OFFICE OF THE SECRETARY OF DEFENSE
1700 DEFENSE PENTAGON
WASHINGTON, DC 20301-1700

OPERATIONAL TEST

20 DEC 2000

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE
(ACQUISITION, TECHNOLOGY, AND LOGISTICS)

SUBJECT: F-22 Test and Evaluation Status

The F-22 flight test program has fallen considerably behind schedule again this year. Although some of the necessary test support activities, such as the Flying Test Bed (FTB) and Avionics Integration Lab (AIL), have been making progress in supporting the test program, the flight testing at Edwards AFB has not met beginning-of-the-year projections. For example, as of December 19, 2000, flight test aircraft have only accumulated 322 hours of the 590 hours planned just one year ago. Test flying was constrained primarily by late delivery of flight test aircraft, canopy transparency cracks, aileron hinge pin problems, flaperon repairs, environmental control system problems, and inlet delamination inspections. As a result, exit criteria demonstrations have been delayed and in several cases have yet to be completed.

Aircraft 4003 completed the exit criterion, "Complete first flight on Engineering and Manufacturing Development (EMD) Aircraft 4003," and was delivered to Edwards AFB on March 15, 2000. However, it did not begin productive flight testing until September 19, 2000, due to a lengthy lay-up for structural modifications and instrumentation calibrations. Aircraft 4003 is the first flight test aircraft to incorporate the extensive structural modifications identified as strength summary operational restrictions II (SSOR II), which is the production-representative structural configuration required to expand the permissible flight envelope. This aircraft must, however, complete selective regression testing of the limited envelope explored by Aircraft 4001 and 4002 before it can start to expand beyond present flight envelope boundaries. As of December 19, 2000, Aircraft 4003 has only flown for 29.5 hours.

Another exit criterion is "Complete static structural testing" to applicable local design ultimate load (DUL) levels in support of flight test clean aircraft envelope expansion. To demonstrate this criterion, all 19 system level tests and nine of the local design loads cases to 150% DUL are required. The static test was stopped during the final, 19th, system level test case at 141% of DUL due to a failure in the test fixture, not in the aircraft. Static Testing to 141% DUL will support Aircraft 4003 clean aircraft envelope expansion for the near future. However, further static structural tests are necessary for full clearance of the clean aircraft envelope. Approximately one and one-half months are required to redesign and change the material of the failed fixture component so the 19th test will not be completed this year. Additionally, one of the nine required local design loads cases has not been completed to wrap up the exit criterion for

static structural testing, but that ninth required local design loads case is planned to be completed by the end of December 2000.

It also appears that the testing on the fatigue test article will be initiated late December 2000 to demonstrate the exit criterion "Initiate fatigue life testing with the goal of completing 40% of first fatigue life." However, the goal of 40% of the first fatigue life certainly will not be met; optimistically 5% of the first life will be completed by the end of the year. Although this fatigue testing does not impact expansion of the allowable flight envelope, completion of the first fatigue life does affect the point at which structural changes necessitated by fatigue test failures can be inserted into the production line, and possible retrofits required as the result of any major fatigue test failures. The first fatigue life probably will be completed by November 2001 and those results should be incorporated in the design of the Low Rate Initial Production (LRIP) aircraft.

Aircraft 4004 is the first flight test aircraft equipped with mission avionics radar; communication, navigation and identification (CNI); and electronic warfare (EW) subsystems and is scheduled to demonstrate the exit criteria "Complete first flight of EMD Aircraft 4004" and "Initiate radar cross section (RCS) flight testing." A year ago, aircraft 4004 first flight was scheduled for May 12, 2000. The first flight of aircraft 4004 was accomplished on November 15, 2000. Major problems causing this six-month slip were environmental control system (ECS) development problems, as well as the SSOR II structural modifications. Since the planned ECS simulator at Lockheed Martin, Fort Worth, was cancelled as a cost savings measure several years ago, the capability to begin ECS ground testing prior to flight testing does not exist except on the actual flight test aircraft. As ECS problems have been corrected, CNI operations have become the pacing problem area.

Low observable measurement and maintainability continues to be a risk area based on previous low observable platforms. This risk category includes reliability and logistics support. The concept for low observable sustainment and how to test it is an issue, not only to validate the new materials and repair techniques, but also to validate the low observable specifications as measured during full-scale pole and chamber testing. All available measurement tools, including ground, air, and range, should be utilized in this validation process. RCS flight testing still is planned to begin on Aircraft 4004 before the end of the year. The baseline plan showed that this would be conducted in mid-2000 on an outdoor test range after RCS mapping in the Lockheed Martin RCS Measurement Facility in Marietta, Georgia. However, late aircraft delivery plus RCS impacts from an inflight main landing gear door gap problem have delayed open-air range testing until late December 2000. RCS measurement with an alternate inflight air-to-air imaging system will be used to spot certain low observability features this month, but this does not meet the requirement to measure full aircraft RCS at a calibrated range.

Aircraft 4005 is the aircraft scheduled to demonstrate the exit criteria "Complete first flight on EMD Aircraft 4005" and "Complete avionics Block 3.0 first flight, initiating testing of Block 3.0 unique functionality." Delivery of this test aircraft has also been significantly delayed beyond last December's planning date of August 21, 2000, and

first flight is now expected to be late December 2000. The current plan is to fly the Block 3.0 software during test flights at Marietta, Georgia, prior to delivery of the aircraft to Edwards AFB. A portable mission control room has been put in place at Marietta, Georgia, for flight test operations and data collection purposes. The flight test will demonstrate the functionality of the Block 3.0 displays, instrumentation, and sensors and assess the closed loop tracking of an airborne target by fusion of the radar, identification friend or foe (IFF) interrogator, and the electronic warfare (EW) radar receiver sources. Extensive regression testing in the avionics integration lab (AIL) and flying test bed (FTB) have increased the confidence in avionics performance, but the program expects to initiate flight testing of Block 3.0 in aircraft 4005 in the next few days.

Avionics hardware and software development has proceeded essentially on schedule in the AIL and FTB. Block 3.0 software testing began in the AIL on June 20, 2000, and FTB testing began on September 1, 2000, a month ahead of the schedule briefed in December 1999. Block 3.0 software continues to undergo testing in both the AIL and FTB in preparation for flying in Aircraft 4005 prior to the end of this year. Another avionics exit criterion, "Complete critical design review of avionics Block 3.1 software," was completed on September 20, 2000, which is the next software build leading to Block 3.1.1 to be used for Initial Operational Test and Evaluation (IOT&E).

Weapons internal carriage provides the F-22 with lethal capabilities while maintaining low observability. The integration of avionics and weapons systems to launch precision weapons is a major step in the flight test program for validation of the software block algorithms. These software block algorithms are also necessary for the mission-level simulation in the air combat simulator (ACS) during pilot training and mission-level IOT&E sorties. The completion of three exit criterion, "Initiate high angle-of-attack testing with weapons bay doors open," "Initiate separation testing of AIM-9 missile," and "Initiate separation testing of AIM-120 missile" demonstrated the initial test tasks in weapons employment. To this date, the flight test program has demonstrated unguided launch of an AIM-9M Sidewinder from the side weapons bay on July 25, 2000, and an unguided launch of an AIM-120 from the main weapon bay on October 14, 2000, from Aircraft 4002. High angle-of-attack testing with the main and side weapons bay doors open began on August 22, 2000. This testing was accomplished relatively easily, further demonstrating the F-22's outstanding high angle of attack flying qualities. Flight test validation of the software block necessary for the start of IOT&E pilot upgrade training is critical. The proposed System Program Office (SPO) parallel developmental test (DT) sorties during IOT&E should be a DAE review topic to better understand the impact on the EMD schedule. In addition, we are concerned about the deferral of the external weapons/stores flight testing to the Seek Eagle Program, currently planned for FOT&E in 2003 at the earliest. It would be better to do this external carriage testing earlier to identify the aerodynamic impact of external stores, so that any issues could be resolved much sooner.

The progress of the flight test program in 2000 has been slow. In terms of flight hour accumulation, only 322 of the planned 590 flight test hours have been added from January through December 19 of this year on the three test aircraft at Edwards AFB.

This brings the total hours to 828 including the 506 hours accumulated through the end of 1999 with two flight test aircraft. Optimistic plans to significantly increase the test flying rate during 2000 were not achieved. The flight test points completed during this year also were well below planning expectations. Of the projected 7,745 test points to be completed by the end of November of this year, only 3,075 test points have been completed, or about 40% of the planned testing.

An additional factor is the continuing late deliveries of the avionics flight test aircraft, 4004 through 4009. As of the beginning of 2000, 21 available aircraft months of avionics flight testing had been lost from the Joint cost Estimating Team (JET) schedule. This year another 21 available aircraft months have been lost. The first flight of Aircraft 4004 slipped from May 2000 to November 15, 2000. Aircraft 4005's first flight has slipped from June 2000 to the end of December 2000. Aircraft 4006's first flight has also slipped from August 2000 to at least the end of December 2000. Aircraft 4007, 4008, and 4009 projected first flights have also slipped; 4007 from October 2000 to June 2001, 4008 from February 2001 to July 2001, and 4009 from June 2001 to September 2001. Also, 4008 and 4009 will make only limited contributions to avionics development because they must be modified to a production representative configuration prior to being ready to support IOT&E pilot training in March 2002.

Of significant concern to DOT&E is the impact of this slow progress on the program being ready to start IOT&E as scheduled in August 2002. The F-22 SPO estimates that approximately 150 flight hours of testing will be required to complete planned airframe development testing by the beginning of IOT&E in August 2002. Furthermore, this same program estimate shows that about 17 aircraft months of required avionics testing will not be completed by August 2002. These estimates are based on the same optimistic flight test planning assumptions that have not been realized during the past two years. In addition, the time to modify Aircraft 4008 and 4009 to production representative configuration prior to the August 2002 IOT&E date, as well as the use of these aircraft for IOT&E pilot training in March 2002, have not been fully considered in the above SPO estimates. Therefore, even the F-22 System Program Office optimistic estimates show that IOT&E cannot be started in August 2002 without clearly unacceptable risks.

In summary, according to the current schedule, the remaining DAB exit criteria can probably be completed by January or February 2001, namely, "Complete first flight on EMD Aircraft 4005," "Complete first flight on EMD Aircraft 4006," Complete avionics Block 3.0 first flight, initiating testing of Block 3.0 unique functionality," "Initiate RCS flight testing," "Complete static structural testing," and "Initiate fatigue life testing with the goal of completing 40% of first fatigue life." Static structural testing will not be complete by the end of the year. The fatigue testing is scheduled to start by the middle of December 2000; optimistically 5% of the first fatigue life will be complete by the end of the year. Forty percent could be completed by April 2001 and the first fatigue life by November 2001. First flight of Aircraft 4006 by the end of this year is in doubt. Also completing the RCS and Avionics Block 3.0 flight testing within the intent by

which the criteria were established does not appear to be possible before the January 3 2001, DAB.

Based on the current status of the test program and the SPO schedule estimates, IOT&E cannot be started in August 2002 without clear unacceptable risks. As of a recent meeting with Air Force leadership, the current Air Force position is to slip IOT&E and the Milestone III decision four to six months. Although we recommend this as a step in the right direction, our estimate is that EMD will need to be extended by at least nine months, and likely a year or more, to complete essential developmental testing prior to IOT&E. The Milestone III DAB must also be extended to an appropriate time to ensure completion of the minimum effective sorties for IOT&E. This will further increase EMD costs. Thus, from a test point of view, there is no reason to authorize LRIP at this time and some justification to delay LRIP. For example, test results from fatigue testing should be incorporated in the LRIP design. Those results probably will not be available until November 2001. Also, as discussed above, IOT&E will probably not begin until June 2003 or later.

Philip E. Coyle
Director

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