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Report to Congressional Committees

June 1999

DEFENSE ACQUISITIONS

Progress of the F/A-18E/F Engineering and Manufacturing Development Program

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United States General Accounting Office
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National Security and
International Affairs Division

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Congressional Committees

As required by the National Defense Authorization Act for Fiscal Year 1999 (P.L. 105-261), we reviewed the Navy's F/A-18E/F developmental and operational test program. We presented the results of our review during testimony before the Subcommittee on Airland Forces, Senate Committee on Armed Services, on March 17, 1999.[1] This report supplements that testimony by providing additional data on the aircraft deficiencies identified during the test program and discusses our conclusions regarding the E/F's progress toward achieving established performance, schedule, and cost goals. Specifically, we (1) determined the extent to which the aircraft is meeting performance requirements, (2) identified risks associated with proceeding into operational test and evaluation (OPEVAL) with unresolved deficiencies, and (3) identified potential cost increases and risks associated with approving the Navy's request for multiyear funding for the program. The act also requires that we certify whether we had access to sufficient information to make informed judgments on the matters covered by this report.

Public Law 105-261 requires us to conduct annual reviews of the F/A-18E/F until the aircraft enters full-rate production. This report covers our first review under the act. During our next review, we will focus on determining whether beginning OPEVAL with a significant number of unresolved deficiencies will result in over reliance on modeling and simulation rather than actual flight testing. We will also determine whether test restrictions on the aircraft configuration or missions flown could invalidate OPEVAL results.

Results in Brief

According to the Navy, the F/A-18E/F is meeting all performance requirements. We do not agree with the Navy's assessment. The Navy based its assessment on the E model's performance and assumed some improvements to the aircraft that have not yet been demonstrated. Without that assumption, the F model, which makes up over half of the E/F planned

[1] Defense Acquisitions: Progress of the F-22 and F/A-18E/F Engineering and Manufacturing Programs (GAO/T-NSIAD-99-113, Mar. 17, 1999).

buy, is not meeting the interdiction range requirement—a primary justification for the program.

The Navy's OPEVAL schedule, combined with unresolved aircraft deficiencies, could cause the E/F to fail OPEVAL. The Navy maintained its original schedule and started OPEVAL on May 27, 1999, even though completion of the development effort slipped from November 1998 to April 1999. Because the Navy is maintaining its original OPEVAL schedule, the contractor has insufficient time to correct some critical deficiencies in the aircraft that, according to Navy criteria, should be corrected prior to OPEVAL. Department of Defense (DOD), Navy, and contractor personnel have stated that there is a medium risk that OPEVAL might find the E/F not operationally effective and/or suitable. Such a conclusion could result in a delay or postponement of the full-rate production decision and the need to conduct additional operational testing.

Corrections of some deficiencies have been shifted to later in the program. This will help the Navy stay within the congressionally mandated developmental cost cap; however, correcting these deficiencies will increase the procurement costs of the aircraft. Congress is considering the Navy's request for multiyear procurement of the F/A-18E/F. A key criterion for obtaining congressional approval for multiyear procurement is design stability. Correction of some E/F deficiencies could result in contract modifications and design changes to the aircraft, which increases the risk associated with Congress's approving the Navy's multiyear procurement request for the E/F at this time. We recommend in this report that the Secretary of Defense defer multiyear funding for the E/F program until all corrections of deficiencies have been incorporated into the aircraft design and successfully tested.

The Navy and the contractors gave us access to sufficient information to make informed judgments on the performance of the aircraft. With respect to program costs, we requested estimates to correct the deficiencies identified during the test program; however, the contractor told us that such estimates are not available. We also requested the procurement unit cost comparisons that the contractor and the Navy program office had prepared of procuring 548 E/Fs to procuring 548 C/D model aircraft. The program office declined to provide us those comparisons.

Background

The F/A-18E/F program began in 1992 to increase the operational capabilities of the current fleet of F/A-18 aircraft. The objectives of the

program are to provide improved capabilities over current F/A-18s in five key areas–range, payload, carrier recovery payload, growth capacity, and survivability. Congress capped the development effort at $4.88 billion (in fiscal year 1990 dollars) and directed that the E/F unit procurement cost not exceed 125 percent of current C/D model costs.

The F/A-18E/F development flight test program began in February 1996. The Integrated Test Team, using five single-seat E models and two 2-seat F models, is conducting the tests. Two early operational assessments of the E/F aircraft, using wind tunnel data and analytical models, were made in early 1996 and 1997. Two operational assessments of the E/F aircraft, based on data obtained during test flights using the engineering and manufacturing development aircraft, were conducted in November 1997 (OT-IIA) and in June through August 1998 (OT-IIB). The Navy's Operational Test and Evaluation Force (OPTEVFOR) conducted these assessments.

The Navy has contracted for 62 aircraft under three low-rate initial production contracts. The first seven of these aircraft will be used to conduct the next operational flight test phase of the program. That phase, OPEVAL, is to be conducted during May–November 1999. The OPEVAL results will be used to determine whether the E/F program should proceed into full-rate production in March 2000.

We reported in June 1996 that current F/A-18s are not as deficient as the Navy reported and that the F/A-18E/F would provide only a marginal improvement in capability over the older F/A-18s at a significantly greater cost.[2] We recommended that DOD reconsider its plan to buy the E/F and instead buy additional F/A-18C/Ds. DOD did not concur with our recommendation and continued to believe that procuring the E/F was the more cost-effective approach to modernizing the Navy's tactical aviation fleet.

In March 1998 we reported that E/F flight test program officials had identified numerous deficiencies that if not corrected in time could affect the OPEVAL schedule or possibly cause the aircraft to have an unsuccessful operational test and evaluation.[3] We recommended that the Navy not be allowed to procure any additional E/Fs beyond the 12 initially

[2]Navy Aviation: F/A-18E/F Will Provide Marginal Operational Improvement at High Cost (GAO/NSIAD-96-98, June 18, 1996).

[3]Navy Aviation: F/A-18E/F Development and Production Issues (GAO/NSIAD-98-61, Mar. 13, 1998).

contracted for in March 1997 until the Navy demonstrated, through flight testing, that identified deficiencies had been corrected and incorporated into OPEVAL aircraft. DOD disagreed with that recommendation and stated that testing had not identified any specific deficiencies that would prevent the E/F from achieving an operationally effective level of performance.

Extent to Which F/A-18E/F Is Meeting Development Performance Requirements

The Navy is nearing completion of its F/A-18E/F development program. The development flight test program began in February 1996 and was completed in April 1999. During this phase of the program, the Navy conducted both developmental and some limited operational testing using the aircraft produced under the engineering and manufacturing development phase of the program. Based on the results of that testing, the Navy reports that the E/F is meeting all performance parameters.

The Navy's statements about the performance of the E/F reflect the performance of the single-seat E model aircraft, not the 2-seat F model. The second seat in the F model displaces fuel capacity, thereby reducing its range. The Navy's assessment was also based on estimates of improved performance from anticipated changes to the aircraft, not all of which, according to the contractor, may come to fruition. If these values are not included in the performance estimates, the F model aircraft will be 33 nautical miles short of meeting the development interdiction range requirement of 390 nautical miles. This is significant because (1) the F model, which was originally planned to be used as a trainer aircraft and therefore made up only about 18 percent of the total buy, now will be used as an operational aircraft and makes up about 55 percent of the total buy and (2) increased range over the current C/D aircraft was critical to justifying the decision to buy the F/A-18E/F. The Navy formally reports that the F/A-18E/F will have over 40 percent more range than F/A-18Cs. However, initial E/F range predictions have declined as actual flight data is gathered and incorporated into range prediction models. Test data currently projects that the E model will have a range of 434 nautical miles, or about 15 percent greater than the 376 nautical mile range demonstrated by current F/A-18Cs. If the anticipated but not yet demonstrated range improvements are not included in the range estimates, the F/A-18E development interdiction range drops to 405 nautical miles, or about an 8-percent greater range than an F/A-18C.

Also, the Navy's assessment of the E/F's performance does not consider the potential degradation of performance as a result of modifications to correct

unresolved deficiencies identified during the developmental and operational flight test programs. These deficiencies and their potential negative impacts relate to the aircraft's combat range, payload, survivability, and ability to accommodate new, future systems. All of these areas were cited as improvements by the Navy when it justified the E/F program.

Combat Range

Potential solutions to problems found during the test program have resulted in a reduction in the E/F's combat range. One of these problems, a condition described as "wing drop," was observed early in 1996 during F/A-18E/F development tests and was described as an unacceptable, uncommanded abrupt lateral roll that randomly occurred at the altitude and speed at which air-to-air combat maneuvers are expected to occur. In October 1998, the OPEVAL Preparedness Team reported that the anticipated fix to the problem, replacing solid wing fold fairings with porous fairings, significantly reduced, but did not totally eliminate, the frequency and severity of wing drop. However, the porous wing fold fairing has caused buffeting of the aircraft. The magnitude of the buffeting was described as severe enough to affect the pilots' voices and could also mask an aircraft malfunction, particularly for aircrews not accustomed to the sensation. This buffeting was projected to reduce aircraft range. However, the actual range decrease is not yet known because resolution of the problem is still being worked on and program officials will not have a complete understanding of the impact of the wing drop design fix until operational testing is completed at the end of 1999. According to program officials, the final production fixes to wing drop may involve something other than the porous wing fold fairing.

Other range-related issues are associated with the Navy's attempts to resolve design problems that had resulted in bombs colliding with each other or with the aircraft. To correct this problem, the Navy toed, or slanted, the inner wing pylons. However, that fix increased the drag on the aircraft and resulted in air loads on the pylons where the 480-gallon tanks would be carried that significantly exceed the load limit designed into the E/F wings in this area. If uncorrected, this deficiency would preclude the E/F from carrying 480-gallon external fuel tanks on each of the two inner wing stations specified for the interdiction mission and would prevent the aircraft from meeting its required range specification. The Navy is studying options for redesigning the pylons and their attachment to the aircraft to correct this problem.

Aircraft range will also be affected by the extent to which pilots use afterburner to compensate for deficiencies in the E/F's climb, turn, and acceleration rates. Using afterburner to overcome these deficiencies will significantly increase fuel consumption and reduce mission range.

Payload and Bringback

The F/A-18E/F reportedly carries a 22-percent greater payload than existing F/A-18s. This increased payload is the result of the E/F's two additional wing stations. However, development flight tests have revealed that the E/F experiences noise and vibration under the wings and at the wing tips that could damage air-to-air missiles carried by the aircraft. The Navy is determining whether a redesign of the missiles will be necessary for them to be carried on the E/F. Additionally, excessive loads on the inner wing pylons have been caused by the closeness of these pylons to the aircraft fuselage and to the toeing of the pylons. Current plans are to restrict what can be carried on these pylons during OPEVAL until a fix is designed and tested. The restrictions would prohibit the E/F from carrying dual MK-83 (1,000 pound) bombs on these pylons during OPEVAL, which would reduce the payload capacity for the interdiction mission. We were told that the aircraft could also have a problem landing on the carrier with unused weapons (bringback) because of the significant stress on these pylons. The Navy is still studying this issue and has not yet identified a final fix.

Survivability

The Navy planned to improve F/A-18E/F survivability relative to existing F/A-18s by reducing its susceptibility to detection and if detected the probability of being destroyed. Initial operational tests cite concerns about E/F survivability systems. While the specifics on E/F survivability are classified, the unclassified portions of the test reports identify concerns with the ALE-50 towed decoy and the ALR-67 radar warning receiver. The ALE-50 towed decoy is designed to improve F/A-18E/F survivability by attracting enemy missiles to the decoy and away from the aircraft. The line that tows the decoy has been burning off when it crosses the heat path of the engine when the engine is in afterburner. The problems relative to the ALR-67 radar warning receiver involve the receiver's ability to provide accurate information on the direction of arrival of enemy threats. The Procurement Executive Officer for Tactical Aircraft identified E/F survivability issues as the major challenges facing the E/F program.

Growth Space

In justifying the need for the F/A-18E/F, the Navy stated that it needed more space than was available on existing F/A-18s to accommodate additional

new systems without having to remove existing capability. The Navy reports that the F/A-18E/F will have 17 cubic feet of growth space. However, program documents show that only 5.46 cubic feet of that space will be usable for growth. We reported in 1996 that growth space was available within the C/D. The Navy's F/A-18 upgrade road map shows that most of the upgrades planned for the E/F are also planned for installation on C/Ds, which demonstrates that the C/Ds have growth space.

Test Schedule and Unresolved Deficiencies Cause Risks to Successful OPEVAL

The objective of OPEVAL is to field test the E/F under realistic combat conditions to determine the aircraft's operational effectiveness and suitability for use in combat by typical military users against threat forces and targets. For OPEVAL tests, the Navy plans to use production-representative aircraft that are being produced under the first low-rate initial production contract. The OPEVAL results will be used to determine whether to proceed into full-rate production of the F/A-18E/F. Accordingly, the primary questions are whether the aircraft is ready to advance into OPEVAL and whether successful completion of that evaluation is highly probable. Test results indicate that the Navy faces significant challenges regarding each of those questions.

F/A-18E/F development was scheduled to be completed by November 1998, with OPEVAL beginning in May 1999. That schedule would have provided time to correct deficiencies in the aircraft before their use during OPEVAL. However, additional test requirements, caused by the need to test corrections of deficiencies such as wing drop, have caused the completion of the development flight test program to slip to April 1999. As a result of the development program delay and the Navy's decision to begin OPEVAL in May 1999 as originally scheduled, the contractor will not have time to correct some aircraft deficiencies that according to the Navy's criteria should be fixed before OPEVAL. In that regard, the OPEVAL Preparedness Team, which comprises DOD, Navy, and contractor personnel, meets periodically to determine whether the E/F is ready for OPEVAL. On February 25, 1999, the team held its final meeting before the scheduled start of OPEVAL. At that meeting, the team concluded that 71 E/F deficiencies would not be corrected until after OPEVAL. The Navy's criteria indicate that 23 of those deficiencies should be corrected prior to OPEVAL. These deficiencies consist of the problems associated with the ALE-50 towed decoy, the ALR-67 radar warning receiver, and the wing pylon loads. In addition, they include such things as vibration that damages ordnance, delamination of the composite surface layers of the horizontal tail, and problems with the nose landing gear tires and wheels during

catapult testing. The Preparedness Team concluded that there is a medium risk that the E/F will not successfully complete OPEVAL without first correcting these deficiencies. The Preparedness Team's agreement to proceed into OPEVAL was based on the existence of correction plans to address these deficiencies.

The Navy began OPEVAL on May 27, 1999. However, it plans to impose some operational limits on the aircraft during OPEVAL as a result of deficiencies that cannot be corrected prior to OPEVAL. For example, as previously discussed, the E/F will not be permitted to carry dual MK-83 bombs because of the excessive air loads they put on the inner wing pylons.

The E/F operational test team has completed two operational assessments, using aircraft produced during the EMD phase of the program, that relate to the potential for a successful OPEVAL. Those assessments, referred to as OT-IIA and OT-IIB, were conducted in November 1997 and from June through August 1998, respectively. Based on these assessments, the operational testers assigned a level of risk relative to a successful OPEVAL to each critical operational issue tested. Table 1 shows that the testers identified two operational effectiveness issues with significant risk (air-to-air weapons and survivability) and six with moderate risk.

Table 1: Critical Operational Issues

Critical operational issue	OT-IIA risk	OT-IIB risk
Air-to-air weapons	Not assessed	Significant
Survivability	Significant	Significant
Fighter escort	Moderate	Moderate
Combat air patrol	Little or no risk	Moderate
Air combat maneuvering	Not assessed	Moderate
Air-to-ground sensor performance	Moderate	Moderate
Air-to-ground weapons	Moderate	Moderate
Air-to-air sensor performance	Moderate	Moderate

Source: Navy operational test reports.

The operational testers' OT-IIB assessment identified 29 major deficiencies in the E/F. The deficiencies related to such things as the E/F's ability to accelerate, turn, climb, and roll. Essentially, the E/F does not do as well in these areas as the F/A-18C aircraft. Additionally, the testers identified

buffeting and lateral instability, or drift, as flying quality deficiencies. They also listed as major problems the ALE-50 towed decoy and the capability of the radar warning receiver to indicate the direction of oncoming threats. The specific deficiencies identified by the operational testers[4] are as follows:

- poor climb performance above 30,000 feet;
- low acceleration;
- airframe buffet;
- high angle of attack and agility and controllability;
- slow response to control inputs, slow loaded energy addition rate, and excessive speed loss during air combat maneuvering;
- tactically ineffective sustained turn rate;
- insufficient cooling capacity for seekers on air-to-air weapons;
- improper indication of direction of arrival of oncoming threat systems;
- damage to AIM-9 missile assemblies caused by wing tip environment;
- ALE-50 tow line burn-off in afterburner;
- difficulty maintaining lateral trim;
- under-wing environment damages aircraft stores;
- unsafe delivery of Rockeye bomb;
- aircraft radar deficiency;
- leading edge extension difficulties;
- inconsistent brake effectiveness;
- inadequate cooling capability of the fuel thermal management system; and
- Targeting Forward Looking Infrared Radar resolution and magnification.

Appendix I describes each of these deficiencies and discusses their potential impact on the E/F's ability to perform its missions.

The operational testers recommended that the E/F continue to be developed. They stated, however, that they based their recommendation on continued improvements in the E/F's current maneuvering performance and the development of follow-on systems that they considered essential to get the operational effectiveness projected for the E/F. These improvements include such things as the Active Electronic Scanned Array radar, the Joint Helmet Mounted Cueing System, the AIM-9X missile, and the Integrated Defensive Electronic Countermeasure System.

[4]Our list does not total 29 deficiencies because we combined closely related deficiencies.

In addition to the risks to OPEVAL identified by the operational testers and the OPEVAL Preparedness Team, the Program Risk Advisory Board, comprising Navy and contractor personnel, in its January 1999 assessment stated that there is a medium risk that OPEVAL might find the E/F not operationally effective and/or suitable, even if all development specification requirements are met. The Board stated that the consequence of this type of conclusion from OPEVAL could result in a delay or postponement of the full-rate production decision and the need to conduct additional operational testing.

F/A-18E/F Costs and Request for Multiyear Funding

The Navy reports that the F/A-18E/F development effort will be completed within the $4.88 billion (in fiscal year 1990 dollars) development cost ceiling established by Congress. However, as of the end of February 1999, 71 identified deficiencies had not been corrected. Correction of these deficiencies will be accounted for as procurement, not development, costs. The contractor said that estimates of the costs of correcting these 71 deficiencies are not available. In addition, Boeing has identified 99 deficiencies in the aircraft that it believes it is not required to correct under the development contract. Estimates of the cost of correcting these deficiencies are also not available.

The Navy's unit procurement cost estimate for the E/F assumes that it will accrue $1.3 billion of savings if Congress approves the Navy's request for multiyear funding as part of the fiscal year 2000 authorization and appropriation process. Approval of such funding has historically depended on the ability to obtain significant savings, a stable system design, an adequately validated requirement, and a commitment to stable funding over the life of the contract. The concerns raised within DOD about the uncertainty that the E/F will successfully complete OPEVAL and the number of unresolved issues, like the final solution to wing drop and buffeting and the inner wing pylon load concerns that could require design changes to the aircraft, increase the risk associated with congressional approval of the E/F multiyear funding request at this time.

Conclusions and Recommendation

The F/A-18F model is not meeting its interdiction range requirement–a primary justification for the program. The aircraft has some critical deficiencies that, notwithstanding Navy criteria to the contrary, will not be corrected until after OPEVAL. Correcting these deficiencies later in the program will enable the Navy to remain within the development cost cap

but will increase the unit procurement cost of the aircraft. The impact of correcting these deficiencies on the cost and final design of the aircraft are factors critical to Congress' decision on whether to approve the Navy's pending request for multiyear procurement of the E/F aircraft.

Given the uncertainty surrounding the F/A-18E/F's final design and the Navy's intention not to correct all deficiencies and test those corrections as part of OPEVAL, we recommend that the Secretary of Defense defer multiyear funding for the E/F program until all corrections of deficiencies have been incorporated into the aircraft design and successfully tested.

Agency Comments and Our Evaluation

In its written comments on our draft report DOD did not agree with our recommendation. DOD stated that no deficiencies have been identified that would require a major redesign of the aircraft or are serious enough to warrant not awarding a multiyear contract. To take this position, DOD is assuming that all major deficiencies will be corrected with minimum impact on aircraft design, cost, or schedule. Specifically, DOD stated that although the aircraft will have 84 major deficiencies when it enters OPEVAL, 50 of them have a road map for solutions and funding. This indicates that the Navy has a plan in place to correct the deficiencies, but the Navy did not specify the dates for incorporating and testing the corrections. We continue to believe that the deficiencies should be corrected and validated through flight testing before the program is approved for multiyear funding. Therefore, we reaffirm our recommendation.

DOD also took issue with our statement that the F/A-18F is not meeting its interdiction range requirement. DOD stated that someone unfamiliar with the E/F program might assume this represents a serious deficiency in the program, which DOD said is not the case. The purpose of our statement was to put into perspective Navy statements that the E/F program is meeting all performance requirements. DOD's comments affirm that the F model is not meeting the interdiction range requirement, but by a tactically insignificant amount. Thus, the issue has evolved into differing perspectives on the magnitude of the F model's range deficiency.

We reported that the range of the two-seat F model aircraft is 33 nautical miles short of the interdiction range requirement, and DOD stated that the deficiency is only 3 nautical miles. The essence of the difference between our conclusion and the Navy's relates to (1) whether projected but not yet demonstrated and approved range improvements are included in the

projections and (2) what development engine is used to make the projections. The interdiction range deficiency that we reported reflects data that Boeing provided us. The data identified various planned range improvement efforts. The planned improvements included reducing aircraft weight, increasing the amount of internal fuel, and using a more efficient engine. Boeing officials stated that since these planned improvements had not yet been demonstrated and approved, they were not included in their range calculations. For the same reason, the planned improvements and their potential effect on E/F range were not included in our reported range figures.

The Navy range projections include the projected improvements and are based on a better performing engine than the one used in the contractor's estimates. In its comments, DOD stated that while Boeing is required by the development contract to use minimum new engine performance in its calculations, the Navy elected to use the Full Performance Qualification (FPQ) engine in its projections. The FPQ engine is a better performing, more efficient engine that will get greater range than the one used in Boeing's range calculations. Using the FPQ engine, the Navy estimates the interdiction range shortfall of the F model aircraft to be 3 nautical miles. Our concerns about the Navy's use of the FPQ engine in its range projections stem from the fact that while Navy officials said that the engine had successfully completed all demonstration, analysis, and testing required for full qualification, the FPQ report, dated December 28, 1998, identified a number of exceptions to full performance qualifications. Specifically, the report stated that a number of engine parts have not yet met life limits and redesign efforts are underway. Other engine redesign efforts identified in the report include addressing the fact that the engine exceeds specified weight limits, is experiencing engine stalls, and has not demonstrated required reliability. We did not attempt to update the status of the engine redesign efforts and their impact on the E/F's range to further reconcile the difference between our and the Navy's E/F range projections because such a reconciliation is not warranted at this stage of the E/F program. OPEVAL of the F/A-18E/F began on May 27, 1999. The flight demonstrated range of the E/F under realistic combat conditions will provide a more meaningful assessment of the aircraft's range than any mathematical calculations that either we or the Navy might make outside of OPEVAL.

DOD disagreed with statements in our report that the number and type of F/A-18E/F deficiencies that testing has identified pose a significant risk to passing OPEVAL. DOD stated that the 84 unresolved major deficiencies

that the E/F will have when it enters OPEVAL are significantly fewer than the number of unresolved deficiencies that the earlier F/A-18A/B model had when it entered OPEVAL and pose an acceptable level of risk to successfully completing OPEVAL. We did not compare the number of unresolved F/A-18A/B deficiencies with unresolved E/F deficiencies because the F/A-18A/B aircraft was a new aircraft development program and the E/F is a modification program. Given that distinction, it is understandable that the A/B aircraft program would have had more deficiencies. However, the readiness of the aircraft to begin and successfully complete OPEVAL is not exclusively dependent upon the number of deficiencies, but rather on the significance of the deficiencies and the status of their resolution.

Regarding the significance and status of the deficiencies, DOD stated that the Navy is following the deficiency resolution process defined in SECNAVINST 5000.2. This Navy instruction provides the criteria that must be met for an aircraft to be certified as being ready for OPEVAL. One of the criteria states that "for aircraft programs, there are no unresolved Board of Inspection and Survey Part I (*) or Part I (**) deficiencies.[5]" Further elaboration of this point is contained in the Board of Inspection and Survey's implementing instruction (INSURVINST 13100.1E), which states that "in general, systems with Part I (**) and Part I (*) deficiencies will not be recommended for OPEVAL." We conservatively applied these criteria and included only those deficiencies identified as Part I (**) in our report. DOD's comments on our draft report did not segregate the 84 E/F major deficiencies into these deficiency categories. In addition, the Navy considers 50 of the 84 deficiencies to be resolved based on the existence of a correction plan. The remaining 34 major deficiencies apparently have not yet been resolved to that point. We believe DOD's comments validate the OPEVAL Preparedness Team's conclusion stated in our report that beginning OPEVAL without correcting these deficiencies results in a medium risk that the E/F will not successfully complete OPEVAL.

Separate from DOD's comments, the Navy provided information on its efforts to correct some of the major unresolved deficiencies identified during testing of the E/F aircraft. Essentially, the Navy commented on its plans to incorporate corrections of these unresolved deficiencies.

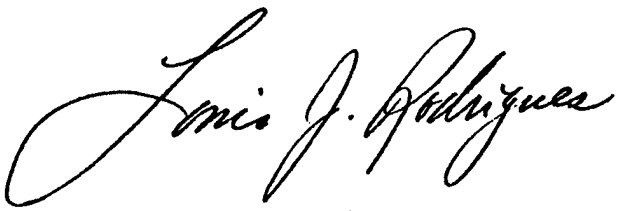
[5]Part I (**) deficiencies are defined as those where there is a high probability that the deficiency will cause aircraft control loss, equipment destruction, or injury. Part I (*) deficiencies are defined as those that would cause excessive operator compensation to accomplish the primary or alternate mission.

However, those plans do not alter our position that multiyear funding should not be approved for the F/A-18E/F program until these corrections of deficiencies have been incorporated into the aircraft and successfully tested.

We conducted our review from September 1998 through June 1999 in accordance with generally accepted auditing standards. Our objectives, scope, and methodology are included in appendix II. DOD's comments are reprinted in appendix III.

We are sending copies of this report to the Honorable William Cohen, Secretary of Defense; the Honorable Richard Danzig, Secretary of the Navy; and the Honorable Jacob Lew, Director, Office of Management and Budget. Copies will also be made available to others on request.

Please contact me at (202) 512-4841 if you or your staff have any questions concerning this report. The major contributors to this report were Steven Kuhta, Jerry Clark, Stacy Edwards, and Charles Burgess.



Louis J. Rodrigues
Director, Defense Acquisitions Issues

List of Congressional Committees

The Honorable John W. Warner
Chairman
The Honorable Carl Levin
Ranking Minority Member
Committee on Armed Services
United States Senate

The Honorable Ted Stevens
Chairman
The Honorable Daniel K. Inouye
Ranking Minority Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Floyd D. Spence
Chairman
The Honorable Ike Skelton
Ranking Minority Member
Committee on Armed Services
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The Honorable Jerry Lewis
Chairman
The Honorable John P. Murtha
Ranking Minority Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

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Abbreviations

DOD	Department of Defense
FPQ	Full Performance Qualification
OPEVAL	operational test and evaluation
OPTEVFOR	Operational Test and Evaluation Force

Major F/A-18E/F Deficiencies Identified During OT-IIB

The OT-IIB report listed 29 major deficiencies in the F/A-18E/F. The following discusses the deficiencies and their impact on the aircraft's ability to perform its missions. Our list does not total 29 deficiencies because we combined closely related deficiencies. We extracted the information from unclassified deficiency reports prepared by the Integrated Test Team.

Poor climb performance above 30,000 feet. The F/A-18E/F's best climb performance was in the low 30,000-foot range, with intermediate power. Although higher altitudes may have been possible, the climb rate was too slow to be useful in most tactical scenarios. Performance predictions indicate that combat and tactical ceilings for the newer F/A-18Cs (Lot XIX) are greater than that of the F/A-18Es when the aircraft are similarly loaded with weapons and fuel tanks. The E/Fs low tactical ceiling reduced the mission effectiveness of the aircraft when in the fighter escort configuration against high, fast-flying enemy aircraft by limiting the regions where the E/F could effectively launch its air-to-air missiles.

Low acceleration. The E/F's maximum level flight airspeed was determined to be less than both the F/A-18C and other threat aircraft in similar fighter configurations at all investigated altitudes. This deficiency reduced the E/F's effectiveness against high, fast-flying aircraft and provided insufficient airspeed when the E/F was attempting to exit a combat situation.

Airframe buffet. The magnitude of buffet has been described as moderate to heavy. At higher levels, the aircraft shakes to the extent that the heads-up displays appear to vibrate. The displays remain readable but are blurred slightly and legibility is somewhat degraded. During some turns at subsonic speed and low altitude, buffet forces the pilot to divert significant attention to maintaining the desired flight path, and combat effectiveness decreases as a result. During some landings, buffet has been heavy enough to be interpreted as an aircraft malfunction. Heavy airframe buffet during catapult launches would result in dramatic increases in the required wind-over-deck for high gross weights, thereby restricting operational capability.

Inadequate high angle of attack agility and controllability. The time required to reverse the aircraft from a nose high to a nose low position took significantly longer than desired and prevented the aircraft from dominating aggressive positions during fights. The aircraft frequently gained the offensive advantage but lost the advantage during the reversal

from nose high to nose low. As a result, mission effectiveness would be reduced and aircraft loss is possible.

Slow response to control inputs, slow loaded energy addition rate, and excessive speed loss during air combat maneuvering. Air combat maneuvering placed the aircraft in the high angle of attack/low airspeed flight regime. To maintain a tactical advantage, the pilots tried to increase the airspeed by reducing the angle of attack. Pilots noted that reducing the angle of attack to the desired level took an unacceptable amount of time in regaining airspeed. As a result of the loss of airspeed, the pilots would lose the advantage during air combat maneuvering, resulting in reduced tactical utility and possible loss of aircraft and aircrew during actual air combat.

Tactically ineffective sustained turn rate. The current performance data indicate that the aircraft might not meet the F/A-18E specification requirement in this area. This would result in a potential reduction in performance during combat turns.

Insufficient cooling capacity for seekers on air-to-air weapons. The current nitrogen bottle will not cool the seekers on air-to-air weapons for the duration of a combat air patrol mission. It is possible to delay cooling the missiles until the aircraft enters a threat area, but this is operationally unacceptable. The bottles will have to be changed after every flight because of their short life. However, changing the bottles requires the E/F's wings to be unfolded on the carrier deck. This would delay deck operations and the availability of the aircraft to conduct its next flight (carrier cycle time).

Improper indication of direction of arrival of oncoming threat systems. The ALR-67 (V)3 radar warning receiver's left/right discrimination is inadequate. While evaluating air-to-air tactics during one-on-one intercepts, the radar warning receiver angle of arrival at times significantly disagreed with actual target locations. On a number of occasions, the actual target location was on one side of the aircraft nose, and the displayed direction of arrival was on the other side. The difference was, at times, substantial. Poor radar warning receiver direction of arrival information would result in degradation of situational awareness and poor aircrew defensive reaction. This would lead to loss of tactical advantage and might result in loss of aircraft and aircrew.

Damage to AIM-9 missile assemblies caused by wing tip environment. Structural failure of AIM-9 Sidewinder hanger on the wing tip stations

could result in damage to the missile and launcher or an increase in required aircraft maintenance. If undetected, the missile damage would result in hazardous separation and/or decreased missile effectiveness. AIM-9 missile hanger failure might be the result of the F/A-18E/F's severe wing tip environment.

ALE-50 tow line burn-off in afterburner. During in-flight evaluation of the ALE-50, decoys and associated towlines were severed when engine afterburners were engaged. Towlines typically failed within seconds of afterburner initiation, which will occur during missile defense and air combat maneuvering. This deficiency would result in the loss of active electronic countermeasures protection and would directly increase the threat to aircraft and crew during enemy missile attacks.

Difficulty in maintaining lateral trim. The aircraft did not readily maintain lateral trim without frequent pilot inputs. The failure of the airplane to maintain lateral trim was not associated with any particular maneuver but rather a variety of maneuvers throughout the flight envelope. This condition would significantly increase the pilot's workload, distracting him/her and severely degrading the performance of more critical mission tasks.

Under-wing environment damages aircraft stores. Damage has been discovered on numerous stores (attachments and ordnance) carried beneath the aircraft's wings. The damage is the result of the noise and vibration beneath the wings. Failure of items carried underneath the wings could result in loss of or damage to the aircraft and/or loss of mission capability.

Unsafe delivery of Rockeye bomb. Clearance was insufficient when the Rockeye bomb was carried on the inboard wing station and the Tactical Forward Looking Infrared Radar was carried on the aircraft's fuselage station. This close proximity is not compatible with safe separation requirements.

Aircraft radar deficiency. The APG-73 radar, new to the aircraft, was slow to lock onto a target during air combat maneuvering. Delayed and unreliable radar acquisitions would result in lost first-shot opportunities and in delayed time to kill, which reduces tactical performance and survivability.

Leading edge extension difficulties. Footing on the leading edge extension was not secure during cockpit ingress/egress. As a result of the small

walkway and steep slope of the leading edge extension and inadequate traction, the aircrew or maintenance personnel could slip off the aircraft during cockpit ingress/egress and experience serious injury.

Inconsistent brake effectiveness. Braking performance was noticeably inadequate during landings by aircraft returning to the carrier without weapons. The primary turnoff was missed and the secondary turnoff was narrowly made. Poor, degraded, or unpredictable braking performance would result in longer landing rollout, turnoff overshoot, and decreased braking sensitivity for ground handling/positioning. Inability to stop the aircraft reliably could result in an aborted landing attempt or injury to ground personnel during aircraft positioning on the flight line or flight deck.

Inadequate cooling capability of the fuel thermal management system. During several missions flown on hot days, test aircraft experienced "FUEL HOT" cautions either shortly after takeoff or prior to mission completion. The "FUEL HOT" conditions resulted in the inability of the fuel to cool the aircraft's fluids that cool the radar and other aircraft systems. In-flight "FUEL HOT" cautions could result in premature mission abort, degraded cooling of accessories such as the radar and hydraulics, and reduced reliability/life of engine management systems.

Targeting Forward Looking Infrared Radar deficiencies. Aircrew determined that as a result of resolution and magnification deficiencies with the aircraft's Targeting Forward Looking Infrared Radar, they could not classify air-to-air and air-to-ground targets. Aircrew would have difficulty quickly and accurately designating a discrete target. Additionally, target identification would require excessive head-down time, during which the weapon system operator would be unable to scan the electronic warfare display and look outside the aircraft for potential threats.

Objectives, Scope, and Methodology

Our objectives were to (1) determine the extent to which the F/A-18E/F is meeting performance requirements, (2) identify risks associated with proceeding into operational test and evaluation (OPEVAL) with unresolved deficiencies, and (3) identify potential cost increases and risks associated with approving the Navy's request for multiyear funding for the program.

To determine whether the program was meeting performance requirements, we compared contractor and program management performance measurements and projections with the five key performance improvements over current F/A-18s that the F/A-18E/F was intended to provide. We also reviewed contractor and Navy comparisons of the aircraft's current performance relative to the development contract specifications and to key performance parameters established in the Navy's F/A-18E/F Operational Requirements Document. Additionally, we reviewed reports on the limited operational assessments conducted in November 1997 (OT-IIA) and from June through August 1998 (OT-IIB) to identify the measured performance of the F/A-18E/F relative to numerous critical operational issues and to existing F/A-18s.

We also interviewed officials in the Navy's Operational Test and Evaluation Force responsible for conducting the operational assessments, including the test pilots who flew the operational tests, to obtain their assessment of the aircraft's current and potential performance as well as its performance compared to current F/A-18s.

To identify risks associated with proceeding into OPEVAL with unresolved deficiencies, we reviewed documents prepared by the Program Risk Advisory Board and the OPEVAL Preparedness Team. These documents and interviews identified operational performance deficiencies that the operational testers, the Advisory Board, and the OPEVAL Preparedness Team concluded could adversely affect the F/A-18E/F's probability of successfully completing OPEVAL, which is to be conducted from May through November 1999.

To identify potential cost increases and risks associated with approving the Navy's request for multiyear funding for the program, we analyzed reports and other program documents prepared by contractor and Navy officials responsible for tracking program costs. Regarding the multiyear funding request, we analyzed the Navy and the contractor lists of aircraft deficiencies and assessed their impact relative to the criteria that must be met to obtain multiyear funding—significant savings, a stable system

design, an adequately validated requirement, and a commitment to stable funding over the life of the contract.

Comments From the Department of Defense

Note: GAO's comment supplementing those in the report text appear at the end of this appendix.

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ACQUISITION AND TECHNOLOGY

'1 2 MAY 1999

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, "DEFENSE ACQUISITIONS: Progress of the F/A-18E/F Engineering and Manufacturing Development (EMD) Programs," dated April 13, 1999 (GAO code 707373). The department does not concur with the recommendations in the draft report (Enclosure).

The draft report provides the GAO's perspective on a number of issues involving the F/A-18E/F EMD program which is not consistent with the information provided by the Navy during the investigative period. Each of these issues is addressed in detailed comments provided separately.

The crux of the draft report and Conclusions and Recommendation comes down to three issues: the GAO states that: (1) the F/A-18F is not meeting its interdiction range requirement; (2) the number and type of deficiencies noted during previous testing will pose a significant challenge to passing the operational evaluation (OPEVAL); and (3) the F/A-18E/F design configuration is not stable, and entry into a multi-year funding should be delayed.

See comment 1.

Someone unfamiliar with the background of the F/A-18E/F program might assume from the statement, "the F/A-18F is not meeting the interdiction range requirement - a primary justification for the program," that there is a serious deficiency in the program. In actuality, the F/A-18F's interdiction range, when configured as specified and using an afterburner takeoff, is only 3 nautical miles short of the 390 nautical mile requirement. The original interdiction range requirement was established for the F/A-18E, which easily exceeds the requirement. It has been known for years that because a separate interdiction range was never included in the Operational Requirements Document for the F/A-18F, and the fact that the F/A-18F's fuel capacity is reduced by the second cockpit, the F/A-18F range will always be somewhat less than that of the F/A-18E. The F/A-18F's range is somewhat less than anticipated because of the difference between early engine model estimates and actual engine performance data.

The Navy is following the deficiency resolution process defined in SECNAVINST 5000.2. If the F/A-18E/F is compared with any other tactical aircraft development program, current or past, it will be seen as remarkably free of serious deficiencies at this stage of development. This is due in part to applying lessons learned from over three million F/A-18A/B/C/D flight hours having been applied to the design of the F/A-18E/F, giving it a maturity at 4,600 flight hours superior to any previous development program. Compared to the F/A-18A/B aircraft, the F/A-18E/F has significantly fewer unresolved major deficiencies, 316 vs. 84, respectively, as it enters OPEVAL. Of the 84 deficiencies, 50 have roadmapped solutions and funding. This has contributed to the assessment that the risk to successfully completing OPEVAL is acceptable.

From the outset of the F/A-18E/F program, affordability has been an overriding consideration. For this reason, multi-year procurement has been planned to begin with the first full-production buy, resulting in a savings to the program of over $700 million. The GAO recommends that multi-year contracting be delayed until the deficiencies noted during developmental and operational testing have been resolved. However, the deficiencies noted to date are not serious enough to warrant delaying the multi-year contract.

The EMD test phase provided the opportunity to refine the F/A-18E/F design. We will continue to enhance it for the next 20 years, as we have done in the case of the F/A-18A/B/C/D, the F-14, and the A-6 before it. The Super Hornet configuration is mature and stable. Multi-year procurement will let the Department of Defense buy Super Hornets in the most efficient manner.

Thank you for the opportunity to comment on the draft report.

Sincerely,

George R. Schneiter
Director
Strategic and Tactical Systems

Enclosure

GAO DRAFT REPORT, Dated April 13, 1999
(GAO Code 707373) OSD Case 1791

"DEFENSE ACQUISITIONS: Progress of the F/A-18E/F Engineering and Manufacturing Development Programs"

DOD COMMENTS ON THE GAO RECOMMENDATION

- RECOMMENDATION 1: Given the uncertainty surrounding the F/A-18E/F's final design and that not all deficiencies will be corrected and tested as part of Operational Test and Evaluation (OPEVAL), the GAO recommended that the Secretary of Defense reconsider the Navy's request for multi-year funding for the program until all corrections of deficiencies have been incorporated into the aircraft design and successfully tested.

- DOD RESPONSE: Nonconcur. There are no deficiencies currently identified that would require a major redesign of the aircraft or are serious enough to warrant not awarding a multi-year contract. Thus we conclude that the design of the F/A-18E/F is stable, and the program is ready to enter into a multi-year procurement.

The following is our comment on the Department of Defense's (DOD) letter dated May 12, 1999.

GAO Comments

1. DOD's statement that a separate interdiction range requirement for the F/A-18F was never included in the Operational Requirements Document is not accurate. An interdiction range requirement of 390 nautical miles for both the E and F model aircraft was included in the final Operational Requirements Document dated April 1, 1997.