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JOINT STRIKE FIGHTER ACQUISITION

Development Schedule Should Be Changed to Reduce Risks

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Mr. Chairman and Members of the Subcommittees:

I am pleased to be here today to discuss the results of our review of the Joint Strike Fighter (JSF) aircraft program. My testimony today summarizes our draft report on the JSF, which was prepared at the request of the Chairman, Subcommittee on National Security, Veterans Affairs, and International Relations, House Committee on Government Reform. The Department of Defense (DOD) is scheduled to provide its comments on our draft by the end of next week. Therefore, my remarks today do not include the Department's views on our report.

DOD has designated the Joint Strike Fighter program as a flagship program for acquisition reform. According to the Joint Strike Fighter Single Acquisition Management Plan, a principal objective of the current concept demonstration phase is to demonstrate to a low level of technical risk those critical technologies, processes, and system characteristics necessary to produce an affordable family of strike aircraft that meets all participants' needs before entering engineering and manufacturing development. Our review focused on whether the acquisition strategy (1) is designed to accomplish this objective and (2) is being implemented in a manner that will ensure that the objective will be achieved.

SUMMARY

The Joint Strike Fighter acquisition strategy is designed to meet affordability goals by reducing program risk before proceeding into the engineering and manufacturing development phase. To that end, the acquisition strategy is designed to ensure a better match between the maturity[1] of key technologies and the aircraft's requirements. Matching the requirements and the maturity of technology when a program enters engineering and manufacturing development (development phase) is a critical determinant of a program's success. Once the development phase begins, a large, fixed investment in the form of human capital, facilities, and materials is sunk into the program and any significant changes will have a large, rippling effect on schedule and cost. Beginning the development phase when critical technologies are at a low level of maturity serves to significantly increase program risk and the likelihood of schedule delays, which in turn result in increased program costs.

While we were encouraged by the design of the Joint Strike Fighter acquisition strategy, we have some concerns about its implementation. Our biggest concern is that critical technologies are projected to be at low levels of technical

[1] A technology is considered to be mature when it has been developed to a point that it can be readily integrated into a new product and counted on to meet product requirements.

maturity when the engineering and manufacturing development contract is scheduled to be awarded. In addition, when the competing contractors experienced design problems and cost overruns, DOD restructured the program in a manner that will provide less information than originally planned prior to selecting between the two competing contractor proposals.

We believe that to demonstrate DOD's commitment to acquisition reform, follow best commercial practices, and reduce the risk of future cost growth, the Joint Strike Fighter program office should continue to focus on risk-reduction efforts by maturing critical technologies prior to entering engineering and manufacturing development, and be allowed to do so without the penalty of withdrawal of funding support.

I would like now to further discuss the factors that led us to our recommendation that the JSF program office adjust its currently planned engineering and manufacturing development decision date of March 2001.

BACKGROUND

As currently planned, the JSF program will cost about $200 billion to develop and procure over 3,000 aircraft and related support equipment for the U.S. Air Force, Marine Corps, and Navy and for Great Britain. To date, the program has awarded

contracts totaling over $2 billion to Boeing and Lockheed Martin for the current concept demonstration phase. DOD is scheduled to award the contract for engineering and manufacturing development to either Boeing or Lockheed Martin in March 2001. During engineering and manufacturing development, the Joint Strike Fighter will be fully developed, engineered, designed, fabricated, tested, and evaluated to demonstrate that the production aircraft will meet stated requirements.

The Air Force expects its JSF variant will cost about $28 million per unit; the Navy variant is estimated to cost between $31 million and $38 million; and the Marine Corps variant will cost between $30 million and $35 million.[2] Other independent estimates are not so optimistic. For example, in congressional hearings held in March 1999, the Congressional Budget Office estimated that the unit cost of the Joint Strike Fighter could be as much as 47 to 51 percent higher than expected, depending on which variant was being procured. DOD and the Congressional Budget Office estimates vary as a result of differing estimating techniques, including estimating the cost of incorporating stealth technologies into the Joint Strike Fighter design.

JSF ACQUISITION STRATEGY DESIGNED TO REDUCE TECHNICAL RISK

[2] Expected costs include the cost to produce the basic aircraft, propulsion system, and avionics and are stated in fiscal year 1994 dollars.

The Joint Strike Fighter acquisition strategy is designed to lower technical risk through aircraft flight demonstrations and advanced technology development prior to awarding the engineering and manufacturing development contract.

During the current concept demonstration phase, DOD requires each contractor to design and build two aircraft--one aircraft for conventional takeoff and landing and one for short takeoff and vertical landing--to demonstrate the following:

- commonality/modularity to validate the contractors' ability to produce three aircraft variants on the same production line;
- the aircrafts' ability to do a short takeoff and vertical landing, hover, and transition to forward flight; and
- satisfactory low airspeed, carrier approach flying and handling qualities.

Each contractor will also be required to submit a Preferred Weapon System Concept, which outlines its final design concept for developing an affordable JSF aircraft to meet the goals specified in the final requirements document. The Preferred Weapon System Concept will include results from the flight and ground demonstrations and will ultimately be used by DOD to

select the winning aircraft design and to award the engineering and manufacturing development contract.

We are encouraged by the design of the acquisition strategy and its focus on risk reduction by maturing critical technologies before entering the engineering and manufacturing development phase. Once in a development environment, external pressures to keep the program moving become dominant, such as preserving cost and schedule estimates to secure budget approval. For example, DOD policies require that a program be funded in the current year and that funds be made available over the next 6 years in the DOD planning cycle. If a program manager decided that an additional year was needed to reach the desired level of technical maturity during the risk reduction/concept demonstration phase, the planned start of the engineering and manufacturing development phase could be delayed. This delay could jeopardize the funding for the development phase, thus risking the funding support for the entire program. Consequently, the program manager may be more likely to accept the risk of moving forward with a lower level of technology rather than risk losing the program. That decision would raise cost/benefit issues because cost increases and performance compromises would likely occur.

IMPLEMENTATION OF JSF ACQUISITION STRATEGY WILL NOT ENSURE THAT PROGRAM OBJECTIVE IS ACHIEVED

Contrary to a principal objective of its acquisition strategy, the Joint Strike Fighter program will not enter the engineering and manufacturing development phase with low technical risk. In addition, when the competing contractors experienced design problems and cost overruns, DOD restructured the program in a manner that is moving away from best commercial practices that were evident in the original strategy toward traditional practices that have caused problems on other programs.

Critical Technologies Not Developed to Acceptable Levels

The aircraft being produced during the concept demonstration phase are not intended to demonstrate many of the technologies considered critical for achieving JSF program cost and performance requirements, such as those for integrated avionics. Instead, many of these technologies will be demonstrated only in laboratory or ground testing environments and therefore will have low levels of technical maturity when the engineering and manufacturing development contract is scheduled to be awarded.

To determine the maturity of Joint Strike Fighter technologies, we requested the program office to identify the technology areas they considered critical to meeting JSF cost and/or requirement objectives. The program office identified eight critical technology areas encompassing avionics; flight systems;

manufacturing and producibility; propulsion; supportability, and weapons delivery system.[3] We then requested the program office and the two competing contractors to assign maturity levels for these critical technologies using a tool referred to as technology readiness levels (TRLs). Using this tool, technology maturity levels are measured on a scale of one to nine: studies of the basic concept have a readiness level of one, laboratory demonstrations have a readiness level between three and six, and technologies that have been proven through integration and operation on the intended product have a readiness level of nine. Without going into the details of each level, let me note that a level four equates to a laboratory demonstration of a technology that is not in its usable form. Imagine, if you will, an advanced radio technology that can be demonstrated with components that take up a table top. A level seven is the demonstration of a technology that approximates its final form and occurs in an environment outside the laboratory. The same radio at level seven would be installed and demonstrated in an aircraft similar to the JSF.

The lower the level of maturity when a technology is included in a development program, the higher the risk that it will cause problems. According to the people in DOD that use the TRLs in rating the maturity levels of technologies, level seven enables a

[3] Due to the current JSF competition, the critical technologies are not specified so as not to associate them with the respective contractors.

technology to be included in a development program with acceptable risk. With this measurement tool, the program office can gauge the likely consequences of placing various technologies at a given maturity level into a development program and make informed choices and trade-offs if necessary to meet program goals.

The TRLs were pioneered by the National Aeronautics and Space Administration and adopted by the Air Force Research Laboratory to determine the readiness of technologies to be incorporated into a weapon or other type of system. The Joint Advanced Strike Technology program--from which the JSF program evolved--made extensive use of TRLs to assess early maturity levels for many of the current JSF technologies. The program also identified TRL 7 as the acceptable readiness level for low-risk transition into the engineering and manufacturing development phase.

We also used TRLs in our prior work when, at the request of the Chairman of the Senate Armed Services Committee's Subcommittee on Readiness and Management Support, we assessed the impact of technology maturity on product outcomes. During that work, we reviewed commercial and DOD experiences in incorporating 23 different technologies into new product and weapon system designs. Table 1 shows that cost and schedule problems arose when programs started when technologies were at low readiness levels and it conversely shows that programs met product

objectives when the technologies were at higher levels of readiness when the programs were started.

Table 1: Cost and Schedule Experiences on Product Developments

		Product Development	
Product and associated technologies	**TRL at program start**	**Cost Growth**	**Schedule Slippage**
Comanche helicopter		101 percent	120 percent
Engine	5		
Rotor	5		
Forward looking infrared	3		
Helmet mounted display	3		
Integrated avionics	3		
Brilliant Anti-Armor Submunition		88 percent	62 percent
Acoustic sensor	2		
Infrared seeker	3		
Warhead	3		
Inertial measurement unit	3		
Data processors	3		
Hughes HS-702 satellite		None	None
Solar cell array	6		
Ford Jaguar		None	None
Adaptive cruise control	8		
Voice activated controls	8		

Note: The Comanche has experienced a great deal of cost growth and schedule slippage for many reasons, of which technology immaturity is only one. Other factors, such as changing the scope, funding, and pace of the program for affordability reasons, have also contributed to cost increases.

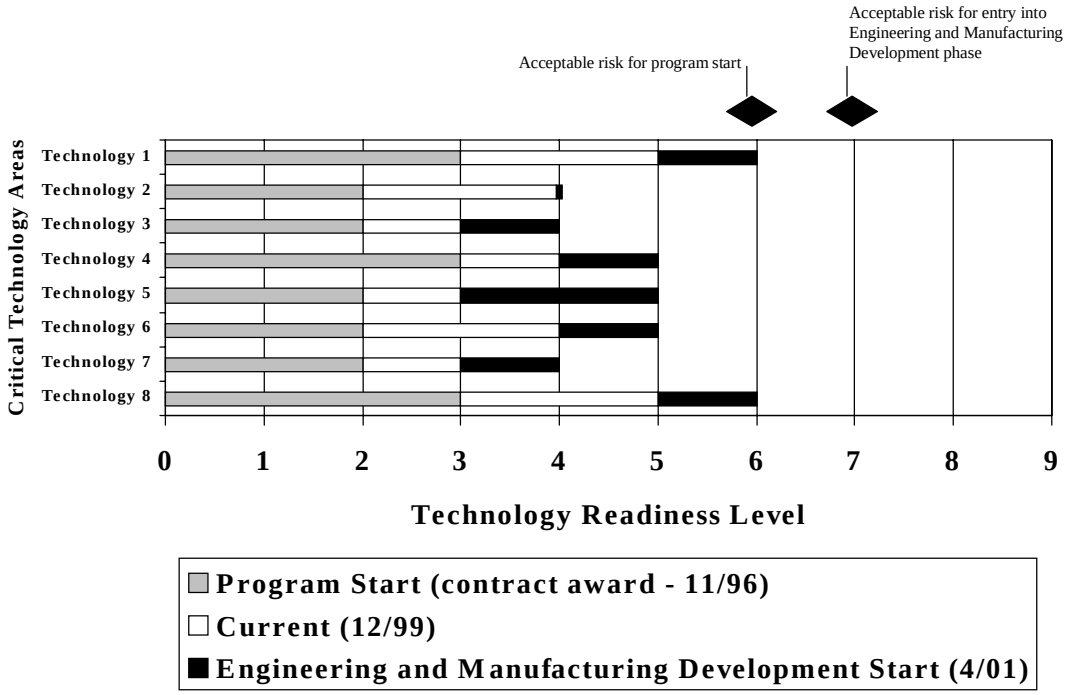
Unlike the Comanche and Brilliant Anti-Armor Submunition programs discussed in table 1, other DOD programs have more attentively matched customer requirements with technological capabilities.

For example, the Joint Direct Attack Munition program used modified variants of proven product lines for its guidance component and global positioning system. It also used mature, existing components from other proven manufacturing processes for its own system for controlling tail fin movements. The designs for the battery and the tail housing both used mature technology and were built using mostly existing tooling and processes. The Deputy Under Secretary of Defense (Acquisition and Reform) attested to the success of the Joint Direct Attack Munition program during a hearing today before the Government Reform Committee. The Deputy Under Secretary testified that the Joint Direct Attack Munition performed flawlessly in Kosovo and was purchased for less than half of its expected unit cost.

Regarding the Joint Strike Fighter, in conjunction with the program office and the two competing contractors, we determined the readiness levels of critical technologies at two points in time: when the JSF program was started in 1996 and when the program is scheduled to enter engineering and manufacturing development in March 2001. Those assessments showed that when the JSF program was started, most of the critical technologies were well below TRL 6, which is the level considered acceptable risk to begin a program by the Air Force Research Laboratory. In terms of engineering and manufacturing development, none of the critical technology areas are projected to be at readiness level 7, which the Air Force Research Laboratory considers acceptable

risk for entry into engineering and manufacturing development. The technology readiness levels of the eight critical JSF technology areas are shown in table 2.

Table 2: JSF Critical Technology Readiness Levels at Program Start and as Projected for Entry into Engineering and Manufacturing Development



Source: Joint Strike Fighter program office.

As shown in table 2, all of the critical technology areas are expected to be at maturity levels lower than considered acceptable risk for entry into engineering and manufacturing development (readiness level 7) and six of the technologies will still be below the level of maturity (readiness level 6) which is considered acceptable risk for program start, which occurred over 3 years ago for the JSF program.

Should any of these technologies be delayed or, worse still, not available for incorporation into the final JSF design, the impact on the program would be dramatic. For example, if one of the

above critical technologies needed to be replaced with its planned backup, DOD could expect an increase of several billion dollars in production and operation and support costs.[4] The backup technology would also significantly increase aircraft weight, which can negatively impact aircraft performance. This technology is expected to be TRL 5 at the beginning of the engineering and manufacturing development phase, which indicates that substantial technology development must still occur during this phase.

DOD RESPONSE TO CONTRACTOR COST AND SCHEDULE PROBLEMS IS INCONSISTENT WITH ACQUISITION STRATEGY GOALS

As a result of cost growth and schedule concerns related to both competing contractors, DOD restructured the JSF program in May 1999. Under the program restructuring, the contractors will provide DOD with less information than originally planned prior to submission of their proposals. For example, the JSF flight test program has been decreased, which will reduce the data available for final proposal evaluation. JSF program officials stated that with these flight test reductions, only the minimum acceptable flight quality demonstrations are expected. The number of preferred weapon system design updates has also been reduced, which means that information submitted for evaluation will be less representative of the final JSF design. Finally,

[4] Specific details cannot be provided due to the competitive nature of the Joint Strike Fighter program.

DOD has eliminated risk-reduction efforts and delayed other technology demonstrations, which will increase the program's technical risk as it transitions into engineering and manufacturing development.

CONCLUSIONS

A key objective of the Joint Strike Fighter acquisition strategy --entering into engineering and manufacturing development with low technical risk--will not be achieved due to the manner in which the JSF program office is implementing the acquisition strategy. On its current schedule, the program will enter the engineering and manufacturing development phase without having reduced to an acceptable level the technical risk of technologies that the program office has identified as critical to meeting the program's cost and performance objectives. This approach is not consistent with best commercial practices in which technologies are more fully developed before proceeding into product development. It is also not consistent with DOD's originally planned approach for developing the Joint Strike Fighter. Instead, the program office's revised approach is consistent with DOD's traditional approach in weapons system programs of concurrently developing technologies and products. This traditional approach has often raised cost/benefit issues as a result of cost increases, schedule delays, and compromised

performance as problems arose in completing technology development.

RECOMMENDATION

The Joint Strike Fighter program is at an early development stage and, therefore, DOD still has the opportunity to both demonstrate its commitment to acquisition reform and chart a course to avoid the problems that often befall major weapon systems. A decision to allow the JSF to proceed as planned, without mature critical technologies, would compromise DOD's position on acquisition reform, not follow best commercial practices, and would perpetuate conditions that have led to cost growth and schedule delays in many prior DOD weapon system acquisition programs. Accordingly, in our draft report we recommend that the Secretary of Defense direct the JSF program office to adjust the currently planned March 2001 engineering and manufacturing development decision date, without the penalty of withdrawal of funding support, to allow adequate time to mature critical technologies to acceptable maturity levels, thereby closing the gap between technology and requirements, before awarding the engineering and manufacturing development contract.

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Mr. Chairman, that concludes my statement. I will be happy to respond to any questions you or other Members of the Subcommittees might have.

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