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Briefing Report to the Chairman,
Committee on Armed Services,
House of Representatives

July 1986

MISSILE DEVELOPMENT

Advanced Medium Range Air-to-Air Missile (AMRAAM) Certification Issues

Released

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The Honorable Les Aspin
Chairman, Committee on
Armed Services
House of Representatives

Dear Mr. Chairman:

This briefing report is in response to your October 1985 request that we review the status of the Advanced Medium Range Air-to-Air Missile (AMRAAM) program, particularly as it relates to the certification requirements in section 210 of the Defense Authorization Act, 1986. This is a follow-up to our February 18, 1986, report (GAO/NSIAD-86-66BR). As you know, the act required the Secretary of Defense to certify by March 1, 1986, that (1) the AMRAAM design is complete, (2) the system performance has not been degraded from the original development specification, (3) the maximum practical number of cost reduction design changes have been incorporated into the flight test program and qualified before production, (4) a fixed price contract not to exceed $556,580,480 has been entered into for research, development, test, and evaluation, (5) the total production cost for a minimum 17,000 missiles will not exceed $5.2 billion in fiscal year 1984 dollars, and (6) the missiles procured will perform in accordance with the development specification. The act states that the AMRAAM program shall be terminated if certification is not made.

On February 28, 1986, the Secretary of Defense certified to the Senate and House Committees on Armed Services those items that the act requires. Information was also provided that explained the basis on which the certification was made.

On March 11, 1986, our Deputy General Counsel testified on the AMRAAM certification before the Subcommittee on Procurement and Military Nuclear Systems of the House Committee on Armed Services. He stated that there is no legal basis to object to releasing the $54.4 million held in reserve pending the Secretary's certification solely because of disagreement with conclusions or judgments that the Secretary of Defense reached in executing the certification. He pointed out that our legal view regarding the Secretary's certification does not mean there are no longer any grounds for the concerns which led to the enactment of the certification requirement. He further stated that there continues to be uncertainties about the cost, schedule, and performance of the AMRAAM. On March 28, 1986, we issued a briefing report (GAO/NSIAD-86-88BR) to you on our legal views concerning the AMRAAM certification.

Our observations on the status of AMRAAM as it relates to each of the certification requirements are summarized below and discussed in more detail in the appendixes. Our review does not address the need for AMRAAM or its affordability.

DESIGN COMPLETION

The AMRAAM Program Manager and Air Force officials stated that the design is complete, based on the Critical Design Review (CDR). The CDR ensures that a design baseline is established for beginning detailed fabrication and production planning. Accordingly, the Program Manager believed the design was complete and ready to begin the next phase. The contractors stated that the design is essentially complete. Both the contractors and the Program Manager stated that design modifications will continue to be made as a result of fabrication, testing, and production.

Our review showed that a number of design changes have been made since the CDR and will continue to be made during development and testing.

A more reliable indicator of design completion would have been the Functional Configuration Audit. This audit validates that development of the missile system has been satisfactorily completed and achieves its performance and functional characteristics. It is scheduled to be completed by November 1986.

DEGRADATION OF PERFORMANCE SPECIFICATIONS

One performance parameter--the F-Pole--which was certified to by the Secretary as not being degraded, was changed. The F-Pole--a measure of the relative engagement range between a launch aircraft and its target--was reduced. The Joint Systems Program Office (JSPO) officials stated that this requirement could not be met without adversely affecting other parameters. They told us that the F-Pole parameter had been reduced before enactment of the certification legislation and that several congressional staff members had been notified. Accordingly, it was difficult for us to determine what the F-Pole performance requirement was for AMRAAM under the act.

Some proposed engineering changes and existing design deviations could adversely affect missile performance, as required in the contractual specifications. However, these were not required to be certified.

TESTING COST REDUCTION CHANGES BEFORE PRODUCTION

An overall master plan developed by JSPO has incorporated plans to test the producibility enhancement projects (i.e., cost-reduction changes) before integration into production lots. The changes are scheduled to be tested and incorporated into production lots #2 through #4 from 1988 through 1990. However, potential slippages in the development and testing of the cost-reduction changes could delay incorporating these changes into planned production lots. If slippages occur, a 1-year delay in integrating all cost-reduction changes would affect 3,000 missiles, which JSPO plans to produce in lot #4 during 1990. The first three lots, totaling about 3,100 missiles, were not intended to have included all the cost-reduction changes.

FULL-SCALE DEVELOPMENT CEILING OF $556.6 MILLION

As of March 1, 1986, the contract with the development contractor did not exceed the ceiling imposed by the act. Before November 1985, recorded obligations under the Hughes fixed-price type contract for AMRAAM full-scale development totaled $556.8 million. However, when the act was passed in November 1985, it placed a $556,580,480 cost ceiling on the AMRAAM development contract with Hughes. Subsequently, JSPO negotiated contract changes to reduce recorded obligations below the ceiling. The AMRAAM Program Manager believes the ceiling will restrain and delay development testing.

PRODUCTION CEILING OF $5.2 BILLION

JSPO prepared a detailed analysis of the estimated production cost of AMRAAM and concluded that these costs are conservative and reasonable. The $5.2 billion production cost estimate is fully documented and the estimating methodology is well developed. However, the cost estimate, when used as a ceiling over the next 10 years, does not appear conservative and reasonable. Uncertainties surround the Air Force's assumptions, forecasts, and judgments used to develop the $5.2 billion estimate for 17,000 AMRAAM missiles over the next 10 years. The accumulation of these assumptions reduces confidence in achieving the estimate.

MISSILE PERFORMANCE

It is too early to assess missile performance because only a few missiles have been produced and flight tested. As of March 31, 1986, 27 full-scale development missiles had been delivered to various test facilities. Nine of these have been returned to Hughes to correct some malfunction. To demonstrate missile performance, 90 development test flights and 8 missile separation control vehicle tests are planned through April 1988. As of March 31, 1986, four test flights and two separation control vehicles have been launched. All six flights were considered successful. Along with these successes, seven flight tests were cancelled or aborted because of missile malfunction. By 1988, the scheduled tests should provide a basis to judge whether the missile performs in accordance with the development specifications.

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In reviewing the AMRAAM's status as it relates to the Secretary's certification, we met with and obtained data from Air Force officials in Washington, D.C., and AMRAAM's JSPO at Eglin Air Force Base, Florida. We also visited and obtained data from the AMRAAM development contractor (Hughes Aircraft Company at Canoga Park, California, and Tucson, Arizona) and the second source contractor (Raytheon Company at Bedford, Massachusetts). Our review was conducted from November 1985 through March 1986.

As agreed with your office, we did not request official agency comments on this report. However, the views of the Air Force, JSPO, and contractor officials were obtained and incorporated, where appropriate. We conducted our work in accordance with generally accepted government auditing standards.

Unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after its issue date. At that time, we will send copies to the Chairmen, Senate Committee on Armed Services and House and Senate Committees on Appropriations; the Director, Office of Management and Budget; the Secretary of Defense; the Secretary of the Air Force; and other interested parties.

Sincerely yours,

Harry R. Finley

Harry R. Finley
Senior Associate Director

Contents

ABBREVIATIONS

AMRAAM	Advanced Medium Range Air-to-Air Missile
CDR	Critical Design Review
JSPO	Joint System Program Office
PEP	Producibility Enhancement Program

OBSERVATIONS ON THE AMRAAM CERTIFICATION ISSUES

BACKGROUND

The AMRAAM is being developed jointly by the Air Force and the Navy to meet their medium range air-to-air missile requirements for the 1989-2005 time frame. The missile is to be compatible with the services' latest fighter aircraft and is to operate both within and beyond visual range. As a follow-on to the Sparrow medium-range air-to-air missile, AMRAAM is intended to improve interceptor combat effectiveness.

Improved performance features over the Sparrow are to include higher speed, greater range, increased maneuverability, all aspect look-down shoot-down capability, better resistance to electronic countermeasures, and an active terminal seeker. The active seeker and a track-while-scan radar aboard the launch aircraft provide the capability to simultaneously track multiple targets, launch multiple missiles, and maneuver. The missile is also intended to be more reliable and maintainable than the Sparrow missile.

The AMRAAM development program includes the missile, rail launchers, aircraft interfaces, support equipment, and aircraft modifications for AMRAAM testing. It does not include modifications to operational aircraft and eject launchers that are to be developed and funded by the appropriate aircraft program offices.

The program is in full-scale development under a contract with Hughes Aircraft Company. Raytheon Company is being qualified as a second source producer for competition.

The AMRAAM JSPO procurement cost estimates had risen from about $10.4 billion in November 1982 to $11.6 billion in December 1984 for 24,335 missiles. This increased unit-cost estimates from $428,000 to $476,000 per missile. These figures are in then-year dollars, which includes future years inflation.

In January 1985 the Secretary of Defense expressed concern about the AMRAAM program's progress and escalating costs, and ordered a complete program review to determine if and how costs could be reduced. The Air Force subsequently restructured the full-scale development phase and extended it from 54 to 79 months and delayed projected deployment to 1989.

To reduce program costs, a number of design and other changes were identified that could reduce production costs by an estimated $2 billion in February 1986 for the combined Air Force and Navy buy. This reduced JSPO's AMRAAM estimate to $9.6

billion in then-year dollars for the 24,335 missiles, or $394,000 per missile. This is also the basis for the $5.2 billion estimate in fiscal year 1984 dollars for 17,123 Air Force missiles, or $304,000 in 1984 dollars.

Congressional concerns over the AMRAAM program led to the certification requirements included in the Defense Authorization Act of 1986. AMRAAM's status regarding each of the certification requirements is discussed below.

DESIGN COMPLETION

The Secretary of Defense, in the information provided with the certification, stated that the CDR has been completed. The Secretary acknowledged that the missile is still in development and that at this stage of any program, design refinements are normal.

The AMRAAM Program Manager states that the AMRAAM design process is complete. This view is based on the degree of design documentation, hardware availability, and the completion of the CDR.

Hughes, the development contractor, and Raytheon, the second source contractor, also stated that the design is essentially complete. They acknowledged that as part of the full-scale development phase, there will be design modifications resulting from development tests and evaluations and manufacturing considerations.

We note that there are several stages in the development process when the design is reviewed. The CDR is made before fabrication to ensure that the detailed design conforms to the performance and engineering requirements. It establishes the design baseline for detailed fabrication and production planning. Accordingly, the Program Manager believes the design was complete and ready to begin the next phase.

A more reliable indicator of design completion would have been the Functional Configuration Audit. This audit is conducted to verify that development of the missile system has been completed satisfactorily and that its subsystems will achieve the specified performance and functional characteristics. Further, the Functional Configuration Audit is a prerequisite to government acceptance of the design and responsibility for further design changes.

AMRAAM's CDR was conducted from November 1984 to February 1985, about a year before certification. At the time of certification, a Functional Configuration Audit was not scheduled to be completed until November 1986, approximately 9 months after the required certification date. Accordingly, the Secretary of Defense relied on the results of the CDR to certify that the design was complete for purposes of proceeding with development. According to JSPO, the CDR was a thorough review of the design which involved over 20,000 hours of effort, and it confirmed that the design was complete.

The Functional Configuration Audit, which will occur after further development and flight testing, will validate that the development is complete. This audit will be and would have been a more reliable indicator of design completion had such an audit been possible at the time of certification.

Our review of AMRAAM's design status showed that the CDR contractor follow-up actions have not been fully completed and AMRAAM's design is still evolving with continuing design changes.

Incomplete CDR follow-up actions

Contractor follow-up actions to satisfy outstanding CDR issues took place from February to December 1985, but some significant follow-up actions were not completed by March 1, 1986. The CDR resulted in 345 JSPO-requested contractor actions to satisfy engineering requirements. JSPO officials considered 44 of these actions to be major. Our review of 15 of the 44 major requested actions showed that 10 had not been completed by the contractor.

Hughes proposed specification changes for eight of these major requests for actions which were accepted by JSPO; however, as of March 1986 these changes had not been completed. JSPO stated that they are not required to be resolved until 45 days before the Functional Configuration Audit, scheduled for completion in November 1986. Hughes stated that the specifications have not been revised because of other higher priority work, and that the revisions are not due until a later date.

Continuing design changes

The AMRAAM design is still being revised since it is in the full-scale development phase. Several engineering change proposals are pending, additional software must be developed and integrated into the missile, a variety of component design problems must be resolved, cost-reduction design changes must be made, and more testing has to be done to determine what modifications may be necessary. These are discussed below.

Pending engineering changes

Several design issues remain unresolved. For example, two engineering change proposals could involve redesign efforts. One of the engineering change proposals was approved in August 1985 to avoid exceeding launch roll rate limits for missiles launched from F-15 aircraft. The problem occurred because the F-15's interface with the missile was not well-defined early in the program. The other engineering change would relax the missile's control section tolerance requirements. Without these changes to the missile's specifications, missile guidance errors could result.

Software tapes

Three of five software tapes have been designed and integrated into the initial missiles. However, the full capabilities of AMRAAM cannot be tested until all of the tapes are designed and integrated. Missile capabilities provided by the second tape include a data link from the aircraft to the missile, look-down shoot-down feature, software for fuzing, built-in test information, and high-pulse-repetition frequencies to obtain more and better target information. Tape three adds features such as multiple target tracking, initial electronic counter countermeasures, and solutions to some targeting problems. The fourth and fifth tapes, with more sophisticated electronic counter countermeasures, are scheduled to be delivered in July 1986 and the spring of 1987, respectively.

Another engineering change proposal, approved in January 1986, allows the initial production of missiles with the fourth tape instead of the originally planned fifth tape. The fifth tape would be added to production units, beginning with lot #2. The fourth tape, which contains most electronic counter countermeasure capabilities, became an interim configuration because the design of the fifth tape--the baseline configuration--would not be completed in time for the initial missile production. However, current schedules show that the design of the fifth tape, which is to include enhanced counter countermeasure capabilities, should be completed by December 1986. As a result, some missiles produced with the fourth tape will be upgraded to the fifth tape configuration for flight testing.

Component design problems

At the end of February 1986, the contractor was addressing missile component design problems. (See app. II.) Following the CDR, completed in February 1985, and six air launch tests, made between December 1984 and March 1986, design changes were required on several key missile components to correct problems.

These include the seeker servo unit, which drives the missile's antenna; the radar frequency processor; the transmitter; and the receiver. JSPO stated that the need for these changes was identified before the CDR.

Cost-reduction design changes

Design changes to reduce costs must be made to meet the $5.2 billion ceiling in 1984 dollars. Hughes and Raytheon have submitted design proposals to JSPO to modify certain missile components and subcomponents to make the missile less costly to produce. Negotiations are underway between JSPO and the contractors on some of the proposals.

JSPO estimated that it will take up to 2 years to design and qualify all of the currently proposed cost-reduction changes and about another year to fabricate and integrate the changes into the manufacturing process.

Design changes from testing

Contractor and JSPO officials acknowledge that the results of testing may indicate some design changes are required to meet missile performance requirements. DOD Directive 5000.3 states that development tests and evaluations are made to assist the engineering design and development process and to verify attainment of technical performance specifications. Operational tests and evaluations are conducted for the users to determine if, among other things, the missile meets operational requirements and if modifications are needed to insure the missile's operational effectiveness.

A significant amount of laboratory and simulation testing has been done. However, 90 developmental and initial operational flight tests of the missile are scheduled through April 1988. As of March 31, 1986, four of these tests have been completed.

DEGRADATION OF PERFORMANCE SPECIFICATIONS

The Secretary certified that AMRAAM system performance had not degraded from the original development specifications, as amended by a draft Decision Coordinating Paper, dated June 14, 1985. This certification was based on a review of flight testing, laboratory environmental qualification testing, simulations, and basic design information.

We reviewed engineering changes and deviations which may affect the missile's performance parameters, as stated in the development specifications and Decision Coordinating Paper. We found that the original development specifications did not contain specific measurable performance requirements for the system. The June 1985 draft Decision Coordinating Paper, however, contained 14 performance requirements, each having a measurable goal and threshold level.

We found that only one of the performance parameters had been changed. Specifically, the F-Pole--a measure of the relative engagement range between the launch aircraft and its target--was reduced about 6 percent. JSPO officials advised us that before enactment of the certification legislation, the F-Pole requirement could not be met without adversely affecting other parameters or increasing cost. Because of this, a pen-and-ink change was made to the Decision Coordinating Paper to reduce the F-Pole parameter. JSPO officials believe that the certification requirement was based on the revised performance parameter because it was shown to several congressional staff members before enactment of the Defense Authorization Act of 1986. This action created an uncertainty of whether the act referred to the original or revised F-Pole requirement. Accordingly, we could not determine whether the performance requirement had been degraded.

The Secretary was not required to certify the more detailed and specific performance requirements of the contract. However, during our review, we noted engineering change proposals and deviations that have reduced or could reduce the contractually specified system performance. The status of these are discussed below.

Engineering change proposals

Engineering change proposals, if approved, are permanent changes to the contract's specifications. As of March 1986, the contractor had submitted 51 engineering change proposals. Some of these are still pending, and if approved, could reduce the contract specification requirements. For example, one engineering change proposal involves an increase in launch sequence time, which would increase the time between the pilot firing and the missile's ejection. Another change involves easing the control surface alignment tolerance requirements. Such a relaxation can cause missile instability upon launch and thus, affect its guidance and control. The contractor has been tasked to study the effects of this change before it is approved. If easing the tolerance is unacceptable, the contractor stated that increased manufacturing controls may be necessary to insure that the tolerances, as specified in the contract, are met.

The engineering change proposal, which brought about the F-Pole requirement, previously discussed, was approved in August 1984. It revised the dimensional limits of the AMRAAM missile by increasing the weight, length, and diameter. These changes caused an increase in missile drag and resulted in, according to the contractor, minor reductions in speed and range. According to the contractor and JSPO, excessive cost and schedule constraints would have jeopardized the program if the contractual requirements had not been changed. JSPO stated that these changes were acceptable to the Tactical Air Command--one of the missile's users.

Deviations

Compared to engineering change proposals, deviations are temporary variations from the contract specifications that do not permanently reduce performance requirements if corrected. However, if deviations are not corrected, they will result in an engineering change proposal that will affect the contract specifications. Deviations are normal in early stages of a development program.

Although the missile components and subcomponents have been designed to meet certain contract specifications, Hughes has reported 15 deviations in the test missiles. These deviations involved, for example, the radar, launch time, guard antenna, and the physical environment. Both JSPO and the contractor consider these deviations temporary or minor, and acceptable. The number of deviations has diminished as work and testing have progressed.

Four deviations have resulted in the submission of engineering change proposals. If approved, three of these proposals will relax the contract specifications. In addition, six deviations, one of which involves the F-Pole, may require engineering changes. The remaining five deviations may not require any change.

TESTING COST-REDUCTION CHANGES BEFORE PRODUCTION

The Secretary stated that the flight test program has been revised to include the maximum practicable number of selected cost-reduction design changes that are qualified and flight tested before production. In the information provided with the certification, the Secretary further said that the Producibility Enhancement Program (PEP), which includes cost-reduction changes, includes provisions for appropriate testing of the design changes before being introduced into production.

An overall master plan developed by JSPO has incorporated plans to test PEP projects before integration into production lots. The cost-reduction changes are scheduled to be tested before they are incorporated into production lots #2 through #4 from 1988 to 1990. JSPO plans to use 10 production missiles from lot #1 to test the producibility enhancement projects. This involves reworking the missiles to incorporate the producibility enhancement changes which are to be tested. The reworked missiles are to be delivered beginning in May 1988 and flight tested while production is occurring.

Although a test plan has been developed, indications are that delays may occur. Any slippages in contract award, development, or testing would potentially delay integration of cost-reduction projects into production missiles and reduce the intended benefits.

In February 1985 JSPO awarded contracts to Hughes and Raytheon to propose producibility enhancement projects that would reduce AMRAAM production costs. The contractors submitted about 40 cost-reduction proposals to JSPO. By the end of November 1985, JSPO had evaluated and selected 24 of these projects for negotiation. The first group of producibility enhancement projects were to be awarded by January 1986. The second group, an additional 11 projects, were to be awarded in the February/March 1986 time frame.

However, initial contracts for cost-reduction changes had not been awarded as scheduled. As of March 31, 1986, no contracts had been awarded for any of the producibility enhancement projects. Raytheon officials stressed that the producibility enhancement changes should be developed and tested in time to be incorporated into production lot #3; otherwise, the estimated savings resulting from these cost-reduction changes will be diminished. Hughes also faces a similar time concern. Hughes' PEP savings are based on integrating the cost-reduction changes into lot #3, but primarily, lot #4.

If slippages occur, a 1-year delay in integrating all the cost-reduction changes would affect 3,000 missiles, which JSPO plans to produce in lot #4 during 1990. The first three lots, totaling about 3,100 missiles, were not intended to have all of these changes. Thus, if delays occur, about 25 percent of the missiles would not have all of these changes.

The August 1985 Secretary's Program Review shows that the cost reductions were planned to be fully incorporated by lot #3 so that they would be included in 95 percent of the missiles bought. A Department of Defense official told us that there are scheduled decision milestones in which alternatives can be considered if delays occur.

FULL-SCALE DEVELOPMENT CEILING OF $556.6 MILLION

The Secretary certified that a fixed-price contract not to exceed $556,580,480 had been entered into with Hughes for research, development, test and evaluation of the AMRAAM system.

As of March 1, 1986, the contract with Hughes did not exceed the ceiling imposed by the Defense Authorization Act, 1986. We found that before the November 8, 1985, enactment of the Defense Authorization Act, 1986, JSPO's recordable obligations with Hughes exceeded the act's $556.6 million ceiling by about $200,000. In December 1985 JSPO modified the contract by deleting certain requirements. This resulted in a downward adjustment of these obligations to comply with the March 1, 1986, certification ceiling. Appendix III shows the cumulative obligations at May 31, 1985; when the contract ceiling was reached; the contract modifications made through February 1986; and the reasons for these changes.

The AMRAAM Program Manager told us that obligations above the ceiling are needed to minimize risk. JSPO planned to open a third test site for AMRAAM at Eglin Air Force Base. We were told that funds are available for the third site; however, the Air Force cannot establish it for the AMRAAM program because of the cost ceiling of the full-scale development contract. Nevertheless, the Program Manager believes the test program can be implemented, using two test sites. Also, JSPO planned to procure a third captive flight test vehicle. The Program Manager said that these actions would necessitate support from Hughes. He believes that if additional funding is not authorized, flexibility in testing would be inhibited and flight testing could stretch out by at least 6 months. He emphasized that such additional funding is not needed for missile design purposes.

As of March 1986, AMRAAM's total estimated development cost to the government was $1.2 billion. In addition, Hughes anticipates that it will absorb $255 million in developing the AMRAAM, making the total estimated development cost $1.5 billion in then-year dollars. As previously noted, modifications to aircraft and eject launchers are not included in this estimate.

PRODUCTION CEILING OF $5.2 BILLION

The Secretary certified that the total production cost to produce 17,000 AMRAAM missiles would not exceed $5.2 billion in fiscal year 1984 dollars. In the information provided with the certification, the Secretary noted that the estimate was derived from a combined Navy and Air Force program, totaling more than 24,000 missiles.

JSPO, in its presentation to the Secretary before certification, stated that the combined Air Force and Navy estimate was $7 billion in 1984 dollars for 24,335 missiles and that the Air Force portion was $5.2 billion in 1984 dollars for 17,123 missiles. Both Hughes and Raytheon confirmed the estimate by stating separately that they could produce 24,335 missiles within the $7 billion estimate in fiscal year 1984 dollars if the schedule and funding for the program are maintained as planned. The estimate is based on a number of assumptions and forecasts. But, JSPO believes the program can be executed within budgeted levels because it is (1) based on a fully documented estimate, (2) conservative, compared to a Secretary of Defense commissioned study, and (3) reasonable.

We agree that JSPO had fully documented its estimate and had a well-developed cost estimating methodology. However, the $5.2 billion estimate, when used as a ceiling over the next 10 years, does not appear conservative and reasonable because of the underlying assumptions, forecasts, and judgments used to develop it. These concerns are discussed below. We also discussed additional AMRAAM program costs not included in the $5.2 billion estimate. We believe the accumulation of these factors reduces the confidence in the estimate being achieved.

Uncertainties of cost estimate

JSPO's estimated production cost of $5.2 billion in fiscal year 1984 dollars was derived from an Independent Cost Analysis, dated December 1984, which projected Air Force costs to produce 17,123 missiles at $5.5 billion. JSPO reduced the estimate by a net of $311 million to the $5.2 billion certified to by the Secretary. Total reductions of about $486 million were offset by about $175 million in inflation and other cost increases. The reductions were made by (1) increasing estimated savings from producibility enhancement projects and competition, (2) deferring depot support, (3) reducing warranty cost factors, and (4) deleting the funding for a classified project. The basis and uncertainties of some of these estimated cost reductions are addressed below.

Producibility enhancement program savings uncertain

JSPO revised and updated estimated savings from the producibility enhancement projects. This reduced the Independent Cost Analysis estimate of AMRAAM production costs by $212 million in 1984 dollars.

More recent estimates indicate even larger savings from the PEP projects. JSPO's July 1985 estimate of PEP cost-reduction changes for both Air Force and Navy missiles was $1.3 billion.

This estimate was made when PEP was still in the study phase. In February 1986 JSPO revised its savings estimate to $1.6 billion based on approved PEP projects. This indicates an increase of about 23 percent more savings than was used in the $5.5 billion Independent Cost Analysis estimate. The most recent estimate assumes 100-percent savings from PEP projects, whereas the July 1985 JSPO estimate included only 75 percent of the savings because of a risk factor used to estimate costs.

Neither estimate considers the sharing of PEP savings with the contractors. According to the PEP plan, contractors will be provided an incentive share of savings in accordance with the value engineering clause of the contract. Computations will be made using sharing arrangements in which 25 percent of the highest 3 of the first 5-year savings are paid to the contractor. Thus, the sharing arrangement would reduce the PEP savings estimate and increase the production estimate.

The sharing arrangement computation will reduce savings, but other factors, such as the availability of data rights and the commitment of funds will also have an affect on the savings. For example, Hughes officials initially noted that the inability to obtain data rights from subcontractors for two projects may prevent the projects from being implemented and thereby, achieving the savings. However, according to Hughes officials, their recent assessment indicated that data rights will not be a barrier to implementing the projects. Hughes also noted that their savings estimate was based on six of their projects being developed together. JSPO divided this set of projects between Hughes and Raytheon. Hughes officials said that it has not projected the impact on savings with the separation.

Raytheon officials believed the total proposed savings could be achieved only if funds are committed in sufficient time to qualify outside vendors and incorporate the PEP projects into the third production lot. According to the Independent Cost Analysis, a 1-year delay in introducing PEP projects and reducing the number by one-third could increase total production costs by 4 percent. As noted earlier, none of the PEP contracts had been awarded as of March 31, 1986.

<u>Savings from competition uncertain</u>

To reduce production costs, Raytheon was brought into the program for production competition. JSPO estimates show that the up-front costs of competing AMRAAM production will not be fully recovered until after 10,000 missiles are produced. Accordingly, if the planned 24,335 missiles are produced, there should be savings from competition.

The Independent Cost Analysis concluded, based on experience with previous missile programs, that if the contractors do not compete aggressively, Air Force production costs could grow by 9 percent. Aggressive competition could reduce costs by 6 percent. In addition, such competition is necessary at the subcontractor level to realize savings. However, a number of major and critical missile components are being bought noncompetitively from subcontractors during this full-scale development phase. The prime contractors told us, however, that they are developing alternate competitive sources for these items for the production phase. Also, JSPO plans to avoid single source subcontractors by lot #3.

The share of missiles produced by competing contractors can affect the amount of savings. At this time, JSPO has intentionally not defined the production share ratio which will be awarded to the winning contractor to encourage aggressive competition between the two sources.

Competition is to begin with production lot #3. For lots #1 and #2, noncompetitive contracts are to be awarded to produce about 1,100 missiles. This process will allow the contractors to gain the production experience and attain a capability for increasing their production rates. The two lots represent 4.5 percent of the estimated total planned production quantity and 17.9 percent of the estimated total production cost.

Savings from deferring depot support uncertain

Another JSPO change to the Independent Cost Analysis production cost estimate involved deferring the cost of field depot facilities until the end of production. According to JSPO, major maintenance and repair for deployed missiles would be performed at the contractors' plants instead of at the military's maintenance depots. This potential logistics change reduced JSPO's estimated production cost for the Air Force by a net of $66.1 million in 1984 dollars. It deleted field depot equipment and related inventory and added costs for contractor equipment and refurbishments.

This concept is under consideration by the Air Force and Navy logistics activities. Additional factors which must be considered include the effects of the change on operation, transportation, and maintenance costs and military readiness. If this concept is not approved, either $66.1 million must be added to JSPO's $5.2 billion estimate or other reductions must be made in the estimate to offset the increase.

Savings from changing
warranty factors uncertain

Another element of uncertainty relates to warranty costs. The Independent Cost Analysis estimate applied a 5-percent warranty factor annually to the missile's hardware cost. This was based on information which indicated that warranty costs ranged from 3 to 15 percent of hardware costs, but averaged 3 to 5 percent.

JSPO reduced warranty cost factors, thereby, eliminating $94.3 million in 1984 dollars from the Independent Cost Analysis estimate. Based on a cost-reduction study, JSPO applied a 5-percent warranty cost factor to the first three production lots, then gradually reduced the percentage until it reached zero by the ninth lot. In JSPO's judgment, warranty costs would decline as the system matured. Because AMRAAM is to be designed with high reliability and procured through competition, JSPO believes the contractor would have incentives to reduce warranty costs and eventually absorb them.

Assumptions used in the cost estimate

JSPO's estimated production cost of $5.2 billion in fiscal year 1984 dollars for 17,123 missiles is based on a number of assumptions. The accuracy of these assumptions is essential to the $5.2 billion estimate. Historically, similar assumptions for other major acquisitions have changed over time. The potential for such changes reduces confidence in the estimate being achieved.

Some of the assumptions include:

--Air Force and Navy procurement funding will range from $750 million to $1 billion annually in then-year dollars over a 9-year period beginning in fiscal year 1988. (The Balanced Budget and Emergency Deficit Control Act of 1985 may reduce future program funding even though the Air Force considers it a high priority.)

--In addition to the Air Force procurements, the Navy will buy 7,212 missiles beginning in fiscal year 1989 for a total production of 24,335 missiles. (The program and cost estimates have assumed production of about 24,335 missiles. If only 17,123 missiles were to be produced, the estimated cost in fiscal year 1984 dollars would exceed the $5.2 billion ceiling by about $500 million.)

--A full production rate of 3,000 missiles annually will be maintained for 7 years beginning in fiscal year 1990. (Recent Sparrow procurement history shows that annual and total planned purchases often vary from actual purchases. However, the estimate does not include the potential for foreign military sales, which could increase total production and reduce unit costs.)

--Most cost-reduction design modifications are planned to be developed and integrated into production lots #3 and #4 in fiscal years 1989 and 1990, respectively. (According to the Independent Cost Analysis, a 1-year delay in introducing producibility enhancement changes and reducing the number of changes by one-third could increase costs by 4 percent.)

--No model or major design changes will be made to the missile over the next 11 years. (The Department of Defense has already endorsed future producibility and performance improvements that emphasize the need to develop and produce an advanced seeker and an advanced processor.)

--No significant schedule slippages will occur. (There is concurrency between the full-scale development phase and initial production. Delays in completing development or needed design or production changes may result in production stretch out and increased costs.)

The effect of these assumptions, including production quantity, an improving production rate, and other related assumptions is a significant drop in unit procurement funding and cost. For example, unit procurement funding is estimated to drop from about $2.8 million per missile in 1987, which includes nonrecurring start-up costs, to about $341,000 per missile in 1990, and to $259,000 per missile in 1996 in then-year dollars. The flyaway costs, which exclude the nonrecurring costs for those years is estimated to be $2 million, $298,000, and $253,000, respectively, also in then-year dollars.

Additional program costs

Similar to other programs, the AMRAAM production cost estimate represents only the cost of the Air Force's missile procurement. Total program costs include other related costs, such as modification costs to install equipment in the aircraft or aircraft design changes to modify the radar and its software. These costs are separately budgeted as modifications to the four types of aircraft that will carry AMRAAM missiles and total well over $1 billion.

In our report to the Congress, Progress and Problems of the Advanced Medium Range Air-to-Air Missile Program (C-MASAD-81-6, Feb. 1981), we stated that Air Force estimates showed that modifications to a portion of the F-15 and F-16 fleets could cost about $900 million. At that time, a Navy estimate showed that development of F-14 aircraft modifications for AMRAAM could cost about $43 million, but the related procurement costs for the modifications had not been estimated. Similar data for the F-18 aircraft was not estimated. Current data is not available to update these estimates.

Costs for operation and maintenance, estimated in 1979 to be about $430 million over a 15-year period, were not included in the estimate. Cost for military construction were also not included. These costs are budgeted in their respective appropriations.

Similarly, as is standard practice, research and development funds are excluded from the production cost estimate. The Air Force and Navy, as mentioned earlier, expect to spend about $1.2 billion in then-year dollars to develop the AMRAAM missile.

MISSILE PERFORMANCE

The Secretary certified that the missiles procured will perform in accordance with the development specification, as amended. He also stated that flight testing, laboratory environmental qualification testing, simulation, and basic design information were reviewed.

Numerous tests, such as captive carry, simulation, integration, reliability, environmental, electromagnetic, and live air-launched flights, are underway to validate missile performance. In our view, as of March 1, 1986, the certification date, not enough testing had been completed to provide sufficient assurance of meeting desired performance criteria.

In response to our assessment, the Program Manager stated that testing is not the only way to project performance. He said that testing completed to date shows that objectives on actual launches have been met and indicates the missile will ultimately meet performance objectives. Our review of AMRAAM's testing status and results are discussed below.

Testing status and results

As of March 31, 1986, 27 missiles have been produced and delivered to field test facilities, such as the Pacific Missile Test Center, Point Mugu, California; Holloman Air Force Base, New Mexico; Raytheon Company's Bedford, Massachusetts, plant; General Dynamics' Fort Worth, Texas, plant; and McDonnell Douglas' St. Louis, Missouri, plant. Nine of these missiles were returned to Hughes to correct some malfunction. Hughes analyzed the problems and modified or replaced the components or subcomponents, as needed. In some cases, the missile test equipment experienced difficulties and required modifications. Some of the missile malfunctions are described in appendix IV.

AMRAAM's performance specification requires a high-kill probability under a variety of combat, weather, and electronic countermeasure conditions. This combat performance value--the probability of kill--differs from physical performance measurements such as weight or speed in that, for the most part, it is determined analytically. Some data is obtained from warhead shots. The probability of kill performance criterion is determined from a series of factors that must be considered together. Examples of these factors are prelaunch reliability, in-flight reliability, guidance accuracy, fuze accuracy, warhead destruction capability, and target characteristics. To attain a high confidence that these factors will achieve the desired probability of kill levels, a large number of environmental tests, ground simulations, captive flights, and flight tests must be made against various types of targets.

Such a volume and variety of testing was not scheduled to be completed by the March 1, 1986, certification date to provide sufficient assurance of meeting the desired performance criteria. This is not unusual for this phase of a program. The current plan shows that by April 1988, 90 flights will have been completed, using four types of aircraft as part of the development and the operational test and evaluations. By then, these tests should provide a basis to judge whether the missile will achieve its required kill capability.

In December 1985 the Director for Operational Test and Evaluation of the Department of Defense stated that he believed there is a low probability of adequate test results being available for an operational capability forecast before the March certification. In his view, limited useful test information would be available. He said testing progress is hampered by limited missile availability, software development, and test assets. He noted that the key test asset, the AMRAAM Captive Equipment pod which fits the F-16 aircraft, has not been successfully flown, and that the program is three missile test flights behind the level of data planned at the time of certification. He pointed out that unplanned test problems which require repeated tests precluded accomplishment of all scheduled events. This, with the normal test problems, he said, could compound schedule slippages. However, according to Hughes officials, the captive equipment pod has been flown on the F-18 aircraft.

In February 1986 the Deputy Under Secretary of Defense for Test and Evaluation, stated that his office could not recommend that the AMRAAM be certified as being expected to meet all of its performance requirements on the basis of the limited full-scale development testing completed at that time. In his view, AMRAAM's design was complete on paper and the missile's performance indicated a slow but positive trend toward meeting its performance requirements.

Live missile firings

In the development phase, JSPO is scheduled to complete 90 live firings at targets, using instrumented or fully operational missiles, and 8 live firings, using separation/control test vehicles. The latter missiles, which are not fired at targets, contain all elements of a fully operational missile except for a seeker and warhead. They are to demonstrate (1) safe separation at launch, (2) airframe flight performance, (3) maneuvering response characteristics, and (4) missile stabilization control.

It is too early to fully assess the results of the flight test program since 4 of the 90 development flight test missiles have been launched as of the end of March 1986. Also, two of the eight separation/control vehicles have been flight tested. All six flight tests were considered successful. Along with these successes, seven flight tests were cancelled or aborted due to missile malfunction. Results of these live firings are shown in appendix IV.

In addition to live flight testing, AMRAAM required performance is demonstrated by numerous types of tests. These include software tape testing, simulations, captive equipment tests, environmental, stress, reliability, and integration tests. The status of these tests are discussed in appendix V.

AMRAAM
UNIT DESIGN STATUS
As of February 26, 1986

UNIT	DESIGN PROBLEM(S)	STATUS	TO BE CORRECTED NOT LATER THAN LAUNCH MISSILE #
RADOME	NONE		
ANTENNA	MAIN ANTENNA PRODUCIBILITY	RE-ITERATING RECTANGULAR SLOT LAYOUT	TO BE DETERMINED
	GUARD ANTENNA COVERAGE	ENGINEERING RELEASED	# 30
	BIT ANTENNA GAIN/PHASE STABILIZATION	ENGINEERING RELEASED	# 43
RADAR FREQUENCY PROCESSOR	HIGH POWER RECEIVER PROTECT	PARTS IN HAND. TESTING HAS BEGUN	# 30
	IMAGE REJECTION	PROCESSOR BEING REWORKED	AS SOON AS POSSIBLE
	SATURATION DETECTOR	REQUIREMENTS RELEASED	# 71
	FULL TEMPERATURE	REQUIREMENTS RELEASED	# 71
CABLE FILTERS	NONE		
TRANSMITTER/ ELECTRICAL CONVERSION UNIT	TRANSMITTER HIGH VOLTAGE REGULATOR REDESIGN	FIX IN TRANSMITTER 0005, DEVELOPING TEST PLAN TO VERIFY OVER ENVIRONMENT ETC.	# 30
	HIGH POWER		
	HIGH PULSE REPETITION FREQUENCY		
	REDESIGN INDUCTORS IN A5	NEW PARTS 3/86. SCREEN OLD PARTS	AS SOON AS POSSIBLE
	-5 v REGULATOR	IN WORK	TO BE DETERMINED
	ELECTRONIC CONVERSION UNIT START-UP	UNDER INVESTIGATION	TO BE DETERMINED
	START-UP HYBRID REDESIGN AND LOSS OF PHASE	ENGINEERING RELEASED	TO BE DETERMINED

UNIT	DESIGN PROBLEM(S)	STATUS	TO BE CORRECTED NOT LATER THAN LAUNCH MISSILE #
FILTER	2 CHANNEL DUS	CLOSED	# 6
RECEIVER/ RANGE CORRELATOR	fo BIRDS (M)	BEING WORKED AS A HIGH PRIORITY TASK. MEDIUM PULSE REPETITION FREQUENCY (MPRF) MODS BY 3/31/86. HIGH PULSE REPETITION FREQUENCY (HPRF) MODS BY 6/14/86	MPRF: # 4 HPRF: # 30
	FILTER 32 BIRD (M&H)		
	FILTER 28/36 BIRD (H)		
	VCXO HARMONIC BIRDS (H)		
	MODE SWITCHING TRANSIENTS	BEING WORKED WITH BIRD STUDY	# 71
	CCD SAT DETECTOR	BREADBOARD DUE SHORTLY. 1st FF UNIT DUE 5/86	# 71
	SPECIAL DETECTOR		
FREQUENCY REFERENCE UNIT	WIDEBAND NOISE FLOOR	ENGINEERING RELEASED.	# 66
	LO/TD POWER OVER FREQUENCY AND TEMPERATURE	IMPROVED WITH VCO REDESIGN FINAL FIX IN LOT I.	# 66
	SPURS	MACOM HAVING PROBLEMS. REDESIGNED VCO.	# 66
INPUT/OUTPUT	SPECIAL DETECTOR	ENGINEERING RELEASED	# 71
TARGET DETECTION DEVICE	TARGET DETECTION DEVICE TURN-ON	CLOSED	# 6
INERTIAL REFERENCE UNIT	FULL TEMPERATURE OPERATION	ENGINEERING RELEASED	# 20
ANTENNA SERVO	SERVO OSCILLATION/HIGH TEMPERATURE DRIFT	ENGINEERING RELEASE IN PROGRESS	# 8
	DIGITAL I/F LOW TEMPERATURE OPERATION	SCREEN EXISTING PARTS. PROBLEM IN A/D CONVERTER. AUGMENT ACCEPTANCE TEST.	TO BE DETERMINED
SKIN/WINGS	REDUCE WEIGHT	ENGINEERING RELEASED	# 20
SAFE, ARM AND FIRE	TACTICAL	CLOSED	# 6

Source - Provided by the Hughes Aircraft Company for AMRAAM Quarterly Program Status Review with JSPO.

AMRAAM MODIFICATIONS TO THE FULL-SCALE DEVELOPMENT CONTRACT FROM MAY 31, 1985, THROUGH FEBRUARY 28, 1986

Date and modification number	Purpose of modification	Recordable obligation amount	Total
5/31/85	-	-	$556,580,480
7/31/85 (P00071)	Preliminary design study of advanced metal material composites for potential improvements to the baseline AMRAAM launcher design to determine weight savings and production cost impact	$125,859	556,706,339
7/19/85 (P00072)	Mini-qualification test on the Safe-Arm Firing Device	81,000	556,787,339
11/08/85 (P00073)	Adjustment to prior recordable obligation (P00072)	-8,370	556,778,969
12/20/85 (P00076)	Reduced from 10 to 7 contractor "inspection and repair as necessary" reliability test vehicles	-411,612	556,367,357

AMRAAM RESULTS OF LIVE FIRING PROGRAM THROUGH MARCH 31, 1986

Date and test missile #	Objectives	Result
12/07/84 S/CTV-1	Demonstrate: Separation from the F-16. Autopilot performance from upper altitude to lower altitude at end of flight. Validate: Ability to use available energy. Explore: Cross-coupled stability during maneuver. Gather: Data for post-flight validation of the aero data base and 6 DOF simulations.	Test objective achieved No target aircraft invol Anomalies included chann disturbance Pitch/Yaw/Ro cross coupling. Correct by modifying Tape 2 autopilot software which activates control sectio before missile is launch
1/17/85 AAVI-1	Demonstrate: Active mode launch capability from the F-16. Safe missile separation from F-16. Medium pulse repetition frequency seeker acquisition and tracking. Verify: Launch-to-eject cycle estimates. Evaluate: Closed loop guidance operation. Missile end-game performance.	Cancelled Telemetry problem.
1/25/85 AAVI-1	Same as above.	Aborted Data Processor problem; terminal seeker battery squib miswired. Problem corrected and has not reoccurred.
2/22/85 AAVI-1	Same as above.	Aborted Launch sequencer timing problem. Problem correc and has not reoccurred.
4/03/85 AAVI-1	Same as above.	Aborted Flight termination syste battery did not function Wire from positive termi broken. Problem correct and has not reoccurred.

Date and test missile #	Objectives	Result
5/14/85 AAVI-1	Same as above.	Test objectives achieved Passed within lethal radius of target. Anomalies: Sudden changes in terminal steering. Power irregularities after fly by. Processing of data stopped after fly by.
8/07/85 AAVI-2	Demonstrate: Inertial launch and safe missile separation from F-15. Medium pulse repetition frequency seeker acquisition and tracking. Evaluate: Missile end-game performance; look down-shoot down.	Test objectives achieved Passed within lethal distance of target. Anomalies: Large angle noise during terminal encounter and sudden changes in terminal steering. Corrections have been identified.
9/17/85 AAVI-3	Demonstrate: F-16 capability to transmit data link. Missile capability to receive and utilize data link. Evaluate: Tape 2 autopilot performance. Missile end-game performance in a high closing velocity.	Test objectives achieved Direct hit on target. Anomalies: None.
12/10/85 AAVI-5	Demonstrate: Long-range shoot up. Multiple mode demonstration. Mid-course heading change.	Cancelled Loose connector plate caused power problem with transmitting wave tube. Returned to Hughes for repair.
1/25/86 AAVI-6	Demonstrate: Maneuvering target. Maneuvering launcher.	Cancelled Other higher range priorities.
1/27/86 AAVI-6	Same as above.	Cancelled Other higher range priorities

Date and test missile #	Objectives	Result
1/29/86 AAVI-6	Same as above.	Aborted Electrical arc caused failure of diode in trans-mitter resulting in over-current. Returned to Hughe for repair.
3/05/86 AAVI-6	Same as above.	Aborted Decrease in pressure resulting from a marginal seal in guidance section caused by an out-of-round terminal seeke bulkhead.
3/25/86 AAVI-6	Same as above.	Test objective achieved Missile made direct hit on target. Anomaly: Guidance section had pressure reduction.
3/07/86 S/CTV-2	Check missile autopilot and control actuator in high G, high dynamic pressure environment. Collect data to generate zero lift drag data base. Investigate low energy (subsonic) maneuverability. Gather data to verify simulations.	Test objectives achieved Anomalies: None.

AMRAAM STATUS OF TESTING

SOFTWARE TESTING

At the end of February 1986, the first three of five software tapes had been designed, coded, and integrated into the missile. The full capabilities of the AMRAAM cannot be tested until all the tapes have been integrated into the missile. Certain coding revisions have been made to these tapes, based on tests. AMRAAM Captive Equipment testing has been completed for the first two tapes and was in process for tape three. The design of the fourth tape was 95-percent complete and about 80-percent coded at the end of February. The fifth tape's design was about 40-percent complete. At the end of February 1986, missile flight testing was virtually complete for the first two tapes, and was to begin for tape three.

SIMULATIONS

Pre- and post-flight laboratory equipment simulations have been made for each live firing. Simulations are used to identify potential operational limitations and examine missile performance in various scenarios.

CAPTIVE EQUIPMENT TESTS

Captive equipment tests are made before live firings. These tests employ the software tape programs. Functions verified in the first tape by the captive equipment tests include aircraft interface, navigation and guidance, acquisition and tracking, and launch profiles. Functional testing for the second tape verified the missile data link operation, acquisition and tracking, and launch profiles. For the third tape, functional testing verified system checkout, radar processing, acquisition and tracking, and electronic counter countermeasures.

By the end of February 1986, some capabilities of the first three tapes had not been verified by captive equipment test. These capabilities include the ability to intercept certain clustered targets, electromagnetic interference/electromagnetic compatibility, and overall data link performance. Appendix VI shows the capabilities tested and not tested.

ENVIRONMENTAL TESTING

An objective of environmental testing is to gather data on shock, vibration, acoustics, temperature effects, and missile loads during captive flights. For this purpose, the Instrument Measurement Vehicle/Captive Loads Vehicle, an AMRAAM missile containing measurement devices, was used on the F-15 and F-16 aircraft. These tests were completed in February 1986, and according to JSPO, no significant problems were identified.

ENVIRONMENTAL STRESS SCREENING

Environmental stress screening determines early manufacturing defects and helps ensure that the electronics hardware performs as required when subjected to specific environmental stress conditions. During this screening process, open traces of copper and bismuth were found on the ceramic cards. At the end of February 1986, Hughes stated that improved screening may be necessary and that more thorough testing may be needed, especially during the powered temperature "up" cycle. These ceramic cards are components of the Input/Output and Receiver/Range Correlator sections of the missile's Electronic Unit. These sections are high-risk components and are the last two to have engineering responsibility transitioned from Hughes' Canoga Park research and development facility to their Tucson production plant.

TEST, ANALYZE, AND FIX

Four early development missiles were dedicated to evaluate reliability and to identify problems so that fixes could be incorporated in the initial missile production lots. Under these tests, the various units are subjected to environments that simulate the critical environment parameters of captive flight.

At the Pacific Missile Test Center at Point Mugu, California, four Test, Analyze, and Fix missiles were undergoing testing for reliability and environmental effects. The power up sequence for one missile was incorrect, resulting in failures of its electronic unit's board and harness. The sequence error was caused by test set equipment problems and not by the missile. A second missile experienced a telemetry system failure. A third missile had a control section failure, caused by the accidental opening of the test chamber, that resulted in condensation damage to some of the missile's subcomponents. The three missiles, which were returned to Hughes for repair, have been reinstated in the test program. A fourth missile, delivered to the test center, failed twice during testing. After each failure, this missile was returned to the contractor for repair. At the end of March 1986, the missile had not been reintroduced into the test program.

CAPTIVE CARRY RELIABILITY PROGRAM

This program involves flight tests implemented in order to provide reliability data from operationally oriented missions and evaluation of the aircraft and missiles built-in test capability. At the end of February 1986, three captive carry reliability missiles were delivered to Nellis Air Force Base, Nevada, for reliability testing. Four additional reliability missiles were to be delivered to Nellis by the end of April 1986.

Testing began at Nellis in January 1985 using an F-16 aircraft and AIM-9 Sidewinder missiles. The tests involved flights using a modular rail launcher. A major portion of a second phase of testing involves the evaluation of the F-16's missile built-in test system capability. Software changes to the central interface unit and fire-control computers are to be made for F-16 aircraft/AMRAAM interface. Another testing stage is to begin in January 1987 and extend through April 1989. The F-15/AMRAAM interface is to be evaluated in this stage.

SAFE, ARM, AND FIRE QUALIFICATION TESTS

At the end of February 1986, Hughes was proceeding with qualification testing on the missile's fuze system. These tests verify the design for operational use. If the system fails in the flight termination system/range safety tests, the contractor recognizes that a redesign of the fuze may be required. These tests should be completed by October 1986.

INTEGRATION TESTS

These test are designed to validate the launch and communication capabilities between the AMRAAM missile and the aircraft that are to use it. Although early successes were achieved with integration tests, some problems occurred with the test missiles. Initial launches from F-15 and F-16 aircraft were successful; however, missiles sent to General Dynamics and McDonnell Douglas experienced built-in test failures. One missile had a telemetry unit failure and the other had a filter rectifier problem. These missiles were returned to the contractor for analysis and rework.

At the end of March 1986, these missiles were returned to Holloman Air Force Base, New Mexico, and the Pacific Missile Test Center, Point Mugu, California. The missile at Holloman is undergoing integration testing. The missile at the Pacific Missile Test Center was accidentally ejected from an F-18 aircraft during testing and is lost at sea. This missile is to be replaced in June 1986 with a missile which was scheduled to be used in the captive carry reliability test program.

AMRAAM
CAPTIVE EQUIPMENT TESTING
AS OF FEBRUARY 26, 1986

DESCRIPTION	FLIGHT PASSES		
	TAPE 1	TAPE 2	TAPE 3
System Checkout/Benign Target	30	26	16
Clutter	41	14	5
Clustered Targets	NOT TESTED		
Multiple Targets			3
Electronic Countermeasures and Chaff			13
Maneuvering Targets		25	
EMI/EMC (Electromagnetic Interference and Electromagnetic Compatibility)	NOT TESTED*		
Data Link Performance/Multipath	NOT TESTED*		
Target Calibration and Signature		10	
Electromagnetic Detection	NOT TESTED*		
Launch Profile Verification	205	216	91
Initialization/Alignments	NOT TESTED*		
Software Performance		1	
Seeker Multipath	NOT TESTED*		
Weapon System Compatibility	NOT TESTED*		
AFOTEC Captive Performance	NOT TESTED		
Contractor Development	17	86	53
Aircraft Radar Evaluation	___	11	___
Total Passes	293	389	181

Source: Hughes Aircraft Company for AMRAAM Quarterly Program Status Review with JSPO.

* Specific missions were not performed, but some test data was collected.

(392181)

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