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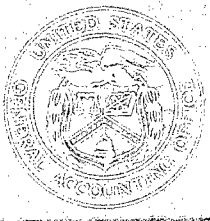
Report to Congressional Committees

September 1997

ELECTRONIC WARFARE

Towed Decoys Could Improve Survivability of Current Navy Aircraft



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GAO

United States
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National Security and
International Affairs Division

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Congressional Committees

We have completed our review of the Department of Defense's (DOD) acquisition plans for the ALE-50 towed decoy system and the Radio Frequency Countermeasures System (RFCM), which includes a more advanced towed decoy. The RFCM is part of the Integrated Defensive Electronics Countermeasures System being developed for some Navy and Air Force aircraft. Our objective was to determine whether towed decoys could improve the survivability of these aircraft. In addition, because Congress has expressed concern for F/A-18C/D survivability, we are issuing this report to bring to your attention the opportunity towed decoy systems offer to potentially enhance survivability of the F/A-18C/D.

Results in Brief

DOD's effort to improve the survivability of its aircraft through the use of towed decoys has demonstrated positive results. According to test reports and test officials, the ALE-50 has done very well in effectiveness testing and the future RFCM decoy system is expected to be even more capable. The Air Force is actively engaged in efforts to field towed decoy systems on a number of its current aircraft, including the F-15, F-16, and B-1, while the Navy is planning towed decoys only for its future F/A-18E/F.

In the year 2010, almost 50 percent of the Navy's tactical fighter inventory will still be current generation fighter aircraft such as the F/A-18C/D, even if new F/A-18E/Fs are procured at the rates desired by the Navy between now and then. Hence, improving the survivability of the F/A-18C/D, as well as other current Navy and Marine Corps aircraft, potentially offers the opportunity to save additional aircraft and aircrew's lives in the event of future hostilities and also addresses congressional concerns expressed for F/A-18C/D survivability.

Background

Traditionally, DOD's combat aircraft have used on-board electronic warfare devices called jammers for self-protection against radar-controlled weapons, including missiles and anti-aircraft artillery. These jammers emit electronic signals from the aircraft to try to impede or deny the threat radar's ability to locate the aircraft. DOD's existing self-protection jamming systems for its tactical aircraft have limitations against certain threats, and these threats are expected to be improved. DOD has modified existing systems, such as the Air Force's ALQ-131 used on the F-16 and the

ALQ-135 on the F-15, and has developed a newer system, the Navy's Airborne Self-Protection Jammer (ASPJ), which is being used on some F-14D and F/A-18C/D aircraft. As we have previously reported, however, testing after deployment has shown that the modified jammer systems have had problems,[1] while operational testing of ASPJ and other jammers showed they were unable to meet effectiveness criteria against certain classified threats.[2]

In an attempt to overcome the limitations of the on-board jammers, the services are acquiring two new towed decoy systems, the ALE-50 and the RFCM, to enhance survivability against the radar-controlled threats. The ALE-50 towed decoy system is in production, while the future RFCM system is in development. The ALE-50's towed decoy component generates and emits its own signals that are intended to lure an incoming radar-guided weapon away from the aircraft by presenting a more attractive target. To provide further improvement for selected Air Force and Navy aircraft, the RFCM is to provide more sophisticated techniques than the ALE-50. A jamming device called the techniques generator carried onboard the aircraft produces jamming signals that are transmitted by fiber optic cable to the RFCM decoy for transmission.

Both decoys are single use systems. Once deployed from the aircraft, the decoy's tow line is severed prior to return to base. Each aircraft is to carry multiple decoys, so if one is destroyed by enemy fire or malfunctions, another can be deployed. Therefore, substantial inventories of decoys are required to sustain potential combat operations. The services expect that these decoys will improve survivability of their aircraft against radar-controlled threats compared to the current technique of emitting the jamming signals directly from the aircraft.

Towed Decoys Can Enhance Survivability

Classified test results show that the ALE-50 towed decoy offers improved effectiveness against radar-controlled threats, including some threat systems against which self-protection jammers have shown little to no effectiveness.[3] Moreover, the future RFCM decoy system is expected to further improve survivability due to its more sophisticated jamming techniques.

[1]Electronic Warfare: Need to Strengthen Controls Over Air Force Jammer Programs (GAO/NSIAD-90-168, July 11, 1990) and Electronic Warfare: Most Air Force ALQ-135 Jammers Procured Without Operational Testing (GAO/NSIAD-95-47, Nov. 22, 1994).

[2]Airborne Self-Protection Jammer (GAO/NSIAD-97-46R, Jan. 29, 1997.)

[3]Performance against specific threat systems is considered classified.

Recognizing the potential offered by these towed decoy systems to overcome the limitations of using just on-board jammers, such as the ASPJ, the Air Force is actively pursuing the use of towed decoys for its current aircraft. It has done the necessary modifications to add the ALE-50 to the F-16, an aircraft slightly smaller than the Navy's F/A-18C/D, and to the B-1, a much larger aircraft. The Air Force is also considering use of the RFCM decoy system on the F-15, which will use its existing on-board jammer instead of the techniques generator, and on the B-1, as well as several other aircraft. The Navy plans to equip only its future F/A-18E/F aircraft with a decoy system.

The ALE-50 decoy system is to be used by the Air Force on 437 F-16 and 95 B-1 aircraft. In addition to the ALE-50 components such as the launcher and controller installed on the aircraft, the Air Force plans to procure 17,306 ALE-50 decoys to meet operational requirements. The Navy plans to buy 466 ALE-50 decoys. These will be used for F/A-18E/F testing and contingencies after the aircraft's deployment until the RFCM decoy is available. The ALE-50 program cost is estimated at about $1.2 billion.

The Navy's estimated RFCM cost for its F/A-18E/F aircraft is about $2.6 billion. The Navy's plan is to procure enough RFCM systems and spares to equip and support 600 of its planned buy of 1,000 F/A-18E/F aircraft. For 600 F/A-18E/F aircraft, the number of decoys to be procured to meet operational needs is 18,000. (These estimates predate the May 1997 decision of the Quadrennial Defense Review (QDR) to recommend a reduction in the number of F/A-18E/Fs.)

The future RFCM decoy system is also being considered by the Air Force for its B-1 aircraft, part of its F-15 fleet, and several other Air Force manned and unmanned aircraft. If the Air Force buys the RFCM system for the B-1 and the F-15, which would use its existing onboard jammer instead of the RFCM techniques generator, the estimated cost, including 9,107 decoys, is about $574 million.

Current Navy Aircraft Will Not Be Provided With Towed Decoys

In contrast with the Air Force, which intends to use decoys to improve the survivability of its current aircraft, current Navy combat aircraft will be at a comparative survivability disadvantage since they will not be provided with a decoy system. In particular, because F/A-18E/Fs will not be replacing all of the C/D models in the Navy/Marine Corps inventory in the foreseeable future, adding a towed decoy system to the F/A-18C/D

potentially offers the opportunity to save additional aircraft and aircrew's lives in the event of hostilities.

In the year 2010, more than 600 of the Navy's tactical fighter inventory objective of 1,263 aircraft will still be current generation fighters such as the F/A-18C/D. This will be true even if F/A-18E/Fs are procured at the Navy's desired rates of as high as 60 per year. At the post-QDR suggested rate of 48 per year, almost 50 percent of the current generation aircraft will still be in the fleet in the year 2012.

DOD and the Navy have done studies to determine whether towed decoys could improve the survivability of the F/A-18C/D. DOD's Joint Tactical Electronic Warfare Study and an analysis conducted by the Center for Naval Analyses concluded that the addition of a towed decoy system to the F/A-18C/D would provide a greater increase in survivability for that aircraft than any jammer, including the ASPJ.

In limited flight testing on the F/A-18C/D, the Navy demonstrated the ALE-50 decoy could be deployed from either a wing station or the centerline station of the aircraft. While the Navy acknowledges that towed decoys can enhance aircraft survivability, it does not consider these flight tests to have been successful because of the following suitability concerns. According to the Navy (1) the tow line can come too close to the horizontal tail or the trailing edge flap when deployed from a wing station, making it unsafe or (2) the tow line can be burned off by the engine exhaust or separated by abrasion if deployed from the centerline station.

The Navy's report on the wing station testing stated that tow line oscillation led to lines breaking on several flights, but did not state that the decoy system was a flight safety risk nor that there was any contact with the horizontal tail or flaps. Concerning the centerline station tests, several tow lines were burned off or otherwise separated from the aircraft by abrasion during maneuvering flights. A reinforced tow line later solved these problems and the Navy is continuing testing on the F/A-18C/D from the centerline station. Based on these test results, the Navy now intends to deploy the ALE-50 decoy from the centerline of the fuselage of the F/A-18E/F.

The Navy also maintains that even if the decoy could be successfully deployed from the F/A-18C/D wing or centerline station, for actual operations, it could not afford to trade a weapon or fuel tank on a wing or centerline station for a towed decoy system. Further, the Navy considers

modification of the C/D model's fuselage for internal carriage of the decoy to be unaffordable due to volume, weight, power, and cooling constraints that would have to be addressed.

The Air Force has modified a wing pylon to successfully deploy towed decoys from the F-16's wing while avoiding major aircraft modifications and without sacrificing a weapons station or a fuel tank. The Navy, however, has not done the technical engineering analyses to determine the specific modifications necessary to accommodate a towed decoy on the F/A-18C/D either from the wing or the centerline without affecting the carriage capability unacceptably.

Survivability of F/A-18 Aircraft Has Been a Congressional Concern

Congress has expressed concerns regarding F/A-18C/D survivability. The Report of the Senate Appropriations Committee on the National Defense Appropriations Act for Fiscal Year 1997 directed the Navy to report on the advantages and disadvantages of using various electronic warfare systems to improve F/A-18C/D survivability. In addition, Congress provided $47.9 million in fiscal year 1997 funding not requested by DOD to buy 36 additional ASPJs for 3 carrier-deployed squadrons to meet contingency needs.

The Navy could have addressed the congressional concern for C/D survivability in the required report by including analysis of the improvement offered by incorporating the ALE-50 and RFCM towed decoy systems. In completing the required report, however, the Navy did not include any analysis of survivability benefits from using towed decoys because it maintains, as described above, that there are unacceptable impacts associated with towed decoys on the F/A-18C/D.

Agency Comments and Our Evaluation

In commenting on a draft of this report, DOD agreed that towed decoy systems could enhance aircraft survivability, but stated the Navy had conducted an engineering analysis that concluded any installation option of a towed decoy on the F/A-18C/D has unacceptable operational and/or safety of flight impacts. In response to our request for this analysis, the Navy provided us with a paper discussing the feasibility of installing a towed system on the F/A-18C/D. This paper concluded that the options considered had risks or created operational concerns but did not conclude that these options were unacceptable. Furthermore, the paper did not consider all possible options.

With regard to the safety of flight issue, the Navy stated that the decoy or towline might contact aircraft control surfaces such as the flaps or the horizontal stabilizers if deployed from a wing station. The Navy's summary of wing station test results, however, does not show any evidence of such contact. The Navy has expressed no concern about a safety of flight issue when deploying the decoy along the aircraft's centerline and continues to fly test missions with the towed decoy, deploying it from a pod on the centerline of an F/A-18D aircraft. Furthermore, the Navy intends to install the system in the fuselage and deploy towed decoys from the centerline of the E/F model aircraft. In addition, the Air Force incorporated the ALE-50 on to the F-16 without loss of a weapon station or fuel tank and without having to undertake major aircraft modifications, demonstrating that it is possible to adapt a towed decoy system to an existing aircraft without creating unacceptable tactical impacts.

DOD did not concur with the recommendations that were set forth in a draft of this report. In the draft, we had suggested that (1) in preparing its congressionally required report, DOD consider F/A-18C/D aircraft upgraded with RFCM and ALE-50 towed decoy systems and (2) the Navy do the necessary engineering analyses of the modifications needed to integrate towed decoys into F/A-18C/D and other current Navy aircraft. DOD completed the congressionally required report without implementing our first draft recommendation. We continue to believe, however, that the Navy needs to explore ways to improve the survivability of its current aircraft and, therefore, should do a detailed engineering analysis of the modifications needed to adapt the towed decoy to the F/A-18C/D. DOD's comments are reprinted as appendix I in this report.

Recommendation

We recommend that the Secretary of Defense direct the Secretary of the Navy to make a detailed engineering analysis of the modifications needed to adapt the towed decoy to the F/A-18C/D.

Matters for Congressional Consideration

In light of the demonstrated improvement in survivability that analyses and test results indicate towed decoy systems can provide, and recognizing that in the year 2010 almost 50 percent of the Navy's tactical fighter inventory will still be current generation fighter aircraft such as the F/A-18C/D, Congress may wish to direct the Navy to find, as it has done for its F/A-18E/F and the Air Force has done for the F-16, cost-effective ways to improve the survivability of its current aircraft.

Scope and Methodology

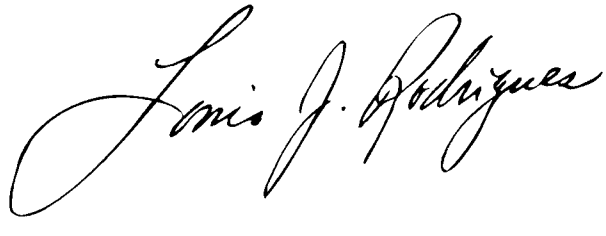
To accomplish our objective of determining whether towed decoys could improve survivability of Air Force and Navy aircraft, we examined DOD and contractor analyses of adding towed decoy systems and reviewed Air Force and Navy ALE-50 test results from testing on a variety of aircraft. We interviewed officials from the Office of the Secretary of Defense, the Navy, and the Air Force involved in the acquisition and testing processes of towed decoy systems. We also interviewed contractor personnel involved in the development, integration, and/or production of towed decoy systems.

We performed our work at the Offices of the Secretaries of Defense, the Navy, and the Air Force; F-15, F-16, and B-1 System Program Offices at the Air Force Material Command, Wright-Patterson Air Force Base, Ohio; F/A-18 and Tactical Air Electronic Warfare Program Offices at the Program Executive Office for Naval Tactical Aviation, Naval Air Systems Command, Washington, D. C.; the 53rd Wing and Air Force Operational Test and Evaluation Detachment, Eglin Air Force Base, Florida; and selected contractor locations, including McDonnell-Douglas Aircraft, Lockheed-Martin, and Rockwell International.

We performed our review from February 1996 to July 1997 in accordance with generally accepted government auditing standards.

We are sending copies of this report to the Secretaries of Defense, the Navy, and the Air Force; the Director, Office of Management and Budget; and other congressional committees. We will make copies available to others upon request.

Please contact me on (202) 512-2841, if you or your staff have any questions concerning this report. Major contributors to this report are listed in appendix II.



Louis J. Rodrigues
Director, Defense Acquisitions Issues

Congressional Addressees

The Honorable Strom Thurmond
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
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Committee on Appropriations
United States Senate

The Honorable Floyd D. Spence
Chairman
The Honorable Ronald V. Dellums
Ranking Minority Member
Committee on National Security
House of Representatives

The Honorable C.W. Bill Young
Chairman
The Honorable John P. Murtha
Ranking Minority Member
Subcommittee on National Security
Committee on Appropriations
House of Representatives

The Honorable Richard C. Shelby
Chairman
The Honorable J. Robert Kerrey
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Select Committee on Intelligence
United States Senate

The Honorable Porter J. Goss
Chairman
The Honorable Norman D. Dicks
Ranking Minority Member
Permanent Select Committee on Intelligence
House of Representatives

Comments From the Department of Defense

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

ACQUISITION AND TECHNOLOGY

OFFICE OF THE UNDER SECRETARY OF DEFENSE

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WASHINGTON DC 20301-3000

May 5, 1997

Mr. Louis J. Rodrigues
Director, Defense Acquisition Issues
National Security and International
Affairs Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Rodrigues:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "ELECTRONIC WARFARE: Towed Decoys Could Improve Survivability of Current Navy Aircraft," dated March 13, 1997, (GAO Code 707143/OSD Case 1314). The Department partially concurs with the report.

The Department agrees that the use of towed decoys could enhance the F/A-18C/D survivability, if they could be successfully integrated onto the aircraft. However, the Department does not agree that even a successful integration of an AN/ALE-50 or the IDECM towed decoy onto the F/A-18C/D makes its survivability comparable to that of an F/A-18E/F.

See comment 1.

The F/A-18E/F Low-Rate Production Decision was made on March 26, 1997. This decision was based on many items including the increased military worth and operationally required warfighting and survivability enhancements that the F/A-18E/F provides over the F/A-18C/D, see Enclosure 1. In addition, the GAO report's assumptions and resulting conclusions fail to recognize the high degree of difficulty of installing and integrating an AN/ALE-50 onto an F/A-18C/D, the potential to jeopardize aircraft flight safety, and the unacceptable tactical impacts, see Enclosure 2.

See comment 2.

The Department nonconcurs with the recommendation in the report. Installing an AN/ALE-50 or the IDECM towed decoy onto the F/A-18C/D does not make its survivability comparable to that of an F/A-18E/F. The Navy has completed the engineering analysis to integrate towed decoys onto the F/A-18C/D, and that information was provided to the GAO. The analysis concluded that any installation option of a towed decoy on the F/A-18C/D has unacceptable operational and/or safety of flight impacts.

See comment 1.

See comment 3.

The detailed DoD comments on the draft report were provided to the GAO under separate cover.

The DoD appreciates the opportunity to comment on the draft report.

Sincerely,

George R. Schneiter
Director
Strategic and Tactical Systems

Enclosures

See comment 1.

F/A-18E/F – ESSENTIAL WARFIGHTING AND SURVIVABILITY ENHANCEMENTS

Electronic Warfare (EW) is just one element comprising F/A-18E/F's survivability advantage over the C/D. Using attrition as a metric for survivability, other critical elements for increased survivability and military worth include:

- Reduced radar cross section (RCS)
- Reduced vulnerable area
- Increased range/endurance
- Increased weapons loads and flexibility with added pylons
- Improved bring back capability
- Improved situational awareness

F/A-18E/F has a radar cross section (RCS) reduced an order of magnitude when compared to the F/A-18C/D. This RCS reduction allows the E/F to penetrate further into a SAM envelope before detection; enhances by the screening effect of an EA-6B; improves the effectiveness of an on-board jammer or towed decoy; and forces an opponent to have a shorter engagement range.

F/A-18E/F has a reduced vulnerable area when compared to the F/A-18C/D which was achieved through added wing hardening, added wing-tank foam, a dry-bay fire suppression system, a stabilized fault-management system, and relocated environmental control system line routing. These enhancements reduce the probability of aircraft loss given nearby missile detonation.

The F/A-18E/F air wing has greater flexibility through increased range, additional load out flexibility, mission route planning options, and regaining organic tactical mission tanking closer to the target. In addition to increased internal fuel over the C/D, the additional weapons stations provide the flexibility to carry more fuel tanks when required, increasing tactical range or mission route planning flexibility without sacrificing strike weapons.

The larger bring back capability (9000 pounds for E/F vs less than 6000 pounds for C/D) permits return of expensive weapons to the carrier rather than jettisoning them when they are not required during the mission. The two additional weapons stations permit the carriage of more self-protection weapons, such as AMRAAM and HARM, plus precision guided munitions such as JSOW and JDAM.

The F/A-18E/F incorporates a new crew station display, the Up-Front Control Display. This new display adds to the F/A-18E/F's survivability advantage by providing the pilot with increased situational awareness.

Enclosure 1

See comment 2.

See comment 2.

See comment 2.

See comment 4.

See comment 3.

ALE-50 – UNSUITABLE FOR INTEGRATION ONTO F/A-18C/D

GAO asserts that demonstrations have shown ALE-50 could potentially be deployed from either wing stations or the centerline of the F/A-18C/D aircraft (GAO report page 7, para 1). As pointed out in the February 1997 report to congress, "There are severe volume, weight, power, and cooling provisions and especially aircraft aerodynamics issues with installing a towed device (ALE-50 or IDECM RFCM off-board device) into the F/A-18C/D." {F/A-18C/D ELECTRONIC WARFARE SUITE ALTERNATIVES, February 1997, p. 1.} Technical analysis includes flight tests and engineering work dating back to the Desert Storm (1991) time frame.

Flight tests of the ALE-50 decoy on the F/A-18C/D were conducted. In summary, wing station deployment of the ALE-50 decoy created a flight safety risk due to decoy and tow line interference with the aircraft's control surfaces and the aerodynamic instability of the decoy induced by aircraft vortices. Decoy/tow line deployed from wing stations interfered with either the trailing edge flap or the horizontal tail. The wing tip stations are unsuitable for ALE-50 installations because of wing tip vortices. Deployment from the centerline station resulted in decoy burn-off from the engine exhaust and abrasion with the aircraft due to the centerline station's forward location on the aircraft.

The ALE-50 installation on the F/A-18C/D also impacts three critical operational mission parameters. The ALE-50 installed on either the wing stations or centerline station results in the loss of a weapons station or the loss of a 330-gallon fuel tank,thereby impacting the aircraft's combat range. The ALE-50 also reduces the carrier bring-back by about 220 pounds.

Extensive engineering analysis has yielded no suitable alternative for internal installation of a decoy system. F/A-18C/D ALE-50 flight testing at Patuxent River and an installation feasibility study developed by McDonnell Douglas Aerospace summarize the deficiencies in aircraft provisions and some of the design challenges of integrating ALE-50 onto the F/A-18C/D. As noted in the report to congress, "Integration of the off-board option is considered high risk as allocation of sufficient space, power, and cooling for the Multi-Platform Launch Controller, the launcher, and the fiber optic lines are still major issues for either a fuselage or pylon installation." Removal or repackaging of other F/A-18C/D systems to make room for the ALE-50 system compromises warfighting capability,is complex,and incurs significant development costs. In contrast, the F/A-18E/F was designed to accommodate the ALE-50 system in its baseline.

Enclosure 2

GAO Comments

Following are our comments on the Department of Defense's (DOD) letter dated May 5, 1997.

1. Our draft report included references to the comparability of F/A-18E/F and C/D survivability, and it was provided to DOD for comment prior to the decision to produce the F/A-18E/F. As DOD states, this decision has now been made. Consequently, we have deleted references to the comparability of the F/A-18E/F and C/D models. The issue of F/A-18C/D survivability remains important, however, because E/F models will not replace all of the current C/D models in the inventory in the foreseeable future.

2. Test results for towed decoys on the F/A-18C/D and other information provided by DOD and the Navy do not support DOD's statements. The safety of flight issue, according to the Navy, arises from the concern that the decoy or towline might contact aircraft control surfaces such as the flaps or the horizontal stabilizers if deployed from a wing station. The Navy's summary of wing station test results does not show any evidence of such contact. According to the test report, the Navy did find that aircraft vortices behind the wing created aerodynamic instability in the towline, but the report does not conclude that this potentially jeopardized aircraft flight safety. Additionally, the Navy has expressed no concern about a safety of flight issue when deploying the decoy along the aircraft's centerline, and use of a reinforced towline appears to have eliminated the burnoff/abrasion problem. Thus, the Navy continues to fly test missions with the towed decoy, deploying it from a pod on the centerline of an F/A-18D aircraft, and intends to install the system in the fuselage and deploy towed decoys from the centerline of the E/F model aircraft. This evidence indicates that Navy concerns about a high degree of difficulty, and severe volume, weight, power, cooling, and aircraft aerodynamics issues associated with installing towed decoys may not be insurmountable.

As for unacceptable tactical impacts associated with towed decoy installation, the Air Force has overcome this problem on the F-16, and we presume that the Navy may also be able to find an integration solution for the F/A-18C/D that avoids unacceptable tactical impacts if it continues to pursue alternatives. The Navy did not abandon towed decoy installation for the F/A-18E/F because of early problems with abrasion and heat breaking the towline. Instead, it pursued alternatives. The solutions for the F-16 and F/A-18E/F do not have to be the only alternatives considered for the F/A-18C/D.

3. The Navy and DOD did provide us with additional information intended to bolster its broad assertion of unsuitability. However, the information provided was not an "engineering analysis" (implying a technical document of some depth), but is instead a rather superficial "installation feasibility study" that while identifying risk areas associated with installing the towed decoy on the F/A-18C/D does not conclude that all installation options have unacceptable operational and/or safety of flight impacts.

4. According to the Navy's feasibility study, 220 pounds is the weight of the towed decoy system mounted in a pod. According to the same study, if the system's launch controller is mounted in the aircraft's fuselage, the bring-back weight is reduced by only 140 pounds. In any case, since studies and test results indicate the ALE-50 system can provide significant improvements in survivability, the Navy needs to determine whether loss of a relatively small amount of bring-back weight is worth the increased risk of losing aircraft to radar-guided missiles.

Major Contributors to This Report

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