project funds the investigation of space logistics infrastructures, technologies and techniques to support an extensive space force of the magnitude and complexity envisioned by the SDIO. Areas to be investigated include, but are not limited to, heavy lift launch vehicles, orbit-to-orbit transfer systems, on-orbit assembly/servicing, robotics, reusable systems, advanced technology propulsion engine systems, avionics, and control systems. SDIO is a participant in the National Aerospace Plane research program.

(U) Research is being conducted by DoD, DoE and NASA on materials and large structures to be used in space and on materials designed to increase the survivability of U.S. elements against natural and hostile environments. There is also research into structures requirements for various space systems concepts applicable to a strategic defense. There is emerging recognition of a need to concentrate the SDIO materials efforts into a single management project. This project, Materials and Structures Development, will be used to identify needs and initiate relevant research.

(U) It has been widely recognized that in order for SDI system concepts to be credible to opponents and proponents alike, the concepts will have to be carefully and thoroughly examined by an independent Red Team. The Countermeasures project supports a series of Red Teams to identify possible Soviet responses to SDI elements and to ensure that the implications of these responses are considered in the development process. The term "Red Team" is used here in a generic sense to indicate the sum of independent technological, political, military, and economic analyses that will be needed to conduct an independent review of a defense system concept and to identify credible potential Soviet responses. Red Team analyses are useful since they identify credible countermeasures to SDI systems and also those countermeasures that can be "ignored" because they are technically, politically, or economically infeasible. Both of these inputs are essential to the defense system designer. The first helps him to design a system which is robust to likely Soviet countermeasures; the second minimizes unproductive responses to threats that are not credible.

(U) <u>System Survivability</u>

(U) <u>Description and Objectives</u>

(U) To ensure that the Systems Architect and hardware designers produce candidate strategic defenses that are capable of surviving to mission completion, the Survivability Project is structured to identify promising survivability approaches that include technologies, tactics and concepts. This project is expected to assure that promising approaches are evaluated for their effect on system performance and that trade-off assessments are conducted among the candidate survivability approaches. The results of the survivability technology, tactics and concepts research program will be provided to the Systems Architect and hardware designers for incorporation into candidate systems and the strategic defense architectures.

(U) Significant Accomplishments (FY 1984-1985)

- (U) An important accomplishment was the identification and transition, where appropriate, of relevant survivability activities to the SDIO. When the System Survivability Project was initiated, there were a number of existing DoD Service and Agency research programs for ground system, airborne system, communication link, and space system survivability. Much of the research was related to SDI goals but was not oriented to meet the specific research objectives of the SDI. The criteria used to decide whether a task should be included in the System Survivability Project was that the proposed research be critical to an informed decision on the feasibility of candidate ballistic missile defenses. Additionally, the effort needed to have sufficient technical uncertainty so that research was warranted to try to reduce the risk to acceptable levels. Thus, a large part of FY 1985 was devoted to weeding out those technical programs that were of low risk and sorting out those efforts that were of interest only to a specific Service or Agency, but not critical to the SDI.

- ~~(C)~~ A reorientation of the survivability project also took place to balance research between near term survivability technical options and concepts that would meet a far term or fully responsive threat. The Systems Architecture will need to be able to handle the near term defense suppression threat, yet evolve to handle the far term threats. Since the nearer term threat is better understood and technical countermeasures to it are more mature, there has been a temptation to focus on the near term. The survivability research project is seeking to provide the correct balance so that the necessary technical concepts are available at the right time.

- ~~(S)~~ Initial research in active survivability technologies produced promising concepts and designs of responsive decoys, electronic countermeasures, electro-optical countermeasures and spacecraft signature modification techniques. A multiyear technology development and test program was developed to support system definition efforts. Technical requirements and concept studies initiated in FY 1984 were completed and have established the role active technologies play in strategic defense systems. The design and development of experimental demonstrations of hardening techniques began in earnest in FY 1985 and have indicated a need to progress to the definition of limited space experiments required to demonstrate promising survivability technologies.

- ~~(S)~~ Limited subscale testing of selected passive survivability technical concepts and materials has led to promising approaches to harden various critical spacecraft components from the effects of lasers. This includes the testing of a new laser radiation rejection material which is a candidate near-term thermal laser shield. The testing to destruction of space-qualified, laser-hardened optical and thermal control hardware has begun. This data will establish the current state-of-the-art in laser hardening techniques that mitigate or prevent laser damage to satellite components.

- ~~(S)~~ A major effort is already underway to reduce the spurious response of nuclear hardened sensors to electron fluxes while maintaining the requisite sensor performance level, and to provide effective lightweight spacecraft armoring techniques to protect vital elements against hypervelocity kinetic energy pellet attacks. Additionally, efforts are continuing to identify candidate testing facilities for upgrade to achieve the required power levels and pellet weight/pellet velocity characteristics that will assure testing of kinetic hardening concepts under realistic conditions.

- ~~(S)~~ The capability to harden electronic components and subsystems from the effects of a nuclear environment has achieved substantial progress. Results from testing shielding packages and RAD-PAK protected microelectronic integrated circuits have met or exceeded all specifications. Shielding effectiveness factors of [redacted] reduction (nuclear enhanced and natural environment respectively) were demonstrated. The required technology base to demonstrate the viability of [redacted] to provide extremely hard electronics has made excellent progress. Additionally, numerous tests and analyses have been performed on [redacted] microelectronic technologies. This will ensure the development and evaluation of alternate and innovative microcircuit technologies.

- ~~(S)~~ Several prototype terminal protection devices, a technique to protect satellite electronics from System Generated EMP (SGEMP) surge currents, have been developed, tested and the design methodology confirmed. The demonstrated capability provides protection to at least [redacted] current guidelines of the Joint Chiefs of Staff (JCS). Furthermore, the prototype device configurations are compatible with spacecraft design practices, integration procedures and reliability considerations.

- ~~(S)~~ A technique for hardening optical surfaces from the effects of nuclear radiation is being developed using the [redacted] Computational models to predict the response to radiation [redacted] Again, preliminary conclusions indicate the capability to attain hardness levels [redacted] JCS guidelines.

- ~~(S)~~ Initial testing of the effects of millimeter/microwaves on generic spacecraft electronics has established preliminary interference effects thresholds, increased the understanding of coupling effects, and advanced the development of hardening strategies for the various levels of potential electronic warfare electromagnetic threats. Tests have focused on the characterization of the excitation environments in terms of amplitude, frequency content and pulse/continuous wave parameters.

- ~~(S)~~ The initial compiling of detailed threat information describing possible responses an adversary may take to defeat potential defenses was completed.

This threat task was undertaken originally within the System Survivability Project since the development of threat data on potential Soviet/adversary responses to U.S. strategic defenses would be a driver in defining the survivability technical objectives. The first Defense Suppression Threat (DST) document, created during FY 1985, contains over 60 excursions. The excursions will be classified according to likelihood of their development. While the excursions span a wide spectrum of threats--including some exotic and far-term threats--care is taken to ensure that the development of countermeasures for the near term be able to defeat the most likely threats that the enemy can be expected to deploy first. The updating and refining of the DST will be an iterative process involving the SDIO and the intelligence community.

(U) Lethality and Target Hardening

(U) Description and Objectives

(U) The objective of this project is to determine the lethality that can be inflicted by the type of weapons being considered in SDIO research on the full spectrum of targets that a U.S. strategic defense may encounter. Project experimental research is expected to validate theoretical models that predict lethality against the hardened and unhardened targets against which the U.S. defense would be employed. Testing is being conducted on both subscale and full-scale models. The resultant data on the induced structural response and target failure modes are of fundamental significance in assessing the potential of proposed SDI weapon concepts.

(~~S~~) The results of the testing are being used to provide a probabilistic assessment of the lethality of projected SDI weapons. This assessment is updated and published annually. The Lethality and Target Hardening Project is heavily oriented toward the generation of basic scientific data. The High Energy Laser System Test Facility (HELSTF) is being used to assess booster vulnerability to high intensity continuous wave thermal lasers. A particle beam test facility for the generation of a particle beam target effects data base has also been developed and will become operational in FY 1986 at Brookhaven National Laboratory. This effort will address electronic kill levels achievable from the penetrating beam. Kinetic energy projectile research will establish a basis for determining hit-to-kill lethality levels and will increase our understanding of layered and composite material response to hypervelocity penetrators. A major FY 1986 effort will determine the lethality of high power microwaves against post-boost vehicles (PBV).

~~(S)~~ The lethality assessment is used in technical trade-off evaluations to support decisions on the selection of system concepts for further development. For instance, testing on realistic targets and threat system mock-ups would allow determination of weapon lethalities before large investments are made in SDI systems. SDIO expects to develop hardening techniques and incorporate them into system testing for evaluation with respect to performance, mission impact, cost and maintainability. To assure maximum cooperation and use of available resources, all SDI Lethality and Target Hardening efforts are being closely coordinated with complementary weapon research efforts in the Department of Energy. Because the lethality project establishes failure levels, much of the data could be useful for survivability assessments. Efforts are, therefore, carefully coordinated between this project and the System Survivability Project.

(U) Significant Accomplishments (FY 1984-1985)

(U) The Lethality and Target Hardening Project has achieved the most progress among the SLKT projects. For a number of years, various Service and Agency programs had supported limited examinations of vulnerability and target hardness issues for particular applications. Portions of these programs were integrated into the SDI lethality project. In addition:

- ~~(S)~~ Continuous wave laser tests were conducted at HELSTF on full-scale solid and liquid boosters under simulated flight loads. The missiles were destroyed and failure models correctly predicted the failure temperature and time. (See Figure VII.F.1 and Table VII.F.1.)

- ~~(S)~~ Impact tests with kinetic energy projectiles at velocities up to [redacted] were performed. The quarter scale test fired an [redacted] at both a post-boost vehicle (with RVs) and a liquid fueled target. (See Figure VII.F.2 and VII.F.3.) The test validated a 3-D Eulerian code that uses the Lagrangian-follower technique to model damage. Significant issues associated with this PBV kill are being assessed. The modification of a gas gun test bed will permit testing at [redacted] in FY 1986. Development of an electromagnetic accelerator test bed was initiated at Los Alamos National Laboratory. Testing at hypervelocities [redacted] will begin in FY 1987.

- ~~(S)~~ Preliminary lethality estimates using available data were completed and published in a single document. These data show that today's missiles could be vulnerable to SDI kill mechanisms at achievable energy levels.

- ~~(S)~~ Construction was initiated on a dedicated particle beam lethality test bed at Brookhaven National Laboratory to be finished in FY 1986. Analyses and validating tests were performed to determine the effectiveness of using particle beams for re-entry vehicle and decoy discrimination.

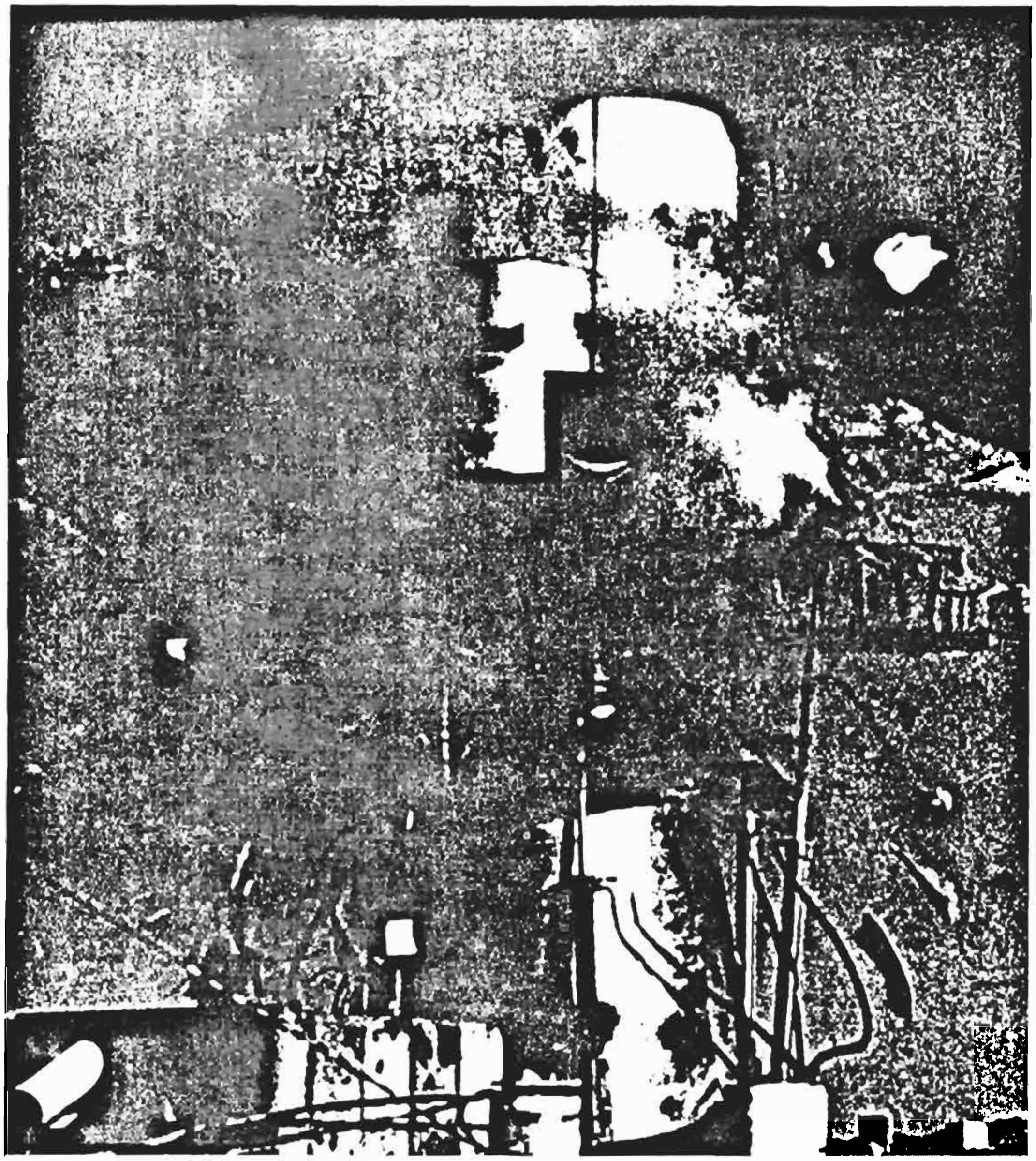

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Figure VII.F.1. (U) A Booster Body Section Being Destroyed in a Test Using a Continuous Wave Laser

PHOTO OF DAMAGE TO REENTRY VEHICLES
(HARD POINT TEST)

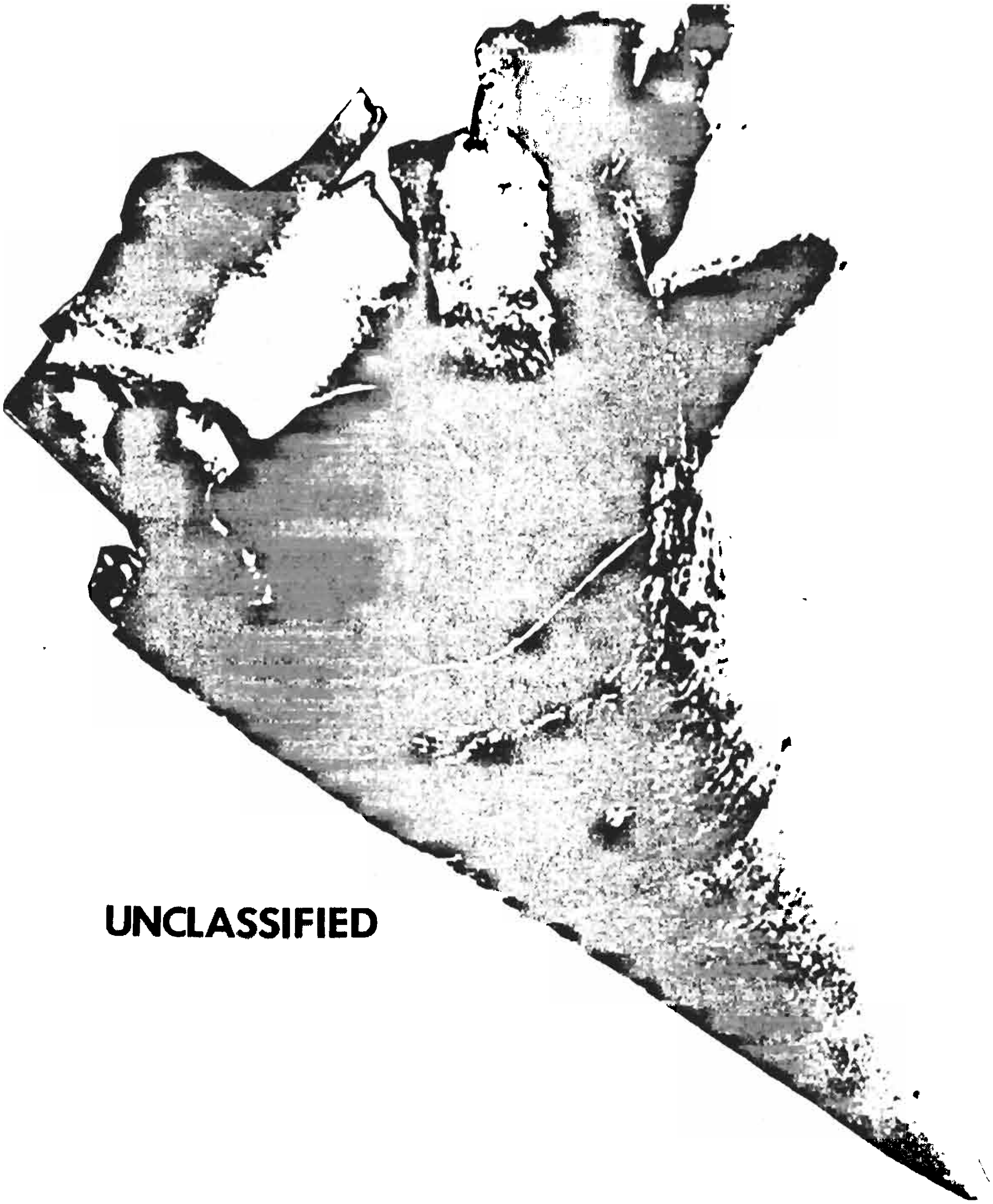

Figure VII.F.2. (U) Actual Damage to Reentry Vehicles (Kinetic Energy Fragments)

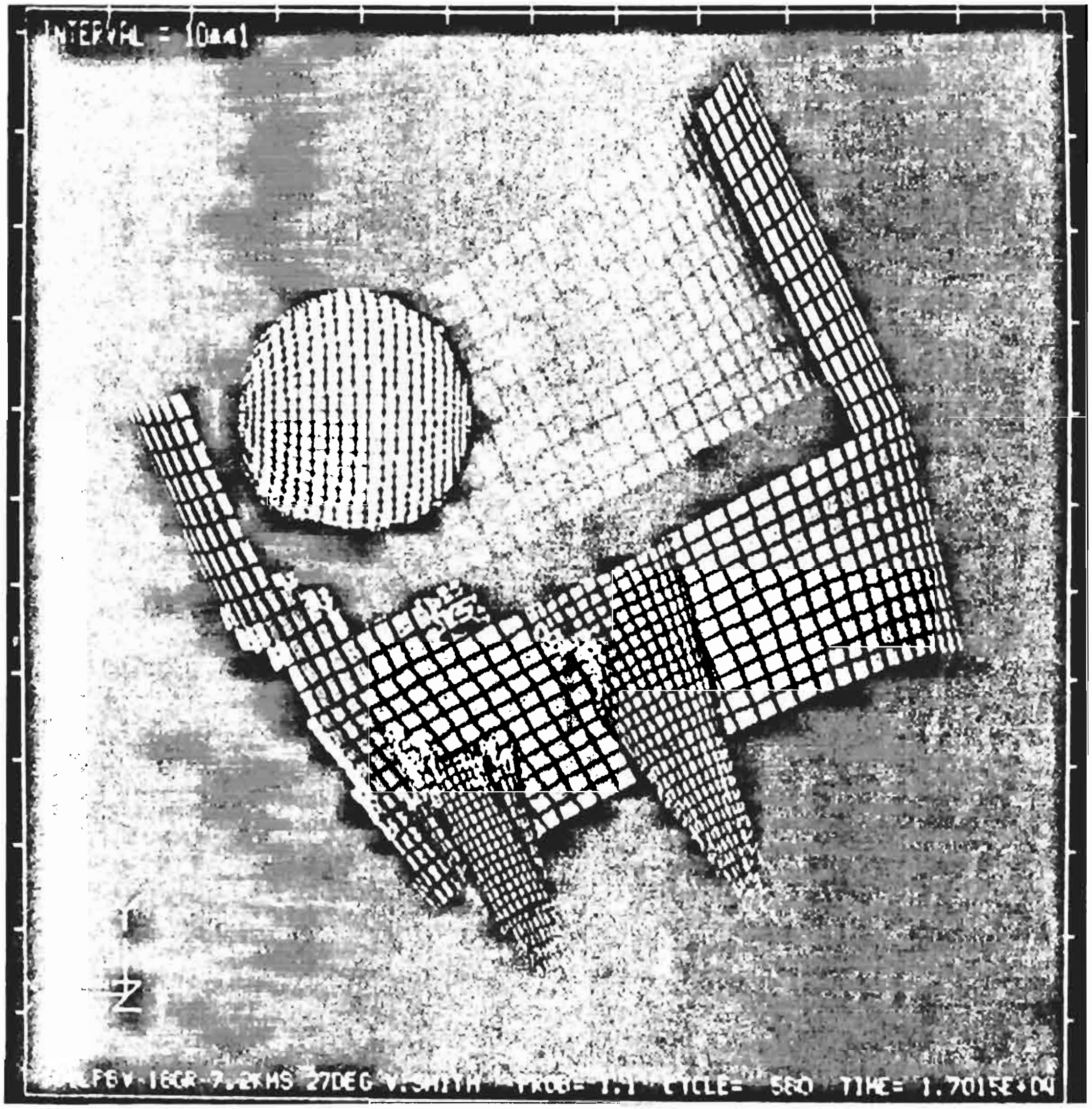

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Figure VII.F.3. (U) Computer Prediction of RV Damage (Excellent Match to Actual Damage)

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- (C) Impulse coupling tests were performed for various materials under differing laser fluence levels to verify the accuracy of existing computer simulation codes. Modification of a large excimer laser at Los Alamos National Laboratory was completed to permit high fluence tests in FY 1986.

- (C) Preparations were largely completed for an FY 1986 test series designed to determine the lethality of high power microwaves against hardened PBVs.

(U) <u>Space Power and Power Conditioning</u>

(U) <u>Description and Objectives</u>

(U) Among the findings of the Fletcher Study was the conclusion that the overall success of certain concepts is highly dependent upon the ability to generate tremendous amounts of electrical power. In response to this challenge, the Space Power and Power Conditioning Project was established to develop power generation and conditioning technologies capable of providing electric power for the projected needs of a strategic defense. Power levels in excess of 100's of megawatts have already been identified. The program consists of four tasks: assessment and analysis of power subsystem concepts and requirements; the joint SDIO/NASA/DoE SP-100 task; multimegawatt (MMW) power research; and pulsed power technology conditioning development.

(U) The Assessment and Analysis task includes the power requirements definition and mission integration studies, power system architecture studies, and the assessment and evaluation of candidate concepts. A requirements document containing a comprehensive set of specific power requirements based upon the system architecture studies is being generated. The document will be updated annually as the system concepts evolve. The power system architecture studies will investigate the effects of the natural and system-generated environments on the power subsystem, and the interactions between the power subsystem and the other subsystems comprising the candidate space platforms. To support Space Power and Power Conditioning efforts, an Independent Evaluation Group (IEG) was formed. The purpose of the IEG is to advise the SDIO on the technical merit, trade-offs and technology needs of proposed concepts, to identify and track the evolving power subsystem requirements through coordination with other program elements under the SDIO, and to provide power subsystem analysis and models to support SDI System Architecture activities.

(U) The SP-100 task represents an intermediate stage of development for high power space-based systems. SP-100 is the cornerstone of the research and technology effort seeking long term continuous power supplies (see Figure VII.F.4). It is a 100 kilowatt-class nuclear power generation subsystem that will have the potential for growth up to the 1 megawatt level. The task is funded jointly by the SDIO, NASA, and DoE. This technology is needed not only to provide moderate continuous power levels for a variety of projected SDIO needs, but also to act as an enabling technology for several NASA and non-SDIO military programs planned for the 1990s. The major subsystems (reactor, power conversion, heat transport and radiator, and control) will be ground tested as part of Phase II. A reference mission that combines the SP-100 with electric propulsion is targeted for a FY 1993 launch.

(U) The multimegawatt research task was initiated in FY 1985 to address the projected SDIO requirements for both high level continuous power and burst mode power. The goal is to establish and advance the technology base sufficiently by the early 1990s to establish the feasibility of satisfying mission requirements within acceptable costs. Both nuclear and nonnuclear power sources are under consideration in open cycle and closed cycle configurations. The overall task strategy is to solicit and evaluate a broad spectrum of candidate concepts from industry and

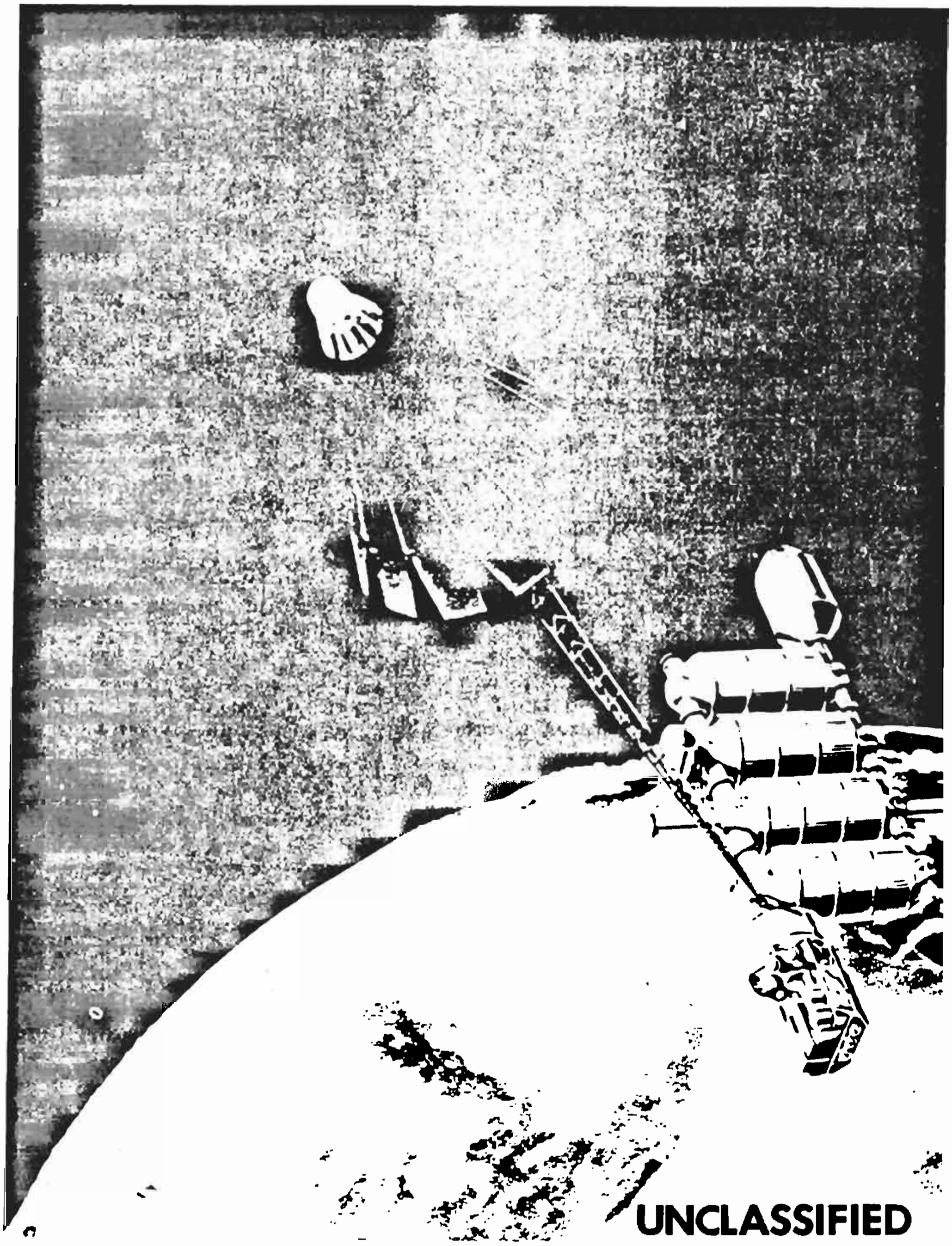

Figure VII.F.4. (U) Space Test of the SP-100 Power Concept laboratories, followed by a narrowing of the number of potential concepts during FY 1986, and then to embark upon both generic and technology specific development. A further narrowing of the number of concepts is expected to occur in FY 1988, with focus placed upon the primary technology efforts in support of the candidate concepts. Ultimately, efforts would continue to develop the data base for these concepts in order to establish overall feasibility.

(U) A new start in FY 1986, the Pulsed Power Conditioning Technology task, addresses the special energy forms and delivery requirements for the weapons systems. It is a broad-based effort that seeks to expand the existing technology base through fundamental research and development with emphasis on critical element development. Pulsed Power technology is the set of technologies used to condition raw power generated from prime power sources to match the electrical requirements of a given load. Critical pulsed power elements include switches, intermediate energy stores, and power conversion elements. The effort will seek to develop elements capable of delivering sufficient energy pulses to drive the proposed weapons concepts.

(U) <u>Significant Accomplishments (FY 1984-1985)</u>

- (U) Under Assessment and Analysis, the first draft of the requirements document is complete, and an RFP for the Power System Architecture studies was issued.

- (U) The SP-100 project is proceeding on schedule and has successfully transitioned from Phase I, Technology and Assessment, to Phase II, Ground Engineering Development Testing. Phase I culminated with the selection of the liquid-metal-cooled fast spectrum reactor and the thermoelectric power conversion option. The Hanford Engineering

Development Laboratory has been selected as the preferred test site for the reactor test. Phase II involves developing and demonstrating the performance, safety, dependability, manufacturability and technology readiness of the selected power system concept through ground testing of the major subsystems at appropriate test facilities. Critical component testing will occur during FY 1986 and FY 1987. The final design will be completed in FY 1988 and ground testing will be completed in FY 1991.

- (U) FY 1985 was primarily a planning year for the multimegawatt task. Major accomplishments included the establishment of the MMW management structure and formation of the IEG. In addition, responses from the solicitation of advanced concepts from industry and laboratories for MMW subsystems and components were reviewed and screened.

(U) <u>Space Transportation and Support</u>

(U) <u>Description and Objectives</u>

(U) The Space Transportation and Support Project funds both research to understand strategic defense system requirements from a logistics and maintenance perspective and the development of technology to significantly reduce costs. This project seeks to identify the transportation and servicing requirements sufficient to deploy and maintain a robust and effective strategic defense; focus research efforts on promising technologies and concepts; and construct a body of knowledge which will contribute to making an informed decision regarding system development. It is clear that there is not now an adequate knowledge of the supply requirements and logistics infrastructure to support a space force of the magnitude and complexity envisioned for a multitiered ballistic missile defense.

(U) Significant Accomplishments (FY 1984-1985)

- (U) The approach to organizing, managing and funding the Space Transportation and Support Project has been formulated.

- (U) Multi-agency Space Transportation Architecture Studies were begun to investigate military and non-military space transportation requirements for the 1990s and in the post-2005 timeframe.

- (U) Transportation Technology Team organized to propose, manage, and direct technology programs to focus on the objective of reducing the costs of space operations.

(U) Materials and Structures

(U) Description and Objectives

(U) In the Fletcher Study, and early on in the SDIO research program, there was an implicit need for concomitant research and development of materials and large structures. Several systems and critical technologies could not succeed if there were not parallel discoveries and improvements in this area. For instance, major platforms for use in space would depend on employment and maintenance of large structures not yet built and tested for space use. It was also recognized that materials and structures do not now exist for the degree of survivability required by a strategic defense.

(U) At the onset, it was believed that such technology could be brought along in association with existing projects, but it has become increasingly clear that individual activities could be more corporately productive through concerted coordination and with better focus on those activities through central management. Also there appears to be a wide number of ongoing research efforts that could be more beneficial to the SDIO if technology managers outside the SDIO could be encouraged to work also toward the SDIO objectives.

(U) While there are fundamental critical requirements toward which the SDIO must work, the area of materials and large structures is one where the end users would especially benefit by innovation and improvement over and above the basic requirements. Gains in materials hardness against enemy weapons is one example of a critical survivability technology whose payoff continues regardless of the level of increased investment. Another example is inexpensive production of lighter weight optics. It is increasingly apparent that a large number of these requirements in the SDIO can be identified and assisted through this project.

(U) Significant Accomplishments (FY 1984-1985)

- (U) Limited research activities investigating materials and large structures for transport, operation and survivability in space (funded under Project 0010, System Survivability and other SDIO Program Elements) indicated this technology area lags behind other efforts within the SDI. Based on this, it was decided to consolidate and/or expand current materials and large structures work.

- (U) Initated an assessment to determine the generic materials and large structures requirements within the SDI research program and to identify ongoing projects both within the SDIO and elsewhere that are relevant to the Materials and Structures Project.

(U) Countermeasures

(U) Description and Objectives

(U) The principal elements of the SDI countermeasures analyses program are (1) a Soviet Red Team, (2) Technical Red and

Blue Teams, and (3) Mediators. The major objective of the Soviet Red Team is to formulate a reasonable Soviet global response to a strategic defense. This team will generate a "top-down" set of Soviet priorities for countering the SDI program (which may not coincide with the current emphasis in the SDI technical programs). For example, the Soviet Red Team may determine that the most likely Soviet response to an SDI system concept is to build a class of weapons that circumvents rather than counters the U.S. defense. The Soviet Red Team will also interact strongly with the Technical Red Teams and assist them in determining probable Soviet priorities for various technical counters.

(U) The Technical Red Teams will be organized as necessary to continue and greatly expand the technical countermeasure analyses conducted to date. They will examine system concepts (boost and midcourse defense concepts, for example) or individual components of a system concept to assist the defense designers in understanding technical responses to their system or component. Each Technical Red Team will interact with a corresponding Blue Team formed by the defense system proponent in coordination with the appropriate SDIO Program Element Director. The Blue Teams will assess the impact of the Red Team analyses on their system design and make appropriate responses to the Red Team.

(U) The iterative process between the Red and Blue Teams will be facilitated by a set of Mediators. The Mediators are a group of senior government and industry people who are experienced in strategic offense and defense and can rapidly review the results of red and blue analyses to determine credibility, assess implications on SDI system concepts or components, and provide sound advice for further analyses. The Mediators report directly to the SDIO Chief Scientist. It is this group that ensures that the analyses are conducted properly and that the implications developed are reasonable. The Mediators formulate recommendations for the Director, SDIO.

(U) Also included in the Countermeasures Project is an experimental program. Here possible countermeasures will be built and tested if it is necessary to determine if a countermeasure proposed by a Red Team and found to be technically feasible by the Mediators will actually work as conceived. The experimental work could be conducted by either industry or government agencies.

(U) Significant Accomplishments (FY 1984-1985)

- (U) Established and staffed an independent office reporting to the Director within the SDIO to manage a continuing program for countermeasures analysis, to identify possible Soviet responses to the SDI and to ensure these responses are addressed by SDI systems designers. The Countermeasures Project began at a very low level in the last half of FY 1985.

- (U) Established Technical Red and Blue Teams to consider the design of the High Endoatmospheric Defense System being developed by the Army. Preliminary results are expected in early FY 1986.

- (U) The Soviet Red Team was established and commenced work formulating reasonable global Soviet reactions to the SDI. This activity adds political and economic considerations to the analysis performed by the Technical Red Team.

G. (U) INNOVATIVE SCIENCE and TECHNOLOGY (IST) OFFICE

(U) Description and Objectives

(U) The Innovative Science and Technology (IST) Office is a technical division within the SDIO tasked with seeking out new and innovative approaches to ballistic missile defense. It allocates funding to sponsor research in these approaches and assures that the other technical divisions within the SDIO are apprised of new results and breakthroughs emanating from IST programs. The funding for FY 1985 for the SDIO/IST effort was $28M (2.0 percent of the total SDIO appropriation). The projected funding level for FY 1986 is $91.8M (3.3 percent of the total SDIO authorization).

(U) The IST Office has several specific roles. First, it establishes a technology base for strategic defense through fundamental research. This kind of research effort is conducted throughout the scientific community in universities, government and national laboratories, small businesses, and large industries. Second, the IST Office provides a window for the scientific community into SDIO programs. This unobstructed view is very important since many of the new ideas and breakthroughs in basic science and engineering have been spawned traditionally from university programs. Many of the basic ideas on which SDIO success may depend may also come from those same universities. Finally, the IST Office has the responsibility to administer the SDIO Small Business Innovation Research (SBIR) Program. This federally-mandated program required in FY 1985 that 0.5 percent of the total SDIO extramural Research & Development funding be allocated to small businesses via the SBIR mechanism. This requirement increases to 1.0 percent in FY 1986.

(U) The IST Office sponsors fundamental research programs in six major areas: (1) advanced high-speed computing, (2) materials and structures for space applications, (3) sensing and discrimination, (4) advanced space power, (5) space sciences and experimentation, and (6) directed/kinetic energy concepts. The research program is centrally managed by IST personnel and implemented through Science and Technology Agents (STAs) located at other government agencies (such as Office of Naval Research, Air Force Office of Scientific Research, Army Research Office, Defense Nuclear Agency, NASA, DoE, and other DoD laboratories). Proposal review, contracting, and day-to-day technical management of the IST research programs are the responsibility of the STA.

(U) Significant Accomplishments (FY 1984-1985)

(U) SDIO's Innovative Science & Technology research programs have been in existence for less than one full year. Nevertheless, a number of significant accomplishments have occurred since its commencement. Ongoing projects have been accelerated by IST funding, or new projects have been initiated by IST. Some of the best examples of these are:

- (U) A new composite material, lithium alumina silicate glass reinforced with silicon carbide fibers, has been recently fabricated. This new material combines its amazing lightweight, laser-resistant properties with very large tensile strength, making it very promising for space structure applications.

- (U) A new insulating polymer, made from resins of vinylidene fluoride and tetrafluoroethylene, has been designed totally via computer simulation and then synthesized in the laboratory. This new polymer will be used in the construction of new high-energy density, super capacitors.

- (U) The first generation of novel super-capacitors for power storage has been designed and constructed. These capacitors can store up to 50 kilojoules of energy in a can the size of a large wastebasket. Such devices could have a large number of applications in many of the directed and kinetic energy concepts being explored by SDIO.

- (U) As part of the high-speed computing effort sponsored by the IST, a program exists in optical data processing. A major breakthrough has occurred in the effort to construct an optical supercomputer--the development of an optical, bistable switch. While this occurred overseas, the institution responsible for this breakthrough is eager to join the IST program in this area and cooperate with American researchers on this project.

- (U) A major program exists at the Lawrence Livermore National Laboratory to develop a laboratory x-ray laser. Although a startling experimental success was realized in 1984, no satisfactory theoretical explanation was forthcoming until IST funded a theoretical program to investigate the phenomenon. In less than 6 months, the new project produced an explanation for the new lasing scheme and substantiated the result with computer simulations.

- (U) A new ultra-high energy density mini-capacitor has been developed by the IST space power consortium, with 1.0 microfarad storage capacity at 5.5 volts in a container of only 15 cubic centimeters. The idea is based on maximizing the ratio of conductor area to separation distance using activated carbon, which has an amazing surface area of 500-1000 square meters per cubic centimeter of particles.

- (U) A new micro-miniature refrigerator the size of a quarter has been developed that can cool to 10 degrees Kelvin a niobium nitride superconductor used in Germanium infrared detectors for the SDIO sensors mission. The refrigerator fluent is pumped by a novel nonmechanical pump that could be powered from the heat extracted by exhaust in a space system.

- (U) A major breakthrough was achieved in the area of Mossbauer spectroscopy when an IST researcher found that he could compensate for the recoil of the nucleus caused by gamma ray emission by employing an external laser as an additional photon source to enhance the energy of the gamma ray via "dressed" isomeric levels. This is the first step toward the possible development of an effective gamma ray laser.

(U) Current Activities and Future Plans

(U) In the coming months, the Innovative Science and Technology Office anticipates that many of the accomplishments listed above could be implemented in ongoing IST-sponsored projects.

(U) In the area of electromagnetic launcher systems, a new technology test bed to be used for lethality, materials, dielectric and insulator research, and other key issues is to be completed soon. The operating specifications of this system will be to accelerate 100 gram projectiles to velocities of 5 km/sec with a duty cycle of at least 20 shots per week. This program should do much to alleviate the stark lack of data in the electromagnetic launcher data base, as well as to serve as test bed for new rail materials and insulators.

(U) The super-capacitor program described above is aimed at extending the frontier in capacitor design to produce a device that stores 250 kilojoules of energy in the same size can as the existing 50 kJ capacitor. In three years, the goal is to store a megajoule of energy in this volume. If this goal is attained, the well-known and reliable technology of capacitors begins to compete with much more complex schemes for economic power storage in space.

(U) The program in metal-matrix composites has recently become interested in using these materials for large mirror fabrication. The implication for the robust optics requirements of the SDI is far-reaching: better uniformity, more survivable, more easily machined, and more lightweight than conventional optics.

(U) The miniature cryogenic cooler described above is to be used in the fabrication of a novel, low-cost, broad-band, infrared detector. These detectors are needed to perform the many sensing tasks required by a strategic defense system, and the development of new miniature devices with very low power requirements will greatly assist in the performance of this mission.

(U) The IST Space Nuclear Power Consortium has, in addition to other schemes, a plan to design a multi-megawatt pulsed gaseous fuel reactor. The advantage of a gas fueled reactor concept is that the gas can be pulsed rapidly throughout the system to attain the burst-mode power requirements needed for many directed and kinetic energy concepts being explored by SDIO. The consortium is also studying the maintainability, reliability, and safety issues associated with such a reactor in concert with the design program.

(U) In the area of directed energy, the study of novel schemes for designing a gamma ray laser has been bolstered by the recent result in Mossbauer spectroscopy. Although this is still a far term effort, the potential for success is quite high and would result in storage of energy in a directed energy beam that would exceed the present SDIO requirement by several orders-of-magnitude. An added attraction of the existing gamma ray laser schemes being investigated is that they do not depend on a nuclear explosive driver to pump the laser.

CHAPTER VIII

(U) ORGANIZATION AND RESOURCE MANAGEMENT

A. (U) DESCRIPTION AND OBJECTIVES

(U) The Department of Defense (DoD) has the responsibility of exploiting emerging technologies that may provide the technical knowledge required to support a decision on whether to develop and later deploy advanced defensive systems. The Strategic Defense Initiative Organization (SDIO) was established as the DoD agency charged with managing and implementing the research and technology efforts of the SDI. The SDI program, drawing heavily from the technology plan identified by the Defensive Technologies Study and the policy guidelines outlined in the Future Security Strategy Study, has been given the highest priority in DoD in an effort to achieve the goals and technical objectives of the SDI.

(U) The SDIO is an independent defense agency whose Director reports directly to the Secretary of Defense. The organizational structure designed to assist the Director, Strategic Defense Initiative Organization (DSDIO), consists of a mix of technical and administrative offices addressing the ongoing scientific research, broader policy issues in conjunction with the Under Secretary of Defense (Policy), and the efficient management of people and resources. Figure VIII.1 identifies the current organizational scheme for the SDIO. From a rather austere beginning in FY 1985, an office staffed by eight military personnel and four civilians, the SDIO has grown to 51 military personnel and 49 civilians by the end of that fiscal year. Due to the critical nature of the SDI research program, the selection of SDIO personnel has focused on highly competent technical, policy and resource management people.

(U) Effective SDIO management of the SDI research and technology program requires guidance to, and careful coordination with, various participating and interested organizations. This includes, but is not limited to, the following organizations: Army Strategic Defense Command, Headquarters U.S. Air Force,

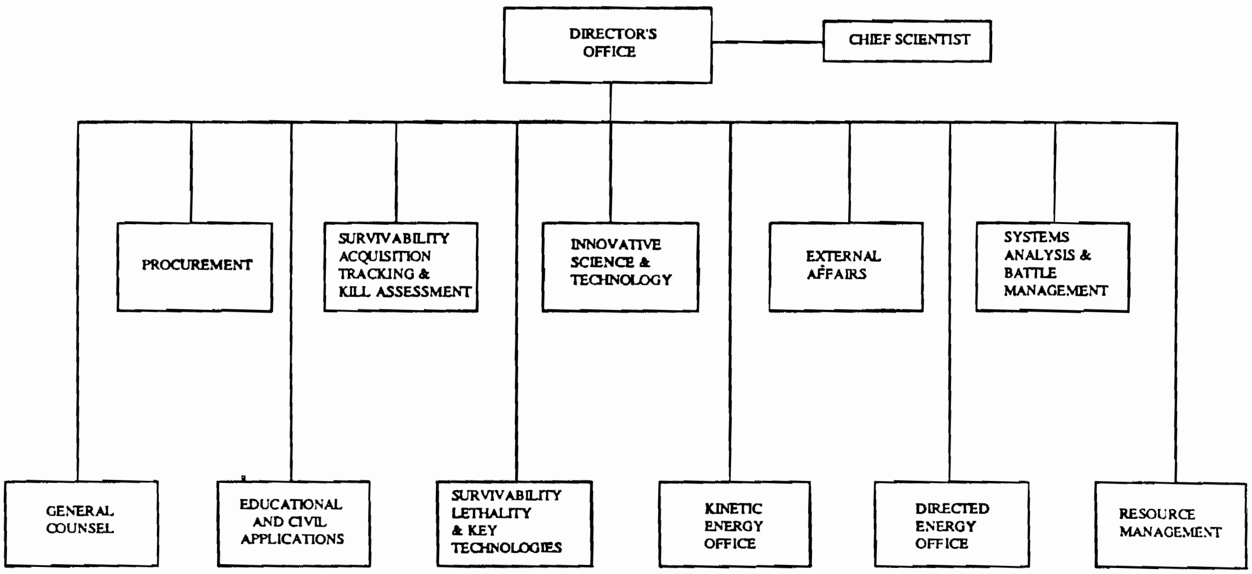

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Figure VIII.1. (U) The Current Organizational Structure of the SDIO

Defense Nuclear Agency (DNA), Department of Energy (DoE), various National laboratories, and numerous civilian contractors. For the most efficient use of resources, constant coordination must exist between the SDIO and non-SDI programs doing SDI-related research. For example, innovative technologies developed in the Defense Advanced Research Projects Agency (DARPA) strategic computing program and Air Force anti-satellite research efforts may address areas of interest to the SDIO. Finally, national policy questions require effective coordination between DoD, the State Department, the Congress and Administration officials.

(U) The DSDIO is responsible to the Secretary of Defense for coordinating and executing the SDI program within the Planning, Programming, and Budgeting System (PPBS). The DSDIO represents the program as a member of the Defense Resources Board (DRB) when strategic defense or related matters are under consideration. The DSDIO is also responsible for submitting the SDI program PPBS inputs to the Director, Program Analysis and Evaluation. It is DSDIO who defends the SDI program and its budget before Congress. Where required, the DSDIO also initiates reprogramming actions in accordance with DoD Directives and Federal Law.

(U) Significant Accomplishments (FY 1985)

(U) The SDIO has made significant progress in the past year. It centralized the planning and control of the SDI program while decentralizing the execution of specific technology efforts. In doing so, achievements in efficient program management and resource management are particularly noteworthy.

(U) Much of the program activity in early FY 1985 was a transitioning of existing research activities in DoD Services and Agencies to the SDIO. Numerous new program starts were initiated, and many existing programs were altered to focus their research efforts on SDI goals and technical objectives. Even though it was difficult to develop a comprehensive program on short notice, SDIO met the challenge with resource management procedures that ensured careful use of funds for the most productive results.

(U) SDIO effectively managed its funds during this period despite normal startup activities and large program growth. Obligation rates for FY 1985 were extraordinarily high. Expenditures were comparable to similar DoD research activities such as the Defense Advanced Research Projects Agency (DARPA) and the Air Force Research and Development (R&D) effort. Approximately 1,000 SDI contracts were awarded during FY 1985. By the end of the year, the majority of FY 1985 work had been completed. Some of the more noteworthy program and resource management accomplishments from the past year include:

- (U) Obligation rates in FY 1985 of 94 percent. Table VIII.1 depicts comparisons of obligations and expenditures in several areas of the DoD most comparable to SDIO. Even though these were multiyear funds available for obligation during FY 1985 and FY 1986, SDIO's obligations were consistently higher than comparable research programs. SDIO managed to attain normal expenditure rates despite normal startup activities and large program growth.

- (U) Over 90 percent of FY 1985 work was completed by year's end. Approximately 1,000 contracts were executed. Figure VIII.2 depicts the geographical distribution of the contracts and funding.

- (U) SDIO established centralized planning and control of the overall program. A review by the General Accounting Office (GAO) regarding SDIO's FY 1985 obligations and program plan was complementary in its findings.

(U) TABLE VIII.1

(U) FISCAL OBLIGATION AND EXPENDITURE COMPARISONS WITHIN DoD

OBLIGATIONS
(%)

	ANN PGM	MAR	APR	MAY	JUN	JUL	AUG	SEP
TOTAL ARMY R & D	$4.4B	53	59	64	69	75	79	89
TOTAL NAVY R & D	$9.3B	70	75	80	84	86	89	93
TOTAL AF R & D	$13.5B	51	58	62	66	71	76	87
SDIO	$1.4B	56	62	66	70	76	83	94
DARPA	$0.7B	44	51	57	66	72	76	84
AF STRAT R & D	$5.7B	44	51	58	60	64	69	85

EXPENDITURES
(%)

	ANN PGM	MAR	APR	MAY	JUN	JUL	AUG	SEP
TOTAL ARMY R & D	$4.4B	18	23	27	32	38	44	50
TOTAL NAVY R & D	$9.3B	14	19	23	33	39	44	51
TOTAL AF R & D	$13.5B	17	21	26	30	35	40	45
SDIO	$1.4B	9	12	16	21	27	34	40
DARPA	$0.7B	3	5	8	20	25	29	42
AF STRAT R & D	$5.7B	10	15	19	21	26	30	34

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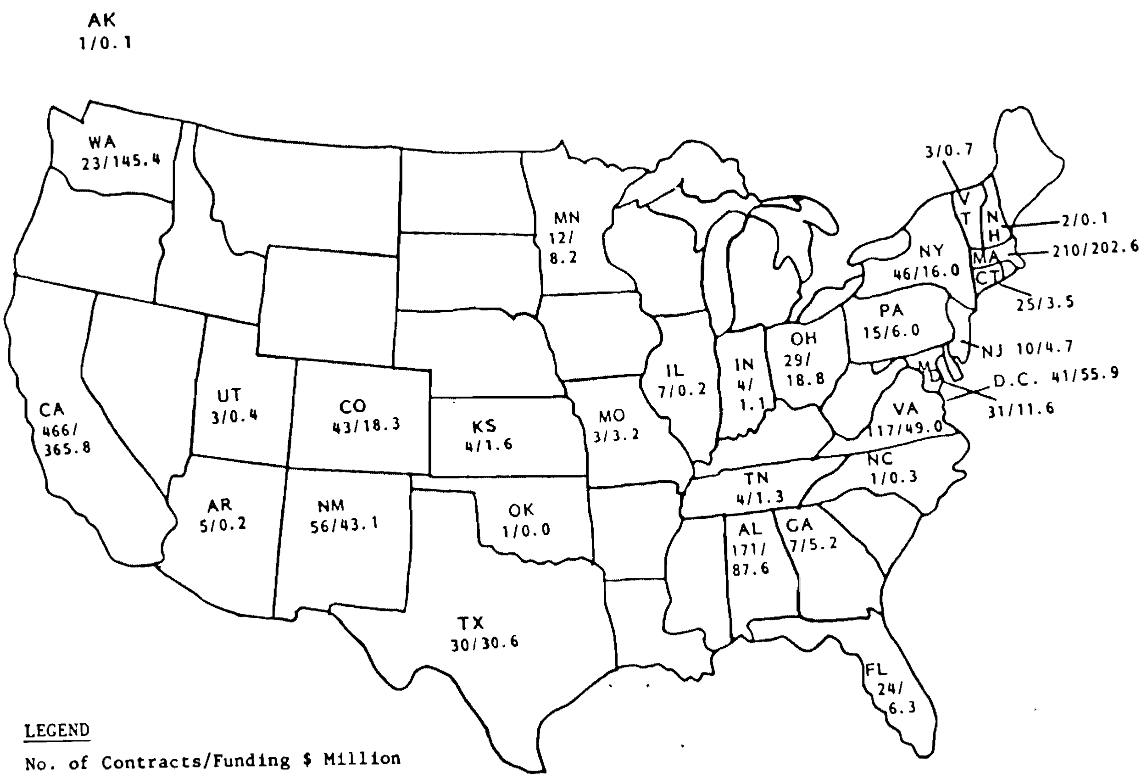

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Figure VIII.2. (U) Geographical Distribution of SDIO Contracts and Funding

B. (U) CURRENT ACTIVITIES AND FUTURE PLANS

(U) Depicted in Table VIII.2 by program element are the appropriations for FY 1985, the appropriation for FY 1986, and the President's Budget Request for FY 1987. Figure VIII.3 indicates the status of SDI funds for FY 1985.

(U) The FY 1986 funding plan includes $2.35 billion in existing contracts started in FY 1985. A significant portion of this SDIO effort was initiated in late FY 1985 after the SDI was restructured to accommodate the FY 1985 Congressional cut of $1.0 billion.

(U) SDIO expects participating organizations to execute more than 1,000 contracts during FY 1986. Most of these contracts will involve technical research in six areas. SDIO is seeking considerable growth in the FY 1987 funding plan because technologies comprising the SDIO program have reached a point where they are ready for evaluation and emphasis. (This phenomenon of large annual growth is common when emerging technologies have undergone low-level research and are ready for applications to potential weapon system concepts.) In this growing effort, the SDIO goal has not changed since the President's March 1983 speech. SDIO plans to continue vital ongoing efforts in the FY 1987 SDI program. The FY 1986 SDIO fiscal projection includes a 95 percent obligation rate, a 90 percent noncancellable commitment rate, and a 60 percent expenditure rate (Figure VIII.4).

(U) Many of our Allies have indicated support for SDI research and in some cases interest in participating. U.S. and Allied security is indivisible. Work will continue closely with the Allies to ensure that Allied views, capabilities and resources are carefully considered. In addition to direct work for the program, their contributions could include innovative university research, individual exchanges, subcontracts to U.S. industry, or associate contractor arrangements.

(U) TABLE VIII.2

(U) SDIO APPROPRIATIONS AND FUNDING REQUESTS, FY 1985-1988 ($M)

	FY 1985	FY 1986	FY 1987	FY 1988
RDT&E				
SATKA	545.950	856.956	1262.413	1558.279
DEW	377.599	844.401	1614.955	1582.037
KEW	255.950	595.802	991.214	1217.226
SYSTEMS	100.280	227.339	462.206	563.998
SLKT	108.400	221.602	454.367	523.654
MGMT HQ	9.120	13.122	17.411	18.118
TOTAL RDT&E	1397.299	2759.222	4802.566	5463.312
MILCON				
SATKA				
DEW				
KEW			10.300	48.147
SYSTEMS				
SLKT				
MGMT HQ				
TOTAL CONSTRUCTION	0.000	0.000	10.300	48.147
TOTAL	1397.299	2759.222	4812.866	5511.459

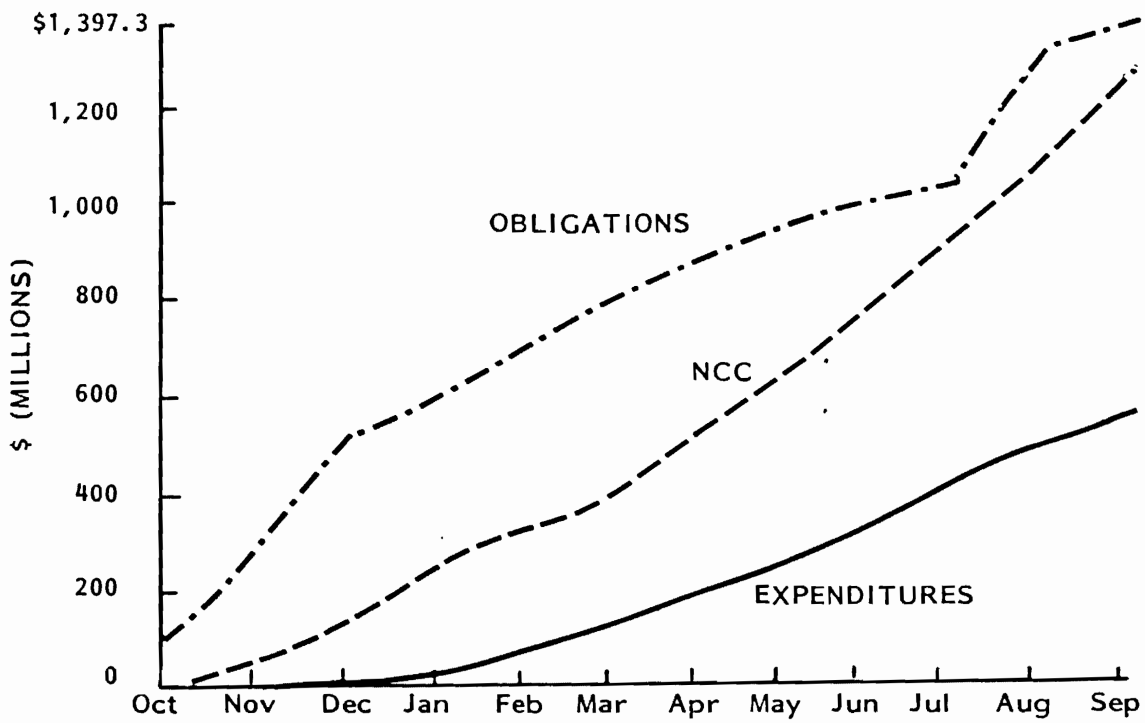

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Figure VIII.3. (U) Status of Strategic Defense Initiative Funds for FY 1985

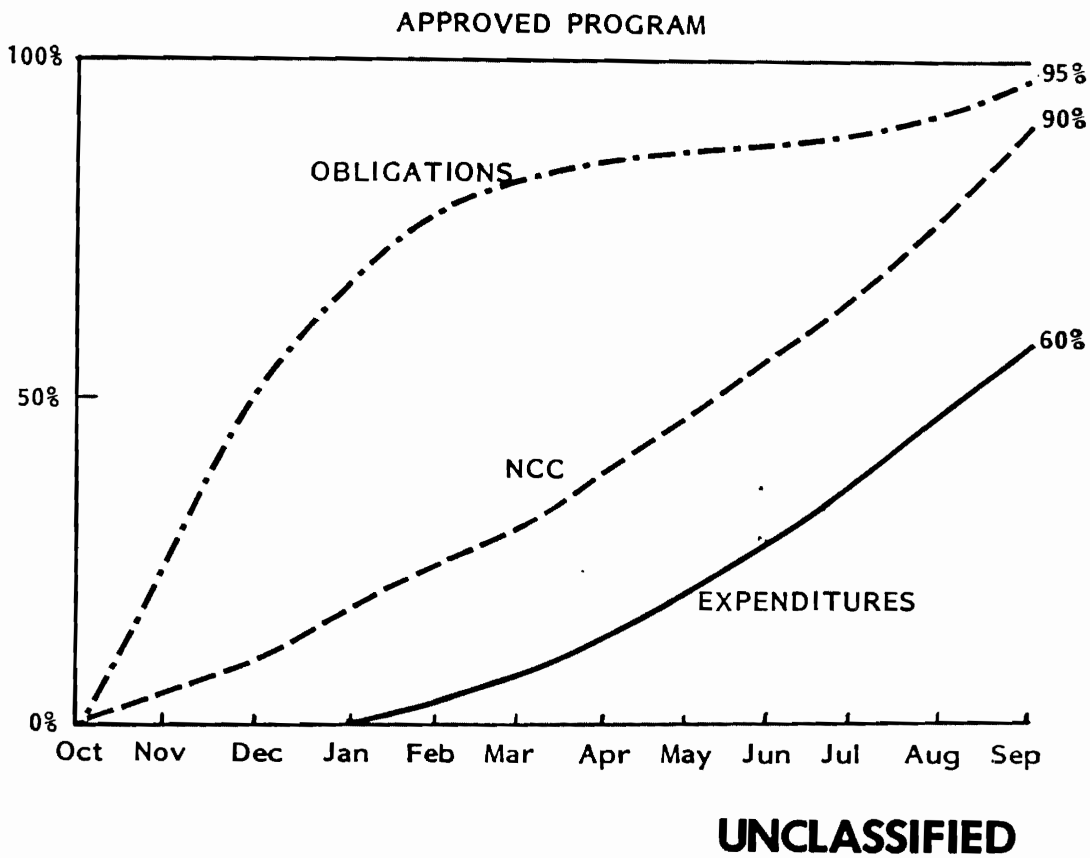

Figure VIII.4. (U) SDIO Fiscal Projections for FY 1986

(U) An aim of SDIO is to put resources to their most productive use. SDIO maintains that the traditional milestones of obligations and expenditures are important, but inadequate. Obligations generally occur when contracts are awarded, and indicate only that work can begin. Expenditures reflect only payments and the data is recorded months after the work has been accomplished. Both of these financial tools fail to reflect the true measurement of actual SDI work accomplished.

(U) In view of the above, SDIO now measures work accomplished to date by means of Non-Cancellable Commitments (NCC). This is a method to determine what has actually been accomplished by estimating actual government liability to date.

(U) NCC is a sound financial parameter since it is closely related to performance. NCC are costs incurred during a given period representing liabilities for goods and services received, other assets acquired, and performance accepted, whether or not payment has been made. In essence, SDIO views the NCC data as more meaningful execution data since it reflects work actually accomplished and actual government liability. It articulates in real-time the debts being incurred by SDIO for research efforts, materials, deliveries, etc. This is closely related to accrual cost accounting procedures used in the private sector. To date, NCC has proven to be a much more meaningful management tool than obligations or expenditures.

APPENDIX A

(U) POSSIBLE SOVIET RESPONSES TO SDI

A.1 (U) INTRODUCTION AND SCOPE

(U) The following section responds to the Congressional request (Sec. 223) of the FY 1986 Appropriations Bill to address:

- (U) What probable responses can be expected from potential enemies should the Strategic Defense Initiative (SDI) programs be carried out to procurement and deployment, such as what increase may be anticipated in offensive enemy weapons in an enemy's attempt to penetrate the defensive shield by increasing the numbers or qualities of its offensive weapons;

- (U) What can be expected from potential enemies in the deployment of weapons not endangered by multi-layered ballistic missile defenses, such as cruise missiles and low trajectory submarine-launched missiles; and

- (U) The degree of the dependency of success for the Strategic Defense Initiative upon a potential enemy's anti-satellite weapons capability.

(U) Although the problem of predicting Soviet responses to possible procurement and deployment of a U.S. strategic defense system is extraordinarily difficult, the Strategic Defense Initiative Organization (SDIO) has developed a methodology and an organizational structure which seeks to ensure that likely countermeasures and responsive threats are understood and evaluated throughout the technical evolution of the SDI.

(U) Any deployed defensive system would be required to operate against a variety of threat types and force levels. A defense system must, however, be capable of achieving the SDI mission objectives against the full spectrum of threats that might emerge over its operating lifetime, including responsive threats of all types. Accordingly, a variety of threats must be considered based on possible alternative attack strategies and tactics.

(U) The SDIO recognizes that a comprehensive understanding of these threats is important for the development of a robust and survivable strategic defense system.

A.2 (U) METHODOLOGY

~~(S)~~ The SDI Organization has adopted a two part methodology designed to assure that the defensive system architectures and technology programs are sufficiently robust to achieve mission objectives, regardless of the form of the Soviet response. First, the SDIO has established and will maintain, with the coordination of the Intelligence Community, the baseline responsive threat to a deployed SDI-type ballistic missile defense system. This task deals with the analysis and interpretation of projected Soviet (and other) ballistic missile and defense suppression (attacks on the defensive system) threats to various types of future U.S. defensive systems. The baseline responsive threat reports will be completed during the second quarter of FY 1986 and will be reviewed, validated and updated annually.

~~(S)~~ The Intelligence Community provides analytic intelligence and threat definition support to the SDIO, through the mechanisms of an interagency intelligence advisory committee and a working group. The established interactions with the Intelligence Community will ensure that the SDIO is apprised of all intelligence analysis on enemy military capabilities and, in particular, on Soviet efforts to counter the SDI.

(U) Second, in order to maintain system design objectivity, the SDIO has also established "Red Teams" to independently examine and assess technical counters to proposed strategic defense systems and technologies. Several Red Teams, each consisting of a group of hand-picked technical experts, have been established to develop and evaluate technical counters to specific SDI system concepts and components. These countermeasures will be presented to appropriate "Blue Teams" which will consider their impact and propose ways to mitigate the countermeasure effects. Continuing Red Team/Blue Team interactions ensure that countermeasures are considered on a continuing basis during all stages of the R&D/system design process.

(U) Red Team analyses are useful since they identify credible countermeasures to defensive systems and also those countermeasures which are less credible because they are technically, politically, militarily or economically difficult. Both of these inputs are essential to the defense system designer. The first helps him to design a system which is robust to likely Soviet countermeasures; the second minimizes unproductive responses to threats that are not credible. Independence is maintained by separating the responsibility for conducting the countermeasure analysis process from the defense system designers. This ensures that the countermeasures threat is not constrained in any way by the vested interests of the system designers.

~~(S)~~ The methodology of the SDI responsive threat/countermeasures analysis program is shown in Figure A.1. The overall approach of coordinated threat definition plus Red Team interactions is designed to integrate the most accurate and up-to-date intelligence analysis with detailed technical countermeasure analysis to assist the SDIO and the defense designers in understanding technical responses to a particular system or component. Since the range of potential enemy responses is broad and

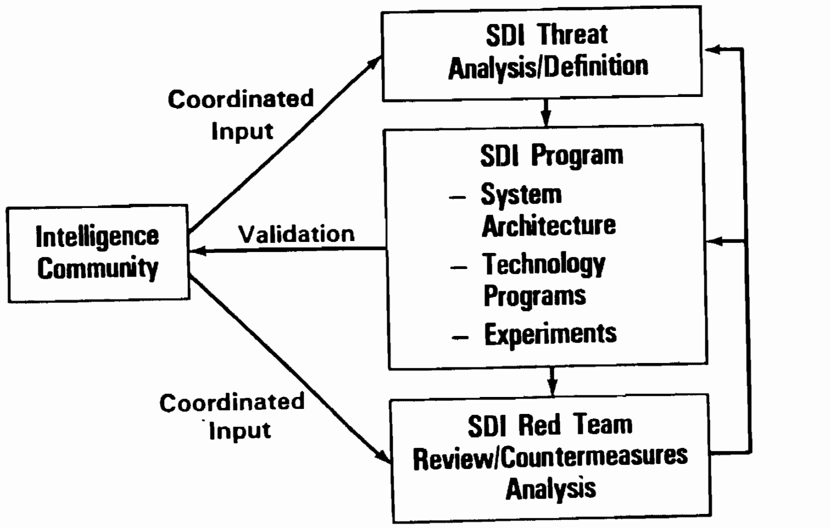

Figure A.1. (U) SDI Responsive Threat/Countermeasures Program the time scale of the proposed SDI effort extends beyond anyone's ability to make accurate forecasts, no great precision in evaluating a potential adversary's course of action is claimed. However, the process we have established will ensure that credible countermeasures and threats are continuously re-evaluated and applied to technology development and system design so that any resultant strategic defense could successfully operate in whatever environment the opponents might create.

(U) Having outlined the dual methodology approach we have adopted, it is appropriate to give examples of the results from each approach. First, we will turn to the preliminary estimates of Soviet threats and then will give an example from a typical Red Team study.

A.3 (U) <u>POTENTIAL SOVIET RESPONSES (THREAT) TO SDI</u>

(U) As we have discussed above, predicting Soviet responses is a complex and difficult problem and we have only just begun the process. Nonetheless, we have formulated an initial estimate of potential Soviet responses (threat) to SDI. They fall into four categories:

(U) a. Political and propaganda actions,

(U) b. Strategic defense capabilities enhancement,

(U) c. Strategic offense improvements which could evade or penetrate a strategic defense, and

(U) d. Defense suppression capabilities development.

~~(S)~~ It is highly unlikely that the Soviets would undertake a "crash" development program in reaction to United States defensive developments. More likely, they would seek to counter them by steadily paced efforts over the years the United States will require for development and deployment of its overall defense. They are likely to look for solutions that would be least disruptive to their way of doing business and involve the least possible change to their planned programs. They have been historically willing to devote more resources than the United States for military and defensive measures. Presumably they would devote large resources in an attempt to counter the effectiveness of the United States SDI, if it appeared that such a U.S. effort would be successful.

A.3.1 (U) Political and Propaganda Actions

~~(S)~~ While the U.S. pursues SDI research and subsequent development, there are a number of political and technical approaches which the Soviets should be expected to follow in an attempt to negate a full-scale development and deployment. In the near term, we would expect the Soviets to rely principally on a concerted political and diplomatic effort to force the United States to restrict, drop, or delay its SDI plans. There are also certain military force structure steps the Soviets could take to improve their bargaining position and to prepare themselves for initial United States deployment should they chose to oppose it rather than negotiate a cooperative approach to the SDI.

A.3.2 (U) Strategic Defense Enhancement

~~(S)~~ Independent of United States actions, it is expected that the Soviets will continue development and deployment of their own ballistic missile defense systems. The Moscow anti-ballistic missile system is being expanded and improved, and a more widespread system could be deployed with additional launchers, improved missile detection and tracking capabilities, and more capable interceptors. The Soviets could expand their ongoing efforts on directed energy weapons. Conventional terminal anti-ballistic missile systems and Soviet directed energy weapons could provide anti-satellite capabilities that could be used against some space-based elements of a U.S. SDI system.

They are likely to pursue these efforts regardless of whether the United States sustains its Strategic Defense Initiative.

A.3.3 (U) Offensive Improvements

~~(S/NF)~~ The Soviets might decide to introduce quantitative and qualitative modifications to their ballistic missile forces in an attempt to maintain their offensive missile strike capabilities. These improvements could be accompanied by enhancements in other Soviet strategic offensive strike capabilities (i.e., cruise missiles and bombers) in order for the Soviets to attempt to maintain a strong strategic offensive force posture. In an international environment where strategic force levels were not constrained by arms control agreements, the number of Soviet offensive warheads could increase to twice their current levels with only a modest increase in the number of ballistic missile boosters through increased fractionization of the missile payloads into warheads.

~~(S/NF)~~ If the Soviets should continue to reject a cooperative approach, they will seek to maintain their strategic offensive forces as a powerful threat against the U.S. and all other nations. Measures consistent with this approach could include proliferation of warheads and launchers, mobility and covertness for more of their strategic forces, and development of defensive countermeasures, such as signature reduction, trajectory modification, booster hardening, decoys, and fast burn boosters. Greater emphasis upon cruise missiles and bomber delivered weapons should also be expected. The Soviets had already started some of these measures before the President's 23 March 1983 speech.

~~(S/NF)~~ The Soviets have invested enormous monetary and human resources in creating the ballistic missile component of their strategic attack forces. They now possess four major design bureaus that develop these types of weapons and have several new and improved intercontinental ballistic missiles

(ICBMs) and submarine-launched ballistic missiles (SLBMs) in development. In addition, their military has structured their strategic war plans around ballistic missiles and prizes the military advantages inherent in ballistic systems--the ability to strike decisive blows quickly and accurately over great distances with a minimum of warning. For these reasons, with or without arms control agreements, it is very likely that they will retain some ICBM and SLBM systems through the remainder of this century and will attempt to preserve some degree of effectiveness by employing modifications and new technologies designed to enhance the missiles' survivability and penetrability in the face of U.S. defense systems--but probably only if we were to deploy a system that would be sensitive to these improvements. Due to their strong and experienced design teams, it is probable that the Soviets will be able to implement some modifications to existing missiles within the next 5 to 10 years, followed by new generation systems further in the future.

~~(S)~~ From a countermeasures standpoint, the offense should be expected to employ penetration techniques to try to defeat the target detection, discrimination, designation and destruction functions of the defense. Attempts will be made to defeat specific elements of the defense by a combination of exhaustion, saturation, deception, evasion, screening, avoidance or hardening approaches.

~~(S)~~ Many of the measures the Soviets could apply to their ICBM force to reduce vulnerability to defensive systems would be applicable to the SLBM force. By 1995, new SLBMs with limited capabilities against near-term U.S. defensive systems could be in test or the early stages of deployment. These, like the ICBMs of that time, could incorporate airframes designed to reduce vulnerability to directed energy effects, maneuvering reentry vehicles (MARVs), and multiple post-boost vehicles (PBVs) that could rapidly dispense RVs and decoys. Such concepts would still have to wait to dispense light decoys above the atmosphere, making this approach less attractive than it first appears.

~~(S)~~ By the mid to late 1990s, the Soviets could design, develop and deploy depressed trajectory SLBMs that would have shorter times of flight for a given distance to their targets. During the early 1990s time period, improved accuracy or evasive MARVs could be designed, developed and deployed. Designed to attack time-urgent counterforce targets, these weapons could be used to attack ground-based components of the United States defensive system.

~~(S/NF)~~ If the United States develops a ballistic missile defense, an obvious response is to place greater emphasis on cruise missiles and bombers. Long-range cruise missiles remain in the atmosphere and can be designed with minimum infrared (IR), visible, and radar signatures. In addition to attacking some target sets currently allotted to ballistic missiles, cruise missiles could be used as defense suppression weapons. Using combinations of speed, stealth, and launch points near the United States, they could attack ground-based elements of the United States defensive system, attempting to disrupt a coordinated defense.

~~(S/NF)~~ A major disadvantage of cruise missiles is that if they can be detected, they can be brought under attack by fairly conventional air defense systems. Therefore, the Soviets could expect that the United States would pursue at least some air defense deployments as a complement to SDI.

A.3.4 (U) Defense Suppression Responses

[redacted]

[redacted]

A.4 (U) EXAMPLE OF RED TEAM RESULTS

(U) The purpose of Red Team is to provide sound technical evaluations of countermeasures and to be an advocate which ensures that countermeasures are taken into account by SDI programs. As with the threat work, the results given here are very preliminary.

A.4.1 (U) Approach

(U) A Red Team process was formulated to evaluate countermeasures to the High Endoatmospheric Defense System (HEDS). During the period from April to June 1984, the evaluation teams were organized, their respective duties and responsibilities were outlined, and organizational meetings were conducted. An Umpire Team decision was made to conduct the process in a phased manner.

(U) During Phase I, which commenced in June and lasted through early November 1984, the Red Team concentrated on developing candidate countermeasures to the High Endoatmospheric Defense System (HEDS).

(U) Phase II (November 1984 to March 1985) consisted of continued Red Team definition of HEDS countermeasures along with an initial Blue Team assessment of the Red Team countermeasure analyses performed in Phase I.

(U) During the final phase (March through June 1985) of Round I, the Umpire Team completed their assessments of the HEDS countermeasures and countermeasure responses and developed recommendations for consideration by the U.S. Army BMD Program Manager (BMDPM). The recommendations were of three basic types: include the countermeasures in the threat; disregard the countermeasures; or have the Umpire, Red, and Blue Teams perform additional analyses during a second round to settle unresolved issues and sharpen the results of Round I.

A.4.2 (U) Summary of Results

~~(C)~~ In Phase I, the Red Team developed a list of potentially stressing countermeasures to a HEDS that was assumed to be preceded by a 90 percent effective midcourse defense tier. The major portion of the Red Team effort involved the design of two different suites of countermeasures--masking and replication suites. Each countermeasure suite employed one particular type of decoy design, required modifications of the reentry vehicles (RVs) and incorporated a number of other penetration aids. The Red Team determined how effective these countermeasure suites needed to be to meet offense goal criteria.

(U) At the completion of Phase I, the Umpire Team considered the set of 28 countermeasures identified by the Red Team and decided that the Blue Team should develop a response to 15 of these countermeasures. The Umpire Team assessed each of the 15 Red Team countermeasures in the areas of technical risk, effectiveness and offense confidence that the countermeasure would work. Then the umpires made observations, conclusions and recommendations. The Umpire Team recommended that the Blue Team base its solution to the discrimination problem on physical principles rather than "a priori" information because of the danger that this information would be incomplete, possibly resulting in catastrophic defense system failure.

~~(S)~~ In Phase II, the Red Team focused its analysis efforts on those countermeasures not included in the countermeasure suites. The Blue Team developed its initial response to the Phase I countermeasures proposed by the Red Team. In this effort, the Blue Team adhered faithfully to the Umpire Team recommendation concerning discrimination by identifying "observables" that resulted from the basic physical properties of RVs and decoys, and based the HEDS discrimination on these physical properties. The Blue Team also determined how well the HEDS needed to perform against offense decoys in order to meet the defense goal. In addition, the Blue Team developed specific defense responses to counter the countermeasure suites, the maneuverable reentry vehicles (MARV), depressed trajectory reentry vehicles and salvage fuzing.

~~(S)~~ In Phase III, the Umpire Team assessed Blue Team responses to the Red Team countermeasures, and as a consequence of this assessment identified requirements for additional work and analyses by the Red Team and Blue Team. In addition, several countermeasures and countermeasure responses were judged to be ineffective.

~~(S)~~ Two of the 15 original Red Team countermeasures-[redacted]-were assessed by the Umpire Team to be ineffective. Of the 15 original countermeasures, the [redacted] Consequently, the Umpire Team recommended that all three of these countermeasures be removed from the baseline HEDS design threat. In the opinion of the Umpire Team, Blue Team responses to the countermeasure suites clearly stressed the original design of the suites, and the Red Team needs to reconsider the designs. On the other hand, Blue Team responses to the MARV and depressed trajectory countermeasures should be reconsidered as design drivers for HEDS.

~~(S)~~ The Umpire Team also identified areas not considered by the Red and Blue Teams in Round I. The Blue Team did not have sufficient time during Phase II to respond to all of the Red Team countermeasures and consequently, in the second round of the analyses, [redacted] They should also evaluate the effects of combinations of countermeasures and develop cohesive system responses to the Red Team threat. The Red Team, in addition to reconsidering the design of the countermeasure suites, should determine how it would use [redacted]

A.4.3 (U) <u>Round I Findings</u>

(U) The process has resulted in an improved understanding of countermeasures and countermeasure responses. New ideas for countermeasures and countermeasure responses were identified, evaluated, and are being considered in the HEDS system design. Other countermeasures and countermeasure responses have been eliminated from the HEDS design threat.

[redacted]

~~(S)~~ Important countermeasure evaluation efforts have been initiated. The U.S. Army Space Defense Command (SDC) has awarded a contract, which will evaluate three different designs for a thrusted replica decoy to better understand how well they can be expected to perform and how well the defense can exploit the imperfect match of RV dynamics. The SDC has begun a program that will first determine how to evaluate the PCM countermeasure and then complete this evaluation to understand what is feasible and how this might effect defensive systems.

A.4.4 (U) <u>Results</u>

(U) Significant results from Round I have been identified, and requirements have been developed for additional analysis by the Red and Blue Teams. Round I efforts have resulted in a HEDS design that is more robust to possible Soviet countermeasures, and it is expected that the second round of the process will produce additional significant modifications to the HEDS design.

A.4.5 (U) Conclusion

~~(S/NF)~~ Although there are uncertainties, we must anticipate Soviet programs across a broad front that includes technologies both to counter SDI and to improve their own ballistic missile defense capabilities. The requirement is to make predictions twenty or more years into the future and to produce a process to improve those predictions steadily over many years, if not decades. Clearly, the scope of the requirement to define Soviet responses over such a long time and over such a large range of possible actions is unprecedented in this country.

~~(S)~~ The methodology and organizational structure which we have developed seek to ensure that all potential responses are evaluated throughout the technical evolution of the SDI. We have established, with the support of the Intelligence Community, interactions to inform the SDIO of Soviet efforts to counter the SDI. In addition, a Red Team function has been established to see that countermeasures are taken into account in all aspects of the program. This iterative projection and evaluation of Soviet efforts to counter the SDI is designed to assure that the SDI system architectures and technology programs are sufficiently robust to achieve mission objectives, regardless of the form of the Soviet response.

APPENDIX B

(U) THE SURVEILLANCE, ACQUISITION, TRACKING AND KILL ASSESSMENT (SATKA) PROGRAM

B.1 (U) <u>DESCRIPTION OF TECHNOLOGY BASE EFFORTS</u>

B.1.1 (U) <u>Radar Technology</u>

(S) <u>Description and Objectives</u>. This project pursues the requisite technology for demonstrating real-time radar imaging concepts required to discriminate between reentry vehicles, decoys, and other elements of ICBM systems as they are dispensed in space from the post-boost vehicle. Many of the SDIO measurement programs will be performed in conjunction with ongoing DoD efforts. During PBV deployment, radars can provide cross-section history, precision metrics to monitor kinematics, and coherent range, cross-range images. During midcourse, further discrimination may be possible by measurements to observe characteristic signatures. Radars will also be valuable for discrimination of reentry vehicles from sophisticated decoys just prior to and during reentry.

(U) The project includes four principal tasks:

- ~~(S)~~ <u>Large Radar Array Technology</u>. Key technologies for large phased array imaging radars for PBV and midcourse discrimination are developed in this task. Such radars would also provide launch warning and tracking through the exoatmospheric phases of flight. Development of [redacted] solid state transmit/receive modules for space-based radars is a major portion of the task. Additional efforts include concept definitions, on-orbit construction techniques and subcomponent development for to allow very large [redacted] radar antennas which may contain up to 10 million array elements.

- ~~(S)~~ Large Radar Technology. This task develops the advanced radar and special purpose signal processing technology required to meet the functional performance of active ground and airborne radar sensors for use primarily in the terminal phase of the trajectory. Research will pursue unique and innovative subarray architectures which will enhance producibility and lower the cost for large, wideband radar sensors.

- ~~(S)~~ Near-Term Imaging Demonstration. Hardware and software necessary to implement and demonstrate real-time imaging algorithms for wideband radar systems are developed in this task. Initially, hardware and software will be developed and implemented in a simulation facility. After successful demonstration of the imaging capability in the simulation facility, the hardware and software will be added to the Millimeter Wavelength Instrumentation Radar (MMWIR) to provide a real-time imaging capability at Kwajalein Missile Range (KMR). Measurements will then be made against targets of opportunity and specially constructed reentry vehicles which will represent Soviet targets.

- ~~(S)~~ Satellite/Aircraft Imaging Radar. Technologies developed under other tasks will be integrated to examine imaging radar concepts for space/airborne deployment.

~~(S)~~ Significant Accomplishments (FY 1984-1985). Space-based radar antenna concepts were defined in FY 1984-1985. Such factors as weight, storability, on-orbit deployment, module cost and weight, and ease of fabrication were considered. The concept for a space-fed phased array experiment was developed and mechanical and radio frequency (RF) technology for an advanced version of a fully monolithic chip transceiver was defined. Also designed and built were [redacted] and a ferrite phase shifter linear array, [redacted] Design of the real-time imaging facility at MIT/Lincoln Laboratory and KMR was completed and hardware procurement was initiated.

~~(S)~~ Current Activities and Future Plans. Antenna material will be tested and space-based radar concepts will be investigated to integrate discrimination requirements with radar technologies. Testing and evaluation of space-fed, phased array radar antennas will proceed. Continued emphasis will be placed on transmit/receive module design, producibility, and cost reduction. Monolithic modules will be tested for reliability and survivability and development of [redacted] monolithic array technology will continue. Installation of the near-term imaging facility will be completed at MIT/Lincoln Laboratory. A data processor with interface hardware will be added to the Kwajalein MMWIR and the imaging and discrimination algorithms for real-time imaging will be installed.

B.1.1.1 ~~(S)~~ Milestones

Complete X-band radar subarray module	FY 1986
Complete monolithic X-band transceiver module development	FY 1986
Complete real-time imaging facility at MIT/Lincoln Laboratory	FY 1986
Complete ground structural test of space radar array	FY 1987
Begin planning satellite/aircraft imaging experiment	FY 1987

Kwajalein 35 GHz real-time imaging radar operational	FY 1987
MMW imaging demonstration	FY 1988
High power X-band monolithic module demonstration	FY 1989
Complete space radar antenna fabrication	FY 1990
Advanced MMW module demonstration	FY 1990
High power X-band subarray demonstration	FY 1991
Integration of modules/antenna test for space radar	FY 1992

B.1.2 (U) Laser Radar Technology

~~(S)~~ Description and Objectives. This project performs research on concepts for future electro-optical laser radar systems. [redacted] Parts of the technology will also find use in ranging systems required for accurate tracking and precise location of targets necessary for handover to the interceptors.

(U) Principal laser radar technology tasks are:

- ~~(S)~~ Large Optics Technology. A comprehensive program of technology development is required to make possible the wide variety of large [redacted] optics required by SDI sensors. Technology is being developed and tested which allows production of very large, very lightweight and very precise optics. These optics will be able to perform at cryogenic temperatures and will have the ability to reject stray radiation even when the source is very close to the target. The optics must ultimately be manufactured at a high rate to allow deployment of a constellation in a timely manner. This task addresses these issues for optics operating in the infrared, visible and ultraviolet wavelengths.

- ~~(S)~~ <u>Laser Radar (LADAR) Technology</u>. This task focuses on technologies required for laser radar transmitters [redacted] and receivers capable of imaging PBV deployment. A vigorous program is being undertaken to confirm the technical feasibility of discrimination using laser radars. Emphasis is placed on discrimination using active sensors without target perturbation, but applications of this technology to interactive discrimination concepts will also be addressed. Potential countermeasures will be identified and their effectiveness addressed.

- ~~(S)~~ <u>Laser Radar Measurements</u>. The objectives of this task include verification of sensor concepts and parameters assumed in initial design studies and development of ground test chambers and new flight test platforms. [redacted]

~~(S)~~ <u>Significant Accomplishments (FY 1984-1985)</u>. In FY 1985 the LADAR project continued the existing technology base activities in areas such [redacted] Several rapid optics fabrication efforts have been selected for demonstration at medium scale [redacted] During this same period, work was initiated to develop algorithms for optical imaging and required technologies for infrared and ultraviolet (UV) laser transmitters and imaging sensors. Plans were also laid for demonstration of optical imaging technology and for trade-off of optical imaging concepts from a variety of platforms including aircraft and satellites.

~~(S)~~ Current Activities and Future Plans. Rapid optics fabrication efforts will focus on demonstrations at medium scale [redacted] Work on optical radar sensor design trade-offs, discrimination techniques and countermeasures against optical discrimination will continue. Evaluation of optics and beam agility techniques will be completed and development of promising methods will be initiated. Parallel efforts to develop [redacted] laser transmitters in the ultraviolet (UV) and infrared (IR) wavelengths will continue. Design, fabrication and demonstration of short pulse, carbon dioxide (CO_2) laser imager transmitters will be completed. Modest size [redacted] receiver arrays for IR range-doppler imaging will be evaluated. Development of larger arrays [redacted] for UV angle-angle imaging will begin. Optical properties of materials [redacted] will be measured, and construction of a ground test bed to demonstrate laser imaging of targets will be completed. Laser measurements of the [redacted] will be made in a vacuum chamber.

B.1.2.1 ~~(S)~~ Milestones

Mosaic Mirror Phasing Test	FY 1985
Ground Test Bed Operational	FY 1985
Optical Radar Platform Selection	FY 1986
Cryogenic Segmented Mirror Phasing Tests	FY 1986
Optics and Beam Agility Evaluation Complete	FY 1986
Optical Radar Platform Design Complete	FY 1987

Laser Transmitter Tests [redacted]	FY 1987
Optical Radar Platform Design Complete	FY 1987
Laser Transmitter Tests [redacted]	FY 1988-FY 1989
Rapid Fabrication Technology Test	FY 1990
Feasibility Decision	FY 1990

B.1.3 (U) IR Sensor Technology

~~(S)~~ Description and Objectives. This project develops and demonstrates the technologies associated with advanced infrared (IR) focal planes for the various surveillance, acquisition, tracking and kill assessment systems. The primary focus of the project is on detector materials, producible integrated focal planes and associated electronics and high efficiency, long-life cryogenic refrigeration systems. Although directed toward passive IR systems, a number of technologies are generic and will support active optical sensors.

(U) Principal IR sensor technology tasks are:

- ~~(S)~~ IR Focal Plane Development. The primary thrust of this task is the refinement of current and [redacted] and demonstration of the pilot line production capability for populating multi-million element sensors. The work is being performed in two broad classes of detectors, silicon and various other intrinsic materials. The silicon effort revolves around the [redacted] because of its superior performance and stable response in a radiation environment. Development efforts are concentrated in two programs: Sensor Experimental Evaluation Review (SEER) and the Precursor Above the Horizon Sensor (PATHS). For longwave infrared, the intrinsic materials effort focuses on [redacted] with the primary effort in the Scanning [redacted]

Module (SLIM) program. In addition, demonstration of [redacted] pilot production line is planned. Finally, new, advanced detector concepts such as the Solid State Photomultiplier will be developed to the proof-of-concept stage for advanced SDI sensors.

- ~~(S)~~ Space Cryocoolers. The objective of this task is to develop and demonstrate the long-lifetime, high efficiency, [redacted] The primary effort of this task is centered in the Prototype Flight Cryocooler (PFC) program. The PFC program will demonstrate the capability of one type of cryocooler by performance testing and actual life testing. An advanced concepts effort will also develop new, higher efficiency and higher reliability refrigerators using concepts such [redacted]

- ~~(S)~~ Optics Technology. This task designs and develops advanced high performance sensors for terminal surveillance, either airborne or rocket probe based, utilizing advanced optical technology. Key efforts include wide field-of-view (40^{o}) optical sensors; large, high quality passive optical sensor components; radiation hardened focal plane arrays; sensor calibration and test facilities; and analytical modeling of infrared target signatures and infrared sensor simulation.

~~(S)~~ Significant Accomplishments (FY 1984-1985). During FY 1985, [redacted] producibility programs were successful in pursuing alternative approaches to improving detector materials, performance, and fabrication processes. Radiation environmental testing of [redacted] conclusively proved superiority in radiometric accuracy and stability. Programs to improve performance and producibility of IBC devices and to incorporate them into multiband modules began in late FY 1985. Hardened mirror and baffle fabrication techniques were successfully demonstrated. The cryogenic cooler life test program continued. The Prototype Flight Cryocooler program was initiated to develop and demonstrate long-life, non-wearing active cryocoolers.

~~(S)~~ Current Activities and Future Plans. Various approaches for [redacted] will be evaluated and the most promising continued as a demonstration. This effort will support the [redacted] which operate at higher temperatures. A major manufacturing technology effort for [redacted] planes will be initiated. Development [redacted] as an alternative [redacted] and for possible use in KEW rail gun projectiles will be initiated. The Advanced Sensor Technology (ASTECH) program will design, fabricate, and test an advanced sensor test bed to characterize and demonstrate advanced optics technology for use on an airborne platform. The Sensor Experimental Evaluation and Review (SEER) program will demonstrate state of the art impurity band conduction (IBC) and/or [redacted] hybrids in a module configuration. PATHS (Precursor Above-The-Horizon Sensor) will continue to improve IBC performance with low-noise, cryogenic readout devices, prepare for a pre-pilot line production demonstration of IBC technology, develop IBC fabrication techniques for multiband modules, and design and develop multiband modules for [redacted] A highly critical IBC pre-pilot production demonstration of IBC detector hybrids for incorporation into a multiband LWIR module will occur in 1987. The Phototype Flight Cryocooler program for LWIR space-based sensors will continue to design non-wearing, long life cryocoolers. Development of advanced cryogenic concepts such as magnetic refrigeration and sorption refrigeration will continue.

B.1.3.1 ~~(S)~~ Milestones

SEERS Module Performance Demo	FY 1986
PATHS Detector Baseline Selection	FY 1986
[redacted]	
Airborne Advanced Technology Test Bed Sensor	FY 1989
[redacted]	
Surveillance Sensor Test Chamber	FY 1989
Advanced Cryocoolers Demos	FY 1989
Multicolor Module Integrated Demo	FY 1990
SLIM Staring Module Demo	FY 1990
[redacted]	

B.1.4 (U) Signal Processing Technology

(U) Description and Objectives. The Signal Processing Project includes those electronics and integrated circuit technologies common to all sensors. Additionally, the project is pursuing those technologies necessary for improvements in real-time signal processing in a nuclear environment. The general thrusts are on the survival in a nuclear environment, real-time processing of large volumes of ~~data,~~ and the sizing of processors and integrated circuits to meet spacecraft requirements.

(U) Principal signal processing technology tasks include:

- ~~(S)~~ Radiation Hardened LSI. To accomplish the various mission objectives during hostilities, key performance elements must survive and operate in the presence of high levels of radiation.

Particularly, very large scale integrated (VLSI) electronic circuits and memories with performance comparable to the DoD very high speed integrated circuit (VHSIC) technology must be developed to very high levels of hardening. Initial efforts focus on materials technology and fabrication processes for both hardened Silicon and Galium Arsenide digital circuitry. Later phases will include design demonstrations, optically inter-connected computer development and technology insertion efforts.

- (U) Real-Time Signal Processors. This task will develop ground-, air- and space-based data and signal processing systems capable of supporting the sensors developed in other projects. Emphasis will be on distributed processors and their associated software that can meet the numerical rate (500 million operations per second) requirements, operate autonomously in a fault-tolerant manner, and allow computer system reconfiguration. Research programs are investigating a variety of programmable signal processors capable of accommodating evolving algorithms. Research will also continue on networked data, signal processors, and hardware suitable for implementing algorithms using expert systems methodology.

(U) Significant Accomplishments (FY 1984-1985). Work continued on hardened LSI technology with demonstration of 20 megarad hard integrated circuits. The hardened Gallium Arsenide (GaAs) Metal Schottky Gate Field Effect Transistor (MESFET) pilot production line commenced operation and a second line, focusing on Junction Field Effect Transistors (JFET), was initiated. A 16K random access memory with significantly improved performance and a

256 bit thin film non-volatile memory storage device that could replace heavy plated wire memories were demonstrated. The design and fabrication of an Advanced On-Board Signal Processor (AOSP) and software development using the Macro Function Signal Processing (MFSP) language were continued. A 32 bit, reduced instruction set, microprocessor architecture was defined that is suitable for GaAs implementation on a single chip. A five node prototype Advanced Distributed On-Board Processor (ADOP) was delivered and installed in the Advanced Research Center at Huntsville.

(U) Current Activities and Future Plans. The FY 1986 radiation hardened GaAs effort will demonstrate a functional 16K static RAM and will initiate efforts to improve low defect density GaAs starting materials. High performance, large pin-out packages for GaAs circuitry will be designed. The radiation hardened Silicon effort will demonstrate a hardened CMOS 64k static RAM and design improvements to reduce access time. It will also demonstrate the potential of CMOS/SOS (Silicon on Sapphire) and CMOS/SOI (Silicon on Insulator) to meet space environment levels of radiation hardness. Design of a hardened VHSIC versions of the ADOP and AOSP nodal control unit will be initiated. A VHSIC version of a 32 bit single chip microprocessor using the MIPS (Microprocessor without Interlocked Pipelined Stages) architecture will be designed.

~~(S)~~ The FY 1987 program will achieve greater level of hardness with test devices leading to demonstration of [redacted] in 1988. Sufficient [redacted] will be fabricated. The basic capability of thermionic integrated circuits (TIC) to achieve useful levels of integration and performance while maintaining very high radiation hardness and temperature tolerance will be shown. Work will continue on design and development of specific VLSI chip sets to meet SDI ground- and space-based applications. Radiation hardness testing and assessment of test chips will be performed while alternate semiconductor hardening techniques will be evaluated for both memories and high risk digital chip sets. An initial three dimensional computer concept will be demonstrated and development of an advanced capability demonstration will be initiated to provide a system capable of [redacted] AOSP will continue to demonstrate real time fault tolerance signal processing with the [redacted] Function Signal Processor algorithms using a live satellite data stream. Studies leading to advanced signal processing architecture concepts will be completed and efforts to demonstrate Silicon, Gallium Arsenide and optical systolic array computing in 1989 and 1990 will be started.

B.1.4.1 ~~(S)~~ <u>Major Milestones</u>

GaAs pilotline in operation	FY 1985
[redacted]	FY 1986
Radiation Hardened [redacted]	FY 1986
	FY 1987
	FY 1987
	FY 1987
	FY 1987
Advanced Hardware in the Loop Test Capability	FY 1987
Radiation Hardened [redacted]	FY 1988
	FY 1988
TIC Family and Pilot Line Requirements	FY 1988
[redacted]	FY 1988
	FY 1989
Fiber Optic Interconnect for [redacted] Circuitry	FY 1989
[redacted]	FY 1990
High Speed GaAs Logic and Memory Chips	FY 1990
[redacted]	FY 1990

B.1.5 (U) <u>Interactive Discrimination</u>

~~(S)~~ <u>Description and Objectives</u>. The Interactive Discrimination project is investigating the essential elements required to discriminate decoys from RVs [redacted] Analysis has shown the preliminary feasibility of one class of concepts which uses directed energy sources (lasers, neutral particle beams, laser guided electron beams) [redacted] This project funds the analysis and development of technology required in order to use directed energy sources as discriminator systems. (The development of the actual directed energy source is funded from PE 63221C, Directed Energy Weapons.) In particular, [redacted] mission will be developed. In addition, other [redacted] will also be examined to determine their feasibility.

- ~~(S)~~ <u>Interactive Discrimination</u>. All interactive discrimination concepts will be examined in enough technical detail to choose the most promising concepts for further development. A national study effort utilizing both industry and government experts will be performed through Lincoln Laboratory. The technology gaps for the chosen concepts will be identified and new efforts initiated to close these gaps when appropriate. In certain areas which have already been identified as critical aggressive technology development programs will be started. [redacted]

~~(S)~~ Current Activities and Future Plans. The technology requirements identified from the broad-based examination in FY 1986 will be used to guide future efforts in this project. Neutral particle beam detector development will continue with laboratory demonstrations of promising concepts. Detector technology for [redacted] will be evaluated and the most promising concepts continued. [redacted]

B.1.5.1 ~~(S)~~ Milestones

Comprehensive Technology Assessment Complete	FY 1986
Neutral Particle Beam Detector Lab Test	FY 1987
Neutral Particle Beam Detector Test (Space)	FY 1989-FY 1990

B.2 (U) DESCRIPTION OF EXPERIMENTS

B.2.1 (U) Boost Surveillance and Tracking System Experiment

~~(S)~~ Description and Objectives. The Boost Surveillance and Tracking System (BSTS) is the critical experiment for boost phase acquisition, tracking, discrimination and hand-off. This project pursues the technical research necessary for a near real-time, fully responsive space-based system to: detect ballistic missiles in their boost stages; provide ballistic missile tactical warning/attack assessment; generate track files; and communicate the information to the National Command Authorities, "battle managers" and/or subsequent layers of defensive weapons and discrimination systems. The program includes concept definition efforts and validation of critical sensor and data processing elements associated with these concepts. The capability to satisfy additional missions such as tactical missile warning, technical intelligence, and air vehicle detection and warning will also be evaluated.

~~(S)~~ Significant Accomplishments (FY 1984-1985). Four Boost Surveillance and Tracking System (BSTS) efforts were completed in FY 1985 to define approaches for survivable, endurable, and cost-effective experimental options. These efforts provided survivability/performance requirements, trade-offs on optimum allocations, and technology and phenomenology assessments which served as the basis for the Phase II Concept Definition efforts. Preliminary concept development contracts were awarded to TRW, Lockheed, and Grumman.

~~(S)~~ Current Activities and Future Plans. The FY 1986 effort will concentrate on developing, assessing, and selecting the appropriate concept for an integrated experiment. The concept definition efforts will: define candidate systems in terms of performance, availability, affordability, survivability, maintainability and performance; develop conceptual designs and identify an optimized concept; analyze growth, logistics concepts, life cycle costs, and perform implementation and transition planning. Risk reduction efforts will be conducted in: hardened signal and data processors (VLSI/VHSIC electronics) and acceleration of the Advanced On-Board Signal Processing (AOSP) demonstration; and development and demonstration of producibility [redacted] A concept selection decision will be made at the end of FY 1986 and a program initiated in early FY 1987 to start development and demonstration of a survivable ballistic missile warning and boost-phase surveillance and tracking experiment.

B.2.1.1 ~~(S)~~ Milestones

Survivability and Systems Concepts Studies completed (four contractors)	FY 1985
Systems requirements review	FY 1985
Concept definition complete	FY 1986
Preliminary design review (PDR)	FY 1988
Critical design review (CDR)	FY 1989
Demonstration flight	FY 1992

B.2.2 (U) Space Surveillance and Tracking Experiment

~~(S)~~ Description and Objectives. The Space Surveillance and Tracking System (SSTS) is the critical experiment for post-boost and midcourse phase acquisition, tracking, discrimination and hand-off. This project pursues experimental research for a near real-time, fully responsive space-based system for midcourse ballistic missile surveillance and tracking. A secondary requirement addresses timely satellite attack warning and verification (SAW/V). These efforts are specifically oriented toward the technology research for a space-based [redacted]

~~(S)~~ The primary activity in this project is concept definition and preliminary research that will provide near real-time, survivable midcourse ballistic missile surveillance and tracking, and SAW/V capabilities. Included in this project are measurement probes to characterize [redacted] and targets. Research on specific SSTS technologies are being conducted to support an early experimental demonstration.

~~(S)~~ Significant Accomplishments (FY 1984-1985). Three requirements definition efforts were completed in FY 1985 to develop approaches for a survivable, endurable and cost-effective experimental demonstration. These efforts provided: a range of specific experiment options; technology assessment and development planning; system transition plans; and life-cycle costs estimates for all options. In parallel, technology risk reduction efforts are underway on hardened [redacted] and long-life cryocoolers.

~~(S)~~ Current Activities and Future Plans. FY 1986 efforts will concentrate on developing, assessing, and selecting the appropriate concept for experimental demonstration and development. The concept definition efforts will start an iterative design of the midcourse surveillance and tracking experiment to include: sensor; data and signal processing hardware and software; command, control, and communications; power generation and distribution; active cryogenic cooling; antisatellite countermeasures; hardened electronics; and autonomous operation. In FY 1986, the space experiment definition efforts will be completed and evaluated and the initiation of the Space Tracking Experiment Program (STEP) will occur. Further risk reduction efforts will be conducted in: hardened signal and data processors; development and demonstration of producibility [redacted] and long-life cryocoolers. In FY 1987, the Sensor System Utility Study evaluation alternate/advanced concepts, associated technology requirements, and potential technology issue resolution programs for a probe will be complete.

B.2.2.1 ~~(S)~~ Milestones

Requirements studies complete	FY 1986
Concept definition start	FY 1986
Proof-of-feasibility flight	FY 1989
System Design Review	FY 1990

B.2.3 (U) Airborne Optical Adjunct Experiment

~~(S)~~ Description and Objectives. The Airborne Optical Adjunct Experiment is the critical experiment for aircraft-based, late midcourse and terminal phase acquisition, tracking, discrimination and hand-off.

- ~~(S)~~ Airborne Optical Adjunct (AOA) Experiment. This experiment develops and validates the technology and airborne optics design data base required for eventual development of an Airborne Optical Surveillance (AOS) System. The primary objective of AOA is to validate those critical functions essential to future applications of airborne optics to defense concepts by developing, integrating and testing an infrared sensor, data processor, and associated communications on a modified Boeing 767 aircraft.

- ~~(S)~~ Airborne Optical Surveillance (AOS)/Laser Ranger. The AOS program performs concept definition for an advanced airborne sensor system fully capable of operating in the tactical environment. The effort includes consideration of advance platforms, optical sensors, signal processing and other required technologies. The Laser Ranger Program provides for the development and validation of critical technologies for an active sensor that will allow the AOS to provide more accurate state vectors (position, velocity).

~~(S)~~ Significant Accomplishments (FY 1984-1985). Fabrication of sensor optics, detector assembly, signal processor, gimbal, and cryogenics began in FY 1984-1985. In addition, construction on the sensor calibration facility was initiated. Navigation and sensor update equipment and communications and ground support equipment were designed or specified for procurement. Mock-ups of the sensor and the sensor cupola were made. Integration, test and evaluation plans have been completed, and target support equipment specification initiated.

~~(S)~~ Current Activities and Future Plans. The AOA experimental demonstration design presented during the Preliminary Design Review will be analyzed for feasibility, requirements traceability and interface definition. Subsystem design trades and subassembly performance analysis will be performed to finalize drawings for the Critical Design Review (CDR). The CDR for the experimental demonstration system will be conducted. The AOA flight worthiness test and system integration will be completed by FY 1988. Concept Definition of the Airborne Optical Sensor (AOS), design and development of the Airborne Optics Platform (AOP), and design of the Laser Ranger will be continued. Efforts for Advanced Sensor Calibration Equipment and Laser Signature Codes will be initiated.

B.2.3.1 ~~(S)~~ Milestones

AOA Preliminary Design Review (PDR)	FY 1985
AOA Mosaic Detector Array Flight Series	FY 1986
AOA Lear Jet Observatory Flights (KMR)	FY 1986
Laser Ranger Concept Definition	FY 1986
AOS Concept Definition	FY 1986
AOA System CDR	FY 1986
Laser Ranger Technology Validation	FY 1987
AOS Technology Validation	FY 1988
AOA Integration and Checkout Complete	FY 1988
AOA Start KMR Flight Tests	FY 1989
Laser Ranger PDR	FY 1990
AOS CDR	FY 1991

B.2.4 (U) Terminal Imaging Radar (TIR) Experiment

~~(S)~~ Description and Objectives. The primary objective of this project is to develop and demonstrate the performance and effectiveness of a ground-based Terminal Imaging Radar (TIR) as a key element in the SDI technology validation program. The TIR is a very wide-band, phased array radar [redacted] in a dense multi-target environment. The TIR is specifically designed to use ~~data~~ from other SDI sensors in performing the target acquisition and discrimination function. At Kwajalein Missile Range, the TIR will search, verify, track, [redacted] provide RV state vector data to a ground-based interceptor, and support damage assessment after intercept.

~~(S)~~ Significant Accomplishments (FY 1984-1985). The six month, competitive Phase I Preliminary Design Contracts were awarded to Raytheon and Westinghouse in FY 1985. The contractors are investigating design solutions for the TIR and will each provide a basic design approach with supporting documentation which demonstrate compatability of their design with the Government's technical requirements.

~~(S)~~ Current Activities and Future Plans. The Phase I Preliminary Design effort is to be completed in FY 1986. A 12 month, Phase II Detailed Design effort will be initiated with one or both of the Phase I contractors. This detailed design effort will result in the contractors delivering complete data packages and proposals for the Phase III Development contract.

(U) The FY 1987 effort will complete the Phase II Detailed Design Contract and a contractor will be selected for the Phase III Development. The selected contractor will acquire long lead items, perform plant production modifications and complete the TIR design for a Critical Design Review (CDR).

B.2.4.1 ~~(S)~~ Milestones

Phase I Design Contract Awarded	FY 1985
Phase II Option	FY 1985
Phase III Development Contract Award	FY 1987
Critical Design Review	FY 1987
TIR Operational at KMR	FY 1991

B.2.5 (U) SATKA Systems: SATKA Integrated Experiment

(U) Description and Objectives. The goal of this effort is to determine the trade-offs between options inherent in the netting of many sensors on various platforms to accomplish birth-to-death tracking of the threat complex. The integrated SATKA Experiments will consist of a series of end-to-end tracking experiments, approximately one per year against dedicated targets, starting in FY 1987.

B.2.5.1 ~~(S)~~ Milestones

First End-to-End Experiment	FY 1987
Subsequent Experiments Against Dedicated Targets	One Each FY

B.3.1.1 ~~(S)~~ Milestones

COBRA JUDY X-band Modification Complete	FY 1985
[redacted]	FY 1986
Land-based or Shipborne PBV Collection Decision	FY 1986
Real-Time Imaging Algorithm Developed	FY 1986
Collection System Definition Complete	FY 1987
Significant COBRA JUDY Data Available	FY 1987
PBV Collection System PDR	FY 1988
Real-time Imaging Algorithm Validated	FY 1988
PBV Collection System Operational	FY 1991

B.3.2 (U) Optical Discrimination and Data Collection.

~~(S)~~ Description and Objectives. This project provides optical facilities, measurement equipment and some test targets for collection of infrared, visible and ultraviolet backgrounds and signatures of ballistic missile components and reentry vehicles and supports collection and interpretation of the data. In conjunction with ongoing DoD efforts, data is collected on Soviet systems, on U.S. systems and on systems specially constructed to evaluate possible future Soviet developments.

(U) Principal tasks include:

- ~~(S)~~ [redacted]

[redacted]

- ~~(S)~~ IR Background Studies. Accurate prediction of both natural, nuclear and man-made backgrounds and their effect on target signatures is needed to understand IR sensor-based system performance. The IR Background Studies task will develop models and computer codes to predict the spectral, spatial, and brightness characteristics of the natural background. Data on earthlimb emissions will be collected by the CIRRIS infrared radiometer and interferometer system to determine the appropriate spectral band widths to maximize target detection ranges. The nuclear background studies will investigate IR emission and absorption under a range of conditions from the benign ambient to the very disturbed during and after a nuclear burst. Data will be collected using rocket borne probes and in the laboratory to support the model development. Celestial data taken by the infrared Astronomical Satellite (IRAS) will be examined to determine star processing requirements and limiting detection ranges. Man-made backgrounds that can mask exoatmospheric targets will be studied using multi-color satellite sensors and Chemical Release Experiments (CRE) and an experiment [redacted]

~~(S)~~ Significant Accomplishments (FY 1984-1985). Critical elements in the Optical Airborne Measurements Program (OAMP) which include detectors/preamps, mirrors, and dither assembly, have been successfully developed and have passed acceptance tests. Aircraft cavity designs and the gimbal integration have been completed. The Three Color system design was completed. The QUEEN MATCH sensors have been completed and are in testing. DNA has released a stand-alone version of C/LAMP multiple low altitude blast code and have introduced an improved version of the IR emission NORSE code that is CRAY compatible. The SPIRIT I multi-spectral rocket probe completed testing prior to being sent to Alaska for launch. A first set of discrimination algorithms for evaluation in a real-time simulation facility was developed.

~~(S)~~ Current Activities and Future Plans. A rocketborne earthlimb viewing auroral experiment called SPIRIT I will acquire [redacted] This information on natural variability and auroral excitation will support modeling the ambient as well as the nuclear excited atmospheric IR backgrounds. A rocketborne electron accelerator (EXCEEDE) experiment, to stimulate IR emissions at very high energy depositions levels will be developed. The High Resolution Infrared Auroral Measurements (HIRAM) experiment will be launched to complete the night/daytime program. The first QUEEN MATCH sensor will be integrated into the rocket hardware and delivered in anticipation of a FY 1987 launch. QUEEN MATCH communication and recovery systems will be designed and built. The OAMP sensor and telescope will be completed and integrated into its gimbal in the KC-135 aircraft. The development of the Three Color Experiment (TCE) hardware for a future DSP satellite system will continue.

~~(S)~~ The OAMP and QUEEN MATCH measurement platforms will be completed and the first two QUEEN MATCH tests will be conducted in FY 1987. The OAMP aircraft will become operational and will be flown in support of the QUEEN MATCH flights and whenever it is possible [redacted] Data analysis of CIRRIS 1A and SPIRIT I will continue and design for a SPIRIT II to advance knowledge on earthlimb and auroral emissions by adding a radiometer to make two-dimensional clutter measurements will be started. EXCEEDE III development will continue along with continued updates to IR emissions codes. The TCE hardware and electronics will be integrated into the DSP for final checkout and flight in FY 1988. The CRE program will be implemented and continued into FY 1988 for use with the TCE.

B.3.2.1 ~~(S)~~ <u>Milestones</u>

Spirit I Flight Acquisition of LWIR Auroral Data	FY 1986
HIRAM I Flight SWIR Auroral Spectra	FY 1986
CIRRIS 1A Spectral Earthlimb Data	FY 1986
QUEEN MATCH First Series from Shemya	FY 1987
OAMP First Flight from Shemya	FY 1987
Three Color Experiment	FY 1988
QUEEN MATCH Second Series	FY 1988
CIRRIS 1B Spectral and Target Penetration Aid Data	FY 1988
[redacted]	FY 1989

B.4 (U) <u>MAJOR MILESTONES</u>

(U) Figure B.1 identifies the important milestones of the Surveillance, Acquisition, Tracking and Kill Assessment Program.

B.5 (U) <u>RESOURCE REQUIREMENTS</u>

(U) Table B.1 outlines the resource requirements for the Surveillance, Acquisition, Tracking and Kill Assessment (SATKA) Program for FY 1985-1988.

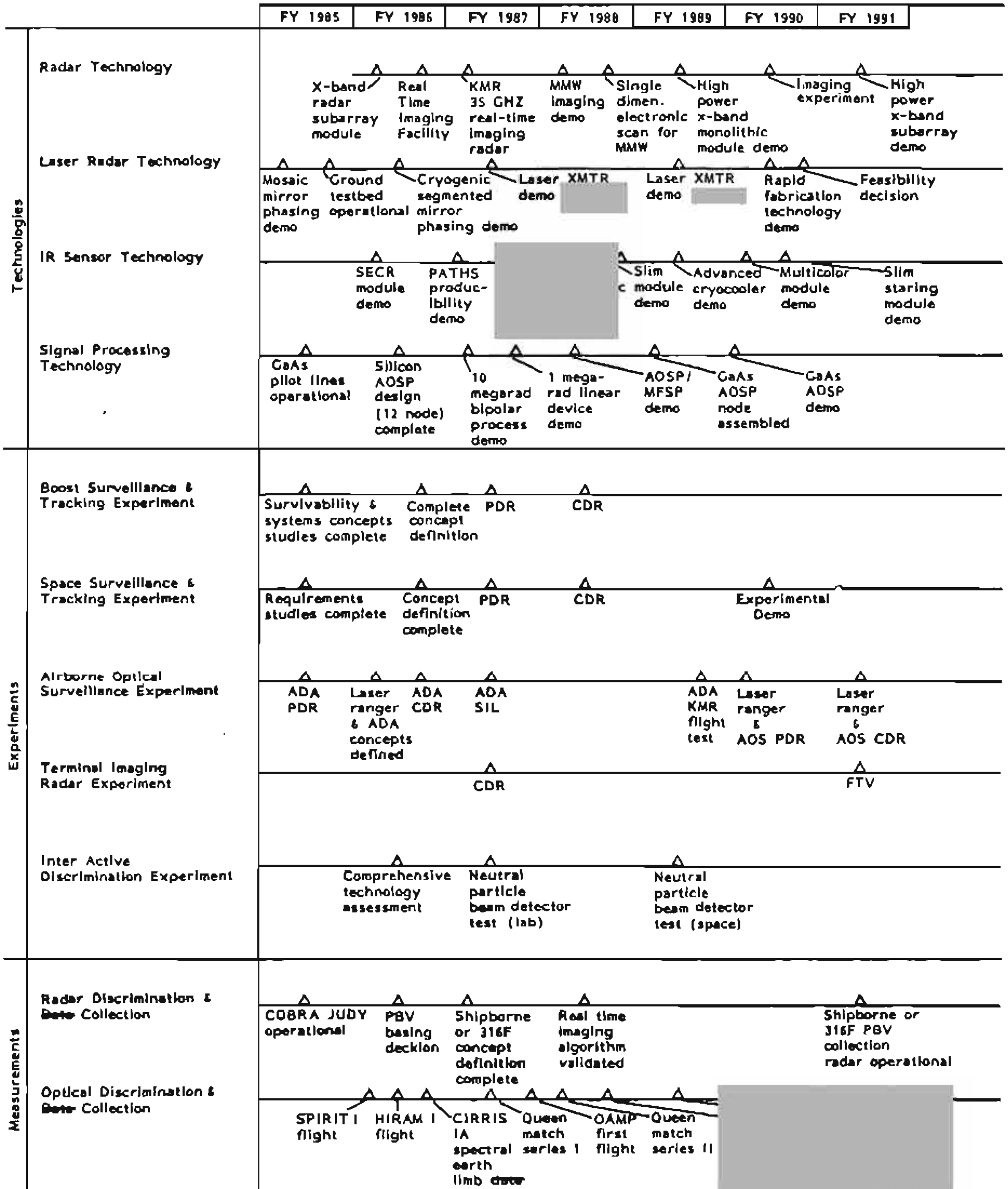

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Figure B.1. (U) Major Milestones - Surveillance, Acquisition, Targeting and Kill Assessment Program

(U) TABLE B.1

(U) RESOURCE REQUIREMENTS, FY 1985-1988 ($M)

Program Element 63220C: Surveillance, Acquisition, Tracking and Kill Assessment (SATKA) Program

	FY 1985 (Actual)	FY 1986 (Actual)	FY 1987 (Budget)	FY 1988 (Estimate)
RADAR TECHNOLOGY				
LG Radar Array Tech	6.900	15.000	30.000	27.000
LG Radar Tech	2.432	4.190	12.573	16.000
NT Imag	5.859	7.665	5.029	0.000
SAT & AC Imag Radar	0.000	0.000	2.000	2.000
TOTAL	15.191	26.855	49.602	45.000
LASER RADAR TECHNOLOGY				
Large Optics Tech	8.400	19.000	20.000	23.000
Ladar Technology	10.900	43.000	66.500	88.500
Ladar Measurements	12.206	15.285	29.013	38.500
TOTAL	31.506	77.285	115.513	150.000
IR SENSOR TECHNOLOGY				
IR Focal Plane	20.400	40.000	47.500	51.300
Cryocoolers	20.500	20.000	33.300	35.700
Optics Technology	16.802	21.901	24.600	23.000
TOTAL	57.702	81.901	105.400	110.000
SIGNAL PROCESSING TECHNOLOGY				
Rad Hard LSI	33.153	64.996	92.520	92.500
RT Sig Proc	29.385	43.680	66.043	67.500
TOTAL	62.538	108.676	158.563	160.000
INTERACTIVE DISCRIMINATION TECHNOLOGY				
BOOST SURVEILLANCE AND TRACKING EXPERIMENT				
BSTS	42.917	73.000	165.000	270.000
TOTAL	42.917	73.000	165.000	270.000

(U) TABLE B.1 (Cont'd)

(U) RESOURCE REQUIREMENTS, FY 1985-1988 ($M)

Program Element 63220C: Surveillance, Acquisition, Tracking and Kill Assessment (SATKA) Program

	FY 1985 (Actual)	FY 1986 (Actual)	FY 1987 (Budget)	FY 1988 (Estimate)
SPACE SURVEILLANCE AND TRACKING SYSTEM				
SSTS	40.718	76.000	110.000	240.000
LWIR Probe	3.316	6.570	12.026	15.000
TOTAL	44.034	82.570	122.026	255.000
AIRBORNE OPTICAL ADJUNCT EXPERIMENT				
AOA	122.699	125.928	94.681	65.100
AOS/Laser Ranger	3.316	8.760	4.373	14.900
TOTAL	126.015	134.688	99.054	80.000
TERMINAL IMAGING RADAR EXPERIMENT				
Term Imag Radar	5.969	32.303	94.572	110.000
TOTAL	5.969	32.303	94.572	110.000
SATKA INTEGRATED EXPERIMENT				
Sys Experiments	0.000	55.861	137.768	175.879
Studies	0.000	14.000	15.000	5.400
Other Tech	0.000	27.303	25.500	26.000
TOTAL	0.000	97.164	178.268	207.279
RADAR DISCRIMINATION & DATA COLLECTION				
Cobra Judy	17.023	10.950	10.933	14.000
PBV Data Collection	2.700	4.000	7.000	11.500
Radar Discrimination	10.059	3.475	4.483	6.500
TOTAL	29.782	18.425	22.416	32.000
OPTICAL DISCRIMINATION & DATA COLLECTION				
OAMP	37.694	38.326	21.648	20.500
Queen Match	35.594	24.638	39.906	28.000
Algorithm Development	22.108	16.425	20.445	11.500
Backgrounds	34.900	36.700	45.000	34.000
TOTAL	130.296	116.089	126.999	94.000
PROGRAM ELEMENT TOTAL	545.950	856.956	1262.413	1558.279

APPENDIX C

(U) THE DIRECTED ENERGY WEAPONS (DEW) PROGRAM

(U) This appendix provides a more detailed discussion of the Directed Energy Weapons Program which is divided into four projects: Technology Base Development Efforts; Technology Integration Experiments; Concept Formulation and Technical Development Planning; and Support Programs.

C.1 (U) <u>DESCRIPTION OF TECHNOLOGY BASE DEVELOPMENT</u>

(U) As previously pointed out, Technology Base Development efforts maintain an aggressive program to advance the state-of-the-art and ensure that there are paths available to achieve the critical ballistic missile defense functions alternative to those being explored in the Technology Integration Experiments. Included are a variety of topics in a wide range of generically applicable and concept specific technologies. At this time, the promising alternatives supported by technology base development include space-based concepts employing either a chemical laser or a RF linac FEL beam generator, ground-based concepts employing the RF linac FEL or an excimer laser beam generator, advanced particle beams for boost-phase intercept and DoD funded efforts supporting nuclear directed energy efforts.

(U) <u>Laser Technology</u> research activities investigate various types of laser devices operating at a wide range of wavelengths and scalable to weapon power levels. Modularized hydrogen fluoride chemical lasers operating at the mid-infrared wavelength are included along with efforts to achieve coherently added devices. Other efforts include research on excimer lasers operating in the near-ultraviolet region, and radio frequency, linear accelerator, free electron laser devices.

(U) Plans for Laser Technology efforts include the following milestones:

- ~~(S)~~ Fabrication complete (FY 1986) on cylindrical chemical laser technology scalable [redacted] and experiments complete (FY 1988)--The ALPHA Program.

- ~~(S)~~ Feasibility shown using phasing and beam control of HF chemical lasers using [redacted] to improve laser brightness.

- ~~(S)~~ Experiments on Raman beam clean-up of a high-energy, pulsed, excimer laser, producing improved laser brightness, complete (FY 1986). Decision on whether to proceed with fabrication of a high pulse energy excimer laser (FY 1987).

- ~~(S)~~ Energy recovery experiments show high efficiencies to be feasible in radio frequency linac, free electron lasers (RF/FEL). Scalability to high beam energies demonstrated in high burst power experiments conducted (FY 1986/1987).

(U) Beam Control Technology efforts provide optical sub-elements for directed energy devices, laser beam wavefront sensing and control, atmospheric compensation to enable the propagation of the beam from ground-based laser devices, phased array optics, and relay and mission mirror technology.

(U) Some important milestones in this many faceted task are:

- ~~(S)~~ Integration completed of MIRACL laser with the beam director; successful integration at the highest Western laser brightness achieved to date [redacted] demonstrated (FY 1986).

- ~~(S)~~ Fabrication of and tests on LAMP mirror complete; feasibility of large [redacted], segmented optics at mid IR wavelengths shown (FY 1987).

- ~~(S)~~ Large Optics Demonstration Experiment (LODE) experiment completed; the feasibility of hierarchial wavefront control established and a test bed for experiments on a broad class of beam control architectures available (FY 1986).

- ~~(S)~~ High power local-loop beam clean-up experiments using MIRACL completed; first step in demonstrating atmospheric compensation for high power laser beams made (FY 1987).

- ~~(S)~~ Experiments completed of low power, large aperture atmospheric compensation of [redacted]

- ~~(S)~~ Initial operation of the rapid retargeting simulator permits on-axis experiments on the effects of retargeting algorithms on approaches [redacted]

- ~~(S)~~ On axis phasing of multiple apertures demonstrated; technical feasibility of phased arrays as a growth path to high brightness [redacted] laser systems established (FY 1987). Phased array experiments completed (FY 1991).

- ~~(TS)~~ Multisegment optics for monocle relay/mission mirrors exhibited (FY 1989).

- ~~(S)~~ Integration experiments on the ground of a space relay platform concept completed (FY 1991).

(U) The <u>Particle Beam Technology</u> efforts are focused on proving the feasibility of space-based neutral particle beams (NPB) by exhibiting: (1) beam generation/conditioning feasibility with a 5 million electron volt (MeV) accelerator; (2) accelerator scalability with an accelerator of about 50 MeV; (3) lightweight magnetic optics that can steer the beam while maintaining microradian level beam divergence; (4) concepts for sensing the beam position and boresighting it to the acquisition, tracking, and pointing (ATP) subsystem; (5) maintenance of microradian divergence in the environment in and around a spacecraft containing a particle beam device; (6) the feasibility of growth technology that can provide higher brightness beams; and (7) integration, on the ground, of key subsystems of a space-based NPB device. The Accelerator Test Stand (ATS) is the major test stand for demonstrating the scientific feasibility of high brightness negative ion beam production and acceleration. It currently consists of a pulsed negative ion source, a low energy beam transport system, and a low energy accelerator -- the radio frequency quadrupole (RFQ). The ATS currently produces a beam energy of 2 MeV out of the RFQ. A high energy accelerator, the drift tube linac, is being added in FY 1986 to increase the energy to 5 MeV.

(U) Particle Beam Technology milestones include:

- ~~(S)~~ Completion of [redacted] including drift tube linac demonstrating scientific feasibility of NPB weapons performance levels (FY 1986).

- ~~(S)~~ Demonstration of a continuous [redacted] needed for extended operation [redacted] (FY 1986).

- ~~(S)~~ Laser channel tracking of intense charged particle (electron) beams at energies greater than or equal to [redacted] over long propagation distances [redacted] with long pulse [redacted] beams exhibited (FY 1987). High energy [redacted] experiments (FY 1991).

- ~~(S)~~ Flight experiments with instrumented target show particle beam stripping and beam divergence increase not excessive in space environment (FY 1987).

(U) <u>Acquisition, Tracking, Pointing and Fire Control (ATP-FC) Technology</u> efforts will provide technologies for acquiring and prioritizing the targets to be engaged, establishing the line-of-sight to hit the aimpoint, holding the line-of-sight on the aimpoint, assessing the target damage, and reinitiating the sequence to engage a new target. Included are the following subtasks: ATP-FC Integration which provides overall technology integration and demonstrates the feasibility of DEW attack management timelines; Rapid Retargeting; Pointing and Control, which develops the technology to stablize and point large structures, including suppression of vibrations and transient disturbances; Advanced Precision Tracking of targets (and also beacon tracking between space-based elements); Ground-Space Tracking to address phenomena associated with ground-based DEW concepts; and Space ATP Experiments Definition to provide program planning for on-orbit experiments essential to validate initial ATP-FC technologies and support the planned early 1990s SDIO decision milestone. This task encompasses ATP-FC technology applicable to all directed energy concepts.

(U) Future Acquisition, Tracking, Pointing and Fire Control activities include the following key milestones:

- ~~(S)~~ Concept selection for an x-ray laser acquisition, tracking and pointing experimental set up (FY 1987); final design for ATP-FC underground tests completed (FY 1988).

- ~~(S)~~ Rapid retargeting simulator construction completed and tests begun (FY 1987).

- ~~(S)~~ Demonstration of passive vibration isolation technology for large space structures (FY 1987); active structural control for retargeting and disturbance suppression (FY 1989); and integrated structures/controls simulation (FY 1990).

- ~~(S)~~ Advanced inertial reference unit design (FY 1989) and laboratory demonstration (FY 1991).

- ~~(S)~~ ATP-FC technology test bed concept selected (FY 1986); test bed development completed (FY 1990); fire control decision algorithms demonstrated (FY 1989); ATP-FC technology integration/DEW engagement timeline feasibility demonstrations (FY 1991).

(U) In <u>Nuclear Directed Energy Weapons technology</u>, the Department of Defense is supplementing Department of Energy efforts.

[redacted]

C.2 (U) DESCRIPTION OF TECHNOLOGY INTERGRATION EXPERIMENTS

(U) Switching now to Technology Integration Experiments, three major efforts were initiated in FY 1986 that will, when completed, provide the basic evidence of scientific feasibility of (1) the ground-based laser as a device capable of being scaled in performance to a boost-phase intercept system and (2) the neutral particle beam as a system for interactive discrimination. By the early 1990s, these experiments will integrate various elements of the technology in tests designed to show readiness for system level development. Integral to these major experiments are the majority of the supporting technology efforts directly required for a successful experiment.

~~(S)~~ Ground-Based Free Electron Laser efforts exploit the Advanced Test Accelerator (ATA) development activities at the Lawrence Livermore National Laboratory (LLNL). The ATA will be used to conduct the basic experiments to demonstrate free electron laser scalability to high power levels and short wavelengths. Initially, the laser work at LLNL will provide the design, fabrication and test of a [redacted] laser device--an induction linear accelerator, free electron laser--which could be combined with a [redacted] diameter beam control/director system capable of proof-of-concept tests of atmospheric compensation at high beam powers. The activity is structured to resolve critical technical issues in integrating the device and beam control hardware. A series of high power uplink experiments at the White Sands Missile Range (WSMR), New Mexico, will provide proof-of-feasibility of the adaptive optics and atmospheric compensation techniques needed to transmit the required power through the atmosphere. Sufficient data and experimentation is to be completed in the near-term (FY 1986/1987) to show proof-of-principle of the device physics and approach to beam control and atmospheric compensation. After the initial experiments at Lawrence Livermore National Laboratory, plans are to increase the optics size first to [redacted] and the device power up to [redacted] at a field test facility at White Sands Missile Range, to show the scalability of the integrated hardware and then scale to a [redacted] ground transmitter with [redacted] of power. Ultimately, a relay mirror from the High Brightness Relay Experiment (an activity under Space Pointing and Tracking Experiments) may be incorporated to carry out ground-to-space laser relay experiments.

(U) This opportunity for achieving very high power devices and high power uplink experiments in the early 1990s results from more than a half decade of research. First, there is the experience gained in developing the Advanced Test Accelerator. Then there is the increased understanding of the free electron laser physics based on tests for high extraction efficiencies with the Experimental Test Accelerator (ETA) at 35 GHz; demonstrations of pulsed power at high repetition rates; and operations of a high brightness cathode. Finally there is the successful low power atmospheric compensation experiments at Maui. Backing up the FEL technology as the source of photons for the weapon is the excimer laser being pursued in the technology base.

(U) The key milestones are:

- ~~(S)~~ A program review of the laser experiments and the beam control design leading to a decision to proceed with fabrication and test of the integrated experiment using the free electron laser (4Q FY 1987).

- ~~(S)~~ Integrated experiments using an FEL scaled to 2 megawatts (MW) and a beam control with a 1 meter (m) aperture in FY 1990, a 10 MW/3 m experiment in FY 1991/1992, and a 100 MW/10 m in FY 1994.

~~(S)~~ The Neutral Particle Beam Interactive Discrimination experiment consists of a [redacted] The objectives of this effort are to use a very low power NPB to show the near-term potential of neutral particle beams for midcourse discrimination. [redacted] This activity will also provide experimental confirmation of theoretical predictions of NPB penetration into the atmosphere and [redacted]

(U) The Ground Test Accelerator (GTA), the former Accelerator Test Stand Upgrade, will be expanded to support the NPB experiment. The GTA will be used as a test bed for integrating elements for this space experiment. The qualification model for the space demonstration may also be incorporated into the GTA. As the low energy "front end" the addition of a subsequent acceleration section and other elements will provide the equipment to perform tests on precision beam control.

(U) The key milestones for these experiments are:

- ~~(S)~~ Conceptual designs of the experiments completed and the hardware phase of the efforts initiated (early FY 1986).
- ~~(S)~~ Tests at the GTA and a critical design review of the experiment completed; initiation of fabrication of the flight hardware (end FY 1987); tests in a space chamber (FY 1988).
- ~~(S)~~ Experiments in space conducted (late FY 1989 and early FY 1990).

(U) Activities under Space Pointing and Tracking Experiments are designed to resolve space tracking and pointing issues generic to all DEW concepts and beam control issues generic to laser concepts. These experiments are organized into three primary efforts: (1) Tracking and Pointing Experiments (TPE); (2) Advanced ATP Experiments; and (3) High Brightness Relay (HIBREL).

(U) The objectives of the Tracking and Pointing Experiments (TPE) are to: (a) define relevant experiments in SDI tracking and pointing technology required for future strategic defense concepts; (b) validate the experimental approaches in space in the near term; and (c) obtain reusable test bed support equipment. Additionally, TPE will provide technical data to support the early 1990s decision in the following areas: beam stabilization and pointing; target signature data; booster plume signatures; hardbody tracking; homing technology for kinetic energy weapons; rapid retargeting; and acquisition, tracking, and pointing for neutral particle beam discrimination. Proposed experiments under TPE would demonstrate the state-of-the-art in controls software for space experiments and in tracking the target and pointing a controlled, directed energy beam from a shuttle-based platform.

~~(S)~~ The objectives of Advanced ATP Experiments are to demonstrate the capability to: [redacted] Requirements and conceptual designs are currently being developed for an experiment demonstrating precision pointing at tens of nanoradians accuracy.

(U) Activity under High Brightness Relay (HIBREL) relies on the space relay technology developed in the Beam Control task of the Technology Base Development project. It consists of a series of experiments designed to receive a laser beam propagated from a ground-based site through the atmosphere, to relay that beam with one or two space mirrors and to deposit energy on the target. These experiments would propagate a low power, controlled beam through the atmosphere and off a relay mirror to a cooperative target. A follow-on series of experiments incorporating evolutionary brightness levels, increasing aperture sizes, and more stringent beam control and accuracy requirements could culminate in an end-to-end demonstration with weapon-level performance requirements. Such a demonstration is not included within the current program.

(U) The key milestones are:

- (U) Selection of TPE experiments (FY 1986).
- ~~(S)~~ Conceptual design of Advanced ATP Experiments and High Brightness Relay Experiments completed (FY 1986).
- ~~(S)~~ Tracking and pointing experiments in shuttle flight (4Q FY 1987 and 4Q FY 1988).

- ~~(S)~~ Advanced ATP experiments in space (FY 1991).

- ~~(S)~~ Low power relay experiments in space (FY 1989 and FY 1991).

C.3 (U) DESCRIPTION OF CONCEPT FORMULATION AND TECHNICAL DEVELOPMENT PLANNING

(U) Concept Formulation and Technical Development Planning (CF&TDP) defines the technology concepts, requirements and plans needed to resolve critical technical issues in all four directed energy weapon concepts. This project defines what it takes to establish the technical feasibility of weapon level performance on a time scale consistent with system architecture requirements. Concept Formulation and Technical Development Planning for promising DEW approaches includes two major events, with a continuing assessment activity linking these events. The initial formulation is currently underway on the four identified DEW concepts. It is designed to identity the technology content of the weapon system by: (1) synthesizing alternative concepts and providing parametric analysis of their potential performance trades; (2) allocating performance among subsystems and major elements with a performance flowdown; (3) assessing technology and selecting a technical implementation; and (4) defining required development with estimated schedules and costs. As a second major event, concept formulation (a planning effort, not hardware fabrication) will be repeated (updated in greater detail) for those concepts that are selected for potential system level validation and/or potential engineering development and production/deployment. This second concept formulation is an essential input to, and will be completed in time for, the early 1990s decision. It will define the conceptual design of an operational weapon, assess the ability of the state-of-the-art of required technology to support possible development and deployment, and define technical cost and schedule risk in supporting development. In the intervening time between the two major formulations, conceptual designs will be updated to reflect the progress of technology. These updates will provide a basis for defining candidate conceptual system designs and achievable performance levels to support the efforts of the overall architect.

(U) The key milestones are:

- (U) Initial concept formulation complete (FY 1986).
- (U) Updated concept formulations to insure up-to-date inputs to systems architect and compliance with performance needs specified by architect (FY 1987-1990).
- (U) Conceptual definition of operational systems for selected concepts completed (FY 1991).

C.4 (U) DESCRIPTION OF SUPPORT PROGRAMS

~~(C)~~ Finally, there are several efforts currently funded under Support Programs. The first funds activities at the DoD High Energy Laser Systems Test Facility (HELSTF) at White Sands Missile Range, NM. This Range provides equipment and facilities for integrated high energy laser experiments and lethality and vulnerability testing of potential targets using the MIRACL--a 2 megawatt deuterium fluoride (DF) laser. The second effort, Targets, supports planning, procurement, operations, and maintenance activities for the targets of DEW Major Experiments. Each experiment requires at least one target or receiver that can indicate the energy deposited on the intended target, demonstrate hits and misses, or the destruction/neutralization of the target in some manner. Options under consideration include: a high altitude scoring system (sounding rockets) as envisioned for the atmospheric compensation experiments; ground stations to record reflected energy (ground-based laser experiments utilizing relay mirrors); scheduled missile test launches or dedicated booster launchers for acquisition, tracking, pointing, lethality, and booster signature experiments; [redacted]

[redacted] and dedicated satellites as receivers or targets for DEW or KEW concepts. Also funded under Support Programs is the DEW portion of the Innovative Science and Technology Program.

C.5 (U) MILESTONES

(U) Figure C.1 summarizes the major program milestones.

C.6 (U) RESOURCE REQUIREMENTS

(U) Table C.1 outlines the resource requirements for the Directed Energy Weapons (DEW) Technology Program for FY 1985-1988.

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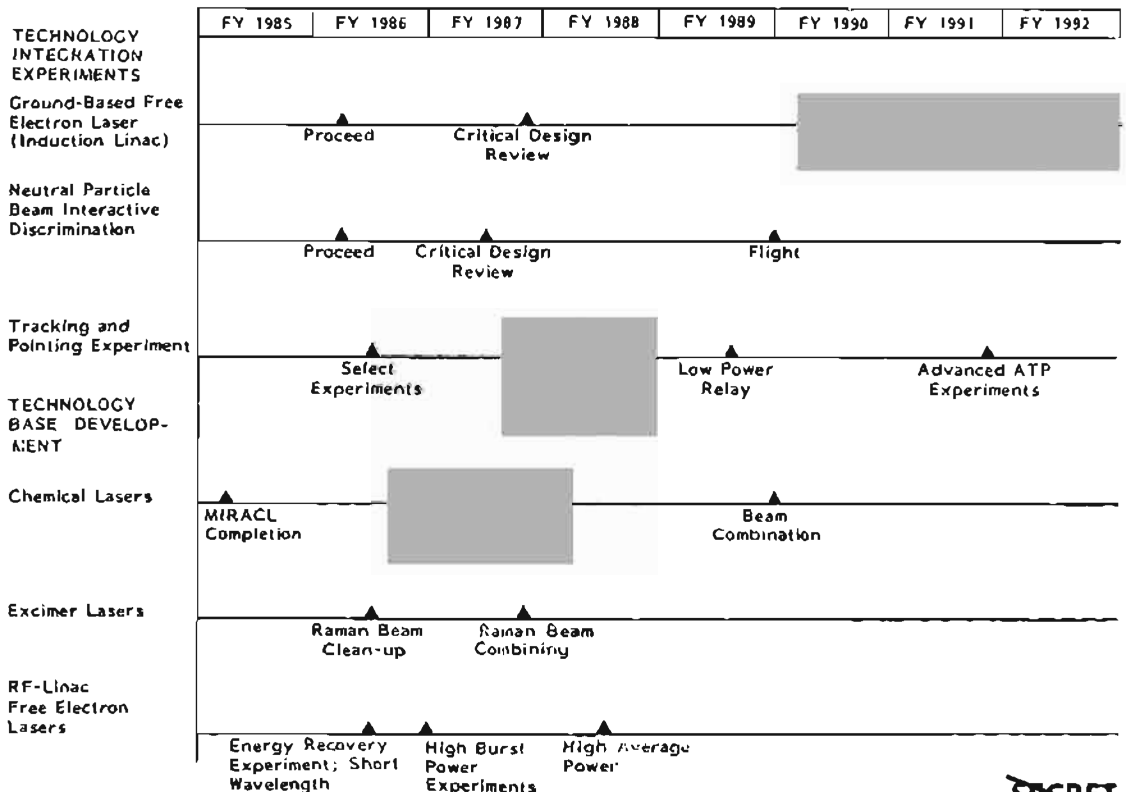

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Figure C.1. (U) Major Milestones - Directed Energy Weapons Program

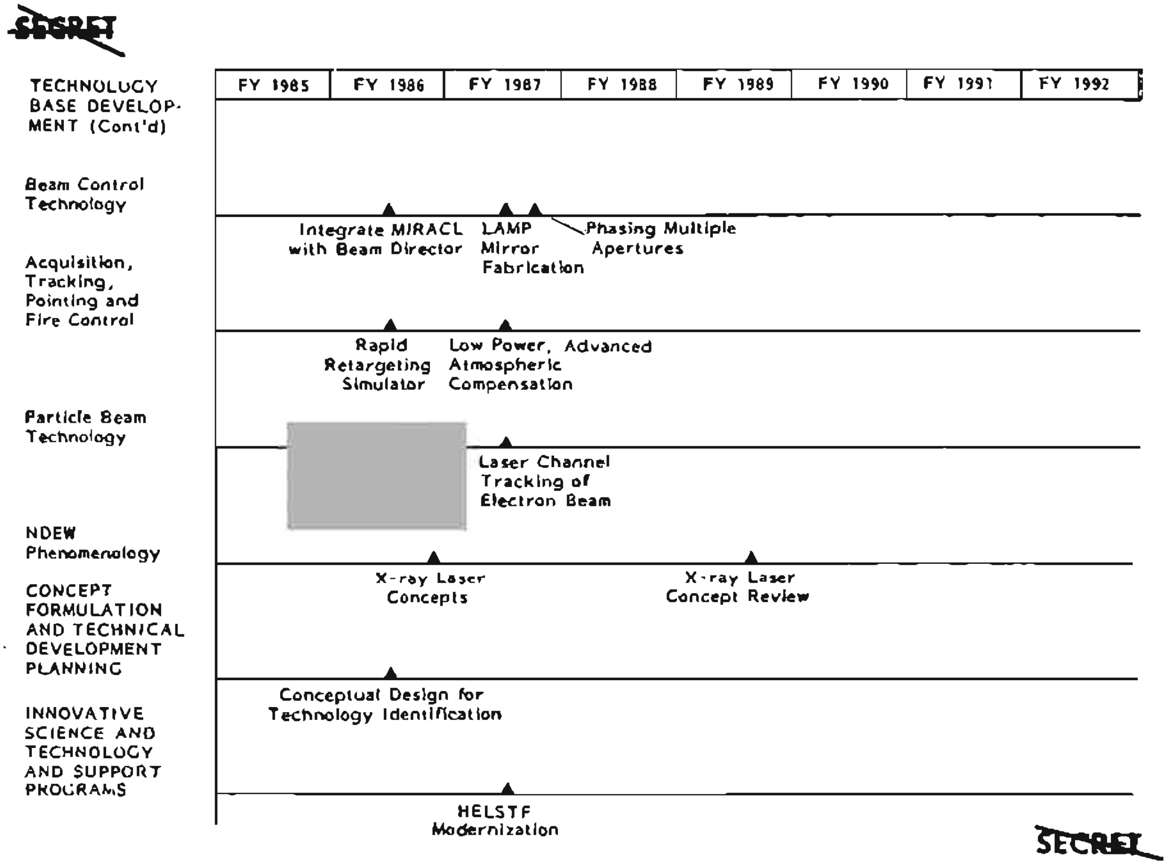

Figure C.1. (Cont.) (U) Major Milestones - Directed Energy Weapons Program

(U) TABLE C.1

(U) RESOURCE REQUIREMENTS, FY 1985-1988 ($M)

Program Element 63221C: Directed Energy Weapons (DEW) Technology Program

	FY 1985 (Actual)	FY 1986 (Actual)	FY 1987 (Budget)	FY 1988 (Estimate)
TECHNOLOGY BASE DEVELOPMENT				
Laser Technology	126.056	113.250	130.000	86.000
Beam Control Technology	94.530	116.700	125.500	100.000
Particle Beam Technology	32.457	49.100	72.000	48.000
ATP-FC Technology	40.379	53.300	55.000	53.000
NDEW Technology	8.200	105.000	25.000	8.000
TOTAL	301.622	437.350	407.500	295.000
TECHNOLOGY INTEGRATION EXPERIMENTS				
GBL Free Electron Laser	2.933	67.000	480.000	440.000
NPB Interactive Discrimination	1.000	73.000	145.000	190.000
SPATE	4.050	76.000	95.000	342.037
SBL Experiment Definition	1.000	2.000	0.000	0.000
GBL Excimer Laser Definition	12.250	2.000	0.000	0.000
Shuttle Integration/Flight	0.000	89.500	59.000	125.000
Other Experiments	0.000	0.000	293.855	(TBD)
TOTAL	21.233	309.500	1072.855	1097.037
CONCEPT FORMULATION AND TECHNICAL DEVELOPMENT PLANNING				
Booster Intercept	8.863	15.500	17.000	25.000
[redacted]				
Allied Defense	0.000	0.000	2.000	4.000
NDEW	0.000	1.000	2.000	5.000
DEO Indep. Analysis and Assessment	0.000	1.225	.500	.500
Other	4.766	1.275	1.500	1.500
TOTAL	[redacted]			
SUPPORT PROGRAMS				
DE Support	21.050	39.900	60.000	110.000
IS&T	11.300	29.400	25.000	30.000
SDIO Support	7.310	4.251	19.600	0.000
TOTAL	39.660	73.551	104.600	140.000
PROGRAM ELEMENT TOTAL	[redacted]			

APPENDIX D

(U) THE KINETIC ENERGY WEAPONS (KEW) PROGRAM

D.1 (U) DESCRIPTION OF KINETIC ENERGY TECHNOLOGY EFFORTS

D.1.1 (U) Endoatmospheric Nonnuclear Kill (ENDO NNK) Technology (KEW 1)

(U) Description and Objectives. The ENDO NNK Technology effort is a sustaining program for maturing those representative technologies whose first-generation levels will be integrated into subsystems and elements and subsequently validated in flight programs. This technology program will span the efforts from basic research, to analytical proof-of-principal, to advanced technology where brassboards, simulations, and hybrid units are ground tested and evaluated for further development and use.

(U) In critical technology areas, multiple competitive concepts and approaches will be pursued during the initial phases of analysis and experimental evaluation. The most promising approaches will be further developed and validated in brassboard level hardware. The program will include efforts ranging from design studies and analysis to laboratory testing and field testing using dynamic SLED tests of NNK warhead/fuzes. Simulations will be developed to determine optimum subsystem requirements and to support hardware-in-the-loop type testing. Since multiple contractors and other Government laboratories are involved in this program, significant effort is directed at test planning and integration, interface definition and technology evaluation.

~~(S)~~ The objective of the ENDO NNK Technology project is to develop those technologies required to support the endoatmospheric nonnuclear kill of incoming reentry vehicles. The program focuses on advanced homing seekers for atmospheric use and associated window cooling techniques necessary for high closing velocities and small miss distances; fire control and guidance for rapid response and high accuracy endoatmospheric flights; and propulsion systems to provide precise direct and extremely rapid axial accelerations. These technologies are required to meet miss distances of [redacted] function at altitudes [redacted] at velocities approaching [redacted] and complete acquisition-to-intercept [redacted] The program places an emphasis on affordability and light weight. Flight testing of active millimeter wave radar homing against tactical ballistic missiles (TBM) under the Small Radar Homing Interceptor Technology (SRHIT) program is also being conducted to validate nonnuclear kill techniques against missiles in trajectories in the atmosphere below the lethal regimes of the other defense tiers.

~~(S)~~ Significant Accomplishments (FY 1984-1985). The ENDO NNK Technology program has made progress in all areas. In the field of windows and radomes, wind tunnel tests at hypersonic velocities performed on transpiration cooled optical windows showed a high potential for meeting cooled window optical and strength requirements. Test MMW fuze brassboards, focused fragmenting warheads and radial isotropic warheads were successfully completed in FY 1985. Bench testing of gyrotron tube millimeter waves for use in a guidance system achieved [redacted] at a bandwidth [redacted] Environmental tests of high response missile altitude control were advanced to successful flight demonstrations. In addition, test facility upgrades increased the Delco ballistic range maximum fragment launch velocity to [redacted] SRHIT flights against stationary targets were flown.

~~(S)~~ Current Activities and Future Plans. Work is presently under way in the development of a modular optical homing seeker test bed and a transportable optics test chamber. Investigations into optics, focal planes, signal processing techniques and cooled optics windows have been started along with concept definitions of MMW homing seekers. Development of ceramic and metallic approaches to radomes and advanced concepts (lighter weight, higher effectiveness) warheads for high endoatmospheric intercepts will start. The program will initiate evaluation of advanced fuzing sensor concepts and complete definition studies of avionics and guidance set requirements. Aerodynamic phenomenology associated with structural configurations for high endoatmospheric intercepts will be initiated. Development and characterization of high density, high burn rate propellants will complement an evaluation of applications of liquid propulsion technology suitable for sustainer motor. Small Radar Homing Intercept Technology (SRHIT) will complete short range flight demonstration (six guided test vehicle flights) to confirm small miss distance intercept of moving ballistic targets. The program will also install and validate an optical homing sensor model in the high fidelity Endo-atmospheric Intercept Simulation (ENDOSIM).

(U) Continuing until FY 1987 and FY 1988, technologies will become test subcomponents and subsequently be tested at the subcomponent level in representative ENDO NNK engagements. The most promising of developments will be incorporated into the HEDI program for system level evaluation using hardware-in-the-loop techniques or flight tests.

~~(S)~~ The focus on technical issues will be on those with high payoff to the high endoatmospheric interceptor.

~~(S)~~ Milestones.

Active Seeker Designs Complete	1Q FY 1986
Initial Optical Sector Test	FY 1989
Divert Thruster Wind Tunnel Tests Complete	1Q FY 1986
Initial Cooled Window Wind Tunnel Tests Complete	4Q FY 1985
Cold Window Tests Started	1Q FY 1988
Optical Fuze Design Complete	3Q FY 1986
Warhead Concepts Selected	1Q FY 1986
Start Design for Fire Control and Guidance	1Q FY 1986
Subscale Warhead Test Complete	1Q FY 1987
Full-Scale Warhead Test Complete	4Q FY 1987

SRHIT Fixed Target Flight Test Start	2Q FY 1986
SRHIT Intercept of TBM Test Complete	4Q FY 1986
Propellent Screening Complete	4Q FY 1986
Propellent Subscale Tests Complete	4Q FY 1988

D.1.2 (U) Exoatmospheric Nonnuclear Kill (EXO NNK) Technology (KEW 2)

(U) Description and Objectives. The focus of this program will be on the development of new and innovative concepts and resolution of critical technical issues associated with space-based intercept against a range of space targets. The program will include efforts ranging from advanced concept definitions, to analytical assessments, to advanced technology developments using brassboards, simulations, and hybrid units in ground tests.

(U) In critical space-based interceptor technology areas, multiple competitive concepts and approaches will be pursued during the initial phases of analysis and experimental evaluation. The most promising approaches will be further developed and validated in brassboard level hardware. The program will include efforts ranging from design studies and analysis to laboratory and field testing. Comprehensive simulation models will be developed to determine optimum subsystem requirements and to support hardware-in-the-loop type testing using advanced technology devices. Since development contractors with multiple/parallel subcontractors, universities and Government laboratories are involved in this program, a significant effort is directed at test planning and integration, interface definition and technology evaluation.

(U) Technology based on past programs will be upgraded to provide baselines for the initial design phases. Concurrently, the analysis and trade-offs will be carried forward with emphasis on performance, cost, miniaturization, device compaction, and high strength designs for operation in natural and hostile environments.

(U) This project develops technology in support of the entire exoatmospheric kinetic energy interceptor program. Technical activity centers around low cost miniature kill vehicles, advanced axial and divert chemical propulsion, guidance/control and avionics, fire control, and sensors. Applications cover the gamut of exoatmospheric (greater than 100 km altitude) interceptors; from chemically propelled missiles to hypervelocity electromagnetically-accelerated projectiles.

~~(C)~~ Sensor technology efforts include passive, active and dual mode seekers of various designs and associated technologies such as optics, antennas and command receivers. The fire control technology efforts include devices such as miniature lasers for inertial reference or ranging and reduced hardware/software complexity. The guidance and control effort includes development of inertial devices and electronics that are lightweight, "g" hardened, and low cost. Miniature hit-to-kill vehicle technology will be pursued with emphasis on reduction in size and weight. A propulsion/structures technology program includes lightweight, high strength materials for booster and projectile applications. Warhead and fuzing development of various nonnuclear expanding warheads for increase of kill radius is also being pursued.

(U) Because of the interactive relationship between elements such as seekers, autopilot, guidance and control (which establish miss distance) and the kill mechanisms and fuze types, a significant ongoing simulation and analysis effort will be maintained within the KEW 2 program.

~~(C)~~ This task also includes the experimental evaluation of a concept for a ground-based chemical rocket interceptor using existing technology--the Braduskill Intercept Concept (BIC). As conceived, each interceptor could consist of a solid propellant booster and a maneuvering post-boost carrier vehicle (CV). The CV would incorporate maneuver motors, a discrimination, designation and destruction (D^3) section associated data processors and [redacted] The kill vehicles would be launched from the carrier vehicle against the multiple reentry vehicles (RV) found on a single MIRVED ICBM booster. Flyout times on the order [redacted] are required with initial intercepts occuring some [redacted] after RV apogee. Total time span for kill vehicle launches would be in excess [redacted] The D^3 function will be performed in a volume of [redacted] Multiple sensor phenomenology such as [redacted] Kill would be accomplished through impact energy over a velocity range [redacted]

(U) The technical objective of this task is to demonstrate and assess carrier vehicle D^3 capability, KV homing and NNK capability, the ability of a booster to place CVs on intercept trajectories, precommit sensor capabilities and to assess BIC's performance against selected countermeasures.

(U) Significant Accomplishments (FY 1984-1985). Several competing firms performed design and limited hardware efforts, leading to a selection of one contractor (Lockheed) for development of the ERIS experimental interceptor under a separate program element. In addition, supporting technology programs (under KEW 2) tested technologies and evaluated design concepts for several ERIS components, such as sensor/seeker/processor designs capable of performing limited onboard discrimination and pattern recognition. In support of the Space-Based Kinetic Kill Vehicle (SBKKV) program, KEW 2 provided testing of lightweight inertial guidance devices and advanced propulsion thrusters.

(S) Improvements were achieved in weight reduction and manufacturing of subelements for Miniature Kill Vehicles (MKV). A new digital function autopilot principle was proven and a new very large single integrated (VLSI) chip design capable of incorporating all autopilot functions on a single chip was verified. Successful acceleration testing of solid state devices at levels [redacted] was achieved.

(U) The BIC proof-of-principle concept and development efforts were completed in FY 1985 by four separate contractors. Active discrimination experiments were conducted in the laboratory.

(U) The BIC proof-of-principle request for proposal was announced in the Commerce Business Daily and the results are being evaluated.

~~(S)~~ Current Activities and Future Plans. During FY 1986, laser, passive infrared or ultraviolet and millimeter wave command links will be evaluated for midcourse guidance. MKV control technologies will focus on advanced solid and liquid rocket concepts, explosive strips, and fluidics. Variation in hit-to-kill fuse designs, including point impactors and web-type warheads, will be investigated. Efforts will be initiated in novel structural materials, and improved manufacturing technology which will reduce projectile mass and cost, and ensure adequate ruggedness. Contracts for 1 year brassboard development will be started.

~~(S)~~ Milestones.

Low "g" Projectiles	
Initiate Element Test	4Q FY 1985
CDR for Projectile Elements	1Q FY 1987
Integrated Subsystem Tests	4Q FY 1988
Flight Weight MKV	FY 1990
Propulsion/Structures	
Initiate Propellant Selection and Test	4Q FY 1985
Initiate Integrated Motor Test	FY 1990

Full Scale TVC Test	FY 1990
Integrated Structures Tests	FY 1990

Guidance/Control/Avionics

Autopilot Requirements Defined	4Q FY 1985
Emulation of Autopilot	4Q FY 1988
Autopilot Test	4Q FY 1989
Integrated G&C	FY 1992

High Performance (Space-Based) MKV Technology

First Element Integration Tests	FY 1987
Technology Transition to KEW 10 Demonstration	FY 1987

Initiate Low "g" Projectile Program	FY 1986
Complete Low "g" MKV Element Testing	FY 1989

Lightweight Low "g" MKV	FY 1992
Advanced Element Test	FY 1989
Advanced Element Input into FSED Option	FY 1991

High Performance (Space-Based) MKV

First Element Integration Tests	FY 1987
Technology Transition Tests	FY 1987
Advanced Elements Tests	FY 1989
Advanced Elements Input to KEW-10	FY 1991
FSED Option	FY 1991

Fire Control/Guidance Technology

Obtain KKV FD Requirements	3Q FY 1987
Transition Technology to KEW-10 for Demo Integration	3Q FY 1987
Transition Technology to Ground-Based Launcher Experiment (KEW-9) for Demo Integration	2Q FY 1989
Transition Technology to KEW-10 to Support Option for FSED	1Q FY 1991

High "g" Miniature Kill Vehicle Technology

Award Competitive Contracts for High "g" Test Projectiles, Test Capability and Critical Technology Developments	3Q FY 1985
Preliminary Design Review of Test High "g" Projectile Efforts	2Q FY 1986
Magnetic Field and High "g" Test Capability Established	2Q FY 1986
Critical Design Review of Test Projectile Designs	3Q FY 1987
Magnetic Field and High "g" Test Capability Established	2Q FY 1986
Critical Design Review of Test Projectile Designs	3Q FY 1987
Demonstrate High Density Focal Plane Array Imagery, Miniature Responsive Propulsion Capability and Guidance/Seeker	3Q FY 1987
Award Projectile Flight Test Contracts	4Q FY 1987
High "g" Test of Entire Projectile	FY 1988
Simulated Flight Program of Complete Projectiles	FY 1989

D.1.3 (U) Hypervelocity Accelerator Technology (KEW 4)

(~~S~~) Description and Objectives. This program will develop, integrate and evaluate the technologies required for a space-based ballistic missile defense using [redacted] These advanced guns use [redacted] For future threats, such as fast burn boosters, [redacted] exit velocities will be examined. Critical technology such as accelerators, power conditioning devices, and subcomponents such as high-current switches will be developed under this project.

(U) The technical objectives are to develop the technology necessary for space-based ballistic missile defense using hypervelocity guns and integrate this technology into a Hypervelocity Gun Program (KEW 9). Higher acceleration, higher efficiencies, rapid fire, multi-shot, lighter mass and longer barrel life, are all primary objectives of this program.

~~(S)~~ Significant Accomplishments (FY 1984-1985). Requirements for a hypervelocity weapon system for ballistic missile defenses were identified, including lightweight interceptors, multitarget/multi-interceptor fire control and guidance systems, high efficiency space qualified guns, power supplies, surveillance systems, and platform requirements. Critical issues surrounding plasma armatures were characterized, and theoretical models have been developed for barrel erosion and ablation. Several microprocessors were launched from electric guns at [redacted] accelerations without failure. Three major switch efforts were initiated to increase the level of current switched [redacted] This is approaching weapons grade switch capability.

~~(S)~~ A burst of five shots [redacted] has been achieved. A major study effort was initiated to determine the feasibility of a rapid fire, high mass, high velocity, high efficiency gun.

~~(S)~~ Current Activities and Future Plans. A data base for guns operating [redacted] will be established. [redacted] Power generation devices will be developed to replace energy-stored machines. Very high pressure barrel technology will be further advanced. A major upgrade to the Armaments Research and Development Center (ARDC) facility will enable routine storage [redacted] Projectile fire control and guidance technology development and test will continue. A preliminary design review of an intergrated fire control and guided interceptor subsystem will be held in 1987. [redacted] continuously rated power supply will be delivered for initial test. The program will continue to advance the state-of-the-art in hypervelocity gun technology.

~~(S)~~ Milestones.

Accelerator Development	
Downselect Competitive Accelerator Design Efforts	1Q FY 1986
Complete Competitive Accelerator Design Efforts	1Q FY 1987
Decision to Build [redacted] Experimental Accelerators	1Q FY 1987
Complete Evaluation of Rail Gun Concepts	3Q FY 1987
Initiate Advanced Alternative Accelerator Technology Efforts	1Q FY 1988
Rapid Fire Technology	
Repetitive [redacted] Validation	3Q FY 1986
Downselect Decision on Alternative Switches	1Q FY 1986
Completed Rapid-fire Concept	3Q FY 1986
Repetitive [redacted] Validation	3Q FY 1986
Initiate Experiments on Integrated Rapid Fire Subsystems	4Q FY 1986
Repetitive [redacted] Validation	4Q FY 1988
Power System Technology Development	
Transition [redacted] to KEW 9	4Q FY 1985
Downselect for Each Component Alternative	3Q FY 1986
Complete Construction of [redacted] Compulsator	4Q FY 1986
Complete [redacted] System Concept Definition	1Q FY 1987

Super Conducting High Voltage HPG Test and Evaluation Complete	1Q FY 1987
Complete [redacted] Construction	4Q FY 1987
Baseline Power System Selection	4Q FY 1988
Test Facility Development	
SDI/Hyervelocity Test Facilities Decision	3Q FY 1986
Westinghouse HPG Upgrade [redacted]	1Q FY 1986
Westinghouse HPG Upgrade [redacted]	4Q FY 1986
University of Texas (Balcones) [redacted] On Line	3Q FY 1986
Vacuum Range Completed	4Q FY 1987
[redacted] Power Source On Line	4Q FY 1988

D.1.4 (U) Endoatmospheric Nonnuclear Kill Test Bed (KEW 6)

~~(S)~~ Description and Objectives. This program will include the design, fabrication and test of integrated hardware and software to demonstrate the capability of enforcing nonnuclear kill of a ballistic reentry vehicle with a high performance interceptor in the high endoatmospheric regime as allowed by the ABM Treaty. The interceptor is envisioned as a two or three stage missile with an optical homing sensor. The program has been structured for limited technology dual development to reduce risk in critical areas. Technical issues will be resolved through a ground and flight test program at White Sands Missile Range and engagement of actual reentry vehicles at Kwajalein Missile Range. Phase I at White Sands Missile Range will consist of interceptors flown against space points to verify missile integrity and characterize the flight environment. Once the technical issues are resolved, Phase II will demonstrate the high speed/high reaction interceptor capability to engage threat reentry vehicles at Kwajalein Missle Range.

(U) The technical objectives of this program are to demonstrate: interceptor divert capability; attainment of miss distance; control response speed; minimum impulse bit control; inertial alignment accuracy with allowable time; discrimination/acquisition time to allow sufficient homing time; lethality compatible with nonnuclear engagement; data processor packaging, through put and function in a nuclear environment; and fuzing accuracy.

(U) Significant Accomplishments (FY 1984-1985). A single contractor was selected to proceed into FTV. The key objectives and risk were identified and a data base on critical issues was established. The issues were bound analytically and a functional technology validation program was designed to address them. Wind tunnel tests of optical window candidates were started.

(U) Current Activities and Future Plans. The program will continue wind tunnel tests to determine optical errors in missile seekers caused by the flow field. The FTV contractor will conduct wind tunnel tests, evaluate the wind tunnel data, and initiate the design of a seeker focal plane array and optical window. Error compensation techniques and control flow field interaction will be tested. Hardware will be developed with the knowledge of the ground test and the simulation of a seeker with optical error compensation. The focal plane array will also be built and tested. Controls will be integrated and tested in a wind tunnel and simulated with an autopilot. Launch equipment and facilities for launch will be designed and kill vehicle integration of the window, seeker, warhead, shroud controls and onboard data processor will provide a flyable design.

~~(S)~~ Milestones.

Contract Award for FTV	FY 1986
Shroud Removal Test	FY 1986
Seeker Boresight Error Tests	FY 1987
Preliminary Design Review	FY 1988
Critical Design Review	FY 1989

and tested in ground facilities. Pulse power, switching and preinjection will be integrated on the ground for feasibility tests, space qualification and payload integration activities. The experiment, in a series of space tests, will perform intercepts against a prescribed target set. The program will stress multi-shot, rapid fire, high efficiency hypervelocity technology responsive to requirements for future spaced-based hypervelocity experiments and concepts.

~~(S)~~ The test bed objectives are structured to support future space-based experiment technology requirements, to provide a mechanism for lethality ~~data~~ collection of hypervelocity impact of complex structures and the associated scaling laws and to provide a mechanism to provide experimental ~~data~~ concerning the hypervelocity gun (HVG) launch environment effects on guided interceptor subsystems. [redacted]

~~(S)~~ <u>Significant Accomplishments (FY 1984-1985)</u>. Requirements for a hypervelocity weapon system for ballistic missile defenses were identified, including lightweight projectiles, multi-target/multi-projectile fire control and guidance systems, high efficiency space qualified guns. Theoretical models have been developed for barrel erosion and ablation. A major study effort was initiated to determine the feasibility of a rapid fire, high mass, high velocity, high efficiency gun.

~~(S)~~ <u>Current Activities and Future Plans</u>. Critical technology developments will continue. There will be a preliminary design review of an integrated fire control and guided projectile subsystem at the end of FY 1987. [redacted] continuously rated power supply will be delivered for initial test.

(~~S~~) The project will continue to advance the state-of-the-art in hypervelocity gun technology. Goals are far higher accelerations, higher efficiencies, lighter mass, and longer barrel life. Successful development of subsystems will be transitioned to major experiments projects within the KEW element.

(U) The selection of a HVG test facility will be made with design and construction of the facility to follow.

(~~S~~) Milestones.

HVG Preliminary Designs Initiated	4Q FY 1985
HVG Initial Concepts Selected	1Q FY 1986
HVG Detailed Designs Initiated (Phase II)	3Q FY 1986
Experiment Support Power Initiated	3Q FY 1986
HVG Detailed Designs Completed	3Q FY 1987
HVG Final Designs Selected (Phase III)	2Q FY 1987
Experiment Support Power Available	2Q FY 1988
HVG Fabrication Completed	2Q FY 1988
Facility Available	2Q FY 1988
First High Velocity Single Shot	2Q FY 1988
First Low Velocity Rapid-Fire	3Q FY 1988
First High Velocity Rapid-Fire	4Q FY 1988
HVG Completion	3Q FY 1989

D.1.7 (U) Spaced-Based Kinetic Kill Vehicle (SBKKV) (KEW 10)

(U) Description and Objectives. This program will demonstrate the technical feasibility of space-based kinetic energy weapons (KEW) capable of space-to-space intercepts. The first phase of this project is conducted in two parts; technology verification and concept definition. The technology verification task is planned to be a 2 year Air Force Laboratory in-house and contractual effort using 1985 technology to build and test laboratory-grade hardware to reduce risk in conducting the space-based KEW experiment. The concept definition phase (Phase I) of the experiment will define operational KEW concepts based on strategic defense mission requirements. These concepts will be used as a basis for judging validity of the space experiment. Phase I will also define the space experiment. Phase II will contract a space experiment. This experiment will produce a minimum cost proof-of-concept test in accordance with SDI technology validation objectives.

(U) Significant Accomplishments (FY 1984-1985). Contracts were completed to define preliminary requirements for ballistic missile boost and post-boost phase intercept. The technology requirements identified by these contracts were provided to the Air Force Space Division and the U.S. Army. A complete launch and test support team has been formed. In the technology verification portion of the program, two interceptor axial propulsion contracts and four divert propulsion contracts were awarded by the Air Force Rocket Propulsion Laboratory acting as an agent for the Air Force Space Division. In addition, four interceptor electronics contracts were awarded by the Air Force Armament Test Laboratory. For the second part of the project--the Phase I concept, requirements, and experiment definition--Space Division awarded four competitive contracts.

(~~S~~) Current Activities and Future Plans. The contracts awarded in FY 1985 for concept, requirements and experiment definition and for technology verification will be continued but restructured to accommodate budget reductions. The restructure will allow hardware risk reduction breadboard tests to be initiated. These contracts, once completed, will provide the necessary information to support a decision to award the space experiment contract during 1987. The SBKKV experiment will be designed to validate the key technology requirements for space intercept of a target in an ABM Treaty compliant test in the early 1990s; thus it will permit a decision to be made on the applicability of those technologies for ABM purposes.

(~~S~~) Milestones.

Preliminary Concept Formulation Complete	FY 1985
Expanded Concept Formulation Initiated	FY 1985
Technology Verification Tasks Initiated	FY 1985
Expanded Concept Formulation Complete	FY 1986
KKV Experiment Program Initiated	FY 1986
Technology Verification Complete	FY 1987
Complete KKV Experiment Design	FY 1988
Complete Development Tests	FY 1989
Complete System Integration	FY 1991
Start Space Test	FY 1991
Space Test Complete	FY 1992

D.1.8 (U) Hardware-in-the-Loop Simulation (KEW 11)

(U) Description and Objectives. This program will consist of the system analysis, system engineering, system integration and test activities associated with the integration of both terminal and late midcourse BMD elements. The integration issues include multiphenomenology discrimination, sensor-to-sensor correlation, traffic handling, equipment planning and execution, kill assessment, tier-to-tier correlation and response to countermeasures. These issues will be addressed via analysis, simulation, and hardware-in-the-loop (HWIL) testing. A HWIL simulation facility will be built and used in the analysis and testing. The HWIL will validate resolution of these issues via simulations by utilizing experimental data gathered through the integrated testing of the individual components. The objectives of this integrated demonstration is to confirm interfaces, assess battle management requirements and determine the potential effectiveness of the integrated technologies. HWIL simulations of KEW systems will become one level of a higher simulation of the SDI multitier defense.

(U) This program will integrate the ongoing subsystem elements and demonstrate via simulation, the integrated KEW SDI concept utilizing an Airborne Optical Adjunct, High Endoatmospheric Defense System and Exoatmospheric Reentry Interceptor Subsystem, the Long Wavelength Infrared (LWIR) probe and the Terminal Imaging Radar. The HWIL simulation capability will model all significant phenomena linked to actual sensor and computation hardware. It will provide both a development and an assessment tool essential to the resolution of the functional integrated issues associated with the integration of two or more elements.

(U) Significant Accomplishments (FY 1984-1985). Two contracts were awarded to provide a HWIL Capability Concept Definition.

(U) Current Activities and Future Plans. A Systems Integration contractor will be selected to perform analysis and devise test design concepts for the integration of component simulations. Initial computational capability will be established for HWIL simulations and system level trade-offs analyzed. The system engineering will include systemwide interface definition, functional performance requirements, test configuration requirements, and test support requirements. The HWIL building design will also be started.

(~~S~~) Milestones.

Complete Project Concept Definition	FY 1986
HWIL Design	FY 1986
Simulation Center Construction/Checkout	FY 1988-1989
Terminal Integrated Functional Simulations	FY 1989
Midcourse Integrated Functional Simulations	FY 1989
Validated Functional Simulations	FY 1993

D.1.9 (U) Kwajalein Missile Range Instrumentation Development and SDI Targets (KEW 15)

(U) Description and Objectives. This program provides the ground-based instrumentation augmentation for support of SDI experiments. Existing Kwajalein Missile Range (KMR) instrumentation will be upgraded and additional instrumentation will be procurred to support late midcourse and terminal phase testing. The instrumentation includes a Multiple Object Tracking Radar, augmentation of the current Kwajalein Range Safety System, ground-based optics, telemetry and the associated communications and control systems to allow operations at Wake Island. The sensors will be integrated to allow designation of interceptors, miss distance measurement, reentry vehicle (RV) damage assessment and precise RV tracking.

(U) The primary objective is to provide timely, accurate and independent test and evaluation data for SDI experiments. The instrumentation will provide independent test and evaluation data in support of the Endoatmospheric Intercept Nonnuclear Kill experiment, Exoatmospheric Interceptor Nonnuclear Kill experiment, the Braduskill Interceptor experiment and is available for all SDIO experiments.

~~(C)~~ The SDI Targets task in this program includes the development, fabrication, flight qualification and timely launch of target complexes to meet KEW user needs. A consolidated SDIO total of 20 ICBM target missions and 16 alternate launch vehicle target missions are planned through FY 1993. Target complexes will consist of a combination of reentry vehicles, heavyweight replicas, lightweight replicas, and other penetration aids as necessary to satisfy optical or radar technical objectives. The alternate launch vehicle capability could provide an augmentation to the diminishing quantity of Minuteman I ICBM boosters. The program makes use of existing and modified DoD booster stages, coupled with payloads configured to meet strategic defense requirements. Potential target deployment systems are Minuteman I, Minuteman III, Polaris A3, and Titan II. Payloads will be provided to establish optical and radar discrimination bases and conduct interceptor proof-of-principle homing and kill validations.

(C) The KEW targets task will provide the flight test targets and target launch support for the nonnuclear kill technology, Braduskill Interceptor Concept, high endoatmospheric defense interceptor and the exoatmospheric reentry vehicle interceptor subsystem. The primary performance goal is the satisfactory launch and accurate deployment of target complexes to meet the schedule and technical performance requirements of the various target users in a cost-effective manner.

(U) Significant Accomplishments (FY 1984-1985). A UHF satellite communications capability was added to Kwajalein Missile Range to provide real-time tracking information to the new optical tracker at Wake Island. Additional telemetry equipment was installed to provide total coverage of the S-band.

(U) A consolidated targets working group was established to optimize the number of target missions to satisfy multiple objectives of the various users. Analyses and design has started on the alternate launch vehicle capability to include the booster and the launch facility at Barking Sands, Hawaii.

(U) Current Activities and Future Plans. Analyses and planning will continue to determine what instrumentation is required to support SDI testing. The MOTR will be added in FY 1987 to complement the safety system for launching interceptors from Kwajalein and the multiple object tracking of reentry complexes. The safety system will be upgraded to allow use of real-time telemetry information, to reduce the cycle time and provide a command destruct transmitter to allow simultaneous launch of two vehicles.

(U) The National Laboratories will develop threat representative payload designs and furnish unique payload hardware where limited quantities are involved. Laboratories will develop an alternate launch vehicle capability and prepare payload specifications for procurement from industry. Flight test targets and target support tasks will be consolidated to optimize the number of target missions necessary to satisfy multiple objectives of the various target users. Targets will be produced for kinetic energy Significant Technical Milestone (STM).

~~(S)~~ Milestones.

Safety System Specifications	FY 1986
Payload Procurements Initiated	FY 1986
Booster/Launch Support Procurements Initiated	FY 1986
Multiple Object Tracking Radar Ordered	FY 1987
Significant Technical Milestone Target Delivery	FY 1987
Alternate Delivery System Demonstration	FY 1988
Alternate Launch Vehicle Payload Mission	FY 1988
ICBM Launch	FY 1988
Timing System Upgrades Complete	FY 1988
Multiple Object Tracking Radar Operational	FY 1989
MPS-36 Radar Upgrades Complete	FY 1989

D.1.10 (U) Significant Technical Milestone (STM) (KEW 23)

(U) Description and Objectives. The STM will provide vital experimental data at the earliest possible time. The use of a single STM to obtain data for many other programs causes STM to act as a technology bridge, interconnecting the diverse kinetic energy programs into a highly focused array.

~~(S)~~ The STM experiment's major thrust is directed towards characterizing the signature of rocket plumes in space at closing velocities [redacted] Two thrusted vehicles in intersecting orbits, the Sensor Vehicle (SV) and the Guided Vehicle (GV), are used. The SV contains four highly sensitive instruments in the infrared (IR), ultraviolet (UV) spectra. The SV is thrusted from a distance [redacted] towards the GV. The GV is also thrusted and contains a radar sensor which collects radar data and uses the data to steer the GV within [redacted] of the SV. The sensors on each vehicle view the plume of the other vehicle and transmit these observations to the ground station.

(U) <u>Significant Accomplishments (FY 1984-1985)</u>. The engineering design was completed on both the SV and GV in July 1985, and fabrication work was initiated on both vehicles. The SV was 50% complete and the GV was 25% complete by the end of the fiscal year. The sensor suite was also determined and all sensors were ordered.

(~~S~~) <u>Milestones</u>

Program go-ahead	1985
Preliminary Design Review (STM)	1985
Critical Design Review (STM)	1985
Range Dry-Run Practice and Static Engine Firings (STM)	1986

D.1.11 (U) <u>Major Milestones</u>

(U) Figure D.1 identifies the important milestones of the Kinetic Energy Weapon Program.

D.1.12 (U) <u>Resource Requirements</u>

(U) Table D.1 outlines the resource requirements for the Kinetic Energy Weapon (KEW) Program for FY 1985-1988.

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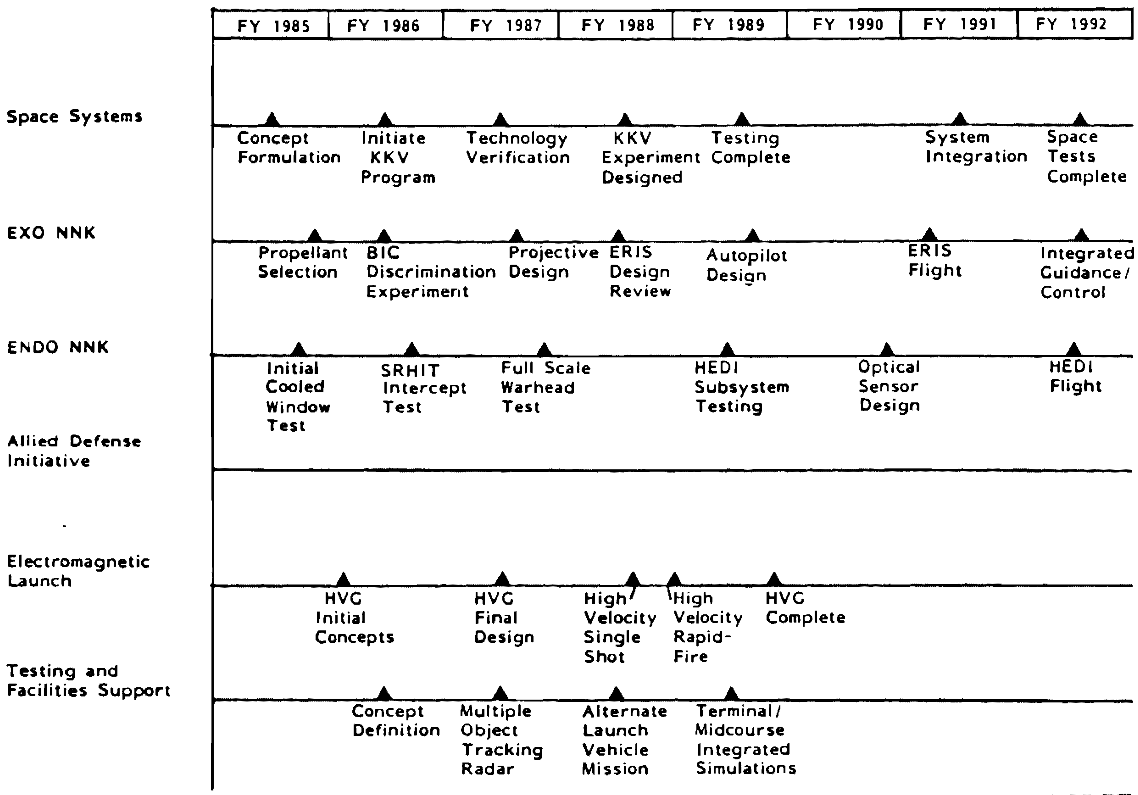

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Figure D.1. (U) Major Milestones - Kinetic Energy Weapons

(U) TABLE D.1

(U) RESOURCE REQUIREMENTS, FY 1985-1988 ($M)

Program Element 63222C: Kinetic Energy Weapon (KEW) Technology Program

	FY 1985 (Actual)	FY 1986 (Actual)	FY 1987 (Budget)	FY 1988 (Estimate)
ENDOATMOSPHERIC NONNUCLEAR KILL TECHNOLOGY				
High Endoatmospheric Technology	78.539	54.242	115.898	139.908
TOTAL	78.539	54.242	115.898	139.908
EXOATMOSPHERIC NONNUCLEAR KILL TECHNOLOGY				
Space-Based Technology	16.689	22.136	36.059	63.185
Ground-Based Technology	10.016	10.056	24.527	42.158
Braduskill Interceptor Concept	2.685	12.000	35.031	62.929
TOTAL	29.390	44.192	95.617	168.272
HYPERVELOCITY ACCELERATOR TECHNOLOGY				
Hypervelocity Technology	32.576	34.121	69.052	95.204
Innovative Concepts and High "g" Project	12.827	20.121	34.842	51.145
TOTAL	45.403	54.242	103.894	146.349
ENDOATMOSPHERIC NONNUCLEAR KILL TEST BED				
ENDO NNK Experiment	22.748	61.991	121.498	227.216
TOTAL	22.748	61.991	121.498	227.216
EXOATMOSPHERIC NONNUCLEAR KILL TEST BED				
EXO NNK Experiment	6.615	73.061	106.907	169.493
TOTAL	6.615	73.061	106.907	169.493
INTEGRATED HYPERVELOCITY TEST BED				
Ground-/Space-Based Experiments	5.543	34.317	62.958	99.559
TOTAL	5.543	34.317	62.958	99.559

(U) TABLE D.1 (Cont'd)

(U) RESOURCE REQUIREMENTS, FY 1985-1988 ($M)

Program Element 63222C: Kinetic Energy Weapon (KEW) Technology Program

	FY 1985 (Actual)	FY 1986 (Actual)	FY 1987 (Budget)	FY 1988 (Estimate)
SPACE-BASED KINETIC KILL VEHICLE				
SBKKV Experiment	34.167	99.407	156.445	158.990
TOTAL	34.167	99.407	156.445	158.990
HARDWARE-IN-THE-LOOP SIMULATION				
Simulation and Integration	12.291	19.372	31.943	75.410
TOTAL	12.291	19.372	31.943	75.410
KWAJALEIN MISSILE RANGE INSTRUMENTATION DEVELOPMENT AND SDI TARGETS				
KMR Instr and SDI Targets	4.900	11.070	45.065	23.342
TOTAL	4.900	11.070	45.065	23.342
SIGNIFICANT TECHNICAL MILESTONE				
Significant Technical Milestone	16.354	143.908	150.989	8.687
TOTAL	16.354	143.908	150.989	8.687
PROGRAM ELEMENT TOTAL	255.950	595.802	991.214	1217.226

APPENDIX E

(U) SYSTEMS ANALYSIS AND BATTLE MANAGEMENT (SA/BM) PROGRAM

(U) The SA/BM program element is organized into the following four projects: (1) Systems Analysis; (2) Battle Management/Command Control and Communications (BM/C^3) Technology; (3) BM/C^3 Experimental Systems; and (4) the National Test Bed.

E.1 (U) SDI SYSTEMS ANALYSIS

E.1.1 (U) Current Activities and Future Plans

(U) To supplement the initial analytical approaches, the FY 1986 effort is concentrating on developing modeling capability and simulation facilities that provide the flexibility to analyze and evaluate evolving system designs and their responsiveness to enemy threats. Emphasis is on developing system-wide compatible simulations.

(U) Analyses and evaluations of all phases of a multitier defense system are continuing, but emphasis is on modeling the various subsystems such as sensor-weapon platforms, and battle environments such as sensor noise backgrounds. In addition, systems and subsystems cost models are being developed as technology evolves. Simulations that allow realistic measurements for system performance are being constructed, to the degree possible, for an evolving system design. These simulations should provide the major tools for: (1) evaluating parametric trade-offs of alternate technologies/concepts; (2) accurately determining weapon leakage and defense system survivability; (3) estimating defense system degradation under various attack scenarios; and (4) conducting cost-effectiveness comparisons of alternate technologies/approaches.

(U) Detailed analyses are being made of multitier BM/C^3 issues and requirements as driven by system architecture considerations. To assist mission evaluation and performance requirements generation system engagement simulation models are being defined and developed that incorporate BM/C^3, Soviet threat and environment models. Preliminary concepts of operation are being determined and pacing technologies are also being identified.

(U) Projections and impact studies of potential future technologies and national resource requirements are continuing in an effort to identify likely drivers in weapons, sensors, support, operations and maintenance for a projected multitiered ballistic missile defense.

(U) Based on progress through FY 1986, the following activity will continue in the FY 1987-1991 time frame: (1) the evaluation and analysis of evolving SDI technologies and designs with emphasis on the internal system interfaces, (2) the analysis of potential responsive threats with which the system will have to cope, (3) the development of appropriate scenarios for use in system simulations of increasing complexity, and (4) the detailed analysis of multitiered BM/C^3 architecture issues and requirements.

(U) Potential logistics and supportability issues will also continue to be addressed at the system level. An interactive examination of the system architectures will be performed to determine logistics requirements and how these requirements can be met. The primary focus of this examination will be on key supportability technologies and related resource requirements.

(U) System and subsystem trade-off analysis will continue with investment strategies being developed to address key system technology issues.

(U) Generally, system analyses and improvements in modeling and simulation tools must continue as progress is made under the SDI research and development program in order to make intelligent engineering and programmatic decisions. In addition, as the SDI functional elements evolve to hardware and software implementations-first development models and later operational models--the simulations developed for system analyses should be adapted to hardware-in-loop simulations of components, such as infrared sensors, and techniques, such as information fusion, since it is not possible to realistically test a complete ballistic missile defense system, the models and simulations must be continually validated and upgraded to provide a high-confidence test bed, demonstration, and training facility.

E.1.2 ~~(S)~~ Major Milestones

Baseline Soviet threat and SDI functional requirements validated	FY 1984
Preliminary BM/C^3 operational concepts and requirements defined	FY 1984
Preliminary Soviet threat/environment system drivers generated	FY 1986
Key subsystem models generated; preliminary system simulations developed	FY 1985
Integrated development plan established	FY 1985
BM/C^3 simulation needs defined; system engagement evaluation, demonstration and test laboratory initiated	FY 1985
Subsystem performance requirements verified by simulations	FY 1986
Continuing architecture plus concept analysis	FY 1986-1990
Critical assessment of elements, subsystem and overall system performance	FY 1990

E.2 (U) BATTLE MANAGEMENT/COMMAND, CONTROL AND COMMUNICATIONS (BM/C^3) TECHNOLOGY

E.2.1 (U) Current Activities and Future Plans

(U) Candidate algorithms for initial alternatives to implement key battle management functions will be developed for evaluation. These algorithms must be suitable for use in a widely dispersed, loosely coupled, real-time, distributed computing system. Low delay, minimum overhead and fault-tolerance are required to maintain a high level of objective correlation and data base consistency and to provide robustness in the presence of network or component failures. The opportunity that knowledge-based systems and artificial intelligence offers the performance of BM/C^3 functions will also be evaluated. Development of algorithms for the BM/C^3 functions will continue until FY 1990. Artificial intelligence concepts will be incorporated into the algorithms whenever potential payoffs exist, but in the near term these algorithms will be generally numeric and procedural. Special emphasis will be directed toward developing the opportunity for exploiting parallelism in the near term (until FY 1988) so that multi-processing computing environments may be used to their fullest advantage. As the SDI sensor and weapon technologies become better defined, the early algorithms based on initial assumptions will have to be refined.

(U) Begun in FY 1985 and progressing through FY 1987, protocols will be developed for an internetted communications system to support multi-tier SDI systems. This network is to be self-managing and capable of providing appropriate connectivity between any hierarchic pair of points. Protocol development must support real-time communications with low delay, priority message passing, self-diagnosis/self-healing capabilities and dynamic load balancing. Alternative candidate network configurations will be analyzed in FY 1986 to assess their ability to satisfy the requirements defined in FY 1985. Through FY 1988, several alternative network approaches will be developed, implemented in emulations of operating system software, and verified.

(U) A baseline set of technology opportunities will be developed to provide potential alternatives for the development of fault tolerant processor concepts, technologies and designs. Additionally, critical circuit technology developments will be pursued that can withstand both high radiation dose rates and single event upsets. Combined hardware and software techniques will be developed to make the resulting numeric/symbolic processors resilient to temporary faults as well as catastrophic failures in major subsystems. The goal will be to develop a processor that can operate in space for ten years without maintenance.

~~(S)~~ Critical circuit technology development will continue through FY 1988. In the period from FY 1988 through FY 1990, results from the efforts in hardened microelectronics and fault-tolerant computing will be combined with research on high performance architectures to build machines with the performance and reliability to support battle management. A fault-tolerant architecture will be verified by FY 1988. Space-qualified hardware will be fabricated and tested in the time frame FY 1988 through FY 1990 and thereafter.

(U) Alternatives for narrow band and wide band carrier links needed to support the internetted communications system will be pursued. Antenna and other hardware requirements will be formulated and analyzed. The development of alternatives for high reliability, secure, robust C^2 narrow band links and high data rate, secure, robust wide band data links and related autonomous software will continue through FY 1990. Emphasis will be on autonomous operation.

~~(S)~~ An initial version of an automated software development environment will be selected. Alternative software development technologies will be analyzed and approaches selected for evolved versions of an automated development environment. The selected approaches must offer the potential for efficient generation of software that can be formally specified and verified. Verification and validation approaches will be analyzed for BM/C^3 application. Development of methodologies, techniques, and tools needed to support the entire software life cycle will continue through FY 1990. All of the work will be closely keyed to the actual BM/C^3 system software needs. Whenever possible, the methods and tools developed will be applied to intermediate SDI system demonstration through successively advanced automated software development environments.

E.2.2 ~~(S)~~ Major Milestones

Research, advanced technology and data acquisition program plans	FY 1984
Baseline performance requirements and candidate configurations defined	FY 1985
Critical technology developments and studies initiated	FY 1985
Test facilities available for critical evaluation of algorithms and software tools	FY 1986
First fault-tolerant hardware and software available	FY 1987
Communications system model evaluation completed	FY 1987
Integration and test of critical communications subsystems for performance verification	FY 1988
Initiate fabrication and test of space-qualified processor hardware	FY 1988
Weapons release and ordnance safety doctrine established	FY 1989
Demonstrated: Fault-tolerance computing architecture; method of generating verifiable software for large systems; BM/C^3 applications algorithms	FY 1990

E.3 (U) BM/C^3 EXPERIMENTAL SYSTEMS

E.3.1 (U) Current Activities and Future Plans

(U) The BM/C^3 Experimental Systems research is divided into three areas: ground-based systems, space-based systems and Allied systems. The ground-based systems research is oriented towards system architectures whose effectiveness relies on assets which are predominantly terrestrially based. The Army is the lead Service.

(U) The space-based systems research activity is oriented to those system architectures whose effectiveness depends on predominantly space deployed assets, but which will normally include a ground-based terminal defense system. The Air Force is the lead Service.

(U) The Allied systems research activity is oriented toward system architectures that are predominantly ground-based in Allied territory.

(U) Research in each of these areas address BM/C^3 experimental systems in five topics: (1) Requirements Identification, (2) BM/C^3 System Architecture/Concept Evaluation, (3) Technology Development, (4) Simulation or Other Analytical Modeling, and (5) Experiments.

(U) Requirements research will place emphasis on the generation of baseline BM/C^3 system operational concepts and requirements such as data rates, connectivity, processing speeds, autonomy requirements, mission analyses and threat for ground-based systems. BM/C^3 requirements originate from three sources: the overall SDI system specification, scenarios assigned to the SDI ballistic missile defense, and those derived in conjunction with other sources and experience, such as the Joint Chiefs of Staff and the Commander in Chiefs inputs on operational concepts. Overall SDI requirements are filtered to select those related to the BM/C^3 segment. An analysis and refinement process identifies lower level BM/C^3 requirements. The end result is a set of functional, time line and "-ilities" requirements for the BM/C^3 segment which are traceable to the original, system-wide requirements.

~~(S)~~ Integrated and non-integrated system architectures and at least two to four alternative architectures for the BM/C^3 system will be developed based on analyses and evaluation of boost, post-boost, midcourse and terminal phase concepts. Several major trade studies will be pursued. Autonomous operation of the battle management system will be simulated under several options beginning with a centralized control and extending to a system of wholly independent subsystems. Allocation of space-to-ground functional requirements and space-to-ground and space-to-space information flow will be explored using evaluation criteria such as mission effectiveness, system message loading, system control, and survivability. Communications trades will determine: (1) the optimum number and location of fixed and mobile terminals; (2) the required up/down/crosslink frequencies, signal design for operation under severe jamming and nuclear scintillation environments; (3) network management of BM/C^3 system; and (4) dynamic system reconfiguration to accommodate threat changes and uncertainties.

~~(S)~~ Battle management systems and strategies also will be evaluated. The studies will include consideration of status monitoring, weapon alert, information management, attack characterization, weapon activation, weapon release, target prioritization, target assignment, self-defense coordination and countermeasure management. Methods for discrimination between targets and various types of survival aids will be studied and preferred discrimination techniques selected. Emphasis will be placed on overall resource allocation and techniques for optimal allocation. There are also a number of policy issues associated with battle management. For example, due to the short time lines involved, opportunities for human interaction albeit will be limited.

(U) Critical technology needs not covered in other research areas will be identified and integrated into the BM/C^3 system architectures. Those technology programs necessary to support the derived architectural candidates will be identified, and specific technology efforts will be undertaken supported to meet the program milestones.

(U) In order to make choices among different architectures and to adequately test these architectures, extensive and realistic simulations which accurately model the stressed environment and deployed situation that may be encountered need to be developed. These system level simulations provide major tools for: (a) determining data flow conflicts, (b) evaluating parametric trade-offs of alternate concepts, (c) system degradation and reconfiguration under various attack scenarios, (d) system survivability, (e) network management, and (f) cost-effective comparison of alternate technologies/approaches. The simulations and analytical models shall be continually upgraded throughout the SDI research program to make engineering and programmatic decisions. In addition to the system level simulation, a set of simulation tools that allow the details of BM/C^3 system operation to be explored will be developed. These models will allow the details of computer hardware and software and communications network specifics to be analyzed.

(U) Mission and utility analyses will be conducted which will include consideration of system effectiveness, network control, resource allocation, system survivability, system degradation under attack, extent of human interaction, cost and risk. The impact on system effectiveness of various levels of discrimination and kill assessment will be analyzed. The system also will be evaluated during the deployment phase and after deployment. From the results of these trade-off studies, preferred candidate BM/C^3 architectures will be selected.

(U) To evaluate system level performance of BM/C^3 architectural concepts and technologies, experimental versions of BM/C^3 systems that incorporate prototypical technologies selected from alternatives developed in the SA/BM technologies project will be demonstrated using the National Test Bed. Prototypical technologies will include alternatives in the areas of algorithms, network concepts, processors, communications, and software engineering.

(U) Experiments using the National Test Bed (see Section E.4) will evaluate architectural concepts and assess architectural performance parameters using simulations that incorporate prototypical technologies (such as, hardware-in-the-loop simulations). Architectural alternatives will be then evaluated based on these performance parameters. The relative merit of these alternatives will be assessed, key technology issues and requirements identified, and opportunities for research programs incorporated into the BM/C^3 technology project.

(U) Experimentation in the BM/C^3 test bed will integrate algorithm studies and technologies and generate the appropriate data base for evaluation of algorithm alternatives. Specific attention will be given to system level algorithms which are peculiar to SDI layered defense and which are not being addressed elsewhere in the SDI program. These algorithms include: discrimination decision-making, based on data collected by the system of sensors, the available intelligence data base, and system resource constraints; boost phase and midcourse weapon assignment algorithms accounting for multiple types of weapons in each phase, the presence of succeeding phases, and the existence of constraints such as illuminator availability for midcourse intercepts; discrimination sensor allocation during the midcourse, and particularly the deployment phase to maximize overall system effectiveness; kill assessment in all phases; reconfiguration of the system when weapon, surveillance, and/or BM/C^3 resources are damaged; and selection of the appropriate defense response when system elements come under attack.

(U) The development of baseline algorithms to support specific battle management functions will build on the data base of algorithmic approaches for target allocation, sensor correlation, attack assessment, damage assessment and sensor fusion developed in other program elements. Technologies that support this strategy will also be evaluated, including distributed data management, global information management resource optimization, and network reconfiguration strategies. This effort will be closely coupled with work being performed in communication network architectures to ensure that a compatible communications-data handling program is defined. Certain algorithms will need to be demonstrated using the BM/C^3 Test Bed/Simulator so that interface capabilities can be verified and performance measurements can be made in a realistic operational environment.

(U) Communications networks also will be modeled and simulations will be developed in order to evaluate networks and candidate designs. A test bed will be defined and configured to design and experimentally validate an internetted communications system capable of supporting the multitiered defense against ballistic missiles. Ultimately, a self-managing system test bed capability is envisioned for developing techniques for arbitrary connectivity between any pair of points in the network. Protocol development on this test bed will feature low-delay real-time communications allowance for priority messages, self-diagnosing/healing, and load-sharing balancing. Particular emphasis will be placed on "smart" switching capabilities in a multinode environment; the switching aspect will be highlighted as a survivability feature in a stressed/disturbed environment. Additional emphasis will be placed on developing techniques and network configurations for accommodating reconfigurable, multiple-connected communications networks with space-, air- and ground-based assets. Issues such as real-time protocols, dynamic reconfiguration and end-to-end security will be addressed and evaluated. Performance and survivability trade-offs of dynamic networks will be made. Results will be used to update the architecture requirements as well as to trade-off alternative configurations/approaches, and to provide a basis for future programmatic decisions.

(U) Given previously established hardware and software requirements, including custom chips, special parts, and unique equipments, fault-tolerant computers for key BM segments will be developed and feasibility demonstrated. The results from this fault-tolerant computer architecture development effort will be combined with the SATKA programs in microelectronics and research in high performance architectures to provide the basis for fabrication of space-qualified hardware with the performance and reliability to support battle management. A specification will be prepared suitable for a full-scale development decision.

~~(S)~~ Development of a robust, secure communications system to internet the SDI system involves integrating advances in communications technology into the communications network development. Communications technology prototypes developed in the BM/C^3 Technology project will be incorporated into the communications network experiments, models and simulations. Communications system performance will be assessed and results will provide a basis for future communications technology efforts.

(U) To evaluate software engineering initiatives and exploit the information from software development feedback mechanisms (design walkthroughs, independent validation teams, testing, etc.), the BM/C^3 Experimental Systems project will include development of experimental battle management software systems. These development projects will be used to evaluate experimental software development tools and innovative software development practices. These projects will also provide the BM systems needed to support other BM technology experiments and development of the NTB. Tools, concepts and practices validated during the experimental BM software system development will be incorporated into the SDI software development system. Shortcomings identified in the experimental system development efforts will be the basis for additional software technology research.

(U) In FY 1986, development and evaluation of architectural alternatives will be expanded to include ground-based systems. Initial definition of the essential complexities for candidate BM/C^3 architectures that must be demonstrated in an experimental program will be accomplished. Methodologies for defining validated experiments or experimental versions of BM/C^3 technology components will be formulated. This also includes demonstration approaches and techniques.

(U) Based on the BM/C^3 architectures developed in FY 1986, experiments and validated experimental versions will be formulated. Initial experiments, part of the incremental buildup to demonstrations of validated experimental versions in later years, will be undertaken. These will consist mainly of simulations of network control concepts; of preliminary constructs of battle management algorithms; and of schemes for survivable, fault-tolerant, and multilevel secure computer networks.

(U) Beyond FY 1987, the incremental buildup to demonstration of experimental versions of BM/C^3 systems, that enable space-based and ground-based options for strategic defense, will continue to develop an information base to support a decision for full-scale engineering development in the early 1990s.

E.3.2 (~~S~~) Major Milestones

Baseline candidate architectures defined	FY 1986
Experiment methodology defined	FY 1986
Experimental systems and experiments definition	FY 1987
Begin execution of experiments	FY 1987
Final demonstration of experimental version for ground-based architecture	FY 1990
Final demonstration of experimental version for space-based architecture	FY 1991

Final demonstration of experimental version for Allied architecture	FY 1991

E.4 (U) NATIONAL TEST BED

E.4.1 (U) Current Activities and Future Plans

(U) In FY 1986 multiple competitive contracts will define the National Test Bed (NTB) and National Test Facility (NTF) initial configuration and operating concepts; initial NTB capabilities; and deliver designs, planning documents and progress towards initial operational capability (IOC). The initial acquisition will involve two phases: Phase I, Concept and Requirements Definition, and Phase II, Preliminary Design and progress towards an NTB capability.

(U) In FY 1987 a prime contractor for final design and development/integration of the NTB will be selected and detailed design will be commenced. Early attention will be given to the final identification of computers and software development tools to be used. In FY 1988 detailed design will be completed and documented in appropriated B-level or other specifications.

(U) The task of site selection and facility design and construction for the NTF will be started in FY 1986. Sites may require new construction or only modification of existing structures. Site selection will be accomplished in FY 1986 based on criteria published early in the fiscal year. Subsequent to site selection, preliminary construction design will be accomplished with a goal of 35 percent final design to be completed prior to the end of FY 1986. Final design will be completed in FY 1987. Construction will be completed with a goal of Beneficial Occupancy Date in 4Q FY 1988.

(U) As part of the contractual effort addressed in the Design and Development task, integration of the NTB will be started in FY 1987. Long lead computer and telecommunications equipment (such as, crypto) acquisition will be initiated based on the computer needs identified by the prime contractor. The remainder of the equipment for the National Test Facility will be purchased and installed in FY 1988. Equipment for interconnection of the NTF with the remainder of the NTB will be acquired and installed. NTB system-wide integration and checkout will be accomplished using integration plans of the prime contractor as approved by the SDIO and its NTB Joint Program Office (JPO) as a guide. Availability of the NTB for essentially full operational capability is planned for the end of FY 1988.

(U) During FY 1988 plans for operation of the NTB and a Joint Program Office for the NTB will be laid. Early integration of existing models and simulations will begin. The NTB management structure will be established in FY 1987. Under its guidance, software development for the NTF/NTB will commence as will its oversight of the other NTB. The JPO will begin system level simulation experiment control, data collection and reduction by the end of FY 1987. During FY 1988 the NTB will be made operational and used to evaluate SDI architectures and technology. As experimental versions of hardware and software (particularly that implementing BM/C^3 capabilities) become available they will be integrated into the NTF. In FY 1988, and the out-years, the capability of the NTB will evolve with enhancement of its computing communications and simulation capabilities.

E.4.2 ~~(S)~~ Major Milestones

Site selection	FY 1986
Complete concept definition phase	FY 1987
Complete preliminary design phase	FY 1987
Start implementation	FY 1988
Initial operating capability	FY 1989

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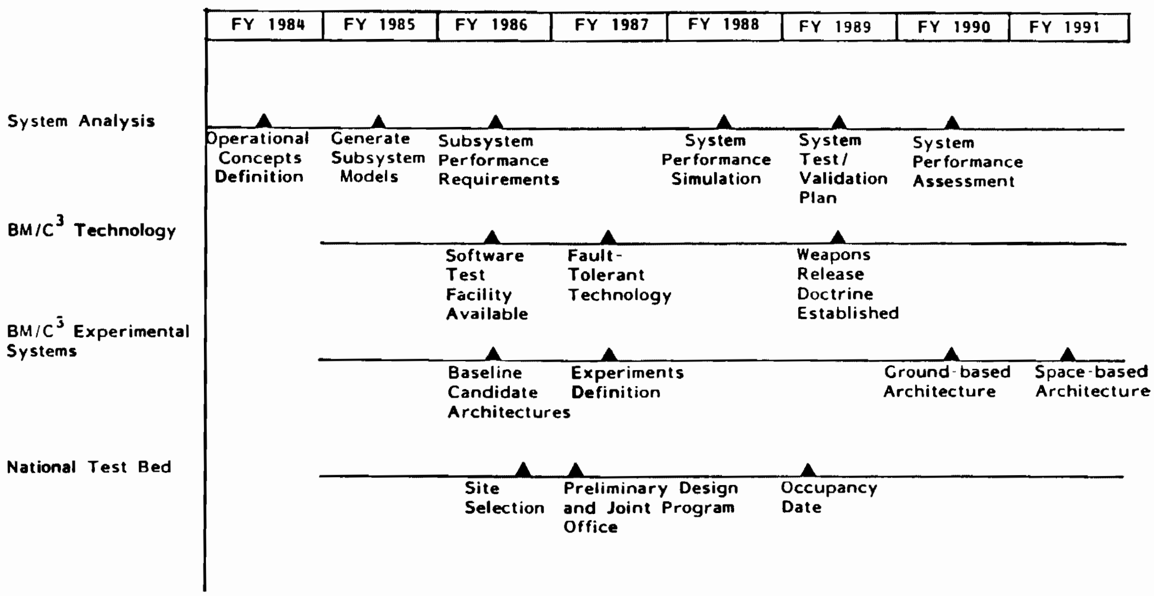

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Figure E.1. (U) Major Milestones - Systems Analysis and Battle Management (SA/BM) Program

(U) TABLE E.1

(U) RESOURCE REQUIREMENTS, FY 1985-1988 ($M)

Program Element 63223C: Systems Analysis and Battle Management (SA/BM) Technology Program

	FY 1985 (Actual)	FY 1986 (Actual)	FY 1987 (Budget)	FY 1988 (Estimate)
SDI SYSTEMS ANALYSIS				
Threat Analysis	5.800	8.000	10.000	11.000
Systems Architecture	35.750	20.000	48.900	45.000
Architecture Analyses	10.000	27.000	29.500	33.000
Architecture Evaluation	11.000	9.100	27.000	35.000
Technical Program Integration	1.200	15.900	27.700	38.600
TOTAL	63.750	80.000	143.100	162.600
BM/C^3 TECHNOLOGY				
Battle Management Algorithms	7.000	16.000	13.000	18.700
Network Concepts	11.500	9.700	16.700	19.600
Processors	6.800	28.700	30.600	34.500
Communications	11.230	12.900	17.600	21.600
Software Engineering		21.639	42.506	45.298
BM/C^3 IS&T		8.000	16.200	19.800
Assessments		0.700	2.000	2.200
Army Program Management		0.000	20.200	22.400
DNA Special Project		9.000		
TOTAL	36.530	106.639	158.806	184.098
BM/C^3 EXPERIMENTAL SYSTEMS				
Ground-Based Systems		10.600	37.800	49.300
Space-Based Systems		12.100	46.000	60.000
TOTAL		22.700	83.800	109.300
NATIONAL TEST BED		18.000	76.500	108.000
TOTAL		18.000	76.500	108.000
PROGRAM ELEMENT TOTAL	100.280	227.339	462.206	563.998

APPENDIX F

(U) SURVIVABILITY, LETHALITY AND KEY TECHNOLOGIES (SLKT) PROGRAM

F.1 (U) CURRENT ACTIVITIES AND FUTURE PLANS

F.1.1 (U) System Survivability

~~(C)~~ The basic threat document and appropriate excursions will be updated annually, with the first revisions occurring in FY 1986, as more knowledge is gained on the threat and probable threat responses. In the interest of efficiency and to expedite the dissemination of Defense Suppression Threat (DST) data to the architectural contractors and other SDI programs engaged in defining individual system concepts, the DST is being consolidated with the Offensive Threat task. The DST data will continue to be an important factor in defining the survivability technical program and assessing the architectural functional survivability.

~~(S)~~ Survivability assessments and analyses in FY 1986 and beyond include creating a set of options for negating or mitigating defense suppression threats, a preliminary analysis of high payoff tactics and techniques, and an evaluation of the status of survivability activities in relevant systems projects. Independent top-level survivability assessments and analyses have been initiated by the SDIO on candidate architectures. Several contracts have been undertaken to stimulate innovative concepts for enhancing survivability. This task is expected to generate a set of recommendations for improving survivability in SDIO systems concepts.

~~(S)~~ There is a continuing need for substantial investments into technical research [redacted] An increase in the emphasis on active survivability technologies work is also needed. Regarding nuclear effects, there will be a prototype demonstration of terminal protection devices and the issuance of initial guidelines to system developers concerning assessments for hardening. Design guidelines will be issued and materials described [redacted] Similar guidelines will be formulated for hardening requirements against [redacted] Engineering compatibility analyses will be performed and a design handbook will be generated for use in designing protection of space assets against kinetic weapons. It is anticipated that significant progress in active survivability technologies will be made in defining the requirements and describing concepts for balloons and obscuration shields. Overall technology design projects should produce promising design concepts beginning in FY 1987. Such concepts for active survivability technology will be selected for development and testing. There will be laboratory testing and simulations being performed for some of the more advanced techniques.

~~(S)~~ There will be increasing emphasis in survivability to provide more detailed tactics, techniques and devices, and engineering solutions to increase confidence in early 1990s decisions. As the System Architecture matures, there will be increased specific and discrete support for evaluations of systems concepts. As systems concepts are described more adequately, there will be increasing interaction [redacted] The survivability project will be closely coupled with the newly created Directorate for Countermeasures [redacted] This interactive play will generate an iterative process in resultant responses of both sides. U.S. planning for protection of space assets and potential response to the defense suppression threat will require a continuing vigorous program that anticipates both systems designers and evaluators. At the same time, there will be continuing efforts to extend the knowledge concerning technology and ideas that show promise in enhancing survivability.

(U) Survivability is not an end item by itself, but a vital attribute of the design of a strategic defense. As such, the whole program is designed to determine what survivability technologies are available, to develop an enhanced survivability technology base for system designers and to assist the designers in making the best use of the survivability technology. To these ends, this program is designed to produce technology and information adequate to incorporate reasonable, affordable features into designs in the FY 1988-1990 period and support informed decisions on potential strategic defenses in the early 1990s.

F.1.2 (U) <u>Lethality and Target Hardening</u>

~~(S)~~ All of the project research efforts will support an initial lethality evaluation against the SDI target set by the end of FY 1987. A lethality and vulnerability data base indicating an extensive knowledge of kill mechanism/target material phenomenology will be completed by FY 1990.

~~(S)~~ [redacted] criteria against unhardened liquid boosters will be developed in FY 1986. Significant scientific uncertainty associated with coupling physics at high irradiance will also be addressed in FY 1986. Tests are planned at HELSTF to investigate the full-scale target response of a missile under boost phase conditions. Materials programs are being supported for asssessments of fully hardened missiles in the FY 1987-1988 time frame.

~~(S)~~ Modifications to the particle beam test facility at Brookhaven National Laboratory will enable tests to begin in FY 1987. Data will be obtained on the use of particle beams for interactive discrimination between actual targets and decoys. Activities in the near term will continue to support the efforts of other SDIO offices to measure [redacted]

Testing to determine the failure mechanisms and thresholds induced by particle beams in electronic, optical and mechanical subsystems will occur at Brookhaven through 1990. Tests will be designed to enable the completion of the discrimination data base and to develop system failure criteria and structural kill levels for a variety of complex targets. The particle beam lethality and vulnerability assessment is expected to be completed in FY 1990.

~~(S)~~ Data on kinetic energy projectile fragmentation and melting have been provided by the [redacted] tests. The upper limit of gas gun capability will be achieved when the current modifications to the DELCO gas gun are completed and will allow lethality testing [redacted] Kinetic energy lethality testing using scale model RVs, PBVs and boosters will continue at [redacted] through FY 1986 and into FY 1987. Additionally, the development of an electromagnetic launcher test facility at Los Alamos National Laboratory will proceed into the hardware development phase. The completion of the electromagnetic launcher will enable testing [redacted] starting in late FY 1987. Lethality testing also will expand to include a wide spectrum of hardened, layered and composite materials providing an extensive lethality and hardening requirements data base by FY 1990.

~~(S)~~ Aboveground and underground [redacted] will be conducted to resolve the major uncertainties in the lethality of potential [redacted] An underground validation test, if possible, will be accomplished in FY 1990.

~~(S)~~ Lethality data from FY 1986 [redacted] experiments will be evaluated and, if considered lethal, the effort will be expanded to develop an extensive [redacted] data base against a variety of targets. In the event [redacted] are not considered lethal, support for the research effort will be discontinued in accordance with the SDIO guidelines to pursue selected technologies that demonstrate satisfactory progress.

F.1.3 (U) Space Power and Power Conditioning

(U) For the Assessment and Analysis task during FY 1986, a preliminary power system requirements document will be completed. Power system architecture studies will be initiated to investigate space and system-generated environmental effects on platform operation. Mission integration studies for SP-100 will also be initiated. Power system modeling and analysis tasks will continue to support the Independent Evaluation Group and other SDIO activities.

(U) FY 1987 will be the first full year of the systems contract for the design, development and test of the major subsystems that comprise the SP-100. This first year is one of intense efforts directed toward establishing design through performance trades and the incorporation of results from the ongoing technology development programs in the national laboratories. Fuel capsule irradiation testing will have attained full burn-up levels for some of the candidate fuel/clad designs. Structural property tests of irradiated material specimens will have been completed for full fluence levels. The design effort and component tests are being conducted in a coordinated fashion to allow the final design review in FY 1988. Spacecraft design for the reference mission will be initiated along with development of the associated electric thrusters.

(U) During FY 1986, technology development of candidate multimegawatt concepts will be initiated. FY 1987 will be a year of intense effort directed toward reducing the number of candidate concepts for multimegawatt power. The multimegawatt program will identify the most promising concepts so that the feasibility effort can be focused on specific technologies. Technology development activities continuing through FY 1987 will provide crucial data for the downselection process in FY 1988. Generic and concept-specific technology development will be the focus of these efforts in both the nuclear and nonnuclear areas. More detailed design and analysis will be conducted on the most promising concepts, plus selected testing, to establish technical feasibility and assure affordable mass and volume.

(U) The Pulsed Power task is a new start in FY 1986. During FY 1985 critical pulsed power elements were identified. During FY 1986 concepts from industry and laboratories will be solicited in order to formulate an overall program plan. Research and development efforts to achieve significant advances in the areas of switching, energy storage, and voltage/current transformation will be the focus.

(U) Pulse power conditioning work is of two basic types: establishment of the technical feasibility of order of magnitude increases in current and voltage levels, switching rates, etc.; and increased energy and power density of certain devices so that space deployment is feasible. Major programs will be conducted for new generations of opening and closing switches, RF sources, inverters, transformers, capacitors, and inductive energy storage.

F.1.4 (U) Space Transportation and Support

(U) The Space Transportation and Support Project is essentially a new start in FY 1986. The final results of the SDI Phase I System Architecture Studies have confirmed a conclusion reached by the Defensive Technologies Studies: namely, that the current costs of space transportation and support must be significantly reduced if affordable space-based architectures are to be seriously considered. This project is assigned the goal of reducing the costs of space operations by an order of magnitude from current operations. To put the scope of this problem in the proper perspective, space-based architectures could generate a launch requirement for 20-200 million pounds to low earth orbit. At today's cost of $1-3000 per pound to orbit, the cost of space transportation alone could approach $60 billion.

(U) The Space Transportation and Support Project is divided into four major activities: architecture studies, iterative assessments, technology developments, and the National Aerospace Plane (NASP) program. A brief description of each activity follows.

(U) The transportation architecture study is a joint activity funded by the SDIO, USAF, and NASA. This study has been directed by the National Security Council. The specified tasks include identifying launch vehicle technologies and investment strategies that could be available in the post-1995 period. The near-term activities will support the response to the NSC tasking. Follow-on activities will emphasize the continuing trade studies and sensitivity analyses to satisfy the emerging requirements for SDIO.

(U) The integration analysis task is an independent assessment that reports directly to the SDIO. This activity reviews the SDIO architecture studies for impacts on space transportation and support systems. Likewise, space transportation architectures are being evaluated for their impacts and implications on SDIO architectures. The objective of this activity is to facilitate the flow and exchange of information between the SDIO and the space transportation architecture studies.

(U) The technology development activity is responsible for managing the investments for reducing the costs of space operations. Currently, this activity is led by a Transportation Technology Team which is funded by the SDIO, USAF, and NASA. This effort has three primary areas of interest: launch vehicles, mission operations and support, and integrated logistics support. Some of the major technology development programs address propulsion systems, structures and materials, avionics, flight controls, ground processing, mission and flight planning, and automated test equipment and checkout. Major advocacy programs will be proposed for future technology demonstrations.

(U) The National Aerospace Plane program is a joint program sponsored by SDIO, DARPA, USAF, USN, and NASA. This is a research program which will enter concept development. One of the objectives is to investigate the potential application of air breathing propulsion in a space transportation mode.

F.1.5 (U) Materials and Structures

(U) The Materials and Structures (M&S) Program is essentially a new start in FY 1986. The anticipated SDIO systems requirements indicate a growing class of critical enabling, yet generic technologies, related to lightweight structures and materials. A review of current materials and structures programs indicate that approximately $300-400M/year is being spent by agencies within and outside of the SDI organization. The M&S Program will coordinate, consolidate, and focus these programs to resolve critical materials and structures issues prior to the early 1990s. Given a minimal budget, the M&S Program will develop SDIO generic areas by leveraging ongoing efforts throughout the technical community (DoD, DoE, NASA, etc.).

(U) During FY 1986-FY 1987 there will be emphasis on determining the generic M&S systems requirements within SDIO and assessing programs and activities which address these requirements throughout DoD, DoE, NASA, etc. The specific materials technology areas to be addressed include: thermal and electrical materials, optical components manufacturing and processing, materials durability, and tribo materials. In lightweight structures there will be emphasis on the development of laboratory scale structural materials and a pilot effort to demonstrate/verify manufacturing and production capabilities of existing materials. The M&S program will also provide a vital interface with the survivability and lethality efforts within SLKT.

(U) Therefore, with a small investment in this program, the large resources of ongoing materials and structures programs can be leveraged and focused to address the urgent needs for SDIO systems. As the focal point for all SDI materials and structures, this program will provide the necessary coherence to ensure that a balanced program is achieved and that critical needs are satisfied at minimal cost. Just as importantly, the program will identify any technological gaps which could impact an early 1990s decision.

F.1.6 (U) Countermeasures

(U) The Countermeasures project will be a continuous program that responds to changes in the SDIO technical programs and the strategic environment. It must continue to interact with system advocates throughout the design process to ensure that whatever systems are eventually developed and deployed will be effective in the face of countermeasures. Hence the activities begun in FY 1985, the Soviet Red Team and the Technical Red and Blue Teams considering the High Endoatmospheric Defense System, will be continued.

(U) In FY 1986 new technical Red Teams will be established to consider space-based sensors, the System Architecture Studies, space-based interceptors, and ground-based directed energy weapons. This work will be further expanded in FY 1987 to include space-based directed energy weapons, ground-based sensors, ground-based interceptors, and key technologies. It is expected that during FY 1987 Red Team analysis will have progressed to the point where it will be necessary to perform some experimental work to validate some of the countermeasures concepts developed.

F.2 (U) MAJOR MILESTONES

(U) Figure F.1 identifies the important milestones of the Survivability, Lethality and Key Technologies Program.

F.3 (U) RESOURCE REQUIREMENT

(U) Table F.1 outlines the resource requirements for the Survivability, Lethality, and Key Technologies (SLKT) Program for FY 1985-1988.

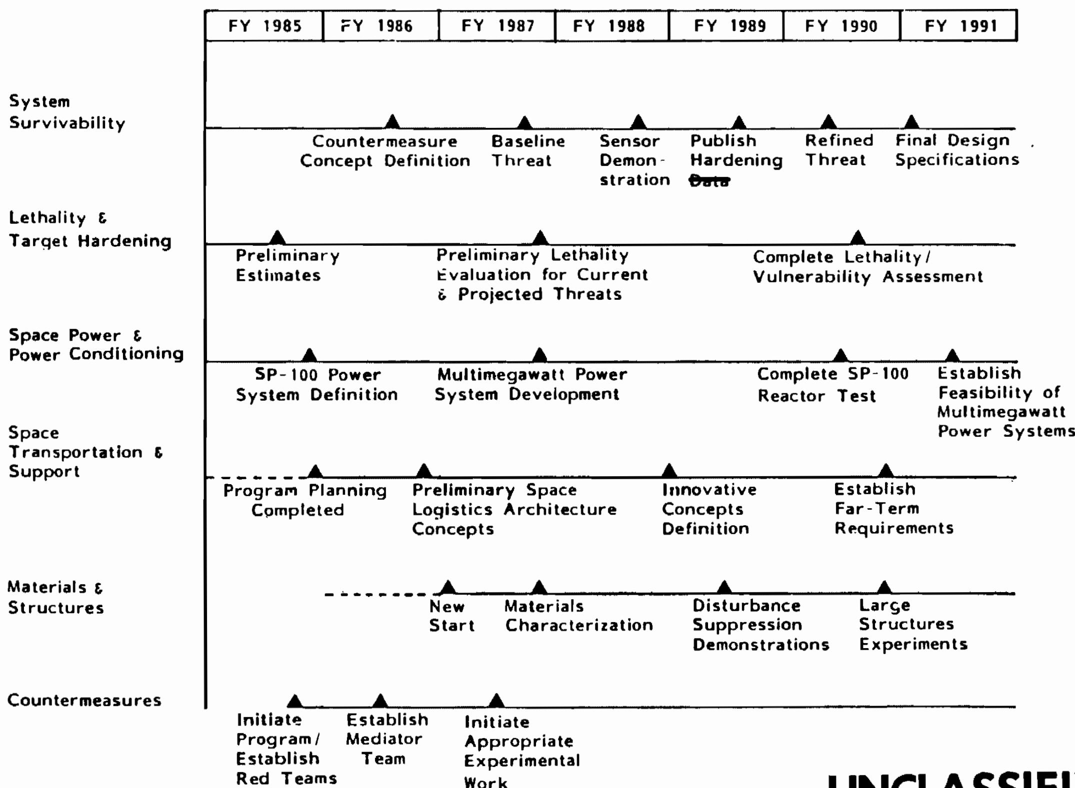

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Figure F.1. (U) Major Milestones - Survivability, Lethality and Key Technologies

(U) TABLE F.1

(U) RESOURCE REQUIREMENTS, FY 1985-1988 ($M)

Program Element 63224C: Survivability, Lethality, and Key Technologies (SLKT) Program

	FY 1985 (Actual)	FY 1986 (Actual)	FY 1987 (Budget)	FY 1988 (Estimate)
SYSTEM SURVIVABILITY				
Survivability Assessment	1.567	3.223	4.755	9.106
Survivability Analysis	3.450	3.600	3.000	3.500
Threat Refinement	2.967	2.600	3.500	3.500
Countermeasures Development	21.224	47.920	57.120	80.200
FEL Medical	3.050	0.000	0.000	0.000
IS&T	0.000	2.080	2.480	3.494
TOTAL	32.258	59.423	70.855	99.800
LETHALITY AND TARGET HARDENING				
Thermal Lasers	23.850	20.470	23.700	12.100
Impulse Lasers	8.200	2.880	0.000	0.000
Impulse Lasers (X-Ray)	8.100	18.640	29.310	30.920
Particle Beams	7.000	7.360	19.700	17.711
Kinetic Energy	10.000	17.730	20.800	24.320
High Power Microwaves	6.300	13.650	3.000	0.000
System Validation	0.000	0.000	0.000	1.300
Repetitive Pulse Power	0.000	5.550	12.200	14.511
Strategic Warhead Lethality	0.000	2.014	3.000	0.000
IS&T		3.202	4.471	3.658
HELSTF			11.556	
TOTAL	63.450	91.496	127.737	104.520
SPACE POWER AND POWER CONDITIONING				
Planning and Assessment	1.000	3.122	3.000	3.000
Multimegawatt Industry Concept	1.000	0.000	0.000	0.000
Multimegawatt Lab Concept	1.000	0.000	0.000	0.000
Multimegawatt Technology	0.000	16.000	52.423	37.905
Advanced Technology	8.000	1.000	5.000	1.000
SP-100 (100 kW)	0.000	15.000	50.000	61.000
Requirements and Analysis	0.000	3.000	5.000	2.000
Pulse Power Technology	0.000	10.000	15.000	18.000
SP-100 Flight System	0.000	0.000	3.000	9.000
Nonnuclear Baseload	0.000	0.100	1.400	1.000
IS&T	-	1.749	4.890	4.820
TOTAL	11.000	49.971	139.713	137.725

(U) TABLE F.1 (Cont'd)

(U) RESOURCE REQUIREMENTS, FY 1985-1988 ($M)

Program Element 63224C: Survivability, Lethality, and Key Technologies (SLKT) Program

	FY 1985 (Actual)	FY 1986 (Actual)	FY 1987 (Budget)	FY 1988 (Estimate)
SPACE TRANSPORTATION				
Space Logistics	1.692	5.900	8.500	9.283
Transportation Assessment	0.000	0.487	1.505	2.150
Technology	0.000	4.600	25.000	87.942
National Aerospace Plane	0.000	9.000	30.000	64.491
IS&T	-	0.725	2.357	5.943
TOTAL	1.692	20.712	67.362	169.809
MATERIALS AND STRUCTURES			20.609	
IS&T			0.747	
TOTAL			21.356	
COUNTERMEASURES			26.387	11.387
IS&T			0.957	0.413
TOTAL			27.344	11.800
PROGRAM ELEMENT TOTAL	108.400	221.602	454.367	523.654

APPENDIX G

(U) SDI AND THE ALLIES

G.1 (U) CONSULTATIONS WITH ALLIES ON SDI

G.1.1 (U) Congressional Reporting Requirements

(U) This appendix responds to the Congressional requirement to include in the annual report on Strategic Defense Initiative programs "the status of consultations with other member nations of the North Atlantic Treaty Organization, Japan, and other appropriate Allies concerning research being conducted in the Strategic Defense Initiative program."

G.1.2 (U) SDI and Allied Security

(U) When President Reagan announced the Strategic Defense Initiative, he made clear from the outset that the program was designed to enhance Allied as well as U.S. security. Thus, the SDI will examine defenses against all ballistic missiles, no matter what their range or armament, and can only strengthen the U.S. commitment to the defense of European and other Allies.

(U) In line with that commitment, the U.S. government has been engaged in close and continuing consultations with its Allies on the Strategic Defense Initiative since the inception of the research program. The U.S. also conducts ongoing discussions with the Allies on the exchanges with the USSR that bear on the SDI program at the Defense and Space Talks in Geneva. Those consultations will continue throughout the SDI research program. Furthermore, if the necessary research criteria are met, the U.S. will consult closely with its Allies regarding any future decision to develop and deploy defenses against ballistic missiles.

(U) Contacts with the Allies on the SDI go well beyond consultation; the U.S. looks forward to the broadest possible Allied involvement in actual SDI research activity. As a result, in March 1985 Secretary Weinberger invited the NATO Allies, as well as Australia, Israel, Japan and South Korea, to participate directly in SDI research.

G.1.3. (U) <u>Bilateral Consultations on the SDI</u>

(U) Consultations with friends and Allies on the SDI broadened and deepened throughout 1985. Indeed, such discussions are a regular feature of numerous meetings with Allied officials at all levels, both in Washington and abroad. The following offers a brief summary of some of the more noteworthy contacts.

(U) President Reagan, Secretary of Defense Weinberger and Secretary of State Shultz have discussed the program in virtually all their bilateral meetings on security matters with their Allied counterparts. High-level and mid-level National Security Council, Department of Defense, Department of State, and ACDA officials also held extensive bilateral consultations with Allied governmental, military and parliamentary leaders, both in the United States and in Allied capitals.

~~(C)~~ The practice, begun in 1984, of periodic interagency briefings in Allied and friendly capitals has continued. Those briefings have covered Soviet activities in strategic defense, the defense and arms control policy implications of the SDI, and the scope and progress of the SDI research program. The briefing teams included representatives of the National Security Council, Office of the Secretary of Defense, Department of State, Defense Intelligence Agency, Central Intelligence Agency and the Arms Control and Disarmament Agency. They visited [redacted]

G.1.4 (U) <u>Multilateral Consultations on the SDI</u>

(U) Multilateral consultations with groups of Allied governments also intensified at all levels in 1985. The President discussed the Strategic Defense Initiative at the May 1985 Economic Summit and at the United Nations in October with the heads of government of Canada, the Federal Republic of Germany, Italy, Japan and the United Kingdom. The President also briefed the NATO Allies -- most of which were represented by their heads of government -- immediately after his November meeting with General Secretary Gorbachev. That briefing included a detailed discussion of his exchanges with Gorbachev on the SDI.

(U) The ministerial meetings of NATO's Nuclear Planning Group, in Luxembourg in March and Brussels in October 1985, featured extensive discussions of the SDI. The Ministers were briefed on the progress of the SDI research program, on the defense and arms control policy implications of the SDI, and on Soviet activities in strategic defense. The communique issued at the close of the Luxembourg meeting underscored NATO Allies' support for the SDI:

> "We have continued the comprehensive consultations on the political and strategic implications of the United States' Strategic Defense Initiative (SDI). This is designed to establish whether recent advances in technologies could offer the prospect of significantly more effective defense against ballistic missiles. We support the United States research program into these technologies, the aim of which is to enhance stability and deterrence at reduced levels of offensive nuclear forces. This research, conducted within the terms of the ABM Treaty, is in NATO's security interest and should continue. In this context, we welcome the United Stated invitation for Allies to consider participation in the research program."
>
> "We noted with concern the extensive and long-standing efforts in the strategic defense field by the Soviet Union which already deploys the world's only ABM and anti-satellite systems. The United States strategic defense research program is prudent in the light of these Soviet activities and is also clearly influenced by the treaty violations reported by the President of the United States."

(U) The United States also consulted with Allied leaders on the Strategic Defense Initiative and other SDI-related issues being addressed in the Defense and Space Talks in Geneva. Specifically, this took place at the ministerial meetings of the North Atlantic Council and Defense Planning Committee in June and December 1985. Further consultations took place below the ministerial level in several NATO fora throughout 1985. In addition, Secretary of State Shultz, SDIO Director Lieutenant General Abrahamson and Special Advisor to the President Paul Nitze discussed the Strategic Defense Initiative with NATO parliamentarians at the North Atlantic Assembly in San Francisco in October 1985.

G.1.5 (U) <u>Foreign Participation in SDI Research</u>

~~(C)~~ Secretary Weinberger's March 1985 invitation to a number of Allied and friendly nations to participate in SDI research led to a series of continuing bilateral discussions with several Allies on potential research involvement, briefings to their delegations who have come to Washington, visits for these groups to SDI research facilities and SDIO technical team visits to Allied countries. The object of this multifaceted dialogue has been to address the various procedural concerns on each side, and to identify areas of SDI research for possible participation, consistent with U.S. security interests, law, and international obligations including the ABM Treaty.

~~(C)~~ Allied firms are free to seek unclassified SDI contracts and subcontracts, with no action required by their governments, except as may be necessary, for example, under U.S. export control laws and regulations. Firms in those countries with which the U.S. has the appropriate bilateral security agreements may seek classified SDI contracts as well. Some Allied government involvement would be required, in that case, to ensure compliance with those agreements: the potential contractor must be cleared by its government; the classified information involved in the contract must be approved for release by the United States to that government; and that information must be transferred through government-to-government channels.

(U) Nevertheless, the U.S. believes that mutually beneficial Allied participation would be facilitated by new government-to-government agreements concerning SDI research involvement. This type of accord would lay down agreed ground rules regarding the basic terms and conditions of participation in SDI research, covering such recurring issues as protection of classified information, control of technology transfer, rights to use research results, etc. On 6 December 1985, Secretary Weinberger and British Defense Minister Michael Heseltine signed such an agreement in the form of a bilateral Memorandum of Understanding. Various other Allied governments appear interested in similar accords.

(U) Allied SDI research involvement will be based on technical merit. The U.S. has made clear to its Allies that there can be no guarantee of a certain level of effort. It is expected, however, that Allied scientific and technical expertise can make a substantial contribution to the SDI research program, which will help accelerate its schedule and reduce overall costs. In addition, research participation will directly benefit the Allies involved through the gains inherent in such a deeper understanding of the military and technical basis for defense against ballistic missiles.

APPENDIX H

COMPLIANCE OF THE STRATEGIC DEFENSE INITIATIVE WITH THE ABM TREATY (1986)

H.1 (U) INTRODUCTION AND SCOPE

(U) This appendix addresses compliance with the ABM Treaty of activities under the Strategic Defense Initative (SDI) and related programs. The treatment of devices based on "other physical principles" is discussed. The existing process for ensuring compliance with Strategic Arms Limitation (SAL) Agreements, including organizational responsibilities and reporting procedures and their application to SDI and the ABM Treaty, is also described.

H.2 (U) POLICY

(U) There are four major points to be made regarding United States policy on compliance with the ABM Treaty.

(U) First, the SDI research program is being conducted in a manner fully consistent with all U.S. Treaty obligations. The President has directed that the program be formulated in a fully compliant manner, and the DoD has planned and reviewed the program (and will continue to do so) to ensure that it remains compliant.

(U) Second, the need for greater precision in our understanding of the limitations of the ABM Treaty recently caused the U.S. Government to reexamine the Treaty as it relates to future systems based on "other physical principles." These devices are addressed in an agreed statement to the Treaty as "ABM Systems based on other physical principles and including components capable of substituting for ABM interceptor missiles, ABM launchers or ABM radars." This review led to the judgment by the President that a reading of the ABM Treaty that would allow the development and testing of such systems based on other physical principles, regardless of basing mode, is fully justified.

The SDI Program was originally structured in a manner that was designed to permit it to achieve critical research objectives while remaining consistent with a more narrow interpretation of the ABM Treaty. This being the case, in October 1985, while reserving the right to conduct the SDI Program under the broad interpretation at some future time, the President deemed it unnecessary to restructure the SDI Program towards the boundaries of the ABM Treaty which the U.S. could observe.* Consistent with that determination, the Administration applies the more restrictive treaty interpretation as a matter of policy, although we are not legally required to do so, in evaluating the experiments in the SDI program. Therefore, statements in this appendix regarding compliance with treaty provisions should be understood as based upon the restrictive interpretation. It should be equally understood, however, that the President believes that this broad interpretation is fully justified.

(U) Third, because there are areas** which are not fully defined in the ABM Treaty, it is necessary in some cases to infer

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*(U) This restrictive interpretation treats ABM devices based on other physical principles and capable of substituting for ABM interceptor missiles, ABM launchers, or ABM radars as "ABM components" within the meaning of Article II of the Treaty, and therefore subject to the provisions of the Treaty, including Article V.

**(U) An example within the restrictive interpretation of the Treaty is the subject of components. ABM components are defined in the Treaty as "currently" (i.e., 1972) consisting of ABM missiles, launchers, and radars. But there is no agreed definition of what constitutes an "ABM component" based on future technology, beyond the guidance in Agreed Statement D: "In order to ensure fulfillment of the obligation not to deploy ABM systems and their components except as provided in Article III of the Treaty, the Parties agree that in the event ABM systems based on other physical principles and including components capable of substituting for ABM interceptor missiles, ABM launchers, or ABM radars are created in the future [i.e., after 1972], specific limitations on such systems and their components would be subject to discussion in accordance with Article XIII and agreement in accordance with Article XIV of the Treaty."

specific standards for compliance. Four of the more important working principles of this review used to establish such standards are that:

- Compliance must be based on objective assessments of capabilities which support a single standard for both sides and not on subjective judgments as to intent which could lead to a double standard of compliance.

- The ABM Treaty prohibits the development, testing, and deployment of ABM systems and components that are space-based, air-based, sea-based, or mobile land-based. However, regarding devices, the Treaty does permit research short of field testing of a prototype ABM system or component. This is the type of research that will be conducted under the SDI program.

- New technologies and devices should not be subjected to stricter standards than existing systems.

- The ABM Treaty, of course, restricts only defenses against strategic ballistic missiles; it does not apply to defenses against non-strategic ballistic missiles or cruise missiles.

(U) Fourth, we have not in this report considered Soviet violations of the ABM Treaty. The United States has reserved the right to respond to those violations in appropriate ways, some of which may eventually bear on the Treaty constraints as they apply to the United States. The United States Government must guard against permitting a double standard of compliance, under which the Soviet Government would expect to get away with violations of various provisions of arms agreements while the U.S. continues to comply with all provisions.

H.3 (U) OVERALL COMPLIANCE ASSESSMENT

(U) The entire SDI research program is being conducted in compliance with the ABM Treaty. The SDI program consists of near-term technology research projects and major experiments. The research projects directly support the major experiments by providing the necessary technologies. These research activities are well defined and clearly compliant. The major experiments, most of which are to be conducted in later years, are also being planned to be fully compliant. Experiments can demonstrate technical feasibility without involving ABM systems or components or devices with their capabilities. Thus useful and compliant experiments, in both "mobile" and "fixed land-based" configurations, are allowed.

H.4 (U) EXISTING COMPLIANCE PROCESS FOR SDI

(U) DoD has in place an effective compliance process (established in 1972 after the signing of the SALT I agreements), under which key offices in DoD are responsible for overseeing and will continue to oversee SDI compliance with all existing strategic arms control agreements. Under this process the SDI Organization (SDIO) and Services ensure that the implementing program offices adhere to DoD Compliance Directives and seek guidance from offices charged with oversight responsibility.

(U) Specific responsibilities are assigned by DoD Directive 5100.70, 9 January 1973, Implementation of SAL Agreements. The Under Secretary of Defense for Research and Engineering (USDRE) ensures that all DoD programs are in compliance with existing SAL agreements. The Service Secretaries, Chairman of the Joint Chiefs of Staff and Agency Directors ensure the internal compliance of their organizations. The DoD General Counsel provides advice and assistance with respect to the implementation of the compliance process and interpretation of SAL agreements.

(U) DoD Instruction S-5100.72 establishes general instructions, guidelines, and procedures for ensuring the continued compliance of all DoD programs with the existing arms control agreements. Under these procedures questions of interpretation of specific agreements are to be referred to the USDRE to be resolved on a case-by-case basis. No project or program which reasonably raises an issue as to compliance can enter into the testing, prototype construction, or deployment phases without prior clearance from the USDRE. If such a compliance issue is in doubt, USDRE approval shall be sought. In consultation with the DoD General Counsel, OASD/ISP and OJCS, the USDRE applies the provisions of the agreements, as appropriate. Military departments and DoD agencies, including SDIO, are to certify internal compliance quarterly and establish internal procedures and offices to monitor and ensure internal compliance.

(U) In 1985, the United States began discussions with Allied governments regarding technical cooperation on SDI research. All cooperative SDI research agreements will be implemented in a manner consistent with U.S. international obligations including the ABM Treaty. The Administration has adopted guidelines to ensure that all exchanges of data and cooperative research ventures are conducted in full compliance with the ABM Treaty obligations not to transfer ABM systems or components limited by the Treaty, nor to provide technical descriptions and blueprints specifically worked out for the construction of such systems and components.

H.5 (U) CATEGORIES OF TREATY COMPLIANT ACTIVITIES

(U) There are three basic types of activity that are permitted in compliance with the ABM Treaty. The SDI major experiments described below are grouped according to these categories.

(U) Category 1 - Conceptual Design or Laboratory Testing. This activity precedes field testing and was considered during the ABM Treaty negotiations to be research that was not verifiable by National Technical Means (NTM) and not subject to Treaty limits.

(U) Category 2 - "Field Testing" of Devices that Are Not ABM Components or Prototypes of ABM Components. As noted earlier, Article V prohibits the development, testing, and deployment of ABM systems or components which are sea-based, air-based, space-based, or mobile land-based.

(U) The negotiating record of the ABM Treaty shows it was clearly understood in 1972 that "development" begins when field testing is initiated on a prototype of an ABM component. The definition of "development" applied to the Article V limitations results in the prohibition on field testing of ABM systems and components, or their prototypes which are other than fixed land-based. Thus, SDI field tests of space or other mobile-based devices cannot involve ABM components or prototypes. All SDI Category 2 experiments must meet this criterion. For any device to be limited by the ABM Treaty, whether labeled "prototype" or some other term of art, it must constitute an ABM system or component (an ABM interceptor missile, ABM launcher, ABM radar) or be capable of substituting for such an ABM component.

(U) "ABM systems and components" are defined in Article II as follows:

> For the purpose of this treaty an ABM system is a system to counter strategic ballistic missiles or their elements in flight trajectory, currently consisting of: (a) ABM interceptor missiles, which are interceptor missiles constructed and deployed for an ABM role, or of a type tested in an ABM mode; (b) ABM launchers, which are launchers constructed and deployed for launching ABM interceptor missiles; and (c) ABM radars, which are radars constructed and deployed for an ABM role, or of a type tested in an ABM mode.

~~(S)~~ We are applying the rule that all SDI "field tests" not involving fixed, land-based devices must not be conducted in an "ABM mode." The term "tested in an ABM mode" is specifically addressed in an Agreed Statement negotiated in 1978 by the U.S.

and USSR in the Standing Consultative Commission. The pertinent portions are:

> 2. Testing in an ABM mode is testing, which ... is carried out only at test ranges or in an ABM system deployment area, for the purpose of determining the capabilities of an ABM system or its individual components (ABM interceptor missiles, ABM launchers, or ABM radars) to perform the functions of countering strategic ballistic missiles or their elements in flight trajectory.
>
> 3. As applied to testing of ABM interceptor missiles, ABM launchers, or ABM radars, the term 'strategic ballistic missiles or their elements in flight trajectory,' used in the Treaty, also refers to ballistic target-missiles which, after being launched, are used for testing these ABM system components in an ABM mode, and the flight trajectories of which, over the portions of the flight trajectory involved in such testing, have the characteristics of the flight trajectory of a strategic ballistic missile or its elements.
>
> 4. The term 'tested in an ABM mode' used in Article II of the Treaty refers to: (a) an ABM interceptor missile if while guided by an ABM radar it has intercepted a strategic ballistic missile or its elements in flight trajectory regardless of whether such intercept was successful or not; or if an ABM interceptor missile has been launched from an ABM launcher and guided by an ABM radar. If ABM interceptor missiles are given the capability to carry out interception without the use of ABM radars as the means of guidance, application of the term 'tested in an ABM mode' to ABM interceptor missiles in that event shall be subject to additional discussion and agreement in the Standing Consultative Commission; (b) an ABM launcher if it has been used for launching an ABM interceptor missile; (c) an ABM radar if it has tracked a strategic ballistic missile or its elements in flight trajectory and guided an ABM interceptor missile towards them regardless of whether the intercept was successful or not; or tracked and guided an ABM interceptor missile; or tracked a strategic ballistic missile or its elements in flight trajectory in conjunction with an ABM radar, which is tracking a strategic ballistic missile or its elements in flight trajectory and guiding an ABM interceptor missile toward them or is tracking and guiding an ABM interceptor missile.

Category 2 experiments must also meet the obligation of Article VI not to give non-ABM launchers, missiles, or radars capabilities to counter strategic ballistic missiles or their elements in flight trajectory.

~~(S)~~ Allowed Category 2 activities include tests of experimental devices to demonstrate technical feasibility and gather ~~data~~ prior to constructing a prototype of an actual ABM component or weapon system. (DODI S-5100.72, revised in May 1977, explicitly states that such field testing is not prohibited.) Tests of non-ABM systems performing functions consistent with Treaty obligations (such as air defense and early warning) are also legitimate Category 2 activities.

(U) <u>Category 3 - "Field Testing" of Fixed Land-Based ABM Components</u>. "Field Testing" of fixed land-based ABM components or systems is permitted as long as other Treaty provisions are met. Under Article IV all such tests must take place at agreed ABM test ranges (for the U.S., White Sands Missile Range and Kwajalein Missile Range), and the total test launcher count must not exceed 15.

(U) Other testing must comply with limitations in Paragraph 2 of Article V on launcher capabilities as follows:

> Each party undertakes not to develop, test, or deploy ABM launchers for launching more than one ABM interceptor missile at a time from each launcher, nor to modify deployed launchers to provide them with such a capability, nor to develop, test, or deploy automatic or semi-automatic or other similar systems for rapid reload of ABM launchers.

Agreed Statement E prohibits "developing, testing, or deploying ABM interceptor missiles for delivery by each ABM interceptor missile of more than one independently guided warhead."

(U) Summary. The SDI projects and experiments have been reviewed to ensure that they will be conducted in accordance with one of the three categories of activities permitted by the Treaty.

~~(S)~~ The Services and SDIO are obligated to plan and implement these experiments in a compliant manner. Many of the SDI devices do not use traditional technology, but are "based on other physical principles" (such as lasers). In these cases, we have reviewed them by considering their capability to substitute for traditional ABM components, whether they will be "tested in an ABM mode" by analogy to the 1978 Agreed Statement (which does not address devices based on new technology), and the intended use of the device in the experiment.

~~(S)~~ DODI S-5100.72 requires the review of all plans to conduct tests of devices, "based on other physical principles" and "capable of substituting for" ABM systems or components.

H.6 (U) COMPLIANCE ASSESSMENT

(U) The entire SDI program has been reviewed to ensure compliance with the ABM Treaty. The bulk of the near-term effort consists of technology research projects which support major experiments to be conducted by the SDI program. Most technology research projects fall in Category 1, some in Category 2, and none in Category 3. Sixteen major experiments and their basis for compliance (thirteen are in Category 1 or 2 and three are in Category 3) are summarized below. Three major new experiments are considered: the Ground-Based Free Electron Laser (FEL), the High Brightness Relay (HIBREL), and the Neutral Particle Beam (NPB). Two experiments, the Long Wavelength Infrared (LWIR) Probe and the Integrated Demonstration, are not considered this year, because they are not funded in the requested program. Other experiments have been substantially revised since last year.

(U) <u>Category 1 and 2 Major Experiments</u>. These thirteen experiments involve devices which are not ABM components or their prototypes and are not capable of substituting for ABM components. These include the six Directed Energy Weapon (DEW)-related experiments and seven Surveillance, Acquisition, Tracking and Kill Asessment (SATKA) and Kinetic Energy Weapons (KEW) experiments.

[redacted]

~~(S)~~ The [redacted] and the [redacted] subsystems from the former [redacted] program will be integrated into an experimental device for ground-based lethality testing against targets at White Sands Missile Range (FY 1987-FY 1990).

We will determine, in a ground experiment, whether we can efficiently integrate a laser and beam director, which (separated or combined) are not capable of substituting for an ABM component. The power, optics, and laser frequency are not compatible with atmospheric propagation at ranges useful for ABM applications. Experiments are planned against ground-based, static targets. The device is not a prototype nor is it "ABM capable." In addition, a dynamic lethality experiment is planned against a modified first stage of a non-strategic ballistic missile at very close range [redacted] just after the missile has been launched from a point close to the [redacted] (FY 1988). [redacted] is fixed, land-based and located at the White Sands Missile Test Range, an ABM Test Site, should it ever be considered to be "tested in an ABM mode," it would remain Treaty compliant. (Category 2)

~~(S)~~ The newly constituted Space Acquisition, Tracking and Pointing (ATP) Experiment program will concentrate on a series of experiments, [redacted] Current plans call for experiments over the next few years, using technologies which are only part of the set of technologies ultimately required for ABM capability (FY 1987/1988). These devices will also not be capable of achieving ABM performance levels. As these plans become better defined, they will be reviewed to ensure they are in compliance. (Category 1/2)

~~(S)~~ The Ground-Based Free Electron Laser Program includes the fabrication of an experimental [redacted] (FY 1989). Longer term plans include upgrading this experimental facility [redacted] of power. Should it achieve ABM capability, the fixed, ground-based FEL still will be in compliance with the ABM Treaty. (Category 2/3)

~~(S)~~ [redacted] consists of a series of experiments to demonstrate the feasibility [redacted] The experiments are not yet well defined; however, [redacted] The experiments will use technologies which are only part of the set of technologies ultimately required for ABM capability. These devices will not be capable of achieving ABM performance levels. (Category 2).

~~(S)~~ [redacted] This experiment will be conducted [redacted] and the device will not be capable of autonomously acquiring or tracking ballistic targets. Because of such limitations, this experimental device will not have ABM capabilities. This experiment will not be a test in an ABM mode. (Category 2)

~~(S)~~ The Boost Surveillance and Tracking System (BSTS) Experiment is a space-based experiment (which is not yet fully defined) to demonstrate technology capable of upgrading current space-based tactical warning/attack assessment (TW/AA) sensors--the Defense Support Program (DSP). This experiment will, if successful, also permit a decision to be made on the applicability of more advanced technology for ABM purposes. The BSTS experimental device will not be a prototype of an ABM component. The experiment will determine if sufficiently sensitive tracking and signature data can be collected on-orbit against the earth's background. The BSTS experimental device will be limited in capability so that it cannot substitute for an ABM component, but will be capable of performing early warning functions, which are permitted by the Treaty. For example, the experimental BSTS will collect ballistic missile plume data, but it will not be capable of real-time data processing for handing-off to a boost-phase interceptor. Other capabilities may be limited as well. An initial launch is scheduled for FY 1992. (Category 2)

(S) The space-based Space Surveillance and Tracking System (SSTS) experimental program has been significantly cut back since last year's evaluation and is now again undergoing an extensive revision. The objectives of this SSTS experiment are to (1) demonstrate technology capable of upgrading the current U.S. Space Detection and Tracking System (SPADATS) and (2) permit a decision to be made on the applicability of more advanced technology for ABM purposes. This experiment will demonstrate the collection of tracking and signature data on a number of space objects against the earth's upper atmosphere and space backgrounds. A data gathering satellite is scheduled for launch in FY 1992. Its capability will be significantly less than that necessary for ABM performance levels or to substitute for an ABM component. (Category 2)

(S) The Airborne Optical Adjunct (AOA) experiment will demonstrate the technical feasibility of long wavelength infrared (LWIR) acquisition, tracking, and discrimination of strategic ballistic missiles from an airborne platform to support a ground-based radar. The airborne platform will initially be a Boeing 767; the ultimate airborne platform is yet to be determined. The AOA experiment has been reduced in scope because of cost considerations to a single, passive sensor. The AOA experimental device will not be capable of substituting for an ABM component due to its performance limitations (i.e., deficient quantity and quality of detector elements, a very limited field-of-view, short acquisition range, and limited airborne platform performance). As part of the feasibility demonstration, the AOA experimental device will observe ballistic missile tests flown into the Kwajalein Missile Range (KMR) during FY 1988-1989. Any increase in the performance of the AOA experimental device or tests involving ABM interceptor missiles will require prior approval. (Category 2)

(S) The purpose of the Space-Based Kinetic Kill Vehicle (SBKKV) project (which is not fully defined) is to prove the feasibility of target acquisition, tracking and rocket-propelled projectile launch and guidance. This space-based experiment will, if successful, [redacted] and will also permit a decision to be made on the applicability of more advanced technology for ABM purposes (FY 1991). The demonstration hardware for any space-based experiment will not be an ABM component, will not be capable of substituting for an ABM component and will not be tested in an ABM mode. To ensure compliance with the ABM Treaty, the capabilities of the demonstration hardware will be limited to [redacted] There will be no intercepts of strategic ballistic missiles or their elements in flight trajectory in a space-based experiment. (Category 2)

(S) The Ground-Based Hypervelocity Railgun (GBHRG) Experiment (which is not fully defined) is intended to validate the weapon potential of a hypervelocity gun and associated miniature kill vehicle (MKV) technology (FY 1988). Several types of projectiles will be fabricated to demonstrate that precision guided munitions can be successfully launched from hypervelocity guns. The test devices will not be ABM components and will not have ABM capabilities. They will demonstrate the capability to launch unguided and guided projectiles at hypervelocities from ground-based railguns within a laboratory environment and will not involve "testing in an ABM Mode." (Category 1)

(S) [redacted] (Category 2)

~~(S)~~ Category 3 Experiments. These three experiments involve tests of fixed ground-based "ABM components" at agreed ABM Test Ranges.

~~(S)~~ The High Endoatmospheric Defense Interceptor (HEDI) project is to demonstrate the capability to intercept and negate strategic ballistic missile warheads within the atmosphere (FY 1990). This is an allowed test of a nonnuclear interceptor missile. Flight tests will be performed at White Sands Missile Range (WSMR) and Kwajalein Missile Range (KMR). Tests at WSMR will involve interceptors flown to points in the atmosphere to verify missile integrity and characterize the flight environment. Interceptor flights at KMR will be against dedicated targets, such as ICBMs launched from Vandenberg Air Force Base, or missiles launched from Hawaii. All flight tests will be from fixed ground-based launchers without the capability of being rapidly reloaded or launching more than one interceptor missile. The interceptor missiles will not be capable of delivering more than one independently-guided warhead. All activity will be conducted in a manner permitted by the ABM Treaty. (Category 3)

~~(S)~~ The Exoatmospheric Reentry-Vehicle (RV) Interceptor Subsystem (ERIS) is intended to engage incoming RVs from the time they separate from the post-boost vehicle bus until reentry into the atmosphere. This is an allowed test of a nonnuclear interceptor missile. All interceptor missile flight tests are to be conducted from fixed ground-based launchers at KMR (FY 1991). The planned flight tests include launch of the first stage, launch of all stages without homing, homing against a point in space, and hit-to-kill against large and small/medium RVs. Fixed ground-based launchers will be incapable of launching more than one interceptor missile and will not be rapidly reloadable. The ERIS interceptor missile will not be capable of delivering more than one independently-guided warhead. (Category 3)

~~(S)~~ The Terminal Imaging Radar (TIR) will be [redacted] ABM radar which may be tested in an ABM mode in full compliance with the terms of the ABM Treaty. This fixed, land-based radar will be tested at a designated ABM test range (i.e., KMR). The objective is to demonstrate performance and effectiveness of [redacted] imaging ABM radar possibly in conjunction with the HEDI experiment at KMR (FY 1990-1991). TIR will be permanently installed in an existing radar building and will require this building for structural support. TIR will have a single radar face which must be rotated to a specific alignment prior to the demonstration. TIR will perform target precommit discrimination and may handover to HEDI (FY 1991-1992). (Category 3)

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URGENT

PRESS GUIDANCE May 31, 1986

SOVIET REACTION TO U.S. DECISION ON SALT

QUESTION: Do you have any comment on the official Soviet statement issued in TASS about the President's decision on SALT II?

√

ANSWER:

— I think that it would be most useful to read the statement carefully, assertion by assertion, and judge for yourself the merit of the Soviet argument and case.

— The first assertion is that the U.S. is intent on spiralling up the arms race in every way. Not only is this objectively not true, but the President's statement indicates explicitly that continued restraint that will be exercised by the U.S. and outlines the nature of that restraint. I refer you to the statement and the associated fact sheet.

— The second assertion is that the President's decision amounts to a refusal to observe "legal treaty documents." This is also objectively not true. The SALT II Treaty is an unratified document, that would have expired on December 31, 1985, even if it had been ratified. Since 1981, when the United States notified the Soviet Union of its intent not to ratify that treaty, the document has had no standing as a legal commitment under international law.

— I would note that, nevertheless, in 1982, the U.S. attempted to establish an interim framework of truly mutual restraint by making the President a political commitment not to undercut this treaty so long as the Soviet Union exercised comparable restraint. While we complied scrupulously, the Soviet Union did not. The President went the extra mile in June, 1985, once again calling upon the Soviet Union to join us in this endeavor. Again, they did not. This led to the President's most recent decision.

— The third assertion is that the U.S. has to move out from under SALT to deploy systems it desires, specificly cruise missiles on bombers, the second 50 PEACEKEEPER/MX missiles, the acceleration of the advanced cruise missile, and the MIDGETMAN program. However, with the exception of the MIDGETMAN, this assertion is simply flat wrong. With respect to MIDGETMAN, a missile which has not yet even begun flight testing, this program is a response to the irreversible Soviet violation associated with the development of a prohibited second new ICBM, the SS-25 mobile ICBM, ~~[illegible]~~ deployed, over 70 of which they already.

— The fourth and fifth assertions are that it is action by the United States which undercuts the foundation of an interim framework of restraint using the SALT structure, and that the Soviet Union is in total compliance with SALT. To these, I would refer you to the recent U.S. fact sheet and three reports provided to the Congress on the pattern of Soviet noncompliance. The U.S. case in this area is clear.

— The bottom line of the TASS article is the Soviet statement that "as soon as the USA goes beyond the established levels of arms or otherwise violates the other main provisions of the mentioned agreements, the Soviet Union will consider itself free from the relevant commitments." We would recommend you contrast this statement the way the President has established over the last 4 years in going the extra mile in trying to deal patiently but firmly with clear Soviet non-compliance.

-- The President continues to hope that the Soviet Union will take the constructive steps needed to change the current situation. If they do, the President will take this into account.

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MESSAGE NO. 776 CLASSIFICATION ~~CONFIDENTIAL~~ UNCLASSIFIED PAGES one

FROM W ROBERT PEARSON WRP NSC

(NAME) (EXTENSION) (ROOM NUMBER)

MESSAGE DESCRIPTION REVISED SUMMARY RE INTERIM RESTRAINT POLICY

TO (AGENCY)	DELIVER TO:	DEPT/ROOM NO.	EXTENSION
STATE	NICK PLATT	EXEC SECRETART	
STATE	JAMES HOLMES	7317	647-1616
DEFENSE	COL DAVID BROWN	EXEC SECRETARH	

~~EYES ONLY~~

REMARKS THIS IS REVISED SUMMARY. PLEASE SUBSTITUTE FOR EARLIER SUMMARY WHICH WAS SENT TO YOU THIS MORNING.

~~URGENT~~

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EXSEC	✓
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THE WHITE HOUSE

Office of the Press Secretary

For Immediate Release   May 27, 1986

SUMMARY OF THE PRESIDENT'S DECISION ON U.S. INTERIM RESTRAINT POLICY

The President has decided to retire two older POSEIDON submarines as the eighth TRIDENT submarine begins sea trials tomorrow. This means the U.S. will stay in technical observance of SALT for some months. This gives the Soviet Union still more time to correct their erosion of SALT. If they do, the President will take this into account.

Our attempt to use the structure of SALT as the basis for interim restraint until a START agreement can be achieved has always been based on the assumption of Soviet reciprocity. It makes no sense for the U.S. to continue to hold up the SALT structure while the Soviet Union undermines the foundation of SALT by its continued, uncorrected noncompliance. Therefore, the President believes we must now look to the the future, not to the past. The primary task we now face is to build a new structure, one based on significant, equitable and verifiable reductions in the size of existing U.S. and Soviet nuclear arsenals. This is what we are proposing in the ongoing Geneva negotiations.

Until this is achieved, the United States will continue to exercise the utmost restraint. Assuming no significant change in the threat we face, as we implement the strategic modernization program, the U.S. will not deploy more strategic nuclear delivery vehicles or strategic ballistic missile warheads than the Soviet Union.

Therefore, in the future, the United States will base decisions regarding its strategic forces on the nature and magnitude of the threat posed by the Soviet Union, rather than on standards contained in expired SALT agreements unilaterally observed by the United States.

It is high time that the Soviets honor their obligations, match U.S. restraint, and get down to negotiating seriously in Geneva. If they do, we can move together now to build a safer and more secure world.

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Urgent

MESSAGE NO. 650 CLASSIFICATION Unclass PAGES 1

FROM RODNEY B. MCDANIEL (b)(6)

(NAME) (EXTENSION) (ROOM NUMBER)

MESSAGE DESCRIPTION Statement by the Principal Deputy Press Secretary NSC LOG#

TO (AGENCY)	DELIVER TO:	DEPT/ROOM NO.	EXTENSION
B	Brinson McKinley		
D	Col David Brown		

REMARKS

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THE WHITE HOUSE

Office of the Press Secretary

For Immediate Release April 21, 1986

STATEMENT BY THE PRINCIPAL DEPUTY PRESS SECRETARY

With regard to the question of interim restraint, the President has started consultations with the Congress and key Allied leaders on his tentative thinking. The substance of these consultations are confidential. No final decision has yet been taken -- and will not be until the consultations are complete. We will not comment on the substance of the consultations at this time.

SALT II is an unratified treaty that would have expired on December 31, 1985. The U.S. is currently following the policy announced by the President on June 10, 1985. At that time, the President committed to go the extra mile. He did so, dismantling a Poseidon submarine, not to comply or abide by an unratified, expired treaty, but rather to give the Soviet Union adequate time to take the steps necessary to join us in establishing an interim framework of truly mutual restraint. The issue is not one of complying or not complying with SALT II -- rather of what actions to take now under the President's policy announced last June. What we do in the future depends on our national security needs, and our commitments to our allies, in meeting the threat that we face, which in turn depends on what the Soviets do.

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