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TESTIMONY OF

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CAIG Analysis of Joint Strike Fighter Engine Alternatives

Mr. Chairman and distinguished members of the committee, thank you very much for the opportunity to appear before you today to discuss the CAIG analyses of the Joint Strike Fighter engine alternatives, prepared in accordance with Section 211 of the National Defense Authorization Act of 2007.

My testimony today will address several topics examined by the Cost Analysis Improvement Group (CAIG) in accordance with Congressional direction. Specifically, I will address: the ground rules for the analyses developed by the CAIG; the CAIG's review of the history of DoD engine acquisition programs for tactical aircraft; a review of the JSF program and JSF engine alternatives; cost analyses for three different JSF engine acquisition scenarios, as directed in the NDAA; and findings and implications for the future.

Ground Rules for Analyses

Consistent with CAIG practice, the CAIG formed a team composed of DoD government personnel to respond to the tasking directed by Congress. In accordance with normal practice, private contractor personnel were not allowed to participate on the team; nor did they take part in the deliberations or the analyses of the CAIG team. In this particular case, because the Congressional tasking required independent analyses from three separate organizations, members of the Instituted for Defense Analysis (IDA) and the General Accounting Office (GAO personnel were not participants or advisors to the team. Also, there was no discussion between CAIG and IDA or GAO personnel on this particular topic. The results of the CAIG work were briefed only to Office of the Under Secretary of Defense for Acquisition, Technology and Logistics (OUSD(AT&L)) staff prior to this presentation to the Congress.

Historical Review

In accordance with the statutory requirements, the CAIG reviewed DoD's historical experience with tactical fighter engine acquisition programs. The CAIG reviewed the history of tactical fighter aircraft engines including the F100, F110, F404, and F119. The F100/F110s were procured in competition for form, fit, and function, and the F404 was procured in a build-to-print competition. The F119 engine for the F-22 fighter program was procured as a sole-source acquisition.

In addition to examining tactical fighter engine programs, the CAIG team reviewed the history of ship, missile, and other defense programs to determine the range of cost savings that DoD has achieved as a result of employing competition as part of the acquisition strategy for defense systems.

The CAIG review led to the following findings:

- The range of estimates of savings in acquisition costs from historical competitions for DoD systems reported in previous studies is extremely broad—varying from estimated net savings of approximately 40 percent, to estimated additional net costs of approximately 20 percent. The specific estimates of cost savings or additional costs of these studies are based on actual costs or projections to the end of the program, and the data account only for changes in recurring costs, with no accounting for investment needed to introduce competition. This methodology is consistent with the CAIG breakeven analysis and, as such, the estimates are directly comparable.
- The CAIG found that the strategic behavior of competitors in historical competitions was difficult to forecast either *a priori* or during DoD competitions. This is most markedly demonstrated in the ”Great Engine War,” the F100/F110 competition, which did not follow a smooth path of cost improvement and savings to the Department that would be predicted by analytic models—the exact same computations accepted by defense economists and used as a matter of course. This suggests that external factors are very influential in determining whether a competition results in

savings, and that the current state of the art for cost estimating does not capture these effects.

- DoD has entered into numerous Performance-Based Logistics (PBL) contracts in the operations and support (O&S) phase of programs (such as the C-17, F/A-18, and many unmanned air vehicle programs) and intends to use PBL extensively in the JSF program. The Department's experience, however, has shown that while operational readiness has generally improved under PBL contracting, there has been little actual return cost data available to the government to support estimates of cost savings.

JSF Program Status

The CAIG team examined the status of the JSF program and the relationship to the F135 and F136 engine programs. Key findings from this portion of the review include:

- Based on a review of weight forecasts for the STOVL aircraft beginning at the time of critical design review in 2006, the CAIG projects that weight growth is likely to remain a concern for the STOVL aircraft in the future. Based on historical weight growth experience for tactical fighter aircraft, the CAIG projects that the JSF STOVL aircraft could exceed the current target weights by about 2,000 pounds within ten years after the planned IOC date.

The CV variant might also experience weight control problems, although it is earlier in the design stage.

- The STOVL variant design is currently projected to meet the Key Performance Parameters (KPPs) associated with Vertical Lift Bring Back (VLBB) and Short Take Off (STO) distance, but with very little margin. Any weight growth above that projected by the program office—specifically, greater than about 3 percent between CDR and IOC—would result in the program's not meeting these STOVL KPPs.
- If this weight growth occurs in the STOVL aircraft, DoD will have to (1) pursue growth in engine/propulsion system capabilities; or (2) pursue additional weight reductions in the STOVL system; or (3) reduce capability and performance parameters for the STOVL variant; or (4) pursue some combination of the above. Because of the maturity of the aircraft design, the cost per pound to pursue dramatic airframe weight reductions is now high. These costs are increased since potential schedule delays for airframe rework would have profound ripple effects across the program. Therefore, the Department would more likely have to pursue propulsion system thrust growth than airframe weight reduction to achieved desired performance levels.

- According to CAIG estimates, the current DoD plan for the JSF development program allocates approximately 16 percent of RDT&E funding to propulsion system development activities and 84 percent of RDT&E funding to the development of the remainder of the aircraft.
- JSF aircraft prime contractor performance, as measured by Earned Value Management indicators provided to the government, has been poor to date. Recent management actions may have slowed the negative trends. However, additional weight reduction challenges to the prime contractor could exacerbate existing cost and schedule variances.

<u>F135 and F136 Engine Alternatives</u>

In reviewing the current status of the F135 and F136 engine alternatives, the CAIG found:

- Due to the F136 program's having started several years after the F135 program, milestones in the F136 development program are currently planned to be achieved three to four years later than the milestones for the F135 program.
- Although the design specifications are the same, the F135 and F136 engine designs are not identical; as a result, the potential thrust growth paths of the two engines are not the same. Due to its late entry in the JSF program, the

F136 is still in the design stage and changes to increase thrust or improve operational reliability are relatively easier to incorporate than in the case of the F135. The F135 is several years past CDR and well into ground testing; hence, additional F135 thrust growth requirements beyond the current specifications would entail considerable effort and cost.

CAIG Cost Analyses for Specified Acquisition Scenarios

The CAIG developed estimates of JSF life-cycle engine costs in accordance with congressional direction, measured in then-year, constant FY 2002 dollars and net present value terms. The analyses are based on the F-35 program of record, and include both U.S. and international engine buys, with a total production engine procurement of 3,089 units plus initial spares. U.S. operating and support costs are forecasted and included through 2065. The O&S costs do not include fuel or military personnel costs, as they are assumed to be neutral requirements for both engines.

The CAIG developed independent estimates of F135 and F136 system design and development costs, procurement costs, and operating and support costs for the acquisition scenarios specified in the NDAA that were determined to be executable. My prepared statement reports the CAIG results in constant FY 2002 dollars for ease of comparison with previous studies on the effects of competition.

The Department typically uses then-year dollar calculations for budgeting purposes and net present value calculations when weighing the pros and cons of investment decisions, such as Analysis of Alternative studies. These results will be provided for the record.

The CAIG considered the three engine acquisition scenarios specified in the NDAA:

- Case 1: F135 engine only, procured on a sole-source basis for the life cycle
- Case 2: F135 and F136 competition
- Case 3: F135 and F135 competition, with FY 2008 downselect

<u>Cost Analysis Results</u>

- For the F135 engine only (Case 1), the CAIG estimated life-cycle JSF engine costs of $60 billion (FY 2002 dollars).
- For the F135/136 competition (Case 2), the CAIG estimated a life-cycle engine cost of $60.3 billion (FY 2002 dollars). This case represents a marginal cost increase of $300 million relative to the sole source case. This is based on the following key assumptions, which generally favor competition:
    - A 5 percent shift and a 5 percent rotation of the cost improvement curve for engine procurement from each

competitor during competition. This behavior would hold for both competitors throughout the competition.

- Procurement competitions held annually, with 60 percent of the procurement quantity awarded to the winner each year, beginning in FY 2014.
- Procurement price savings achieved during the competitive engine acquisition phase are carried forward in the pricing of engine modules and components during the operations and support phase of the program.
- The buys are efficiently split between the two suppliers to minimize mixed fleets and hence reduce O&S costs.
- Cost savings realized in production or operations are included only if they accrue to the U.S. government.

- The CAIG also estimated the “breakeven” procurement cost savings necessary to pay for the up-front cost associated with conducting the engine competition and the reduced early learning relative to the sole-source scenario. Measured in constant FY 2002 dollars, the CAIG found that the procurement unit cost savings necessary from competition to achieve breakeven was 21.1 percent. While 21.1 percent savings is in the realm of plausible outcomes based on historical estimates of savings from prior competitions, it is not considered likely to occur in this case. (This simple "breakeven" calculation ignores any potential savings in O&S costs.)

- The CAIG examined Case 3 specified in the NDAA and determined that this alternative is not executable because the F135 is currently more mature than the F136 engine. As a result, the only near-term production option consistent with the 2008 date specified for this scenario is the selection of the F135 engine.

The CAIG also found a number of additional benefits of competition other than cost savings. The CAIG did not quantify these benefits in its analysis.

- Competition acts as a hedge, or a form of insurance, against risks that are present in specific aspects of a development, production, or operational phase of a defense program. In the case of the F-35, an alternate engine program could mitigate weight concerns or aircraft grounding associated with a single engine experiencing a significant design flaw.
- Competition results in increased contractor responsiveness to government concerns and in technological innovation, leading to better products even when offsetting direct costs are not realized.

- Competition secures a more robust industrial base and retains U.S. core design skills related to fighter engine development at two companies, reducing the Department’s risk for future programs.

Summary

- The CAIG analysis of JSF engine alternatives showed relatively modest additional life-cycle costs or savings associated with the competition scenario relative to a sole-source scenario. Also, the scenario for an early downselect in FY 2008 (as specified in the NDAA) was found to be unexecutable.
- While the engine life-cycle cost estimates alone do not provide a compelling case for or against use of a competitive acquisition strategy, other factors could prove important to the determination of the most appropriate acquisition strategy. For example, the potential for weight growth in the aircraft during the next 15 years is cause for DoD consideration of and development of a plan for growth of JSF propulsion capabilities over time.
- The operating and support costs associated with JSF propulsion are significant over extended time periods. DoD currently has a relatively small experience base with Performance-Based Logistics contracts for large programs such as the JSF, including the propulsion system. PBL contracting strategies should be developed and used to ensure DoD obtains prices during the O&S phase that are consistent with the best available acquisition prices demonstrated during the procurement phase of the program.

I again thank the committee for their time in allowing me to present these findings and would now be pleased to take any questions.

Case 1: F135 Sole Source Life Cycle Cost Analysis

	TY$B	Constant FY02$B	NPV $B
SDD	$7.2	$6.5	$6.7
Sunk*	$5.3	$4.9	$5.2
To Go	$1.9	$1.6	$1.5
Production	$36.4	$24.5	$18.0
O&S (US only)	$66.4	$29.0	$14.2
Total	$110.0	$60.0	$38.9

* Through FY07

Case 2: F135/F136 Competition Life Cycle Cost Analysis

	TY$B		Constant FY02$B		NPV $B	
	Dual Source	Delta From Sole Source	Dual Source	Delta From Sole Source	Dual Source	Delta From Sole Source
SDD	$9.6	+ $2.4	$8.6	+ $2.1	$8.6	+ $1.9
Sunk*	$5.3	--	$4.9	--	$5.2	--
To Go	$4.3	+ $2.4	$3.7	+ $2.1	$3.4	+ $1.9
Production	$34.5	- $1.9	$23.4	- $1.1	$17.4	- $0.6
O&S (US only)	$63.7	- $2.7	$28.3	- $0.7	$14.1	- $0.1
Total	$107.8	- $2.2	$60.3	+ $0.3	$40.1	+ $1.2

* Through FY07