United States General Accounting Office

GAO

Report to the Chairman, Subcommittee on Military Research and Development, Committee on Armed Services, House of Representatives

September 2000

UNMANNED AERIAL VEHICLES

Questionable Basis for Revisions to Shadow 200 Acquisition Strategy

GAO

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GAO/NSIAD-00-204

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United States General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-285860

September 26, 2000

The Honorable Curt Weldon, Chairman
Subcommittee on Military Research
and Development
Committee on Armed Services
House of Representatives

Dear Mr. Chairman:

The Army plans to buy 44 Shadow 200 tactical unmanned aerial vehicle systems. Each system includes three unmanned aircraft (equipped with an imagery sensor[1]); a vehicle to carry the aircraft; two ground control stations mounted on vehicles; and launch, recovery, and support equipment pulled on trailers behind the vehicles. From inside the ground control station, soldiers operating the unmanned aircraft will fly them over hostile or contested territory, collecting imagery of areas of interest for Army commanders so they can detect, identify, and locate enemy forces. The acquisition cost, including research and development costs, for the 44 systems is an estimated $430 million through 2004.

Because the Army does not currently have enough unmanned aerial vehicle systems to meet its requirements, it devised an acquisition strategy in 1999 focused on procuring and fielding the Shadow 200 system as quickly as possible. The Army's strategy called for acquiring a system that incorporated mature technologies,[2] which will be integrated and

[1] The sensor is the payload carried by the aircraft to accomplish its mission. Imagery sensors are generally electro-optical (for collecting television-type images) or infrared (for collecting images based on detected heat radiating from objects). Infrared capability is especially useful at night and in other low-light conditions. Combined electro-optical/infrared sensors are available.

[2] Mature technologies are those that have been developed to the point where they can be integrated into a new product and counted on to meet product performance requirements.

demonstrated before the Army commits to full-rate production.[3] The Army's acquisition strategy also included the low-rate initial production of four Shadow 200 systems to be used in developmental and operational testing.[4] After evaluating the developmental and operational test results, the Army plans to decide in September 2001 whether to begin full-rate production of the Shadow 200 system.

To field systems more quickly, the Army revised its Shadow 200 acquisition strategy in March 2000 by planning to increase the number of low-rate initial production systems from four to eight. The decision to produce these four additional systems would be made in February 2001–2 months before operational testing and 7 months ahead of the scheduled full-rate production decision. As you requested, we have assessed whether the Army made a sound decision in revising its acquisition strategy. You also expressed an interest in the extent to which the Army has incorporated lessons learned from previous experience and from Kosovo/Operation Allied Force into its Shadow 200 program.[5] This information is provided in appendix I.

Results in Brief

The Army has a questionable basis for revising its acquisition strategy to procure four additional Shadow 200 systems in February 2001 before operational testing is conducted. In contrast, the Army's original strategy, which would prove system capabilities before producing additional systems, was sound. Among its reasons to justify the revision, the Army contends that accelerating the program will enable it to field a much

[3] In DOD's formal acquisition process, the decision to enter full-rate production does not occur until a system has been operationally tested in an environment that realistically simulates the system's expected combat environment. However, before operational testing, low-rate initial production can take place to produce articles for testing, to prove manufacturing and production processes, or to build-up to planned higher rates of production.

[4] Developmental testing is a technical test conducted on components, subsystems, and system-level configurations of hardware and software to provide data on the achievability of critical system performance parameters. Operational testing refers to testing conducted in a realistic combat environment on production or production representative articles to support the decision to proceed beyond low-rate initial production. The purpose of this test is to provide a valid estimate of expected system operational effectiveness and suitability.

[5] Operation Allied Force refers to a military operation conducted from March to June 1999 by the U.S. and our North Atlantic Treaty Organization (commonly referred to as NATO) allies to bring an end to Serbian atrocities in Kosovo.

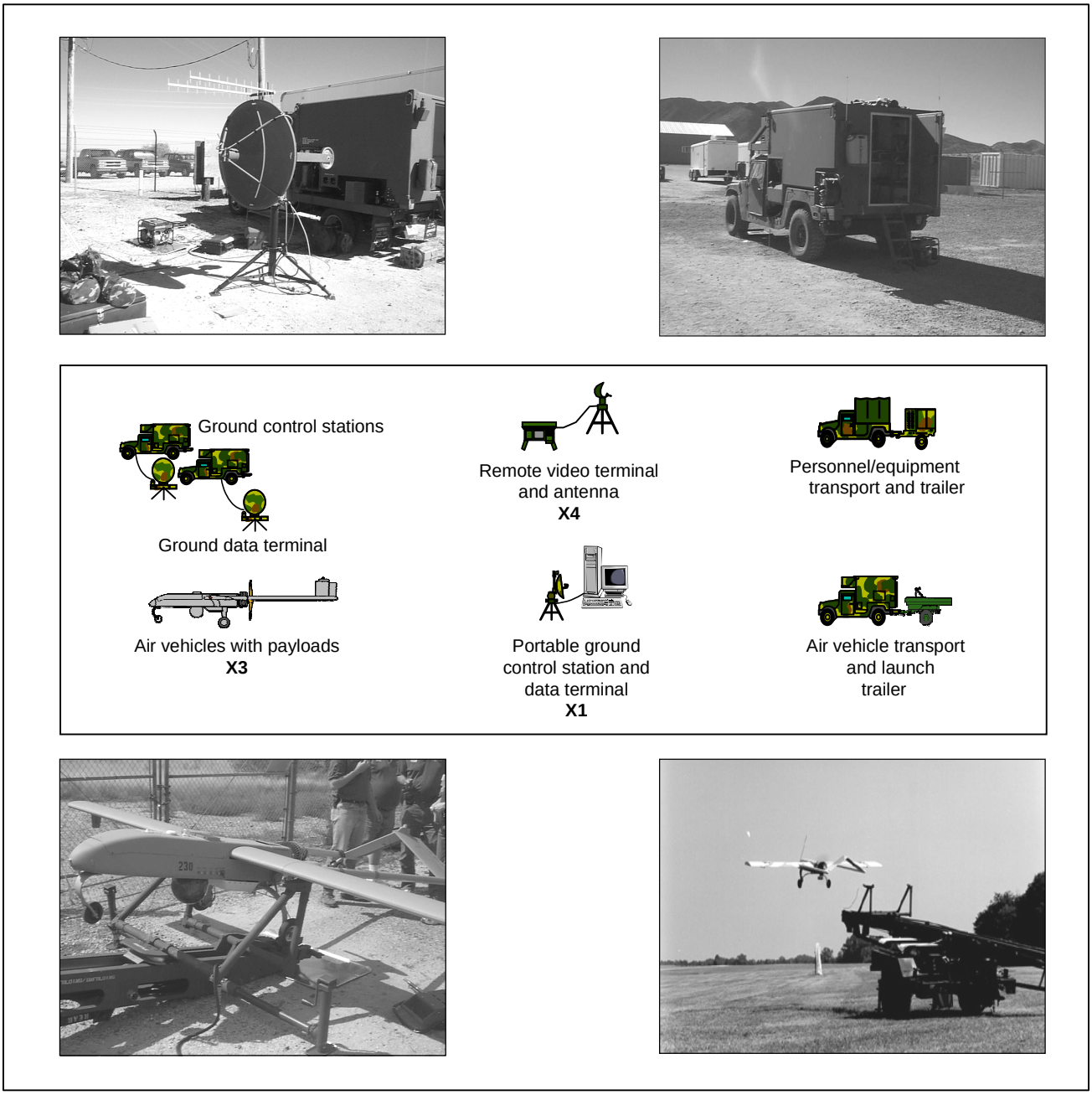
needed capability sooner. Also, the Army believes that risk associated with additional production prior to operational testing is substantially mitigated by significant developmental and other testing that is planned. We are concerned that the Army cannot know whether the Shadow 200 system will be operationally effective before operational testing takes place. Our previous reviews of other unmanned aerial vehicle programs have shown that buying systems before successfully completing testing has repeatedly led to defective systems that were later terminated or required costly redesign and retrofit to achieve satisfactory performance.

This report recommends that the Army not buy four additional systems until after operational testing is completed. The Department of Defense disagreed with us and stated that the risk associated with procuring these additional systems prior to operational testing is minimal. We continue to believe that the Army should not buy the additional systems because only operational testing of the system in a realistic combat environment can show whether the overall system will meet the Army's operational needs. If the Army does not implement our recommendation, we believe the Congress should consider directing it to do so.

Background

The Shadow 200 unmanned aerial vehicle system is expected to provide the Army with day or night reconnaissance, surveillance, and target acquisition capability. The Shadow 200 aircraft will allow Army commanders a view into heavily protected battlespace that cannot be penetrated by other intelligence assets or one that presents a high risk to manned aircraft. The Shadow 200 unmanned aerial vehicle system, formally designated the RQ-7A, is shown in figure 1. The aircraft weighs approximately 325 pounds, has a wingspan of 13 feet, and measures 11 feet from nose to tail.

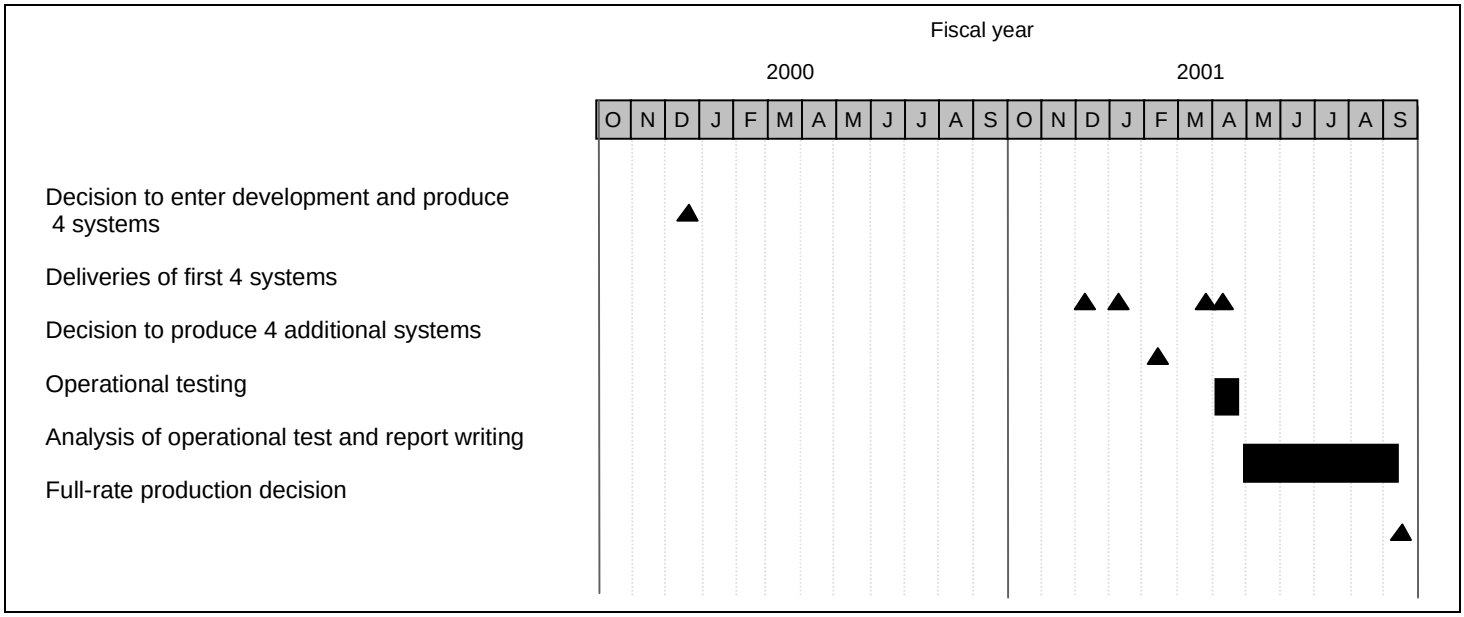
Figure 1: Shadow 200 Unmanned Aerial Vehicle System



Source: U.S. Army

On December 27, 1999, the U.S. Army awarded a contract to AAI Corporation for the engineering and manufacturing development of the Shadow 200 system. During the planned 16-month engineering and manufacturing development phase, the primary objectives are to translate the most promising design approach into a stable, interoperable, producible, supportable, and cost-effective design; validate the manufacturing and production process; and demonstrate system capabilities through testing. Because the Army believes the basic Shadow 200 system design is mature, low-rate initial production of four systems was started at the beginning of the engineering and manufacturing development phase. The Army expects to receive the first four systems between December 2000 and May 2001, when the engineering and manufacturing development phase is scheduled to be completed. These four systems will be used for developmental and operational testing, contractor and government performance testing, training, and equipping the first Army unit. In March 2000, the Army revised this acquisition strategy and now plans to exercise a second contract option in February 2001, buying four additional systems prior to operational testing at a cost of $31.8 million (see fig. 2).

Figure 2: Revised Schedule for Shadow 200 Acquisition Strategy



Source: Data from U.S. Army.

Justification for Buying More Low-rate Initial Production Systems Is Questionable

The Army has a questionable justification for revising its acquisition strategy to procure the four additional Shadow 200 systems before operational testing begins. Prior to this decision, the Army's acquisition strategy for the Shadow 200 system was sound because it minimized risk by (1) using mature technologies, (2) completing engineering and manufacturing development, and (3) demonstrating system capabilities through operational testing before buying any additional systems.

Original Acquisition Strategy for Shadow 200 Was Sound

Ensuring the maturity of components included in a system's design is a key to establishing a sound acquisition strategy. The Army's program office considers all five of the technologies critical to the Shadow 200 system's basic design to be mature—that is, at a level considered acceptable for programs entering the engineering and manufacturing development phase and ready to be integrated into a single system.[6] Our past work has shown the soundness of this approach; programs using more mature technology at the program start are more likely to succeed in meeting their objectives. In contrast to this lower-risk approach, the Department of Defense has often allowed immature technologies to be incorporated into its programs, thereby increasing technical risks.[7] For example, in the Hunter unmanned aerial vehicle program, the contractor used a motorcycle engine that was unproven as an airplane engine. Subsequently, in the flying environment, the engines overheated and valves seized, leading to a redesign of the engine to eliminate the problem.[8]

The original Shadow 200 acquisition strategy was also sound because it committed the Shadow 200 contractor to complete all its engineering and manufacturing development activities by May 2001, well before the next planned production decision scheduled for September 2001. Included in these activities were all the critical engineering steps necessary to ensure that the Shadow 200 design is cost-effective, stable, supportable, and producible. The original strategy also envisioned that the manufacturing

[6] The critical technologies are those incorporated into the airframe, engine, sensor payload, datalink, and ground control station.

[7] *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes* (GAO/NSIAD-99-162, July 30, 1999).

[8] *Unmanned Aerial Vehicles: No More Hunter Systems Should Be Bought Until Problems Are Fixed* (GAO/NSIAD-95-52, Mar. 1995).

and production processes for the system would be validated by May 2001. In contrast, at the time the Department committed to acquiring the Hunter unmanned aerial vehicle system in January 1993, the system design was neither stable nor supportable. Subsequently, a number of Hunter aircraft crashed during testing due to design flaws, costing the U.S. government millions of dollars and the program time and credibility.

Further, the original Shadow 200 acquisition strategy was sound because it committed to producing only four systems prior to operational testing, which is scheduled to begin in April 2001. Operational testing is the primary means of evaluating weapon system performance in a realistic combat environment. Although the Shadow 200 design incorporates mature technologies, operational testing will provide the Army with knowledge about whether these technologies, when integrated into a single system, will meet the Army's needs before it commits itself to the system's full-rate production in September 2001. Moreover, because operational testing was scheduled to take place in April 2001 and additional production was not planned to be approved until September 2001, the original strategy provided the Army with ample opportunity to fully analyze the operational test results.

Army Has Questionable Basis for Revising Acquisition Strategy

In December 1999, the Army's acquisition executive authorized the Shadow 200 program to enter the engineering and manufacturing development phase and also authorized building four low-rate initial production systems to be used in developmental and operational testing. At that time, the program manager was also directed to develop a plan to accelerate the fielding of the Shadow 200 system. Subsequently, in March 2000, the Army revised its original strategy. The revised plan will achieve accelerated fielding by exercising an option to buy an additional four low-rate initial production systems in February 2001 before engineering and manufacturing development is completed and operational testing is conducted (see fig. 2). These four additional systems would be fielded with operational Army units; they are not needed for testing.

The intent behind this revision is to enable the Army to field Shadow 200 systems to operational Army units earlier than called for in the original plan. We asked Army officials, including the program manager, to explain the basis for this decision. They told us that recent reductions in the Army's force structure have put a premium on surveillance and reconnaissance to provide greater situational awareness and knowledge, and acceleration of the program would allow early fielding of the much needed Shadow 200's

capability. They also stated that risk is substantially mitigated by significant developmental and other testing. Further, acceleration only places a portion of the $31.8-million cost for the four additional systems at risk because most of the hardware could still be used if problems are later identified during operational testing.

Although the Army might be able to deploy the Shadow 200 systems sooner if more systems are produced beginning in February 2001, we are concerned that the Army cannot guarantee their operational effectiveness at the time it plans to make that decision. Only operational testing can ensure that the components—even if mature—will work together in a realistic combat environment. Our previous reviews of other unmanned aerial vehicle programs have shown that buying systems before successfully completing operational testing has repeatedly led to defective systems that were later terminated or required costly redesign and retrofit to achieve satisfactory performance. For example, because predecessors to the Pioneer unmanned aerial vehicle system had been used successfully by Israeli forces, the Navy procured nine Pioneer systems in 1985 without testing and deployed the system to operational forces. As we reported in 1990, numerous problems ensued that led the Navy to redesign and modify virtually the entire system at a cost of about $50 million.[9] The redesign and modification costs about matched the Navy's cost of $56 million to initially procure its nine systems.

Conclusions

The Army's initial acquisition strategy for the Shadow 200 system appropriately minimized risk by scheduling operational testing before committing to additional production. The Army's revised—and riskier—plan to procure four additional systems before operational testing has a questionable rationale. Although the Army designed the Shadow 200 system using mature technologies, it has no assurance that its components will work well together in a realistic combat environment until operational testing is completed. We believe that the Army should not risk procuring systems before proving that they will meet its needs and will not require costly and time-consuming retrofits.

[9] *Unmanned Aerial Vehicles: Realistic Testing Needed Before Production of Short-Range System* (GAO/NSIAD-90-234, Sept. 28, 1990).

Recommendations for Executive Action

We recommend that the Secretary of Defense direct the Army not to exercise the option to procure four more Shadow 200 unmanned aerial vehicle systems until operational testing has been successfully completed and shown that the systems meet the Army's needs.

Matters for Congressional Consideration

If the Army does not implement our recommendation, we believe the Congress should consider directing the Army to do so.

Agency Comments

In its written comments on a draft of this report, the Department stated that the Army should have the option to procure four more Shadow 200 systems before successfully completing operational testing. It stated that the risk associated with procuring these additional systems is minimal given the mature technology used in the program and the extensive developmental and operational tempo testing[10] planned before the February 2001 scheduled decision. The Department added that the Army does not need to wait for the results of operational testing before exercising an additional production option because the Army will have tested all of the system's critical technical performance parameters during developmental and other system testing. The Department also stated that this minimal risk is outweighed by the benefits associated with accelerating delivery of the Shadow 200 system.

We continue to believe that the Army should wait until after completion of planned operational testing of the Shadow 200 system in May 2001. The ongoing developmental and operational tempo testing will provide the Army with valuable information on critical technical performance parameters such as range and endurance, but it will not provide the data about the overall performance of the system in a realistic combat environment that will be obtained during operational testing. According to

[10] Operational tempo testing differs from operational testing in that it attempts to increase the pace of system operations to increase stress on the system, but its main purpose is to identify problem areas in design that need correction rather than to determine if a system will be effective and suitable in a realistic combat environment when operated by Army units.

the Department of Defense guidance for its major system acquisitions,[11] attainment of individual critical technical performance parameters does not guarantee that overall system performance will meet operational needs. Although the Shadow 200 system has not been designated a major system, we believe this concept is equally applicable to the performance of the Shadow 200 system.

The Department of Defense's written comments are reprinted in appendix II. The Army also provided technical comments, which we incorporated as appropriate.

Scope and Methodology

To assess the Shadow 200 program's acquisition strategy and plans, we met with Department of Defense, Army, and contractor officials, and analyzed Shadow 200 system cost data, assessment reports, requirements documents, and program plans. To assess Shadow 200 system maturity, we asked program officials to identify the system's critical technologies and apply an analytical tool developed by the National Aeronautics and Space Administration to assess the technical maturity of each critical technology at the time the program entered the engineering and manufacturing design phase.

To assess the extent to which lessons learned in Operation Allied Force were used to improve the performance of the tactical unmanned aerial vehicles (see app. I), we reviewed the Department of Defense's lessons learned report,[12] reviewed program documentation, and held discussions with program officials. We conducted our work at the Directorate for Intelligence, Surveillance, and Reconnaissance Systems, Office of the Secretary of Defense, Washington, D.C.; Tactical Unmanned Aerial Vehicle Project Office, Huntsville, Alabama; Training and Doctrine Command System Manager for Unmanned Aerial Vehicles, Fort Huachuca, Arizona; and AAI Corporation, Hunt Valley, Maryland.

[11] Department of Defense Regulation 5000.2-R, Mandatory Procedures for Major Defense Acquisition Programs and Major Automated Information System Acquisition Programs (Mar. 15, 1996), appendix III, page III-7.

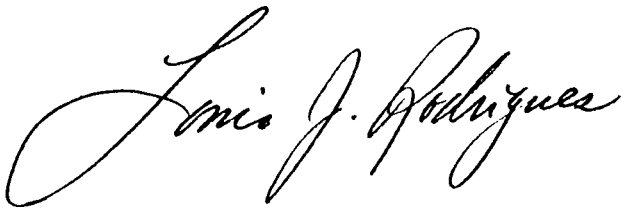
[12] *Report to the Congress: Kosovo/Operation Allied Force After-Action Report, Department of Defense* (Jan. 31, 2000).

We conducted our work from August 1999 through September 2000 in accordance with generally accepted government auditing standards.

We will send copies of this report to interested congressional committees; the Honorable William Cohen, Secretary of Defense; the Honorable Louis Caldera, Secretary of the Army; and the Honorable Jacob Lew, Director, Office of Management and Budget. Copies will also be made available to others upon request.

If you have any questions regarding this report, please contact me at (202) 512-4841. Other contacts and key contributors to this report are listed in appendix III.

Sincerely yours,



Louis J. Rodrigues
Director

The Army Is Incorporating Lessons Learned From Previous Experience Into Its Shadow 200 Strategy

In 1999, the Army, the Navy, and the Air Force operated RQ-5A Hunter, RQ-2A Pioneer, and RQ-1A Predator unmanned aerial vehicle systems, respectively, in support of Operation Allied Force in Kosovo.[1] According to the Department of Defense, these unmanned aerial vehicles were used to an unprecedented degree and played an unprecedented role in Operation Allied Force. They were used extensively for surveillance and reconnaissance missions, and their ability to loiter over hostile territory enabled them to provide information that was otherwise unavailable while avoiding the risk of losing aircrews. Nevertheless, in its January 2000 Kosovo/Operation Allied Force report, the Department of Defense identified a number of technical improvements it believes unmanned aerial vehicles need to attain their full promise on the battlefield. These include the need for (1) improved tactics, techniques, and procedures; (2) more capable sensor payloads (e.g., advanced imagery, radar, and laser); and (3) air vehicles that can operate in all types of weather conditions. Based on its previous experience operating Hunter unmanned aerial vehicles in peacetime, however, the Army had already learned these lessons and has been incorporating them into its acquisition strategy for its new tactical unmanned aerial vehicle system, the Shadow 200.

In January 1999, to improve the Army's understanding of tactics and of planning considerations for using unmanned aerial vehicles in future operations, the Army removed a Hunter system from storage and approved its use for joint readiness training at Fort Polk, Louisiana. Several Army units have rotated through the training center, and Army operational concepts are being validated and new lessons learned. One critical lesson learned is that the Army will be sending its unmanned aerial vehicles into high-risk areas to conduct surveillance where they are likely to be lost in battle. Thus, Army unmanned aerial vehicles must be inexpensive enough to be considered expendable. Hence, the Army's objective cost for a Shadow 200 air vehicle is about $452,000, which is a fraction of the cost of a manned observation helicopter.

To address the need for more capable sensor payloads in its unmanned aerial vehicles, the Army began a yearlong payload study in March 2000. During the study period, the Army is exploring alternatives and benefits that synthetic aperture radar, chemical weapons detection, laser range finders, signals intelligence, and other payloads could provide

[1] *See Report to the Congress: Kosovo/Operation Allied Force After-Action Report,* Department of Defense (Jan. 31, 2000).

commanders.[2] Until the study is complete, the only payload that will be integrated with the Shadow 200 is an imagery sensor to provide television and infrared pictures. The study will take into account that the Shadow 200 must remain inexpensive and expendable. Therefore, the more complex and expensive a particular payload is, the more benefits it must provide to the commander if it is to be incorporated into the Shadow air vehicle.

The Army also recognizes the value of unmanned aerial vehicles with all-weather capability. Before Operation Allied Force, the Army understood that unmanned aerial vehicle flight and sensor performance are adversely affected by the elements—especially icing. However, the Army's belief that tactical unmanned aerial vehicles must be inexpensive enough to lose and the Shadow 200's small size make it impractical to give the Shadow 200 aircraft all-weather capability. The Army plans to integrate a sensor on the Shadow 200 aircraft to detect icing; once icing is detected, the aircraft operator can fly the aircraft out of the icing environment. Other than this sensor, the Shadow 200 aircraft will not have all-weather capability because adding additional weight in the form of deicing equipment to a vehicle of this size would substantially limit its range and sensor payload capacity.

[2] A synthetic aperture radar uses radar signals and the complex information processing capability of modern digital electronics to provide high resolution imagery that is used by the aircraft operators on the ground for reconnaissance and targeting.

Comments From the Department of Defense

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ACQUISITION AND TECHNOLOGY

18 AUG 2000

Mr. Louis J. Rodrigues
Director, Defense Acquisitions Issues
National Security and International
Affairs Division
U. S. General Accounting Office
Washington, DC 20548

Dear Mr. Rodrigues:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "UNMANNED AERIAL VEHICLES: Questionable Basis for Revising Shadow 200 Acquisition Strategy," dated July 20, 2000 (GAO Code 707439/OSD Case 2052). The DoD nonconcurs with the recommendation that the Secretary of Defense direct the Army not to exercise the option to procure four more Shadow 200 Unmanned Aerial Vehicle systems until operational testing has been completed.

The DoD comments on this recommendation are provided in the enclosure. The Department appreciates the opportunity to comment on the GAO draft report.

Sincerely,

George R. Schneiter
Director
Strategic and Tactical Systems

Enclosure

GENERAL ACCOUNTING OFFICE DRAFT REPORT DATED JULY 20, 2000
(GAO CODE 707439) OSD CASE 2052

"UNAMNNED AERIAL VEHICLE: QUESTIONABLE BASIS FOR REVISING SHADOW 200 ACQUISITION STRATEGY"

DOD COMMENTS ON THE GAO RECOMMENDATION

RECOMMENDATION: The GAO recommended that the Secretary of Defense direct the Army not to exercise the option to procure four more Shadow 200 Unmanned Aerial Vehicle systems until operational testing has been successfully completed. (p.11/GAO Report)

DoD RESPONSE: Nonconcur. We believe the Army Acquisition Executive should have the option to procure additional Shadow 200 Unmanned Aerial Vehicle (UAV) systems prior to the completion of operational test and evaluation (OT&E). This option will be exercised only upon successful completion of developmental testing, occurring now, and Operations Tempo (OPTEMPO) testing, scheduled for 2 months prior to the start of OT&E. The risk associated with procuring these additional UAV systems is minimal, given the mature technology used in the program and the extensive developmental and OPTEMPO testing planned. This minimal risk is outweighed by the benefits associated with accelerating delivery of this much-needed UAV capability by about ten months. In addition, this acceleration is consistent with the Secretary of Defense's policy memorandum on UAVs dated July 6, 1999.

The Tactical Unmanned Aerial Vehicle (TUAV) program uses mature critical technologies in the airframe, engine, sensor payload, datalink, and ground control station. The Shadow 200, first flown in 1992, was selected from a field of four competitors during a System Capability Demonstration (SCD) in December 1999. The SCD evaluated operational performance of the UAV competitors against ten requirements thresholds during mission-representative flight scenarios. The Shadow 200 achieved eight of these ten requirements thresholds at the SCD.

Since contract award, the TUAV program has conducted extensive developmental testing, with more to follow prior to the start of OPTEMPO testing. By the completion of OPTEMPO testing, every critical technical performance parameter to be evaluated in OT&E will have already been evaluated. Thus, there is minimal risk of new problems surfacing during OT&E.

As mentioned previously, the acceleration of the TUAV program will allow early fielding (by about ten months) of this much-needed UAV capability. The draft GAO report suggests acceleration is not required since the Army already has the Hunter UAV system. While the Army is using Hunter systems, these assets are extremely limited, and Hunter does not meet the mobility, deployability, and transportability requirements of the much smaller Brigade-level TUAV.

We believe the Army has structured the TUAV program to include sufficient testing for the Army Acquisition Executive to make an informed decision on whether to approve procurement of additional Shadow 200 UAV systems prior to the completion of OT&E. At the time of his decision, the Army Acquisition Executive will have test results on every critical technical parameter to use as a basis for this decision. We believe the Army Acquisition Executive should be allowed the opportunity to make this decision.

GAO Contacts and Staff Acknowledgments

GAO Contacts

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Charles A. Ward (202) 512-4343

Acknowledgments

In addition to those named above, Thomas L. Gordon, Danny G. Owens, Jose A. Ramos, Jr., and Susan Woodward made key contributions to this report.

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