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GAO's Views on SDIO's Phase I Cost Estimate

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Mr. Chairman and Members of the Subcommittee:

I am pleased to appear before the Subcommittee today to discuss our review of changes in the Strategic Defense Initiative Organization's (SDIO) estimate of the cost for acquiring and deploying Phase I of the Strategic Defense Initiative (SDI). In June 1987 SDIO estimated that the cost to deploy Phase I of SDI would be between $75.6 billion and $145.7 billion (fiscal year 1988 dollars). In June 1988 SDIO estimated that Phase I would cost $115.4 billion (fiscal year 1988 dollars). In October 1988 SDIO estimated (the current estimate) that Phase I would cost $69.1 billion (fiscal year 1988 dollars). You asked us to explain the difference between the June 1987 high estimate of $145.7 billion and the current estimate of $69.1 billion.

Although we have not completed our review, it appears that the decrease resulted primarily from

-- reductions in the quantities of some items to be produced and deployed,
-- changes in technical characteristics of some items, and
-- differences in the models used to estimate the costs.

The $69.1 billion estimate (about $89 billion in escalated dollars) is dependent on the validity of a number of assumptions, some of which we believe may be optimistic. Department of

Defense (DOD) independent cost analysts also believe some of the assumptions are optimistic.

SDIO has not yet fully defined the follow-on phases of SDI or estimated their costs. Annual operation and support costs for Phase I are estimated at $2.8 billion (fiscal year 1988 dollars).

BACKGROUND

When President Reagan announced the establishment of SDI in 1983, he said that its goal was to eliminate the threat posed by Soviet nuclear ballistic missiles. Through its studies, research, and technology development activities, SDIO has concluded that this goal can best be achieved through a phased deployment program. Each phase would be required to meet specific military and policy objectives and provide the basis for deploying subsequent phases. On September 17, 1987, the Secretary of Defense approved for demonstration and validation six Phase I elements. The approved six elements of Phase I are

-- Boost Surveillance and Tracking System (BSTS)
-- Space-Based Interceptors (SBI)
-- Space-Based Surveillance and Tracking System (SSTS)
-- Ground-based Surveillance and Tracking System (GSTS)
-- Exoatmospheric Reentry Vehicle Interceptor System (ERIS)
-- Battle Management/Command, Control, and Communication (BM/C3)

The current cost estimate includes the cost of these six elements, plus the remaining elements--(1) Ground-Based Radars (GBRs) that are being considered for Phase I, (2) launch systems, and (3) system engineering and integration.

CHANGES IN ESTIMATES

When SDIO made its estimate in June 1987, costs were stated as a range because details of the system were not well defined or decided on and the low and high estimates represented systems with different capabilities. Since June 1987 SDIO has made a number of changes in the Phase I system architecture. For example, a ground-based radar is being considered as an option to help detect, identify, and track reentry vehicles in midcourse. SDIO revised its estimate of the quantities of sensors and weapons needed for Phase I.

There is ongoing work related to the follow-on phases of SDI. Planning is underway and money is being spent for research and development of technologies such as directed energy (lasers and neutral particle beams) that will be needed for follow-on phases. According to SDIO, the DOD Five-Year Defense Plan includes about $20 billion for developing advanced technology for SDI. This technology will be needed for both Phase I and follow-on phases.

To date, we have reviewed the estimated cost reductions for four of the system elements. We believe that these estimates are representative of estimates prepared by SDIO, the Army Strategic Defense Command, and the Air Force Space Division for the remaining elements as well. A chart showing the cost change for each system element and more detailed results of our review of the four selected system elements are included in the attachment to my testimony.

Quantity Changes

Much of the reduction from the June 1987 high estimate to the October 1988 estimate can be attributed to reductions in the quantity of sensors and weapons. The quantities of weapons and sensors included in these estimates are classified. However, between the June 1987 high estimate and the October 1988 estimate, SDIO made significant reductions in the quantities of some of the elements.

For example, the number of SBIs planned for deployment was reduced by 51 percent, which reduced the estimated cost of the SBI element by almost $19 billion. The reduction in the quantity of SBIs also resulted in a $900 million reduction in the cost to launch the satellites.

The quantity of planned GSTSs was also reduced by about 42 percent, and the planned number of GSTS launch sites was reduced by 73 percent. These reductions reduced the estimated cost of the GSTS element by about $400 million.

Changes in Technical Characteristics

The technical characteristics for some of the system elements were also changed. For example, the number of sensors on each GSTS was reduced by 50 percent. Also, the size of the sensor's mirror was reduced, but more detectors were added to the sensor's focal plane array. These technical changes resulted from contractor studies that were not available in June 1987. The changes contributed to a substantial reduction in the estimated GSTS cost.

There were also significant changes in the technical characteristics of the SBI. Some of these changes include (1) reducing the size of the SBI satellite or carrier vehicle, (2) deleting the fire control system from the carrier vehicle, (3) deleting some BM/C3 functions from the carrier vehicle, and (4) reducing SBI's ground-based control network. These technical changes, along with other changes, reduced the cost of the SBI element by $18.7 billion.

Use of Different Cost Models

Another large portion of the decrease from the June 1987 high estimate to the October 1988 estimate was due to the fact that the two estimates were prepared with different parametric cost estimating models.

Parametric cost estimating models forecast a system's cost based on the costs of similar systems acquired in the past. The models consist of a series of cost estimating relationships, which are formulas that express the relationship between the historical costs and changes in some technical characteristic such as weight. For example, a parametric model might forecast the cost of a GSTS sensor based on the projected size of its mirror and the number of detector elements in its focal plane array.

Parametric models are most useful for forecasting the costs of systems in early design and development phases when all of the detailed tasks involved in developing, producing, and testing the system cannot be accurately specified. Different parametric models may yield different cost estimates for a number of reasons. For example, different historical systems may be included in the databases used to derive their cost estimating relationships.

For example, the model used by SDIO to estimate GSTS costs in the June 1987 estimate was derived from space systems or satellites. SDIO assumed that GSTS would be designed like a satellite since it would operate in space. On the other hand, SDIO's October 1988 estimate prepared by the Army Strategic Defense Command's assumed that GSTS was more like a missile than a satellite, because it will be ground-based and operate in space for only a short period of time. Therefore, the Army used a model primarily based on missile and radar systems.

Using different cost models for the two GSTS cost estimates reduced its estimated cost by about $700 million between the June 1987 high estimate and the October 1988 estimate. The change in cost models reduced the estimate for the SBI element by $14.1 billion.

OBSERVATIONS ABOUT THE ESTIMATE

There is still a great deal of uncertainty about the Phase I system. None of the system elements have been fully designed, built, or tested.

SDIO and the military services had to make many assumptions in preparing the October 1988 estimate. For example, they had to assume the availability of needed technology, the pace at which the development and production effort could proceed, the cost for

which many technologies can be produced, the success of the development and production effort, and how well the initial design will perform against the actual threat. The validity of the cost estimate is directly dependent on the validity of the assumptions used in preparing it.

Although it is necessary to make many assumptions in order to estimate the cost of systems in their early design stage, some of the assumptions used in the October 1988 estimate may be optimistic. For example, SDIO has assumed that the technology required will be available when needed, that contractors will be successful in developing and implementing innovative production processes and techniques to significantly reduce the cost of the system, and that the program can stay on a relatively tight schedule.

Some of the technology that will be needed to build the Phase I system is not yet available. Also, the size and quantities of some of the components needed for the Phase I system will require innovative production processes and techniques to achieve the current cost estimate. SDIO has research programs to provide the needed technology and producibility improvements. If some of these programs are not successful or SDIO encounters other technical or producibility problems, the schedule for deploying Phase I would likely slip. The current schedule provides little or no time for resolving unanticipated problems. A slip in the

schedule could cause an increase in the Phase I system's cost. The DOD Cost Analysis Improvement Group has expressed some of the same concerns about the assumptions used to prepare the October 1988 estimate.

The October 1988 estimate includes a cost reserve of $7.6 billion which is about 11 percent of the estimate. This reserve is intended to cover cost increases which may result from such things as technical or schedule changes. Whether or not this reserve will be adequate will depend, in large part, on the extent to which the estimate's assumptions prove to be correct.

This concludes my prepared testimony. At this time I will respond to any questions you may have.

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CHANGES IN PHASE I COST ESTIMATES

The following chart shows the June 1987 and October 1988 estimates for each element of the Phase I Strategic Defense System.

System element	June 1987 Low est	June 1987 High est	October 1988 estimate	Percentage Change[1]	Percentage Change
	(in billions)				
BSTS	$ 5.0	$ 9.2	$ 8.0	$ -1.2	13%
SBI	23.4	69.3	17.7	-51.6	74%
SSTS	9.4	14.5	9.2	-5.3	37%
GSTS	7.9	9.3	3.3	-6.0	65%
GBR[2]	--	--	3.1	3.1	100%
ERIS	5.1	6.6	5.8	-0.8	12%
BM/C3	4.8	7.0	7.3	0.3	4%
Launch	12.7	16.3	8.6	-7.7	47%
System engineering and integration	7.3	13.5	5.0	-8.5	63%
Performance reserve[3]	____	____	1.1	1.1	100%
Totals	$75.6	$145.7	$69.1	$-76.6	53%

1 Amounts in this column are the difference between the June 1987 high estimate and the October 1988 estimate.

2 The GBR was not included in the June 1987 estimates.

3 The performance reserve was included in the October 1988 estimate to cover the possibility that additional quantities of one or more system elements would be needed to meet the military requirement established for Phase I. An additional cost reserve of $7.6 billion in embedded in the other eight cost elements.

We limited our review of the cost reductions to four of the system elements. These were the GSTS, SBI, Launch, and BM/C3. These elements together account for $65 billion, or about 85 percent, of the total $76.6 billion reduction.

Following are the results to date of our evaluation of changes in the cost estimates for the four elements.

GROUND-BASED SURVEILLANCE AND TRACKING SYSTEM

In June 1987, SDIO estimated that the GSTS would cost between $7.9 billion and $9.3 billion (fiscal year 1988 dollars). In October 1988, the Army Strategic Defense Command estimated that GSTS would cost $3.3 billion. The October 1988 estimate is $6 billion, or 65 percent, less than the June 1987 high estimate.

About $4.8 billion, or 80 percent, of the reduction resulted from quantity and technical changes in the GSTS program. About $700 million, or 12 percent, of the reduction is attributable to differences in cost models used to prepare the two estimates. The remaining $500 million, or 8 percent, of the reduction was due to a mathematical error in the June 1987 estimate.

Quantity and Technical Changes

Between June 1987 and October 1988, SDIO reduced its estimate of the quantity of GSTSs needed in the Phase I system used as the basis for the high estimate by about 42 percent. SDIO also reduced the number of planned launch sites by 73 percent. These changes resulted from a revised estimate of the best mix of sensors needed to detect, identify, and track reentry vehicles in the midcourse regime (after the reentry vehicles are deployed from their boosters but before they reenter the atmosphere).

GSTS is one of three sensors that will be used to perform these functions. The reduction in the quantity of GSTS was made possible, in part, by the addition of Ground-based Radars. Ground-based Radars were not a part of the Phase I system used as the basis for the high estimate when the June 1987 cost estimate was prepared.

In addition to different quantities, the two cost estimates are based on substantially different GSTS designs. For example, the October 1988 estimate includes 50 percent fewer sensors per GSTS than the June 1987 high estimate. There were other substantial changes in the technical parameters of the sensors such as reducing the size of the sensor's mirror and increasing the

number of detectors in the focal plane array. There was also an overall reduction in the weight of the system.

These changes reflect the Army's and its contractors' refined estimates of the capabilities needed to accomplish the military objectives established for the Phase I system and the progress of technology that can be used in GSTS.

Change in Cost Models

About $700 million of the decrease in the GSTS element cost estimate can be attributed to the fact that different cost models were used to prepare the two estimates. For the June 1987 high estimate, SDIO used a model that forecasted GSTS cost from the historical costs of space-based systems. SDIO assumed that GSTS would be a satellite since it would operate in space and therefore used the Air Force's "Unmanned Spacecraft Model" to estimate GSTS cost.

In preparing the October 1988 estimate, the Army Strategic Defense Command assumed that GSTS was more like a missile than a satellite because it would be ground-based and operate in space for only a short period of time. Therefore, the Army used a model that forecasts cost from historical cost experience of other Army missile and radar systems.

Satellites are generally more costly than ground-based systems because they cannot be repaired or replaced as easily. Space-based systems must operate for longer periods without repair and contain more redundant components in order to assure longer operation.

Error in June 1987 Estimate

Because of an arithmetic error, SDIO overstated the June 1987 high estimate for GSTS by about $500 million. The error was in the nonrecurring investment category which includes costs for items such as production facilities and tools.

SPACE-BASED INTERCEPTOR

In June 1987, SDIO estimated that the SBI would cost between $23.4 billion and $69.3 billion (fiscal year 1988 dollars). In October 1988, the Air Force estimated that SBI would cost $17.7 billion (fiscal year 1988 dollars). The October 1988 estimate is $51.6 billion, or 74 percent, less than the June 1987 high estimate.

About $18.8 billion, or 36 percent, of the cost reduction was due to a reduction in the quantity of SBIs to be produced and

deployed in Phase I. About $18.7 billion, or 36 percent, of the cost reduction was due to technical and programmatic changes. The remaining $14.1 billion, or 28 percent, of the reduction was due to differences in cost models used to prepare the two estimates.

Quantity Change

Between June 1987 and October 1988, based on the system used to support the high estimate, SDIO reduced the quantity of SBI carrier vehicles and interceptors to be included in Phase I by 51 percent. According to SDIO and the Air Force Space Division, recent technological advances will permit development of a more capable Space-Based Interceptor. As a result, fewer interceptors will be needed to accomplish the military objectives established by the Joint Chiefs of Staff for the Phase I system.

Technical and Program Changes

About $18.7 billion of the reduction in the SBI element cost estimate can be attributed to technical and program changes. These include (1) reducing the size of the carrier vehicle, (2) deleting the fire control system from the carrier vehicle, (3) planning for one rather than two contractors during full scale development, (4) deleting the BM/C3 function from the SBI,

(5) reducing SBI's ground control network requirements, (6) deleting planned tests in space during the demonstration and validation phase, and (7) deleting some planned flight tests during full scale development.

Cost Model Changes

The June 1987 and October 1988 estimates were derived from different parametric cost models. The model used for the June 1987 estimate was based primarily on cost estimating relationships derived from historical costs of systems that incorporated older technology and that were produced one at a time in a very labor intensive environment.

In order to be conservative in its June 1987 estimate, SDIO did not forecast cost reductions that might result from advances in technology or production processes. The Air Force's October 1988 estimate takes these advances into account. The cost model used in October 1988 assumes that there will be significant advances in both technology and production efficiency. These are expected to substantially reduce SBI cost.

Other Change

The Air Force Space Division estimated that the SBI would cost only about $14.4 billion (fiscal year 1988 dollars). However, during the review process the Air Force's Cost Analysis Improvement Group concluded that the estimate was optimistic. The improvement group was concerned that the schedule might slip; system weight might increase; development and production of the telemetry, tracking, and control system might prove more difficult than anticipated; and technology might not advance as far or as quickly as predicted by the Space Division. Because of these concerns, the Air Force added about $3.3 billion to the SBI estimate, increasing it to its current level of $17.7 billion.

LAUNCH

In June 1987 SDIO estimated that it would cost between $12.7 billion and $16.3 billion (fiscal year 1988 dollars) to launch those Phase I system elements that will be based in space. In October 1988, SDIO estimated launch cost at $8.6 billion (fiscal year 1988 dollars). The October 1988 estimate is $7.7 billion, or 47 percent, less than the June 1987 high estimate.

The decrease in the launch cost estimate can be attributed primarily to (1) a reduction in the number of SBI satellites to be launched and (2) a change in the kinds of rockets used to launch some satellites. The reduction in the number of SBI satellites resulted in a decrease of about $900 million in Phase I launch cost. The remaining $6.8 billion decrease in launch costs can be attributed primarily to changes in the types of rockets to be used to launch some of the Phase I satellites.

Quantity Changes

The number of SBI satellites to be launched based on the high estimate was reduced by more than 50 percent between the June 1987 and the October 1988 estimates. In addition, the size and weight of each SBI satellite was reduced. These reductions in quantity and weight resulted in a reduced estimate of the launch capability requirements. About $900 million of the reduction in Phase I launch cost can be attributed to the reduction in the number and size of SBIs.

Launch Vehicle Changes

When the June 1987 cost estimate was prepared, SDIO anticipated that the Advanced Launch System (ALS) to be developed jointly by SDIO, the Air Force, and NASA would be used to launch many of the

Phase I satellites. Development of the ALS and associated launch facilities was expected to cost $17.5 billion but the ALS was expected to reduce recurring launch cost by 90 percent from the current $3,000 a pound to about $300 a pound. For the June 1987 high estimate, SDIO assumed that the ALS development and facility costs would be shared equally with NASA and the Air Force.

Development of the ALS, however, did not proceed as SDIO originally anticipated. When the October 1988 Phase I estimate was prepared, it was apparent that the ALS would not be available in time to be used to launch the Phase I system. SDIO now plans to develop a rocket specifically for use in launching some of the Phase I satellites. Because this rocket will be an adaptation of an existing missile, its development is expected to cost less than the ALS. This change accounts for about $3.2 billion of the reduction in Phase I high estimate launch cost.

Between the June 1987 estimate and the October 1988 estimate, SDIO also revised its estimate of the kind of rocket needed to launch Space-Based Surveillance and Tracking System satellites. A reduction in the estimated weight of the satellites made it possible to use a less expensive rocket. This change reduced estimated launch cost (using the high estimate) by about $3.9 billion.

Other Changes

Other minor refinements and changes such as an increase in the number of Boost Surveillance and Tracking System satellites cause a net increase of about $200 million in launch cost. This increase partially offset the reductions described above.

BATTLE MANAGEMENT/COMMAND, CONTROL, AND COMMUNICATIONS

In June 1987, SDIO estimated that the BM/C3 system would cost between $4.8 billion and $7.0 billion (fiscal year 1988 dollars). In October 1988, SDIO estimated that the system would cost $7.3 billion (fiscal year 1988 dollars), an increase of $300 million over the high estimate.

We have not yet had an opportunity to inquire into all of the details of the change in the BM/C3 system cost estimates. Between June 1987 and June 1988, SDIO increased the estimated cost (the high estimate) for the BM/C3 system from $7.0 billion to $14.6 billion. Subsequently, SDIO decreased the estimate for BM/C3 from $14.6 billion to its current level of $7.3 billion.

We do not yet have information on why the estimate increased from $7.0 billion in June 1987 to $14.6 billion in June 1988. The decrease between June 1988 and October 1988 resulted primarily

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from (1) a change in the concept of BM/C3 for the Phase I system and (2) a decision to lease rather than purchase a ground-based communications network.

When the October 1988 estimate was prepared, SDIO had decided to redistribute the BM/C3 functions. As a result, there will be less redundancy in the system.