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Skunk Works Mailing List

ATF testing

Date: Sat, 19 Jun 1999 08:13:43 -0400
Subject: ATF testing
From: "James P. Stevenson"

Art wrote:

> It's going to be 22 years from the time the ATF started for it to reach I=OC.
> Over 13 years from first flight! It doesn't have to be that way. Again,
> consider the Tomcat: Contract award in Jan. '69. First flight, Dec. 197=0.
> Navy workups 1973, IOC 1974 and first deployment (on Enterprise) in 1975.
> F-15 (which didn't have benefit of F-111 experience) didn't take that muc=h
> longer. This was normal for those days and earlier. Why not now?

The reason it takes so long is a function of political engineering. The contractors and the Air Force want to lock in the contracts so the public is on the hook for an airplane that has never proven itself.

The Air Force claims that the F-22 (formerly the ATF) has three pillars that make the F-22 invincible: stealth, supercruise, and avionics. The problem with the testing is not only has it taken a long time but the production decision will be made before it will have proven itself in flight test. Neither stealth nor the avionics have been proven to work even in the DemVal version, nor can the F-22 supercruise much further than the F-15C it is designed to replace.

Approval for the F-22 EMD

The decision for approval to proceed into EMD was set for mid-1991. As the date approached, the decision makers received inputs from various factions within the Department of Defense. What concerned one of them, the office of Program Analysis & Evaluation (PA&E), was the failure of the Air Force to adequately fund the F-22. In addition, PA&E was concerned that the ATF was so expensive, the Air Force could not replace retiring aircraft on a one-for-one basis. This meant that in order to keep the inventory at the same level, the Air Force would have to increase the average age of its aircraft. The only way to avoid that was to have a less expensive ATF. PA&E argued that the Air Force should procure a single engine version to reduce cost. It also reasoned that the Air Force should delay implementing the program until it had better resolution on the fiscal reality of the program.

PA&E was also concerned that there was inadequate flight test data from the DemVal phase. Indeed, the "prototypes" had accumulated only 157 hours compared with the 4,337 hours planned for the EMD phase. Spinney could not understand why the Air Force was in hurry now that the Cold War was over. What Spinney wanted was a real prototype program.

"The ATF was conceived at the height of the Cold War. Its System Operational Requirement (1 Mar 91) is clearly premised on the belief that the Soviet Union is the threat to be countered and that the intensity of cold-war competition would continue. . . .

"We can reduce this risk by reducing concurrency--that is, by partitioning the program into a Phase II Advanced Development Program aimed at producing a truly combat-capable prototype with full-powered engines and fully-integrated stealth and avionics capabilities, while deferring manufacturing development until a competitive fly-off against current generation fighters confirms the advantages of proceeding with manufacturing development and production."

The arguments from PA&E did not prevail. In July 1991, the Milestone Authority approved the Air Force award of the Engineering, Manufacturing & Development (EMD) contract to the winner of the ATF Dem/Val competition, Lockheed, GD, and Boeing. On August 2, 1991, it awarded a cost plus award fee contract (4% guaranteed, 9% guaranteed) for \$9.55 billion in FY1990 dollars. The contract called for 11 flyable aircraft plus 2 test articles which was subsequently reduced to 9 flyable aircraft plus 2 test articles. The contract specified first flight in June 1995.

The Engineering, Manufacturing & Design (EMD) Phase

There are three aspects to the EMD phase: aircraft construction, flight test, and the inevitable attempt by the other services to reach for some of the money earmarked for EMD and production. These battles usually result in an increased justification for the program and a fiscal revamping with the funding pushed further out into the future. There is precedent for these assertions.

When the F-15's increasing costs were exposed in the early 1970s, it created some analysis that showed that with a heat-seeking missile still on the drawing boards, it could garner an exchange ratio of 955-to-1 against a Russian MiG-21. As both Congress and the other military services reached for some of the funds tagged for the F-22, the Air Force and Lockheed have expanded their justification and produced a brochure that shows over 5,000 modern fighters as potential threats to U.S. forces. However, over 30 percent of them are U.S. fighters sold to friendly countries, including Canada.

The fiscal stability of the F-22 is also threatened by the questionable financial willingness or capability of the contractor to build the F-22. Their potential for profit is aggravated by the Air Force's insistence on a fixed price contract for early production models in which fiscal risks are still residual unknowns.

The promise of 750 production aircraft was, no doubt, an inducement to Lockheed and its subcontractors, to initially invest their own money. But the payback on the declining production numbers may inhibit future enthusiasm as Lockheed Skunk Works president Ben Rich pointed out.

"We won the competition, but all five companies involved in the F-22 competition have lost. We, the winners, will never make back our original investment because in the current budget crunch the government has cut back sharply on the number of F-22s it now plans to purchase. Currently, [1994] the Air Force has budgeted for four hundred new F-22s,

but that number could decrease even further. [It is now 339.] The fewer the new airplanes produced, the more expensive the unit cost. . . .

"The sad truth," Ben Rich wrote, referring to the original amount of the YF-22 contract, "is that our stockholders would have done better financially if they had invested that \$690 million in CDs."

If the president of the Lockheed Skunk Works thought it could not make a profit on the 442 planned F-22s in 1994, how will it now that the planning number is 339? How will the fixed price contract the Air Force plans to use on these initial research aircraft give Lockheed an opportunity to recoup its investment in the YF-22?

The F-22 EMD Flight Test Program

The flight test program began with the August 7, 1997 first flight of the F-22. However it was an aborted beginning. The F-22 required some structural additions to the airframe. The second aircraft did not fly until late June of 1998.

F-22 Flight Planned Test Hours and Sorties

Of greater significance is the demonstration plan the Air Force has to insure that the F-22 can meet its contractual specifications. The Air Force wants to go into production with only four percent of the total flight test completed, concurrency reminiscent of the Cold War. Indeed, it wants to obtain production commitments with only 183 hours of flight test out of a planned total of 4,337. This is only 26 hours more than the total 157 hours on the combination of YF-22 and YF-23 DemVal aircraft for which the government and contractors have already spent \$6.4 billion.

Planned Stealth Flight Test Program

The F-22 specification for radar cross section has a requirement that measures from a vertical angle of +20° to -20°. The flight test program, as outlined by the Air Force Program Office, stops at +/- 15 degrees. Furthermore, the Air Force wants production commitments prior to any flight testing on two of the F-22's three pillars--avionics and stealth. In fact, the flight testing on radar cross section alone will not be completed until the introduction of the ninth test aircraft which is not scheduled to fly until the year 2001. Even at that, according to an Air Force System Program Office presentation, it will not completely test to the radar cross section specification.

Avionics

The F-22 will have in its production version, 1.7 million lines of software code. As testimony to this level of effort, a good programmer can produce three lines of debugged software code per day. Thus the F-22, when it has completed its flight test, will have over 2,000 man years of software code effort. Aircraft number one has 300,000 lines of code and the current plane to migrate up to the 82 percent level with 1.4 million lines of code in aircraft No. 9. The development test and evaluation (DT&E) phase will not include code for dropping the JDAM munitions.

Costs

Congress put a cap on the cost of the F-22 in the National Defense Authorization Act for Fiscal Year 1998, November 18, 1997. It "imposed cost limitations of \$18.688 billion on the F-22 EMD program and \$43.4 billion on the production program." However, it did not specify a quantity of aircraft to be procured. This means that if the program acquisition unit cost (PAUC) increases, the quantity of aircraft will decrease because the money authorized is a constant. In August 1998, the Air Force was planning how announce that it would exceed the EMD cost cap by over \$1 billion. Current overrun estimate greatly exceed the \$1 billion overrun.

Dividing the fixed amount authorized by Congress for EMD and production with the previous money spent on Concept Formulation and DemVal, the F-22 program unit cost will exceed of \$190 million. Adding the \$1 billion EMD overrun will add approximately \$3 million to the program acquisition unit cost. Thus, if there were money in the budget to fund the F-22, which there is not, the aircraft would end up with a total program acquisition unit cost exceeding \$200 million. Such an aircraft the U.S. might be afraid to risk taking to war. That is, unless it flew with heavy jamming like the "stealthy" B-2 did in Kosovo. But then, if you have heavy jamming, you don't need stealth.

Fuel Fraction

The seminal work on supercruise was done by Col. Everest Riccioni USAF Ret. at the Northrop Corporation during the early years of the ATF competition. He determined that fuel fraction was a critical factor in obtaining range for a supercruising aircraft. At the time of the ATF competition, the range goal for the ATF was to cruise sub-sonically for 100 miles, then in 400 miles in supercruise, back out in supercruise, and home 100 miles subsonically.

The F-22 has breached the Riccioni ideal of 0.38 as well as the minimum acceptable fuel fraction of 0.35 due to increasing weight. Indeed, the Air Force admits to a fuel fraction of 0.29, a figure that is bettered by other aircraft including the F-15C, the aircraft the F-22 was designed to replace. The F-22 does not have the fuel fraction of, for that matter, the F8H a Navy jet that first flew in the mid-1950s. Riccioni estimates that the F-22 at its current fuel fraction has a supercruise range between 90-125 miles.

The Problematic Production Decision

Making production decisions before substantial completion of flight test has been historically justified because "the Russians are coming." Yet, in making them prior to the completion of testing, the military runs the risk that the hard tooling of the production aircraft or the aircraft themselves will have to be changed. Even without the pressure of the Soviet threat, there is a tendency to lock in production commitments so that the program has a better political potential. The best example of this is the F-18E/F.

In spite of 25 years of two flying prototypes, (the YF-17 and the F-18A/B/C/D), the F-18E/F--an airplane justified in large part for its increased range--developed a wing drop problem almost from the beginning, (see "Testing the Super Hornet: A Status Report," Aerospace America, June 1998). The Navy was 2,500 flight hours into its flight test program before it said that it had solved the problem. As a result, the Navy was successful in gaining approval to enter production before the flight test program was over. The production aircraft would incorporate the fix for the wing drop.

Yet as the F-22 approached the December 1998 183 flight test hour mark, the point at which the Air Force wanted to gain a production commitment for the Raptor, the F-18E/F wing drop problem re-emerged. The production fix functions more poorly than the interim fixed used to gain the production approval. As a result, the Navy almost lost an F-18E. The fix was not something for nothing, either, in a low level range comparison, an F-18C flew further than the F-18E, defeating in large part, the justification to build the F-18E in the first place.

The question that is now on the table is what unknowns will emerge in the flight testing of the F-22, now that we have gone into production.

Jim Stevenson

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