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Report to the Chairman, Subcommittee on National Security, Committee on Appropriations, House of Representatives

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ACCESS TO SPACE

Issues Associated With DOD's Evolved Expendable Launch Vehicle Program

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National Security and
International Affairs Division

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The Honorable C.W. Bill Young
Chairman, Subcommittee on National Security
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

The Department of Defense (DOD) is acquiring a multi-billion dollar Evolved Expendable Launch Vehicle (EELV) system to replace the existing fleet of expendable launch vehicles in the 21st century. For an initial investment of about $2 billion, the EELV program goal is to reduce the costs of launching satellites into space by at least 25 percent, compared to using existing vehicles.

As you requested, we reviewed DOD's progress in acquiring the EELV system. We specifically reviewed factors associated with program cost, schedule, and performance and examined selected aspects of EELV's relationship to the commercial launch vehicle market. This report discusses program issues and risks that need to be addressed before the program proceeds into the engineering and manufacturing development (EMD) phase of the acquisition process, which is currently scheduled for June 1998.

Background

The federal government currently uses a fleet of expendable launch vehicles—Delta, Atlas, and Titan—to transport a variety of national security and civil satellites into space. According to DOD, these vehicles (which are acquired by DOD), currently operate at or near their maximum performance capability. Also, DOD and congressional sources consider these vehicles to be very costly to produce and launch. Since 1987, the government has made several attempts to develop a new launch vehicle system, but these attempts were canceled either because of funding issues, changing requirements, or controversy regarding the best solution.

In 1994, by congressional direction, DOD developed a space launch modernization plan that led to the initiation of the EELV program. Currently, two contractors—Lockheed Martin Astronautics and McDonnell Douglas Aerospace—are competing in a pre-EMD phase, and one is to be chosen for the EMD phase. Of the total planned $2 billion investment, the EMD phase is expected to cost about $1.6 billion and take

approximately 6 years. Concurrent with the EMD decision, DOD plans to authorize the start of EELV production. An initial quantity of 29 launch vehicles is estimated to cost about $1.5 billion. In addition, toward the end of the EMD phase, a decision is to be made on whether to produce a significantly larger quantity that would cost several billion dollars.

Results in Brief

Reducing the cost of launching satellites into orbit is the paramount objective of the Evolved Expendable Launch Vehicle program. However, DOD faces many risks in making the transition to the vehicle program that could increase costs, cause schedule delays, and possibly jeopardize some satellite schedules and missions. Vehicle development is less than 25 percent complete, and DOD has about 1 year to address these risks before proceeding into engineering and manufacturing development, which is scheduled for June 1998. With several billion dollars at stake, risk mitigation efforts are essential.

Cost risk is inherent in the vehicle acquisition plan because production could be initiated from 1 to 2 years before the first system development test flight. Pursuing such a strategy could result in costly modifications to the production vehicles because historically, most launch systems have had several failures during their early flight period. In addition, there is program cost uncertainty as evidenced by significant estimating differences between the Office of the Secretary of Defense and the Air Force. Also, existing satellite programs expect to incur at least $117 million in added costs as a result of launch vehicle transition, and these costs are not included in the Office of the Secretary of Defense or Air Force cost estimates for the vehicle program.

There are schedule risks that could seriously affect the program. First, as currently planned, DOD will purchase the last of its existing expendable launch vehicles before the first system development test flight is scheduled to occur. An unsuccessful test flight, coupled with the expiration of existing vehicle contracts, could create a void in the government's launch capability. DOD has not developed contingency plans to address this potential risk to national security and civil satellite schedules and missions. However, it did indicate that commercial launch vehicles could be used for an emergency procurement in the event of an Evolved Expendable Launch Vehicle failure or schedule delay. Second, the Air Force has identified the meeting of launch facility preparation

schedules as a significant program risk. At the Cape Canaveral and Vandenberg launch ranges, there are conflicts between the planned use of certain facilities for the Evolved Expendable Launch Vehicle program and the current use of these same facilities by other programs. Also, the environmental regulatory process that is required before facility construction can begin could cause an 8-month program delay.

In addition, there are technical issues that raise concerns about potential system performance. The Air Force has identified vehicle propulsion, systems integration, and software as technical risk areas. Propulsion systems are expected to require significant development. Integrating all design, engineering, testing, manufacturing, and launch functions and the software information system are expected to be challenging tasks. Although risk mitigation plans have been developed, problems could arise in these areas, adversely affecting program cost and schedule goals.

The commercial application of the Evolved Expendable Launch Vehicle poses a unique situation for the government. The space industry expects a large international market for commercial satellites, particularly communication satellites, and therefore, for launch vehicles. As a result, the winning contractor will enjoy an enhanced competitive position in the international launch vehicle market from DOD's investment in the program. Although the competing contractors have indicated that they intend to make private investments in program development, they are not contractually obligated by the government to do so under the existing pre-engineering and manufacturing development contracts. Given this situation, the question arises as to how the government should be compensated for its major investment by the winning engineering and manufacturing development contractor who stands to benefit substantially in the commercial marketplace from that investment. Alternatives could be for DOD to employ a cost-sharing contract for the engineering and manufacturing development phase and/or arrange for the government to recoup part of its investment based on commercial launch vehicle sales.

Program Cost Uncertainty

DOD has emphasized reducing the costs of space launches as the paramount EELV program objective. OSD established a $2-billion development cost objective. The Air Force established a production and launch cost-reduction goal of 25 to 50 percent, compared with the cost of using existing launch vehicles. However, considering the uncertainty in program cost, as evidenced by risk in the acquisition plans and the differences in the cost estimates done by OSD and the Air Force, the potential exists for program cost increases.

Acquisition Plans Contain Cost and Mission Risks

Cost risk is inherent in the EELV acquisition plan because production could be initiated from 1 to 2 years before the first system development (medium-lift) test flight. Initial procurement funding is planned for fiscal year 2000, and the system test flight is scheduled for as early as June 2001, but not later than December 2001. This test flight could have a relatively high risk of failure because, as indicated in DOD's space launch modernization plan, (1) historically, most launch systems have had several failures during their early flight period and (2) generally, failure rates increase subsequent to a major design or operational change. In the event that the EELV test flight does not perform as required, the result could be costly modifications to production vehicles.

DOD usually considers the initial production strategy and authorizes the initial production quantities concurrently with the EMD decision. Our experience has shown, however, that once the initial production decision is made, the options available to decisionmakers, when a system is found to be deficient, are significantly limited.[1] DOD has the latitude to modify its usual concurrent approach and schedule a separate initial production milestone authorization at a later point when more program risk assessment information is available. The opportunity to do this would extend up to 15 months from June 1998—the planned EMD decision date—to October 1999—the earliest that fiscal year 2000 procurement funds could be obligated.

EELV acquisition plans show that all 29 of the initial production vehicles—20 for DOD and 9 for other U.S. government organizations—will be used for launching operational satellites, and none will be used solely for operational test and evaluation purposes. Generally, DOD's major programs include separate production-representative articles for operational testing. However, according to the acquisition plans, cost dictates that there not be any EELV operational "test article" per se. Instead, assessments are to be performed on the operational flights. Although this strategy may be economically sound, there is increased mission risk to costly national security and civil satellites because of not having assurance that a production-representative vehicle will perform as intended.

Program Cost Estimating Differences Are a Major Issue

EELV program cost uncertainty became evident during the December 1996 Defense Acquisition Board review process when estimates were prepared for system development and production and launch costs. The uncertainty

[1]Weapons Acquisition: Low-Rate Initial Production Used to Buy Weapon Systems Prematurely (GAO/NSIAD-95-18, Nov. 21, 1994).

was manifested in significantly different cost estimates done by OSD and the Air Force, which used different assumptions and methodologies. Both OSD and Air Force estimates were higher than the $2-billion development cost objective, and the calculations differed by several hundred million dollars. Regarding production and launch costs, both OSD and Air Force primary calculations showed cost reductions that exceeded the 25-percent cost-reduction goal. However, differences between the two organizations ranged from over $1 billion to about $2 billion. In addition, a separate OSD analysis, using a different assumption, showed that the minimum 25-percent cost-reduction goal would not be met. Overall, OSD's position was that the program would likely cost more than the Air Force estimated.

A complicating cost-estimating factor was fluctuations in the national mission model[2]—the primary concern being a decrease in heavy-lift vehicle requirements. The model was used to prepare a launch cost baseline, assuming the use of existing launch vehicles, to compare with the estimated EELV production and launch costs for the purpose of assessing the achievement of the program cost-reduction goal. In addition to the heavy-lift requirements issue, the baseline was questionable because of long-term predictions of U.S. satellite launches that extended 25 years to fiscal year 2020. OSD cost analysts characterized the production and launch cost estimates as highly uncertain.

DOD recognizes that EELV cost estimates need more attention. The Under Secretary of Defense for Acquisition and Technology directed that every effort should be made to further understand the cost differences that exist between the Air Force and OSD for both EMD and production.

Additional Satellite Costs Are Already Evident

As discussed in DOD's 1994 space launch modernization plan, redesigning satellites to fly on new launch vehicles is extremely costly. Therefore, a key consideration in establishing the EELV program schedule was to minimize the cost of satellite redesign and integration with the vehicle.[3] This was to be achieved by making the transition from the existing Delta, Atlas, and Titan vehicles to EELV at planned satellite design change or satellite constellation replenishment points.

[2]The national mission model is a long-range mission requirements plan, prepared periodically by the Air Force Space Command that lists planned U.S. space launches.

[3]Integration in this context means mating the satellite and vehicle to each other using compatible mechanical and electrical interfaces. To aid in reducing costs, EELV requires a single standard satellite interface design for each vehicle class in the EELV family.

We identified at least $117 million in additional costs, separate from the EELV program, that satellite programs expect to incur as a result of the transition to EELV. These satellite systems—the Defense Satellite Communication System (DSCS), Defense Meteorological Satellite Program (DMSP), Defense Support Program (DSP), and Global Positioning System (GPS)—were specifically designed to be launched on the Delta, Atlas, or Titan vehicles. Each system must now have payload interface adapters, or associated equipment, designed and developed to allow them to be launched on EELV. A new satellite system currently under development—the Space-Based Infrared System (SBIRS)—is to be made compatible with both the Atlas and EELV in the eventuality that EELV may not be available when needed.

Schedule Issues to Address

The interrelationship between the EELV program schedule and other space-related activities involves some significant risks that DOD needs to address. The activities affected are existing launch vehicles, future satellite launches, and launch facilities. Ensuring that the EELV program and these activities are effectively coordinated is essential to preclude schedule disruptions, cost increases, and adverse effects on operational satellite schedules and missions.

Vehicle Transition Plans Contain Future Satellite Launch Schedule and Mission Risks

DOD either has purchased or will purchase the last of its Delta, Atlas, and Titan launch vehicles before the first EELV system development test flight in fiscal year 2001. An unsuccessful system test flight, coupled with the planned expiration of existing vehicle contracts, would (1) delay EELV's availability, (2) create a void in the government's in-house medium-lift launch capability, and (3) place national security and civil satellite launch schedules and missions at risk.

Replacing the existing medium- and heavy-lift launch vehicle fleet with EELV requires effective planning to ensure that the continuity of scheduled satellite launches is maintained while minimizing the cost of retaining duplicate launch capabilities. However, in planning this transition, DOD representatives told us that they had not yet assessed the need for or feasibility of either extending existing vehicle contracts or using U.S. commercial launch vehicles (such as Delta III or Atlas IIAR) as an alternative to ensure the continuity of planned satellite launches.

Launch Facility Transition Requirements Could Delay Program

The Air Force EELV program office identified the meeting of launch facility preparation schedules at the Cape Canaveral and Vandenberg launch ranges as a significant program risk. The Air Force Space Command characterized the required lead times for facility projects as the greatest risk to meeting EELV operational milestones. Effective transition planning at the ranges is critical to ensure that existing space launch facilities are available for satellite launches and that EELV facilities are available on schedule.

There are two specific areas of concern—(1) conflicts between the planned use of facilities for the EELV program and the existing use of these same facilities by other government and commercial launch programs and (2) the length of time normally required to complete the environmental regulatory process associated with modifying existing facilities or building new ones for EELV.

The most critical goal is to have the facilities available for the first EELV system development test flight in June 2001. However, some significant launch facility conflicts could cause major disruptions to ongoing programs, requiring DOD to address facility priorities. In addition, based on nominal time frames associated with the environmental regulatory and construction process, the EMD contract award, and possibly the system development test flight, could be delayed by 8 months.

Potential Performance Issues

The Air Force identified vehicle propulsion, systems integration, and software as technical risk areas. Major changes in vehicle propulsion systems are expected that could require significant development, and propulsion represents a significant portion of EELV estimated costs. Systems integration, which involves combining all design, engineering, testing, manufacturing, and launch functions and the software information system necessary to complete a project, is a common risk in most programs. Although the Air Force has required the contractors to submit risk mitigation plans, these risk areas could still pose significant system development challenges and adversely affect EELV program cost and schedule goals.

Commercial Application for EELV

DOD's 1994 space launch modernization plan stated that although the four national space community sectors—defense, intelligence, civil, and commercial—have distinct space missions with their own unique cultures and practices, they have one thing in common—the requirement for space

launch. In this regard, the plan referred to a natural synergy that could be created with the commercial sector. It cited the emergence of the commercial satellite market during the past several years—particularly communication satellites—as a significant driver for launch vehicles and an opportunity for potential private sector investment in space launch.

DOD has an interest in seeing that EELV is used for commercial purposes in order to lower EELV costs. For example, the EELV acquisition plan states that the government is interested in the competing contractors' ability to develop a successful commercial EELV system, which should result in achieving recurring cost reductions by virtue of a significantly larger customer base (government and commercial) for the EELV contractor.

In addition, both contractors have indicated that they intend to make private investments in EELV development, and they have an incentive to do so because of the potential to enhance their positions in the international commercial markets. In December 1996, the Air Force informed the Defense Acquisition Board of DOD's potential to benefit from contractor commercial (private) investment in EELV. However, the contractors are not obligated by the government to make such investments under the existing pre-EMD contracts. According to program officials, the option of contractually binding the winning EMD contractor to such an investment is available, if it is considered prudent.

Considering the commercial benefit to the winning EMD contractor from using the EELV design, a mechanism to ensure some reduction to the government's estimated $2 billion investment would be reasonable. From a government perspective, the question is how the contractor, who stands to benefit substantially in the commercial market place from the government's investment, should compensate the government for that investment. Alternatives could be for DOD to employ a cost-sharing contract for the EMD phase and/or arrange for the government to recoup part of its investment based on commercial launch vehicle sales.

Recommendations

Considering the cost and schedule issues associated with the EELV program, we recommend that the Secretary of Defense:

- Either (1) revise the program strategy, by decoupling the planned concurrent engineering and manufacturing development decision and initial production authorization, to take advantage of the most current program risk assessment information available prior to obligating

procurement funds planned for fiscal year 2000 or (2) review the initial production authorization prior to obligating any procurement funds, if that authorization is made concurrently with the engineering and manufacturing development decision.

- Develop contingency plans to (1) meet national security and civil satellite launch schedules when the existing launch vehicle production contracts expire and (2) address the potential for delay in the availability of launch facilities.

In view of the expected compensating benefits to the winning EELV contractor to enhance its competitive position in the international commercial launch vehicle market, we recommend that the Secretary of Defense devise a mechanism, such as a cost-sharing approach and/or a recoupment arrangement for commercial launch vehicle sales, to help reduce the government's investment in EELV and see that the mechanism is included in the Air Force's request for proposal for the EMD acquisition phase of the EELV program.

Agency Comments and Our Evaluation

In commenting on a draft of this report, DOD generally agreed with two of our recommendations and disagreed with one. We modified that recommendation in an attempt to address DOD's concerns while still retaining the thrust of what we believe needs to be done.

- DOD stated that it had initially implemented a launch vehicle transition strategy and would continue to refine it as the EELV program matures. DOD indicated that the commercial demand for Delta and Atlas vehicles would keep the production lines operational during the transition. DOD also indicated that the Air Force was tracking the potential delay in the availability of EELV launch facilities and developing risk mitigation plans.
- DOD stated that several cost-sharing approaches will be evaluated during the next 12 months; the actual arrangement for any cost sharing between the government and the winning EELV contractor would be included, as appropriate, in the source selection process; and the approach that provides the best value to the government would be incorporated into the EMD contract.
- DOD disagreed with the recommendation in our draft report on refraining from authorizing EELV production concurrently with the EMD decision and holding a separate production decision meeting subsequent to the planned EMD decision to take advantage of the most current program risk assessment information available prior to obligating procurement funds. Although DOD agreed that the decision to begin full production

(milestone III) should be based on as much program risk data as possible, it viewed the implementation of our recommendation as limiting the Defense Acquisition Executive's flexibility in the milestone II acquisition review process.

Concerning the last item, we believe that the extent of the risks in the EELV program makes a concurrent EMD decision and initial production authorization unwise. We also believe that the Defense Acquisition Executive's flexibility should not be restricted in making the best milestone II decision. Accordingly, we modified our recommendation to call upon the Secretary to choose between (1) revising the EELV program strategy by decoupling the planned concurrent EMD decision and initial production authorization or (2) reviewing the initial production authorization prior to obligating any procurement funds, if that authorization is made concurrently with the EMD decision.

DOD's comments are reprinted in appendix II.

Scope and Methodology

We evaluated the Air Force's plans and progress in developing EELV. We reviewed the interrelationships among EELV and existing launch vehicles, satellite programs, and launch facilities. We also reviewed program cost, schedule, and performance information; program risk areas; transition plans; and national mission model data. We specifically examined acquisition planning documents, budget information, launch requirements, contractor proposals, launch facility plans, and space policies and studies.

We performed our work primarily at the Air Force Space and Missile Systems Center in El Segundo, California. In addition, we held discussions with representatives from the Office of the Deputy Under Secretary of Defense for Space, the Office of the Secretary of Defense's Program Analysis and Evaluation Directorate, the Air Force's Office of the Assistant Secretary for Acquisition, and the Air Force Cost Analysis Agency, Washington, D.C. We also held discussions with representatives from the Air Force Space Command, Colorado Springs, Colorado; the Air Force's 30th and 45th Space Wings, Vandenberg Air Force Base, California, and Patrick Air Force Base, Florida, respectively; the Air Force's Phillips Laboratory Propulsion Directorate, Edwards Air Force Base, California; the Air Force Operational Test and Evaluation Center, Albuquerque, New Mexico; and the Aerospace Corporation, El Segundo, California.

Competition sensitive information associated with the ongoing EELV program acquisition is not disclosed in this report.

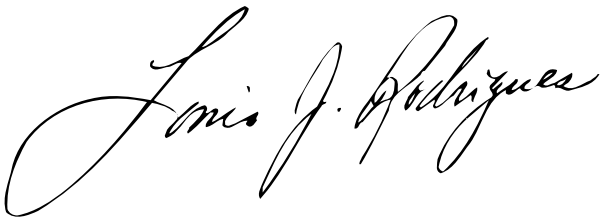
Appendix I provides detailed information on the EELV program.

We performed our review between January 1996 and January 1997 in accordance with generally accepted government auditing standards.

We are sending copies of this report to the Ranking Minority Member, Subcommittee on National Security, House Committee on Appropriations and to the Chairmen and Ranking Minority Members of the House Committee on National Security; the Senate Committee on Armed Services; and the Senate Subcommittee on Defense, Committee on Appropriations. We are also sending copies to the Secretary of Defense and the Director, Office of Management and Budget. We will make copies available to others upon request.

This report was prepared under the direction of Thomas J. Brew, Associate Director, Defense Acquisitions Issues, who may be reached on (202) 512-4841 if you or your staff have any questions. Major contributors to this report are listed in appendix III.

Sincerely yours,



Louis J. Rodrigues
Director, Defense Acquisitions Issues

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Abbreviations

DMSP	Defense Meteorological Satellite Program
DOD	Department of Defense
DSCS	Defense Satellite Communications System
DSP	Defense Support Program
EELV	Evolved Expendable Launch Vehicle
EMD	Engineering and Manufacturing Development
GPS	Global Positioning System
OSD	Office of the Secretary of Defense
SBIRS	Space-Based Infrared System

Evolved Expendable Launch Vehicle Program Plans and Issues

The federal government uses expendable launch vehicles to provide transportation for communication, navigation, ballistic missile warning, meteorological, environmental, intelligence, and scientific satellites into space. U.S. policy asserts that access to and use of space is central to preserving peace and protecting national security as well as civil and commercial interests.

Since 1987, the United States has been attempting to develop a new launch vehicle. The Advanced Launch System program during 1987 to 1990, the National Launch System program from 1991 to 1992, and the Spacelifter program in 1993 were each subsequently canceled because of funding issues, changing requirements, or controversy over the best way to address national launch needs. These development efforts resulted from a combination of factors, including (1) policy decisions in the late 1970s regarding exclusive reliance on the space shuttle for space transportation, and the corollary action to terminate investments in expendable launch vehicles; (2) the 1986 space shuttle Challenger accident; (3) restoration of expendable launch vehicle programs that were based on 1960's and 1970's technology, which did not take advantage of newer technology and manufacturing concepts; and (4) a concern about reduced competitiveness in the international launch market.[1]

The existing launch vehicles—Delta II, Atlas II, Titan II, and Titan IV—were derived, to one degree or another, from ballistic missile systems, and currently operate at or near their maximum performance capability. In addition, these vehicles lack standardization, even among different configurations of the same vehicle. In its October 1993 Bottom-Up Review report, the Department of Defense (DOD) characterized U.S. military space launch capabilities as very costly, with serious operational limitations. The report stated that the existing expendable launch vehicles (1) were able to meet their performance requirement of delivering satellites to a specific orbit, but with less than desired reliability and (2) fell short of the operational flexibility requirement—meaning the capability to perform rapid payload integration, servicing, substitution, and launch.

In November 1993, the Congress directed the Secretary of Defense to develop a space launch modernization plan with clearly defined priorities, goals, and milestones regarding modernization of space launch capabilities for DOD or, if appropriate, the government as a whole.[2]

[1]Final Report to the President on the U.S. Space Program, from the Vice President, Chairman of the National Space Council, Jan. 7, 1993.

[2]National Defense Authorization Act for Fiscal Year 1994 (P.L. 103-160, Nov. 30, 1993).

In May 1994, DOD's space launch modernization plan (known as the Moorman study) discussed the increasing hardware costs associated with DOD's medium- and heavy-lift launch vehicles, with particular emphasis on the heavy-lift Titan IV and its inefficient production rates. In addition, it discussed the manpower intensive aspects of launch system manufacturing and operations, also with particular emphasis on Titan IV, and the multiple launch complexes at Cape Canaveral and Vandenberg—the Air Force's two space launch ranges. The plan provided four options to alleviate these conditions—(1) sustain existing systems, including austere upgrades; (2) evolve existing systems; (3) develop a new expendable system; and (4) develop a new reusable system. DOD chose to pursue the second option as a cost-saving measure and to accommodate schedule opportunities when several satellite systems were to undergo design changes. In September 1994, the Congress provided the initial funds to develop a new family of medium- and heavy-lift expendable launch vehicles evolved from existing technologies.[3]

In November 1994, DOD developed an Evolved Expendable Launch Vehicle (EELV) implementation plan, stating that the program objective was to reduce total cost for medium- and heavy-lift vehicle space launch. The plan summarized DOD's launch assets as including 11 launch pads, 5 launch teams, 3 launch vehicle production and processing industries, 2 launch ranges, and various support resources. It discussed an EELV program strategy to incorporate industrial competition, resulting in a single production contract that would (1) maximize common systems and components to reduce procurement costs and enhance production rates and (2) decrease the number of launch complexes, launch crews, and support requirements to reduce operation costs.

Acquisition Strategy and Status

EELV is intended to be the federal government's only medium- and heavy-lift expendable space transportation capability for several years after the beginning of the 21st century. This planned family of vehicles is intended to launch the government's portion of the national mission model, which is currently being launched by the existing fleet of Delta, Atlas, and Titan vehicles. For EELV, this model consists of 193 government launches for fiscal years 2002 through 2020—177 for defense and intelligence purposes and 16 for the National Aeronautics and Space Administration.

[3]Department of Defense Appropriations Act, 1995, (P.L. 103-335, Sept. 30, 1994).

In May 1995, the Office of the Secretary of Defense (OSD) established an EELV development cost objective of $2 billion (in then-year dollars). The Air Force's acquisition plan included a threshold amount not to exceed $2.3 billion. In addition, the Air Force Space Command established a goal of reducing EELV production and launch costs by a minimum of 25 percent from the estimated costs of using existing launch vehicles, with an objective of 50 percent. In August 1995, the Air Force awarded four competitive $30 million contracts for a low-cost concept validation phase. The purpose was to provide system specifications, cost estimates, trade-off analyses, risk mitigation results, environmental analysis reports, and manufacturing plans.

In December 1996, DOD decided to proceed into a 17-month pre-engineering and manufacturing development (pre-EMD) phase, and the Air Force awarded competitive $60 million development contracts to both Lockheed Martin Astronautics and McDonnell Douglas Aerospace. The purpose of this pre-EMD phase is to refine system specifications, update cost estimates, complete risk-reduction efforts, and support the government in the environmental regulatory process.

In June 1998, DOD plans to decide whether to proceed into a 6-year EMD phase, and the Air Force anticipates issuing one cost-plus-award-fee development contract for an anticipated $1.6 billion. During this phase, the contractor is to provide detailed system specifications, perform two system test flights (one medium-lift and one heavy-lift), validate manufacturing processes, and activate the launch sites. Also, at this EMD decision point, DOD plans to authorize the initial production strategy and quantities. Air Force documents show that 29 initial production vehicles are planned—20 for DOD and 9 for other U.S. government organizations—which we estimated to cost about $1.5 billion, based on Air Force budget information. A decision on whether to produce larger quantities that would cost several billion dollars is also to be made during the EMD phase. In its fiscal year 1998 research, development, test, and evaluation budget, the Air Force is requesting $91.6 million for EELV. Of this amount, $28.4 million is to initiate EMD.

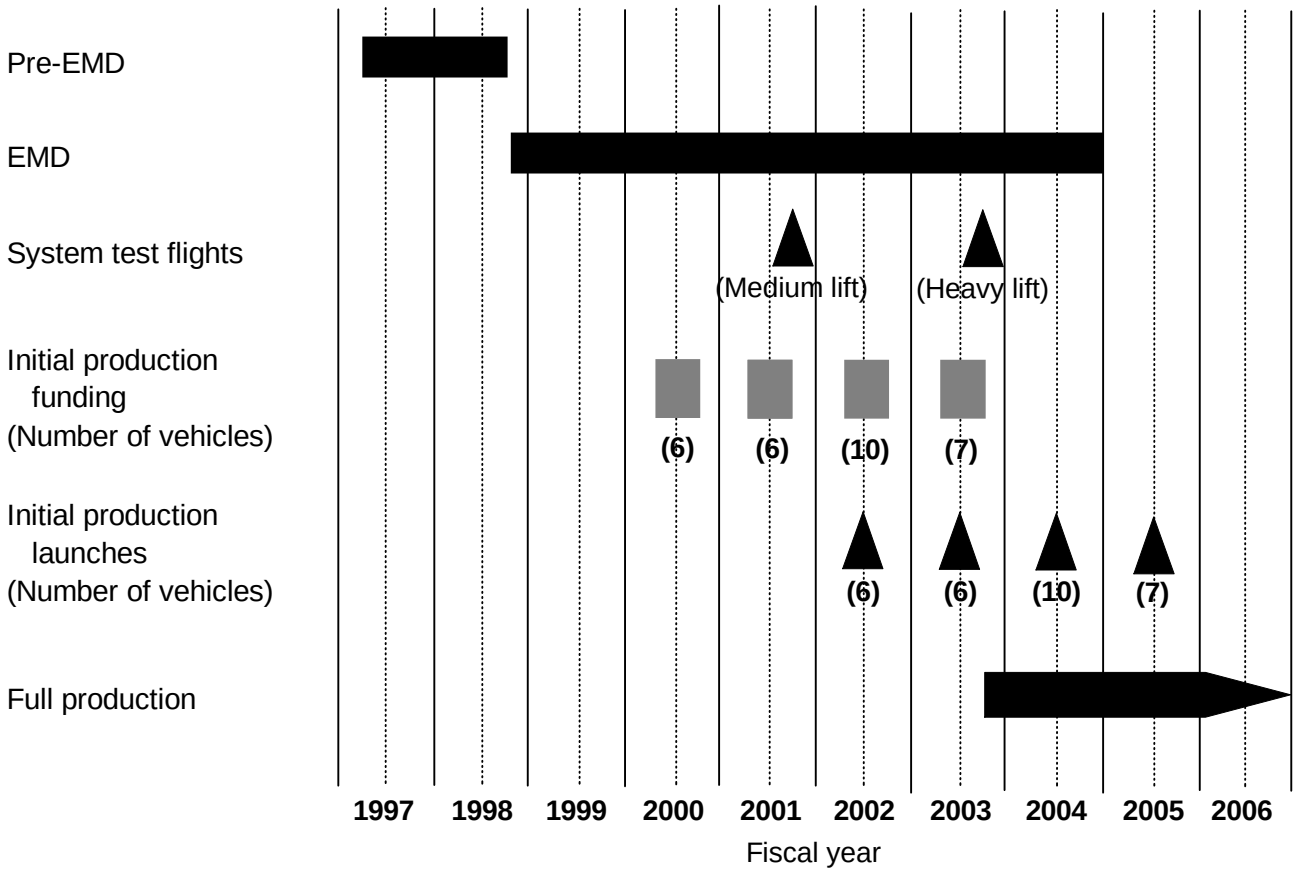
Acquisition Plans Contain Cost and Mission Risks

Air Force EELV acquisition plans show that the 29 initial production vehicles would be procured over a 4-year period (fiscal years 2000-2003) during the EMD phase. Assuming appropriations are provided, missile procurement funds for the first six initial production vehicles would be obligated in fiscal year 2000—at least 1 year, and possibly

2 years, before the first system development (medium-lift) test flight. The preferred date for this test flight is June 2001, and the threshold date is not later than December 2001. Missile procurement funds for a second set of six vehicles are planned to be requested for fiscal year 2001. If these funds are appropriated at the outset of the fiscal year, they could also be obligated before this test flight actually occurs.

Although the Air Force acquisition plan assumes a 2-year lead time from initiating production to delivering and launching a vehicle, it states that the industry has historically required over 2 years. According to the plan, if more than 2 years are needed, missile procurement funds could be requested as early as fiscal year 1999—at least 2 years, and possibly 3 years, before the test flight. Figure I.1 shows the current funding and launch plans for the 29 initial production vehicles and the associated concurrency of these plans relative to the EMD schedule.

Figure I.1: Planned Concurrent Development and Production in EELV Schedule



Source: Air Force EELV acquisition plan.

We have reported on numerous occasions about the risks associated with program concurrency and initiating production without adequate testing. For example, in 1990, we concluded that although concurrency can expedite the development and production of weapon systems, entering production before critical tests are successfully completed has resulted in the purchase of systems that do not perform as intended. In 1994, we reported that programs are often permitted to begin production with little

or no scrutiny, and the consequences have included procuring substantial inventories of unsatisfactory weapons requiring costly modification to achieve satisfactory performance. Once production is started, the options available to decisionmakers, when a system is found to be deficient, are significantly limited.[4] DOD usually considers the initial production strategy and approves the quantities concurrently with the EMD decision. Generally, a favorable decision authorizes the program manager to initiate production.

The EELV acquisition plan states that there will be no initial production vehicles dedicated solely for operational testing because of high vehicle cost. Instead, the Air Force plans to use all of these vehicles for operational purposes by launching navigational, missile warning, communications, meteorological, scientific, and classified satellites. Although this strategy may be economically sound, there is increased mission risk to costly national security and civil satellites because of not having assurance that a production-representative vehicle will perform as intended. The planned involvement by the Air Force Operational Test and Evaluation Center in the EELV program is to acquire and evaluate data from the first system development test flight and the initial six operational flights to support a decision to continue long-term production in fiscal year 2003.

Program Cost-Estimating Differences Are a Major Issue

EELV program cost-estimating differences between OSD and the Air Force became evident during the December 1996 Defense Acquisition Board review process. The primary reasons given were the use of different assumptions and methodologies.

Development Cost Objective

DOD's development cost objective of $2 billion was for all three development phases—low-cost concept validation, pre-EMD, and EMD. This objective was based on the 1994 space launch modernization plan, which estimated that nonrecurring costs for evolving a family of medium- and heavy-lift launch vehicles were in the range of $1 billion to $2.5 billion. The study's wide cost range was largely due to the lack of detailed engineering and program estimates for this particular evolved expendable launch vehicle approach.

[4]Weapon Systems: Concurrency in the Acquisition Process (GAO/T-NSIAD-90-43, May 17, 1990) and Weapons Acquisition: Low-Rate Initial Production Used to Buy Weapon Systems Prematurely (GAO/NSIAD-95-18, Nov. 21, 1994).

Of the $2-billion objective, $1.6 billion was planned for EMD, which is to be performed by one contractor. OSD's development cost assessment for the EMD phase (in constant 1995 dollars) was several hundred million dollars higher than the Air Force estimate, and both calculations exceeded the objective. (Details regarding cost estimates are considered competition sensitive and therefore not disclosed.)

Production and Launch Cost-Reduction Goal

The Air Force Space Command's 25 to 50 percent production and launch cost-reduction goal meant that an evolved family of vehicles should cost less than if existing vehicles were used. This goal was to be measured by first establishing an estimated recurring cost—called the launch cost baseline—of producing and launching Delta, Atlas, and Titan vehicles to satisfy the government launch needs during fiscal years 2002 through 2020. This calculation was then to be compared with the EELV contractors' proposed cost estimates for satisfying these launch needs during the same period. The Air Force's latest baseline was estimated at $20.6 billion. It was prepared by the existing vehicle program offices based on the Air Force Space Command's January 1996 national mission model for 193 predicted launches.

OSD's assessment of EELV production and launch costs for fiscal years 2002 through 2020 (in constant 1995 dollars) ranged from over $1 billion to about $2 billion higher than the Air Force's estimate. OSD calculations showed cost reductions that exceeded the 25-percent goal, and the Air Force showed reductions that exceeded the 50-percent goal. However, there was considerable uncertainty regarding these recurring costs. For example, OSD cost analysts believe that some of the estimated component costs were too low, and in the process of performing a net present value analysis, determined that the minimum 25-percent reduction would not be met. (Details regarding cost estimates are considered competition sensitive and therefore not disclosed.)

In addition, the validity of the national mission model, which was used to prepare the launch cost baseline, was questionable because (1) of the uncertainty in predicting government space launches 25 years into the future; (2) the model had fluctuated from 171 to 193 launches since the EELV program was established in 1995; and (3) the model is expected to continue changing, probably downward, because of recent OSD analyses regarding decreased heavy-lift vehicle requirements. According to DOD cost analysts, such long-term predictions and fluctuations made credible

assessments of production and launch costs and the comparative baseline more complicated.

DOD Recognizes That Cost Estimates Need More Attention

As a result of a Defense Acquisition Board review, the Under Secretary of Defense for Acquisition and Technology authorized the Air Force to proceed with the EELV program into the pre-EMD phase of the acquisition process. However, considering the differences in estimated program costs, the Under Secretary emphasized that every effort should be made to understand the cost differences between the Air Force and OSD estimates for both EMD and production. He indicated that the variability of these cost estimates, which stem from both increases and decreases in the national mission model, as well as the effect of varying requirements for heavy-lift capabilities, should be fully explored.

OSD established criteria for the program to exit the pre-EMD phase and enter the EMD phase, which is scheduled for June 1998. These criteria included (1) preparing an updated life-cycle cost estimate with a detailed cost risk analysis and (2) performing an independently reviewed economic investment analysis that would identify projected recurring cost savings and investment payback. An independent program cost estimate is a statutory requirement under 10 U.S.C. 2434 for entry into EMD.

Additional Satellite Costs Are Already Evident

Five Defense Satellite Communications System (DSCS) satellites, which have been built, remain to be launched during fiscal years 1998 through 2003 as the transition is made to EELV. Although these satellites were designed to be launched on Atlas II vehicles, the last two are now scheduled to be launched on EELV. According to program representatives, an additional $25 million has been budgeted for a payload interface adapter design and modification that will be needed for these last two satellites.

Six Defense Meteorological Satellite Program (DMSP) satellites, which have been built and are currently in storage, remain to be launched during fiscal years 1998 through 2007 as the transition is made to EELV. Although these satellites were designed to be launched on Titan II vehicles, the last four are now scheduled to be launched on EELV. According to program representatives, an additional $28 to $30 million has been estimated for a satellite payload interface adapter design and modification effort that will take about 5 years. They believe that other costs could be incurred because there is concern that the satellites may need to be modified to

withstand the stress anticipated from an EELV launch. Whether this will be necessary will not be known until the EELV launch tolerance parameters are demonstrated during the first system development flight test in fiscal year 2001.

According to program officials, five Defense Support Program (DSP) satellites are either built and in storage or being fabricated and are scheduled to be launched during fiscal years 1998 through 2003 as the transition is made to EELV. Although these satellites were designed to be launched on either Titan IV vehicles or the Space Shuttle, the last satellite is now planned to be launched on the EELV heavy-lift test vehicle in fiscal year 2003. According to program representatives, an additional $29 million is needed for hardware and cable associated with satellite and vehicle integration.

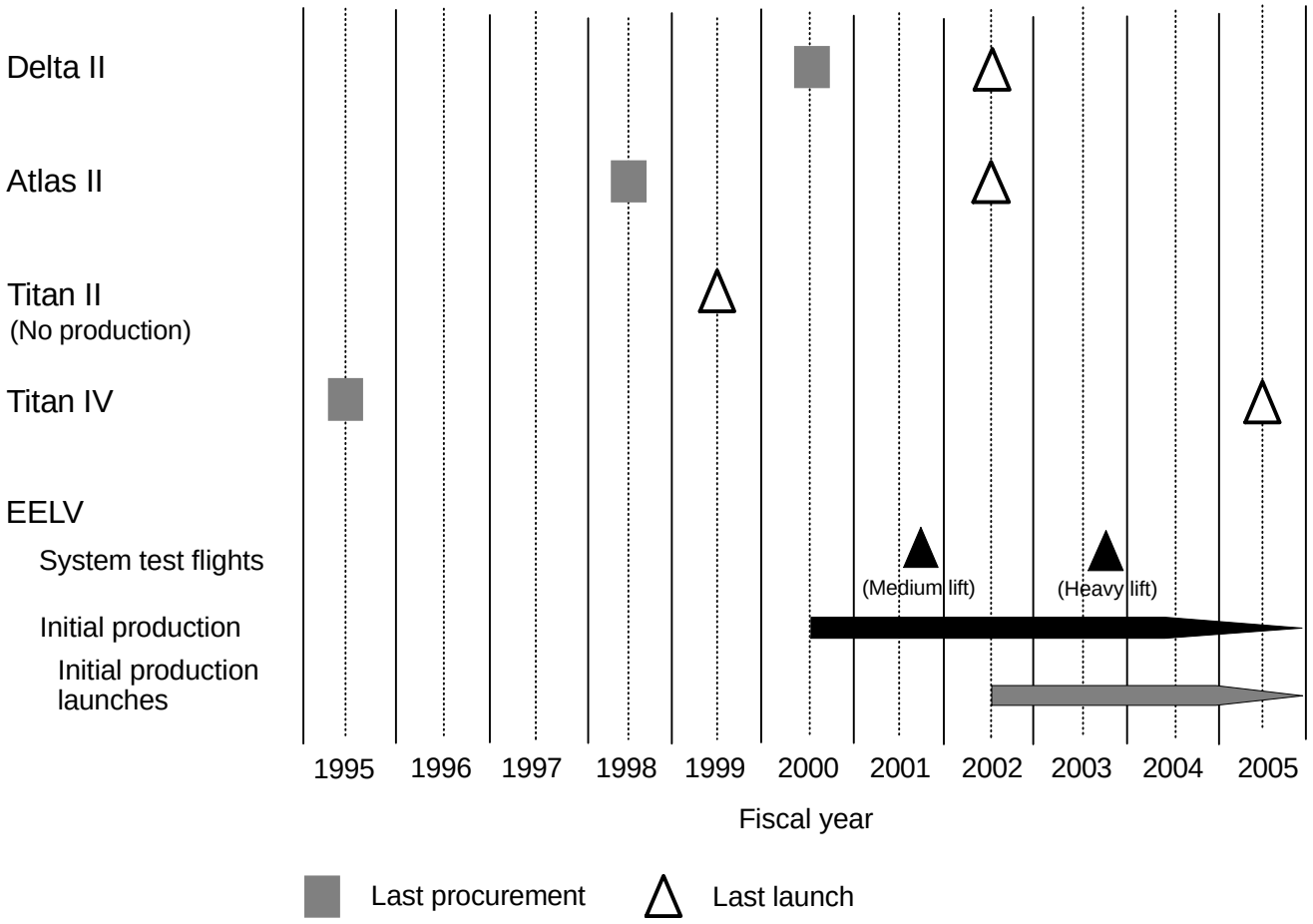
The Global Positioning System (GPS) is currently launched on Delta II vehicles, and the satellite system is undergoing a redesign, referred to as a block change, from the IIR to the IIF version. Although most of the IIF satellites are planned to be launched on EELV, the first satellite must be launched on Delta II. This is because the scheduled launch date is in fiscal year 2001 and the first operational EELV flight is not scheduled until fiscal year 2002. In addition, according to a program official, all IIF satellites need to be compatible with both launch vehicles because there is some uncertainty regarding the stress anticipated with an EELV launch. GPS program representatives informed us that about $35 million would be needed to develop and build a payload interface adapter for EELV.

The new Space-Based Infrared System (SBIRS) satellite program includes a geosynchronous earth orbit component and a low-earth orbit component. This program is intended to replace the DSP satellite system. SBIRS program officials initially intended to use EELV for the first geosynchronous launch scheduled for fiscal year 2002. However, because they want to mitigate the risk of delay in EELV availability, SBIRS is to be compatible with both EELV and Atlas. The deployment schedule for the low-earth orbit component is yet to be finalized. DOD originally scheduled the first launch for fiscal year 2006 using EELV; the Congress directed the first launch to be in fiscal year 2002; and now DOD is revising its schedule for launch in fiscal year 2004.

Vehicle Transition Plans Contain Future Satellite Launch Schedule and Mission Risks

The Delta, Atlas, and Titan programs are managed under separate Air Force production contracts and each have a different expiration date. Considering when the last procurement action is scheduled under these vehicle contracts relative to the schedule for the first EELV system development test flight, DOD appears to be taking some risk regarding future satellite launch schedules and missions. Figure I.2 shows the last scheduled procurement actions and the last planned launches for the government's existing launch vehicles, relative to key EELV scheduled events.

Figure I.2: Last Procurement Action and Launch for the Government's Existing Launch Vehicles Relative to Key EELV Scheduled Events



Source: Air Force Program acquisition plans.

The last of 21 Delta II launch vehicles for the government is to be procured in fiscal year 2000—1 year before the first EELV system development test flight. The last government Delta launch is planned for fiscal year 2002—the same year that medium-lift EELV operational flights are to begin.

Regarding Atlas II, a contract option is to be executed for the last of six government launch vehicles in fiscal year 1998—3 years before the first EELV system development test flight. The last government Atlas launch is planned for fiscal year 2002—the same year that medium-lift EELV operational flights are to begin.

The Titan II space launch vehicles were converted from deactivated intercontinental ballistic missiles, thus there was no production activity. According to program officials, after the last Titan II launch in fiscal year 1999, the Air Force plans to deactivate the launch pad.

Since 1991, Titan IV production rates have declined from 10 to 2 vehicles per year because of reduced requirements, with the resulting effect of increasing unit costs. The last Titan IV purchase was in fiscal year 1995 for 2 of 41 vehicles. Any follow-on procurement is in doubt because of uncertainties regarding future DOD heavy-lift requirements. The last Titan IV launch is planned to occur 2 years after the scheduled heavy-lift test flight.

In commenting on a draft of this report, DOD indicated that although these last procurement actions are scheduled, the vehicle contracts will still be in place, giving DOD the opportunity to procure additional vehicles, if required. However, such extensions usually require contract renegotiations, and the result is usually price increases. DOD also indicated that commercial launch vehicles may be available to mitigate some of the risk.

Launch Facility Transition Requirements Could Delay Program

There are three factors affecting a smooth launch facility transition at the Cape Canaveral and Vandenberg launch ranges—existing facility conflicts, environmental regulatory requirements, and the amount of time needed for facility construction.

Existing Facility Conflicts

In April 1996, the Air Force Space Command prepared an EELV plan that identified the need to coordinate efforts at the Cape Canaveral and Vandenberg launch ranges for making the transition from existing launch vehicles to EELV. At these ranges, the competing contractors were expected to use a combination of existing facilities, modified facilities, and possibly new facilities for the various launch support functions, such as

material receiving and storage, vehicle and upper stage processing, payload integration, final assembly, and launch services and operations.

In August 1996, the Command completed a launch site facility baseline study to provide the EELV program office with facility information necessary for risk assessment, management decisions, and answering contractors' questions. The study identified several existing facilities at Cape Canaveral and Vandenberg that were of interest to the EELV contractors but that were being used by other government or commercial programs. Some of these facilities were forecasted to be used through mid-to-late fiscal year 2000 or beyond and would require negotiations with the existing user regarding availability for EELV. Although resolution of several conflicts is the responsibility of Air Force launch range officials, there were indications that significant issues associated with certain facility priorities may have to be addressed at the DOD level. (Specific conflicts are considered competition sensitive and therefore not disclosed.)

Environmental Regulatory Requirements

Before construction of EELV facilities can begin at the Cape Canaveral and Vandenberg launch ranges, the Air Force must complete an environmental impact statement. According to the EELV acquisition plan, the environmental process, which is based on National Environmental Policy Act requirements, is to be completed during the pre-EMD phase, prior to committing EMD funds. However, the plan also states that it takes about 24 months to obtain approval. A representative from the Air Force Center for Environmental Excellence confirmed this estimate.

EELV program officials informed us that some preliminary environmental work was started during the low-cost concept validation phase. However, the actual contract for the environmental effort was not awarded until February 1997. This means that to initiate EMD on schedule in June 1998, only 16 months are available to complete the nominal 24-month environmental effort. Thus, the EMD contract award could be delayed up to 8 months, until February 1999.

Facility Modification and Construction Requirements

Existing facilities cannot be modified and new facilities cannot be constructed at the launch sites until (1) all environmental requirements are completed and (2) DOD decides to proceed into the EMD phase. In its transition plan, the Air Force Space Command urged that sufficient time be set aside to allow for facility planning, programming, design,

construction, and acceptance. It used traditional planning factors in estimating the duration of facility projects, such as 2 to 3 years for modifications to existing facilities and 4 years for new construction.

According to EELV program officials, the nominal facility construction time is 36 months. Given the requirement for a sequential environmental and construction process, and the possible 8-month delay in initiating EMD because of environmental regulatory requirements, the first system development test flight could be delayed by 8 months from the preferred date of June 2001 to February 2002.

Potential Performance Issues

The Air Force identified vehicle propulsion, systems integration, and software as technical risk items. EELV propulsion could be a primary area of risk because of the significant anticipated development. Although systems integration, including development and reuse of software, is a common risk area, it is expected to be a major system development challenge. Problems in these areas could result in an adverse effect on EELV program cost and schedule goals.

Propulsion Could Be a Primary Risk

From inception, the EELV system design was intended to be evolved from the existing medium- and heavy-lift vehicles into one family of vehicles. Despite this evolutionary concept, major changes in vehicle propulsion systems are expected that could require significant development. Changing propulsion systems appears to be necessary considering that the 1994 space launch modernization plan stated that (1) existing propulsion systems (both solid and liquid propellent variants) were the cause for 25 to 50 percent of the launch vehicle failures in previous years and (2) there was general consensus that propulsion technology was the most serious area of deficiency in the existing U.S. launch vehicle fleet. In addition to the expected technical risk, propulsion represents a significant portion of the estimated launch vehicle costs. Thus, development, testing, and integration of propulsion components could pose special challenges to the EELV program.

Systems Integration and Software Are Usual Risks

Systems integration involves combining all design, engineering, testing, manufacturing, and launch functions, as well as the software information system, that are essential to complete the intended project. Systems integration problems can occur, even though the various components and subsystems performed successfully on previous systems. As an example,

similar to EELV, the Air Force's C-17 aircraft program intended to use current, available, and proven technology to minimize development costs and structure a low technical risk effort. The integration of sophisticated technologies into a workable aircraft design was a major engineering and management task that eventually contributed to significant cost increases and schedule delays.[5] EELV system integration could be similarly challenging.

Air Force officials informed us that new computer software would be developed and existing software (from other programs) would be reused for EELV. They stated that software issues are particularly challenging and that program cost and schedule could be affected. Because of this, they have performed an assessment of the contractors' ability to develop software and intend to perform another one to help mitigate the risk.

Reusing software can be cost-effective, but it can present significant problems. For example, in June 1996, the initial flight of the European Ariane 5 launch vehicle failed because of inadequate software testing. The software was used successfully on previous Ariane 4 launch vehicles and then reused on Ariane 5. According to the report of an inquiry board established to perform an investigation, the failure was caused by the complete loss of guidance and attitude information resulting from specification and design errors in the software of the inertial reference system. The report stated that (1) there was inadequate analysis and testing of systems that included the reused software and (2) if testing had been performed, the potential failure could have been detected.

[5]Military Airlift: Cost and Complexity of the C-17 Aircraft Research and Development Program (GAO/NSIAD-91-5, Mar. 19, 1991).

Comments From the Department of Defense

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ACQUISITION AND
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Mr. Louis J. Rodrigues
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Mr. Rodrigues:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "Access to Space: Issues Associated with DoD's Evolved Expendable Launch Vehicle Program", dated April 11, 1997 (GAO Code 707131), OSD Case #1339.

The detailed DoD comments on the draft report recommendations are provided in the enclosure. Suggested technical changes were separately provided to the GAO staff. The DoD appreciates the opportunity to comment on the GAO draft report.

Sincerely,

Gil I. Klinger
Acting Deputy Under Secretary of Defense (Space)

GAO DRAFT REPORT - DATED APRIL 11, 1997
(GAO CODE 707131) OSD CASE 1339

"ACCESS TO SPACE: ISSUES ASSOCIATED WITH DOD'S EVOLVED EXPENDABLE LAUNCH VEHICLE PROGRAM"

DEPARTMENT OF DEFENSE RESPONSES

Now on pp. 8-9.

Recommendation #1: Considering the cost and schedule issues associated with the Evolved Expendable Launch Vehicle (EELV) program, the GAO recommended that the Secretary of Defense refrain from authorizing initial EELV production concurrently with the planned engineering and manufacturing development decision, and instead, hold a separate initial production decision meeting subsequent to the engineering and manufacturing development decision to take advantage of the most current program risk assessment information available prior to obligating procurement funds planned for fiscal year 2000. (pp 11-12/GAO Draft Report)

DOD Response: Non-concur.

While the DoD agrees that the decision to begin full procurement of EELV's should be based on as much data regarding program risk as possible, implementation of this recommendation would limit the flexibility of the DoD Acquisition Executive (DAE) in the Milestone II review process. Currently the program is in the Pre-Engineering and Manufacturing and Development (Pre-EMD) phase. The detailed acquisition strategy for the Engineering and Manufacturing Development (EMD) phase of the program will developed during the next 12 months of the program. The issue of procurement authorization will be discussed between the Air Force and the OSD staffs to determine the best approach considering both cost and schedule risks to the program. The EELV system requirements will be reviewed by the Joint Requirements Oversight Council and the EMD baseline will be approved by the DAE at Milestone II, currently scheduled for FY98. As part of the Milestone II decision, the quantity of Low Rate Initial Production (LRIP) vehicles will be established using the most current data available pertaining to program technical, cost and schedule risks.

The current program strategy outlined in the Single Acquisition Management Plan (SAMP) allows for the maximum flexibility on the part of the government and potentially stabilizes the development and production process for the contractor at no additional risk to the government. This strategy also enhances opportunities to implement GAO Recommendation #3 to explore ways to reduce overall costs to the government while still in a competitive environment.

Now on p. 9.

Recommendation #2: The GAO also recommended that the Secretary of Defense develop contingency plans to meet national security and civil satellite launch schedules when the existing launch vehicle production contracts expire and to address the potential for delay in the availability of launch facilities. (p. 12/GAO Draft Report)

DOD Response: Concur with comments.

The DOD agrees that assured access to space must be preserved during the transition from the current launch vehicle fleet to EELV. This capability will be traded against the overall risk and cost to the government required to maintain assured access to space for all government payloads. The transition strategy, which includes providing for additional vehicle options, has been initially implemented and will continue to be refined as the EELV program matures. The production lines for the Delta and Atlas vehicles are projected to be operational based on the anticipated commercial launch market demand well past EELV Initial Operational Capability (IOC). This will insure the capability to acquire additional vehicles in support of DoD, national security and civil missions if required. The GAO report identified DoD payloads that are currently providing or will need to provide the ability to launch on either EELV or the current launch vehicle fleet. This approach is consistent with commercial satellite industry practice, and will support timely launches of national security payloads if EELV schedule is delayed, directly addressing the GAO concern.

The issue regarding potential delay in availability of EELV launch facilities is a risk item that is being tracked by the Air Force Program Office and risk mitigation plans are under development within the Air Force, with assistance from the two Pre-EMD vehicle contractors. These risk mitigation plans are an integral part of the EMD acquisition strategy that will be approved prior to contract award. The EELV program schedule accommodates the Environmental Impact Statement (EIS) process and has been coordinated with the Air Force Center for Environmental Excellence (AFCEE). The EIS process schedule will support the first system test flight scheduled for 2001.

Recommendation #3: In view of the expected compensating benefits to the winning EELV contractor to enhance its competitive position in the international commercial launch vehicle market, and to help reduce the Government's investment in EELV, the GAO further recommended that the Secretary of Defense devise a mechanism, such as a cost-sharing contract and/or a recoupment arrangement for commercial launch vehicle sales, to be included in the Air Force's request for proposal for the engineering and manufacturing development (EMD) acquisition phase of the EELV program. (p. 12/GAO Draft Report)

Now on p. 9.

DOD Response: Concur with comments.

The acquisition strategy for the EMD phase of the program will be developed over the next 12 months. The issue of cost sharing as part of the EMD phase will be reviewed in order to provide the best product for the government. The DOD agrees that it should be in the best interest of the winning contractor to participate in a cost sharing arrangement. The actual arrangement for any cost sharing between the government and the winning EELV contractor will be included, as appropriate, in the source selection process and become an integral part of the EMD acquisition strategy. There are several

cost sharing approaches, as mentioned by the GAO report, that will be evaluated during the development of the acquisition strategy. The approach that provides the best value to the government will be incorporated into the EMD contract.

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