UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

INSTITUTE FOR PROGRAM
EVALUATION

May 4, 1983

The Honorable David Pryor
United States Senate

Dear Senator Pryor:

As you requested on October 27, 1982, we have conducted a follow-up review of the IR Maverick program. The purpose of this letter and enclosures is to present the facts associated with the developmental and operational testing, the engineering design changes and the cost growth of the IR Maverick program. As you know, our letter report on the IR Maverick, published June 25, 1982, could not take advantage of all of the IOT&E data, since the complete IOT&E results were not published until December 1982.[1] We have therefore now obtained all of the IOT&E test data and are presenting this information here. In our search for other data, however, we have had disappointments in two areas: (1) no report on developmental testing (DT&E) or survivability analysis is available, and (2) we could not conduct pilot interviews because we were unable to grant the pilots confidentiality. The detailed statement of facts for each of these program segments is presented in Enclosure I. Below, I will highlight and summarize some of the major facts.

Although the need for the IR Maverick program, based on the serious Soviet threat to Central Europe, has not changed, the intended capability of the IR Maverick has changed. It has been redefined from "complete day/night/adverse weather system" to a system which will provide (1) a daytime capability in all terrain (2) a nighttime capability which is currently limited due to the fact that the aircraft do not have low-altitude capability which would enable them to fully utilize the capability of the missile at night and (3) a reduced visibility capability.

The tasks or missions for the employment of the IR Maverick have generally remained the same with one exception. The employment of the IR Maverick in the close air support environment has been further specified. In instances where

---

1 IOT&E is the initial operational test and evaluation which provides an estimate of the system's expected operational effectiveness and suitability.

(21, p. 3) Consequently, the problem of which we raised in our earlier report (GAO/C-IPE-82-1), may not be a problem of IR Maverick employment if it is not employed in close air support situations where

The quantity of missiles to be procured nearly doubled in 1980 from 31,113 to 60,697. According to TAC officials, these additional missiles are for use by the Rapid Deployment Force. The redefinition of the missile's capability has not affected the USAF's assessment of the quantity of missiles to be procured. However, OSD officials in the Program and Analysis (PA&E) group have plans to examine the USAF's assessment of quantity.

In the following sections, I have related some of the major facts of the developmental and operational testing of the IR Maverick to the six critical issues of the program, as defined by the U.S. Air Force in the Test and Evaluation Master Plan (TEMP) for this program. We examined all of these issues in our earlier report. The present discussion updates that report through the addition of the more recently acquired data.

1. The Adverse Weather Capability

Developmental testing on the adverse weather capability of the IR Maverick, although planned for, was never successfully conducted. Three months of tower testing resulted in poor quality data which could not be used to answer questions about the adverse weather capability of the IR Maverick seeker.

The results of operational testing in adverse weather are mixed.

In 1977, as a result of the Ft. Polk test, the USAF concluded, ". . .employment was successful. . . . ." (13, p. iv)

In 1978, as a result of the European test, the USAF concluded, "The IR tracker demonstrated remarkable capabilities at night,

(14, p. 83)

In 1982, as a result of the IOT&E, the USAF concluded, "Effects of rain, snow, and fog were not completely determined during the IOT&E. . .The missile is more

capable in snow, rain and fog than television-guided systems, but the limits of these capabilities are yet to be defined." (11, pp. 35, 83)

In addition, there has been only limited operational testing of the IR Maverick under conditions of reduced visibility. If one considers visibility of as "reduced," 3 of the 23 test missions in the Ft. Polk test, 1 of the 14 test missions in the European test and none of the IOT&E test missions were flown under conditions of reduced visibility.[2]

Operational testing is constrained by safe, peacetime flying requirements and consequently it is difficult to assess the adverse weather capabilities of the IR Maverick. However, an adverse weather assessment of the system could have been conducted as part of developmental testing, as was planned. The limits of the IR Maverick in adverse weather need to be specified, if as TAC has stated, a battlefield commander will use weather information to assist him in his selection of Maverick type. In addition, knowledge about the performance of the IR Maverick under various weather conditions is needed as a basis for using IR weather forecast techniques. At this time there are no plans for an adverse weather assessment of the IR Maverick.

2. Integration of the Missile System with the Aircraft and Acquisition Aids

The interoperability of the IR Maverick with the aircraft and acquisition aids was rated satisfactory in the IOT&E. However, some problems were reported. Two mission-essential service reports in the IOT&E involved the missile and the aircraft. One involved the F-16 which was not equipped with a target acquisition aid that could be used to position the IR Maverick. Thus, the interoperability of the IR Maverick with the F-16 was based on the pilot's ability to relate his visual cues to IR target area signatures. Although the F-16 is equipped with an inertial navigation system (INS) which provides steering information to the target area, the Another problem involved the F-4G aircraft and its APR-38 (acquisition aid). An occurred. These problems were expected to be correctable.

---

2 One countermeasure IOT&E mission was flown under conditions of reduced visibility.

3. IR Maverick Performance

Developmental and operational testing showed that the missile could be launched under various specified conditions. It was determined that IR Maverick performance in the

The IOT&E results suggest that IR Maverick performance is better at night than during the day. A better understanding of the effect of weather on thermal imagery could lead to a better understanding of this difference in performance. The IOT&E results also suggest that the benefits which could be gained from the use of acquisition aids are not fully realized. AFTEC officials have suggested that improved weather forecasting techniques which would result in a better prediction of lock-on range, are needed to capitalize on the potential improvements in performance affected by acquisition aids.

While the standoff capability of the IR Maverick is stated to be improved over that of the TV Maverick for all environments except the performance of the IR Maverick in terms of survivability of the aircraft has not been addressed. There is doubt that the profiles flown in the IOT&E are realistic in terms of surviving enemy air defenses. However, the ground troops did not use realistic evasive maneuvers in response to the air threat. Consequently, the validity of using IOT&E data to estimate survivability may be questionable.

The IR Maverick

.[3]

The Defense Intelligence Agency has stated that

The

---

[3] Susceptibility is defined as a system limitation or weakness.

USAF is not concerned about these threats, however, because of their belief that the Soviets will not find it feasible to implement these countermeasures anywhere.[4]

4. Visual, Day/Night Single-Seat Employment

In 1977, based on Ft. Polk test results, the USAF concluded that single-seat employment of the IR Maverick was successful both in daytime and nighttime. In the IOT&E, the single-seat A-10 and F-16 aircraft were used, but no conclusions specific to single-seat employment were made. Along with the two-seat F-4, it was recommended, based on IOT&E results, that the low-altitude capability of the A-10, F-16, F-4E and F-4G aircraft be enhanced to fully exploit the increased nighttime capability provided by the IR Maverick. USAF Studies and Analysis conducted a cost-effectiveness analysis of the IR Maverick which was based on the A-10 and F-16. They reported that "... the A-10 has a very limited night attack capability." In their analysis they considered of the A-10 missions to be day missions and night missions. They also assumed that the F-16 would have the projected as part of its multi-staged improvement program. Based on the USAF Studies and Analysis cost-effectiveness study, the IR Maverick whose performance tends to be better at night than during the day (see above, page 4, results of the IOT&E) is primarily targeted for single-seat aircraft. Yet, the nighttime capability of these aircraft is questionable.

5. IR Maverick Performance with Pave Penny Cueing

The IOT&E results showed that IR Maverick performance was enhanced by the use of the Pave Penny. However, the use of the Pave Penny depends on This was not tested.

6. IR Maverick Performance with Pave Tack and Wild Weasel Cueing

Problems with the Pave Tack and IR Maverick were reported in the IOT&E. Pave Tack switchology and inconsistencies in the IR Maverick field of view selection required workarounds and created an excessive workload on the aircrew. In other words, the Pave Tack, which is suppose to help direct the pilot to targets, did not work well. Along the same lines, a problem was also reported with the Wild Weasel (APR-38, as mentioned under issue #2) acquisition aid. In this instance, the Wild Weasel

---

[4] Feasibility is defined as the practicality and probability of an adversary exploiting a susceptibility in combat producing an unacceptable degradation in performance.

would erase all of its input to the IR Maverick (i.e., direction to the targets) when the pilot would manually direct the IR Maverick. Both of these problems, although reported to be correctable, have not yet been resolved.

In the next two sections, I briefly highlight facts about the operational suitability of the IR Maverick and program cost.

Operational Suitability and Engineering Design Changes

The operational suitability of the IR Maverick system was generally rated as deficient in the IOT&E. More specifically, the reliability, qualitative maintainability and the supportability of the IR Maverick software were all found to be deficient. A recent test program, the Reliability/Maintainability Validation Program has addressed some of these concerns, but only five missiles were used and no live launches were conducted. Although the System Program Office and the contractor, Hughes Aircraft Company, believe that most of these problems (i.e., operational suitability) have been fixed, AFTEC believes, as does OSD, that it is very important to further test reliability and maintainability in the FOT&E. OSD officials found it very difficult to assess the operational performance of the missile based on the IOT&E when the missile was frequently sent back to the contractor for repairs. According to the official FOT&E plan, operational suitability will be addressed in the FOT&E. In addition, proposed engineering design changes to improve producibility and reduce cost under ECP 604 will also be tested in the FOT&E.

Program Cost

The IR Maverick program has grown from the initial estimate in 1975 that 31,113 missiles would be purchased at a cost of $51,200 per missile for a total expenditure of $1,592.9 million to a December 1982 estimate of a total of $5,847.2 million for 60,697 missiles at $96,300 per missile. These recent cost estimates for the program include the expectation of saving $442.8 million through multiyear procurement and competitive second sourcing. The evidence is lacking that a $442.8 million saving is likely to occur. Furthermore, if at least this amount is not saved, an increase in program cost will result.

Observations

Let me conclude by commenting on the relationship of the new data to the questions we raised in our letter report (GAO/C-IPE-82-1) on the IR Maverick program.

(1) "Can the IR Maverick pilots navigate to an initial point over enemy territory at low-altitude, at night, and in poor weather?"

Based upon the IOT&E we have learned that the aircraft do not yet have a low-altitude night capability which would enable them to fully utilize the capability provided by the missile. No survivability analysis of the IOT&E test data has been conducted. Consequently, it is not possible to determine if the aircraft would survive its delivery of the IR Maverick over enemy territory. OSD has specified the issue of survivability as one needing further evaluation in the FOT&E.

(2) "Is the IR Maverick pilot workload in single-seat aircraft flown in poor weather a problem?"

Tactical Air Command (TAC) has redefined the capability of the IR Maverick to be one of reduced visibility, as opposed to adverse weather. However, all IOT&E test missions were flown with visibility conditions at or better.[5]

(3) Can pilots find valid targets in unfamiliar areas?

IOT&E pilots trained in the same area that the test missions were flown and test missions consisted of as many as fifteen passes during one mission. OSD has raised this issue as one that should be addressed in the FOT&E. As a result of this, the FOT&E plan has specified that training and testing will be on separate ranges, if possible, or at least separate sites. In addition, each F-16 pilot will fly two missions and each F-111 pilot will fly five missions. On each mission only two valid passes will be flown with run-ins separated by at least 90 degrees.

(4) Can pilots find targets in the absence of unique visual cues, as happens in poor weather?

As noted above, all IOT&E test missions were flown when visiblity conditions were or better. Acquisition aids, such as the Pave Tack, could aid the pilot in finding targets in the absence of visual cues. Only the F-111 aircraft is currently equipped with such a

---

5 One countermeasure IOT&E mission was flown with visibility conditions of .

system, however. The single-seat F-16 currently has no aid to find targets, but according to a USAF cost-effectiveness study, it is one of the two primary aircraft for employing the IR Maverick.

(5) Does the IR Maverick long employment range seriously handicap

Tactical Air Command (TAC) has respecified the employment of the IR Maverick in close air support missions when In such cases, the A-10 would use the 30mm cannon. Thus, TAC does not plan to use the IR Maverick in situations where

raised by us in our earlier report, has therefore, ceased to exist given respecification.

(6) Can problems of breaklock known to be caused by inadvertent and intentional countermeasures under test conditions be corrected?

One inadvertent countermeasure we discussed in our earlier report was Although it was anticipated that the could be corrected, all efforts during the IOT&E to solve this problem have been unsuccessful. Thus,
However, the respecification of the close air support task for the IR Maverick suggests that the IR Maverick will not be employed in situations where

Again, respecification has generally caused the problem to disappear.

Intentional countermeasures still cause breaklock problems, however, AFTEC has reported that the missile

They also report that, according to current intelligence estimates,

The question about the susceptibility of the IR Maverick to countermeasures has been empirically demonstrated. However, the capability

Summary

Of the six issues we raised in our earlier letter report five remain problematic and one, the problem of has been respecified (The other respecification, is only one aspect of the larger issue of countermeasures which remains problematic.). In addition to re-examining those six issues in light of recent data, our present review has included two additional issues, operational suitability and program cost. Both AFTEC and OSD believe that the operational suitability of the IR Maverick needs further evaluation. The program cost has grown from the time of our letter report from $4.9 to $5.8 billion dollars. Savings are expected, but we find that the evidence for these is either lacking or unconvincing. Consequently, the program cost may grow further should these specified savings fail to occur.

Sincerely yours,

Eleanor Chelimsky
Director

Kwai Chan

THE USAF's IR MAVERICK PROGRAM

Transmittal letter
and
Statement of fact

"NATIONAL SECURITY INFORMATION"
UNAUTHORIZED DISCLOSURE SUBJECT
TO CRIMINAL SANCTIONS

Classified by Maverick Security Guide
Declassify on October 31,1998

MAY 4,1983

ALL CLASSIFIED INFORMATION HAS
BEEN REMOVED FROM THIS REPORT

ENCLOSURE I

THE USAF'S IR MAVERICK PROGRAM

STATEMENT OF FACT

TABLE OF CONTENTS

As requested in the letter of October 27, 1982 from Senator Pryor to GAO, we obtained the following information in interviews and from available documentation. Our sources are listed in enclosure II. We present the information obtained in three major sections: (1) the need, intended capability and operational tasks for the IR Maverick system, [1] (2) the developmental and operational testing and evaluation, and (3) the program cost growth.

I. THE NEED, INTENDED CAPABILITY AND OPERATIONAL TASKS FOR THE IR MAVERICK SYSTEM

In this section, we present the need, intended capability and operational tasks for the IR Maverick system as the USAF has defined them. In particular, recent changes in the documented capability and operational tasks of the IR Maverick are highlighted.

A. The Need for the IR Maverick

The need for the IR Maverick is defined in the Decision Coordinating Paper No. 154 dated August 23, 1976. It is as follows:

> "The need for IIR Maverick is based on the serious threat to the security of Central Europe posed by the Warsaw Pact conventional ground forces and their current doctrine of employment. To counter this threat, the tactical air forces must be capable of rapid response in both day, night and adverse weather conditions, must have maximum flexibility in weapons employment, and must maintain aircraft maneuverability to operate in an environment of integrated air defense systems." (8, p. 2; emphasis added)

B. The Intended Capability of the IR Maverick

The capability of the IR Maverick is defined in various sources. In some sources the capability has been revised from the original statement. The capability statement for the IR

---

[1] The term, IIR Maverick (which stands for imaging infrared Maverick) is used interchangeably with the term IR Maverick.

Maverick in the Decision Coordinating Paper corresponds to the original.[2] According to this document,

> "The IIR Maverick will provide a high single pass kill capability against surface targets during day, night and adverse weather conditions. . .It will operate during day or night adverse weather conditions but will not be capable of 'seeing' through heavy fog or cloud ceilings." (8, p.1)

The same document also notes the following advantage,

> "Initiation of IIR Maverick FSD contract in FY77 provides for proper time phasing of the missile with acquisition systems and aircraft modification programs which will result in the deployment of a complete day/night/adverse weather system." (8, p. 22; emphasis added)

The December 31, 1981 Selected Acquisition Report (SAR) stated that the IR Maverick is "designed to destroy small hard tactical targets during day or night even under adverse weather conditions. . ." (25, p. 2; emphasis added) This was revised in the March 31, 1982 SAR which stated that the IR Maverick is "designed to destroy small hard tactical targets during day or night even under limited adverse weather conditions. . ." (26, p. 2; emphasis added) No explanation is provided for this revision to "limited adverse weather" nor is any definition given.

The System Operational Concept for the IR Maverick has also been revised. The original document, dated October 30, 1979, stated that,

> "The Infrared (IR) Maverick system will augment the TV Maverick during daylight and also provide a night and limited visibility capability. . .It is designed to have an autonomous night, clear air mass capability not available in the AGM 65A or B and to have improved performance in adverse weather conditions." (20, p. 2-1, 3-4; emphasis added)

In January of 1983, the Tactical Air Command (TAC) revised the System Operational Concept dated October 30, 1979. According to TAC, "this revision is intended to address OSD concerns about

---

[2]This document was one of four documents that providedauthority and background for the USAF's IR Maverick IOT&E. which was conducted from February 1981 to August 1982.

the intended Maverick employment and ultimately used as a basis for justification for continued production funding." With respect to the passage we have quoted immediately above, the revisions are as follows:

> "The Infrared (IR) Maverick system will augment the TV Maverick during daylight and also provide a night and reduced visibility capability. Recent improvements in weather forecasting designed to predict conditions suitable for imaging infrared techniques can assist the commander in the selection of the Maverick type. IR Maverick is well suited for conditions of high thermal contrast while TV Maverick is more suited for conditions of high thermal clutter such as hot, dry, desert conditions. . . It is designed to have an autonomous night, clear air mass capability not available in the AGM 65A or B and to have improved performance in reduced visibility conditions." (21, pp. 2,5; emphasis added to denote changes)

In an interview, TAC officials further defined "reduced visibility" conditions as conditions of "low visual contrast." For examples of "low visual contrast" conditions, they gave "flying into the setting sun", "haze", "camouflage", and "drab" (i.e., settings characterized by dull grey or brown colors). TAC officials also stated that it was never intended for the IR Maverick to be used in bad weather conditions such as rain and snow.

C. Change in Operational Tasks for IR Maverick

According to its System Operational Concept (SOC) the Maverick will have five tasks which are:

-close air support
-battlefield air interdiction
-air interdiction
-defense suppression
-offensive counter air.[3]

The description of the close air support task was revised by TAC in January of 1983. The first segment of the description has remained the same.

---

[3]The offensive counter air task was listed in first place in the SOC dated October 1979. However, the recent revisions tothis SOC moved it to a lower ranking, based on the rationale that, "this order of precedence is more consistent with planned employment of Mavericks." (22, p. 3)

"The Maverick weapon system will be employed against enemy armor threats along the FEBA. This will include air attacks against hostile targets which are engaged with friendly forces and which require detailed integration of each air mission with the fire and movement of those forces. The use of the Maverick, as with any munition, when used in an area where there are troops fighting at close quarters will be situation dependent. The accuracy and fragmentation of the Maverick with the shaped charge warhead does not preclude its use against any compatible target in close proximity to friendly forces." (20, pp. 2-1, 2-2) [4]

The second segment of this description as stated in the October 1979 SOC was as follows:

"However, a requirement would exist for positive identification of friendly and enemy targets, particularly at night or in low visibility conditions, before employment of either the IR or TV Maverick. The pinpoint accuracy and dependability required when operating near friendly troops or for hitting individual small targets necessitate a precision munition such as the Maverick." (20, p. 2-2)

The second segment, from the January 1983 TAC revisions to the SOC, is as follows:

"However, the use of the IR Maverick is dependent upon a or the use of other means of differentiating friend from foe, such as Pave Penny designation and instructions from ground or airborne forward air controllers. In addition, innovative tactics involving combined attacks by teams of A-10s and helicopter gunships improve this ability. During those instances when A-10s may be forced to rely on close-in visual attacks utilizing the 30mmcannon. During these times, IR Maverick attacks will be The pin-point accuracy of the IR Maverick is of additional value in CAS situations which preclude the use of area weapons such as combined effects munition (CEM), Rockeye and sensor fused weapons." (21, pp. 2-3)

TAC officials stated that they could not identify what proportion of the IR Mavericks would likely be used in each of the five specified tasks.

---

[4]FEBA is the forward edge of the battle area.

II. DEVELOPMENTAL AND OPERATIONAL TEST AND EVALUATION

In this section, we present information on the IR Maverick Development Test and Evaluation (DT&E) and Operational Test and Evaluation (OT&E) combined program.

A. Definition of Terms

There are two basic types of test and evaluation performed by DOD: Development Test and Evaluation (DT&E) and Operational Test and Evaluation (OT&E). According to Air Force Regulation 80-14,

> "DT&E is conducted to demonstrate that engineering design and development are complete, that design risks have been minimized, and that the system will meet engineering and operational specifications. DT&E is essentially a detailed engineering analysis of a system's performance (beginning with individual subsystems and progressing through a complete system), where system design is tested and evaluated against engineering and performance criteria by the implementing command.
>
> OT&E is conducted to estimate a prospective system's operational effectiveness and operational suitability, and to identify any operational deficiencies and need for any modifications. In addition, OT&E provides information on organization, personnel requirements, doctrine and tactics. OT&E is essentially an operational assessment of a system's performance where the complete system is tested and evaluated against operational criteria (requirement and employment concepts) by personnel with the same qualifications as those who operate, maintain and support the system when deployed." (6, p.2)

In addition, AF Regulation 80-14, notes that,

> "Operational testing should be sperate from developmental testing. However, early phases of OT&E may need to be combined with development testing where separation would cause delays involving unacceptable military risk, or would cause an unacceptable increase in the cost of the system." (6, p.2)

B. The IR Maverick Combined DT&E and OT&E Program

For the IR Maverick, a development test and evaluation (DT&E) and an initial operational test and evaluation were combined.[5] The system program officer stated that although the program was to be a combined program, it was never planned to be as intertwined as it turned out to be. OSD officials stated that it is very difficult to assess the OT&E results because the missile was still in the developmental stage and was sent back to the contractor for repairs during the OT&E.

1. Purpose of the combined program

According to the Test and Evaluation Master Plan (TEMP) for the IR Maverick, dated April 15, 1980, the purpose of the combined test was to:

> "Evaluate capability in limited visibility and night operations.
> Evaluate lock-on and tracking capability.
> Evaluate accuracy and trajectory characteristics within the specified launch envelope.
> Evaluate reliability, maintainability, availability.
> Evaluate military operational suitability and effectiveness." (9, p.12)

More specifically, the TEMP stated that the critical issues to be addressed by all phases of test and evaluation during engineering development were the following six:

> "1. The adverse weather capability of the IR MAVERICK weapon system.
>
> 2. The integration of the missile system with the aircraft and aircraft acquisition aids to provide a weapon system of high utility in target acquisition and target handover from acquisition aids to the missile system.

---

[5]IOT&E is the initial phase of OT&E and provides an estimateof a system's expected operational effectiveness andsuitability. IOT&E ends with the first major production decision. Thereafter, follow-on operational testing and evaluation (FOT&E) continues to refine estimates of the system's military utility in order to inform further production decisions and any necessary system configuration changes.

3. Validation of general MAVERICK missile launch condition flexibility, launch standoff range capability, and missile performance with the IR guidance and control section.

4. Validation of visual day/night single seat attack capability.

5. Validation of the use of PAVE PENNY cueing for day/night single seat attack in visibility conditions beyond the visual target acquisition range of the pilot.

6. Validation of use with PAVE TACK and Wild Weasel acquisition aids." (9, pp. 3-4)

2. Status of Testing

a. DT&E

DT&E on the IR Maverick consisted of 14 live launches, which were conducted from December 1980 to April 1982 at Eglin AFB, Florida; Ft. Riley, Kansas; and the Utah Test and Training Range, Utah. Some captive-carry missions were also conducted for the purposes of software evaluation. No USAF DT&E report has been published at this time.

b. IOT&E

IOT&E on the IR Maverick was conducted from February 1981 to August 1982 at Ft. Riley, Kansas; Eglin AFB, Florida; Ft. Drum, New York; the Naval Weapons Center (NWC), China Lake, California; and the Utah Test and Training Range (UTTR), Utah. The missile was flown on A-10, F-4E, F-4G, F-16, and F-111F aircraft. The test scenarios consisted of close air support, battlefield and preplanned interdiction, defense suppression, and hunter-killer situations. Special testing considered armor Red, versus Blue scenarios, susceptibility to IR countermeasures compatibility with other aircraft systems. In the IOT&E, there were 52 training missions, 12 live launches, 48 captive-carry missions, and 27 1/2 special testing captive-carry missions. The final IOT&E report was published late in December 1982. In table 1, we present the overall IOT&E evaluation criteria and the reported results.

Table 1

IOT&E EVALUATION CRITERIA AND RESULTS

Measure of Effectiveness	Threshold a/	Goal b/	IOT&E result	Performance c/
Probability of launching against a valid target d/				
Probability of maintaining lock				
Probability of hit e/				
Accuracy of inherent thermal contrast forecast				
Accuracy of acquisition and lock-on range forecasts				
Incoming reliability				
Logistics reliability				
Mission hardware reliability				
Maintainability (in mean time)				
Remove and replace guidance and control sections				
Remove and replace hydraulic actuation system				
Remove missile from container				
To shop checkout (single missile)				
Break out of storage (single missile)				
Run cluster test				
Load cluster				
Load single missile on triple rail launcher				
Load single rail launcher				
Maintainability of seeker software				
Documentation source listings				
Usability of support equipment software operator machine interface				
Maintainability of support equipment software				
Availability				

NOTES: This table was derived from the IOT&E Final Test Report.

a/A threshold is the quantitative or qualitative minimum level of performance or capability that is required for a mission's accomplishment.

b/A goal is the quantitative or qualitative level of performance or capability that is required to improve the system or is a new requirement identified after milestone II (i.e., full-scale engineering decision).

c/Performance is excellent if it meets or exceeds a goal, satisfactory if it lies between a threshold and a goal, or deficient if it falls below a threshold and, thus, indicates the necessity for a modification of the system, continued development of it, a change in its operational or maintenance concepts, or "workarounds" to meet the minimum operational requirements. Performance is undetermined for levels that have not been tested or that have been tested insufficiently to support a conclusion.

d/Probability of launching against a valid target is the ratio of the number of launches against a valid target to the total number of launches.

e/Probability of hit is the ratio of the number of missiles which hit the intended target to the total number of launches [note only live launches considered].

c. Reliability/Maintainability Validation Program

At the IR Maverick Program Review in March 1982, the Office of the Secretary of Defense (OSD) directed that another test program, the Reliability/Maintainability Validation Program (RMVP), be conducted to identify the effect of reliability and maintainability improvements on the preproduction missiles. The RMVP was conducted at Nellis AFB, Nevada, from December 20, 1982, to January 21, 1983.

d. FOT&E

The follow-on test and evaluation (FOT&E) of the IR Maverick program is currently in the planning stage. The USAF submitted an FOT&E test plan to OSD on April 1, 1983. According to this plan, AFTEC believes the following issues require further evaluation: (1) operational suitability, (2) verifica-tion of missile fixes, (3) need for ground boresight and (4) IR weather forecast techniques. In addition, this test plan notes that OSD proposed the following test issues: (1) operational suitability, (2) target acquisition in unfamiliar terrain, day and night, in the battlefield and pre-planned interdiction roles, (3) delivery aircraft survivability and (4) the impact of ECP-604 on performance. Three phases of FOT&E are planned. Phase I will take from June through September 1984 and will evaluate the issues AFTEC raised. Phase II will take place from October through November 1984 and will evaluate the issues OSD raised. Phase III will take place in 1985 and will evaluate the impact of ECP-604.

In the following sections, we discuss the details of these programs as they relate to live launch missions, the operational effectiveness of the IR Maverick system, and its operational suitability and engineering design changes.

C. Results from Live Launches

1. Overall Results

Live launches were conducted during the test programs to verify the missile's launch transient survivability, free-flight performance and terminal accuracy. In table 2, we present the dates and results of the 26 live launches. We have included the explanations for the misses provided by the System Program Officer (SPO) in the briefing at the September 1982 OSD program review. According to the SPO, corrections for 4 of the misses

TABLE 2

Live Launches-Dates and Outcomes

Launch #	Test	Date	Outcome	Comments
1	DT&E	Dec. 4 80		
2	DT&E	Dec. 12 80		
3	DT&E	Jan. 23 81		
4	DT&E	Feb. 4 81		
5	DT&E	Feb. 22 81		
6	IOT&E	Mar. 2 81		
7	DT&E	Mar. 28 81		
8	DT&E	Apr. 7 81		
9	DT&E	Jun. 19 81		
10	DT&E	Aug. 25 81		
11	DT&E	Sep. 3 81		
12	IOT&E	Oct. 8 81		
13	DT&E	Nov. 23 81		
14	DT&E	Dec. 3 81		
15	IOT&E	Dec. 12 81		
16	IOT&E	Apr. 2 82		
17	DT&E	Apr. 9 82		
18	DT&E	Apr. 13 82		
19	IOT&E	May 7 82		
20	IOT&E	May 15 82		
21	IOT&E	May 15 82		
22	IOT&E	Jun. 18 82		
23	IOT&E	Jul. 13 82		
24	IOT&E	Jul. 13 82		
25	IOT&E	Aug. 7 82	HIT	
26	IOT&E	Aug. 17 82	HIT	

had been validated in the subsequent DT&E and IOT&E launches and were still to be validated in the RMVP, but no live launches were conducted in the RMVP. Corrections for one of the two missile failures on July 13, 1982 (launch #24), will not be evaluated until the FOT&E; the exact cause of the other (launch #23) could not be determined because there was no telemetry data.

2. DT&E Results

The TEMP states that "a minimum of 16 free-flight launches will be conducted to satisfy primary DT&E objectives." Fourteen DT&E free-flight, or live, launches were conducted. Of these 14 launches, there were (yielding a probability of success).

The TEMP states the conditions that were planned for the 5 launches to be made by the contractor and the 11 to be made by the Air Force in the DT&E [6]. The five contractor DT&E live launches and ten of the eleven USAF DT&E launches that were planned were conducted.

3. IOT&E Results

Twelve IOT&E live launches were conducted. Of these 12 launches, there were The IOT&E threshold for the probability of hit (defined in Table 1, note a) was and the goal was The IOT&E test data show the result as probability of hit, which exceeded the threshold but did not meet the goal. In the 1976 Decision Coordinating Paper for the IR Maverick the values of this threshold and goal are different. It is stated that the threshold for the probability of hit is and the goal is and that a probability of hit had been demonstrated at that time.

The conditions of the IOT&E launches are presented in the IOT&E test report. Ten live IOT&E launches were planned to assess probability of hit. The conditions of these 10 launches were met, with the following exceptions. The F-16 launches (#20 and #21) were planned as day launches but were conducted at night due to the difficulty of employing the IR Maverick in a environment. The F-4G launch (# 19) was to be a night launch but was conducted at dawn. The F-111 day mission (#22) was to be conducted with the Pave Tack as an acquisition aid, but the Pave Tack was not used because it was not working

---

[6]Launch conditions include factors such as, the time of day, target, altitude, dive angle, slant range, aircraft, aircraft speed and objective of each launch.

at the time. In addition, 2 launches were added to the original 10. These launches were conducted with the A-10 in the desert at dawn (#25) and at night (#26). According to the TEMP, a live launch with intentional countermeasures was to be conducted. USAF documentation shows that the second live launch that was scheduled, was to be flown with

The following quotation presents the reason the Air Force gave for canceling the launch:

(15, pp. 2-3)

The overall effect of these test changes on the evaluation criteria, the probability of hit, is unknown.

D. Operational Effectiveness

Of the five IOT&E objectives which dealt with the operationaeffectiveness of the IR Maverick, three involved evaluating the IMaverick's

--operational performance under day and night conditions,
--compatibility with other onboard aircraft systems, and
--interoperability with other systems.

In addition the IOT&E was to address the

--survivability of the delivery aircraft during weapons delivered and
--accuracy and utility of weather forecast techniques for u potential aids in operational employment decisions for th Maverick.

In this section we present the IOT&E results on each of these objectives and, where applicable, we present information from

past operational testing and operational testing planned for the future.

1. Operational performance

To engage a target, a pilot flies to an initial point or to a rendevous point, acquires a target area, [7] transfers the target to the IR video display, detects and acquires a target on the IR video display, locks onto the target and finally launches the IR missile. Acquisition aids such as the Pave Penny, the Pave Tack, and the Wild Weasel APR-38 system may be used for initial target acquisition and recognition before transferring to the missile for launch. In this section, we present information on the operational performance of the IR Maverick system.

a. Finding the target area and the targets

In the IOT&E, pilots aborted a pass if they could not find a target within an acceptable time. No specific acceptable time was defined. Table 3 presents the abort rates for the Ft. Polk test, the European test and the IOT&E [8]. The overall abort rate in the 1977 Ft. Polk test to in the recently completed IOT&E.

Table 4 presents the IOT&E abort rates for each aircraft and mission by the time of day. Abort rates

Table 5 presents the IOT&E abort rates for each aircraft and mission by acquisition aids. Abort rates for visual acquisition for all aircraft and mission groups where

---

[7]The following describes acquiring a target area:"using his acquisition or cueing aid, the pilot adjusts the attitude of th aircraft so that his gunsight reticle ('pipper') is on the prob target area." (43, p. II-11)

[8]It should be noted that no statistical significance is discussed with respect to these figures.

Table 3

Abort Rates

	Ft. Polk 1977				Europe 1978				IOT&E 1981-1982												
									Ft Riley				Ft Drum	Eglin	NWC	UTTR					
Aircraft & Mission	A-7 PPI	A-7 CAS	A-10 CAS	A-10[b] CAS	A-10 CAS	A-10[b] CAS	F-4 CAS	F-4 PPI	A-10 CAS I	A-10[b] CAS I	A-10 CAS II	A-10[b] CAS II	A-10 BI	F4E BI	F4G DS	F-16 BI	F-16 HK	F-111F BI	F-111F HK	F-111F PPI	
No. of passes																					
No of aborts																					
% abort rate																					
% overall abort rate																					

Notes: [a]/ Missions are as follows: PPI is preplanned interdiction
CAS is close-air support
CASI is close-air support with tanks firing their main guns.
CASII is close-air support with tanks firing their main guns and receiving return fire from a defensive armored force that was sometimes in a retreating posture.
BI is battlefield interdiction
DS is defense suppression
HK is a hunter-killer mission.

[b]/ With the Pave Penny, a sensor for acquiring laser-designated targets.

[c]/ These figures differ from our June 25, 1982, letter report (GAO/C-IPE-82-1) because four passes were excluded from the IOT&E data base as "no test" passes.

Table 4

IOT&E Abort Rates by Time of Day

Aircraft	Mission[a]	Time of Day			
		Dawn	Day	Twilight	Night
A-10	CAS I				
	CAS II				
	BI				
F-4E	BI				
F-4G	DS				
F-16	BI				
	HK				
F-111F	BI				
	HK				
	PPI				
Total	—				

Notes: a/ Missions are described in footnote a to Table 3.
b/ No. of aborts/No. of passes
c/ Abort rate

Table 5

IOT&E Abort Rates by Acquisition Aids

Aircraft	Mission[a]	Acquistion Aid				
		Visual	Pave Penny	INS	APR38	Pave Tack
A-10	CAS I					
	CAS II					
	BI					
F-4E	BI					
F-4G	DS					
F-16	BI					
	HK					
F-111F	BI					
	HK					
	PPI					
Total						

Notes:a/ Missions are described in footnote a to Table 3.
b/ No. of aborts/No. of passes
c/ Abort rate

comparisons could be made with one exception. The abort rate for F-16 BI missions was for visual acquisition in comparison to INS acquisition Overall, the abort rate for visual acquisition was lower than Pave Penny, INS, APR-38 and Pave Tack acquisition (25%).[9]

In an earlier report (GAO/C-IPE-82-1) on the IR Maverick, we noted that the abort rates for A-10 CAS missions were based upon the Ft. Polk and European test results. In the IOT&E the abort rate for A-10 CAS missions was with the Pave Penny and without it (See Table 3). The abort rate with the Pave Penny has Another comparison with past operational testing involves the abort rate for the European test and the IOT&E Ft. Drum missions. AFTEC reported that the weather experienced at Ft. Drum was representative of European weather. The abort rate for missions flown at Ft. Drum was This was than the abort rate for missions flown during the European test (See Table 3).

The abort rate in the IOT&E occurred during F-111 preplanned interdiction scenarios. These captive-carry missions were flown against a simulated petroleum, oil and lubricants (POL) storage facility. The target array consisted of 2 empty berms, a berm filled with a large aviation fuel bladder and 192 55-gallon drums. Only the fuel bladder and 55 gallon drums were considered valid targets. On PPI missions the pilots were prebriefed on the exact target locations. One pilot flew all the F-111 PPI missions.

In our earlier report (GAO/C-IPE-82-1) we discussed the inadequacies of the simulation of pathfinder aircraft in past testing. In the IOT&E a hunter-killer scenario was flown against a target array consisting of two convoys. In this scenario the F-111F acquired the target array with Pave Tack, attempted to launch on a valid target and then passed targeting information to the F-16. The F-16, then attempted to attack the same group of targets. The abort rates were, for the F111F and for the F-16.

---

[9]These figures are based upon detailed AFTEC documentation. These figures are different from those reported in the IOT&E Final Test Report, where it was stated ". . .tactical aircrews acquired targets and simulated launch on percent of the passes made utilizing visual only acquisition. This value was percent when acquisition was added by Pave Penny, Pave Tack, APR 38 or intertial navigation systems INS."(11, p. 1) (i.e., and abort rates, respectively).

b. Acquiring a valid target

The valid targets in the IOT&E were surrogates for Soviet vehicles. AFTEC reports this as a limiting factor of the testing. AFTEC reports,

(11, p. 7)

In some cases were also used in captive-carry missions. AFTEC tried to by various means. However, according to AFTEC officials, this attempt was not very successful.

Rates of success at finding valid targets are shown in Table 6, reporting the percentage of valid targets per simulated launch and the percentage of valid targets per pass for the tests at Ft. Polk, in Europe and the IOT&E. The overall rates of acquiring valid targets rose from Ft. Polk to the European test, but declined from the European test to the IOT&E.

The weather experienced at Ft. Drum was representative of European weather. The rate of acquiring valid targets per launch at Ft. Drum was This was lower than the overall rate of acquiring valid targets per launch for missions flown during the European test.

As shown in Table 1, the goal for the probability of launching against a valid target is and the threshold is Overall, the threshold was met, demonstrating satisfactory performance. Table 6 shows that four categories, the A-10 CAS I, F-4E BI, F-16 BI and F111F BI resulted in a probability of launching against a valid target which equalled or exceeded Two categories, the A-10 CAS II, and the A-10 BI missions resulted in a probability equal to or greater than Four categories, the F4G-DS, the F-16 HK, the F111F HK and the F111F PPI resulted in a probability of less than

Rates of success at acquiring valid targets per launch by the time of day are presented in Table 7. AFTEC concluded that the same probability of launch against a valid target was demonstrated both day and night. However, the rate of acquiring valid targets was during day missions than night missions As mentioned earlier, AFTEC reported that the employment of the IR Maverick was limited

Table 6

Valid Target Acquisition Rates

	Ft. Polk 1977				Europe 1978				IOT&E 1981-1982												
									† Riley				Ft Drum	Eglin	NWC	UTTR					
Aircraft	A-7	A-7	A-10	A-10b	A-10	A-10b	F-4	F-4	A-10	A-10[b]	A-10	A-10[b]	A-10	F4E	F4G	F-16	F-16	F-111F	F-111F	F-111F
Mission [a]	PPI	CAS	CAS	CAS	CAS	CAS	CAS	PPI	CASI	CASI	CASII	CASII	BI	BI	DS	BI	HK	BI	HK	PPI
No. of passes																				
% valid targets acquired per launch																				
per pass																				
% overall valid targets acquired per launch																				
per pass																				

Notes: [a]/Abbreviations for missions can be found in footnote a to Table 3.

[b]/With the Pave Penny, a sensor for acquiring laser-designated targets.

Table 7

IOT&E Valid Target Acquisition Rates by Time of Day

Aircraft	Mission a/	Time of Day			
		Dawn	Day	Twilight	Night
A-10	CAS I				
	CAS II				
	BI				
F-4E	BI				
F-4G	DS				
F-16	BI				
	HK				
F-111F	BI				
	HK				
	PPI				
TOTAL					

Notes: a/Abbreviations for missions are described in footnote a to Table 3.
b/No. of valid targets acquired/no. of simulated launches.
c/Valid target acquisition rate per launch.

Excluding the passes flown in the desert at UTTR, the rate of acquiring valid targets was during day missions than night missions

Table 8 presents the rates of success at finding valid targets per launch by the various acquisition aids including visual acquisition. Overall, the rate of finding valid targets was when employing various acquisition aids than when only using visual acquisition

Earlier it was noted that four categories of missions, the F4G-DS, the F-16 HK, the F111-HK and the F111 PPI resulted in a probability of attacking a valid target of Tables 7 and 8 show that time of day and acquisition aids do not increase this probability for any of these categories with one exception. The F111F PPI night mission which, however, is only based on one pass did acquire a valid target successfully.

c. Target area acquisition and lock-on ranges, and wings level time to lock on.

In IOT&E the range at which the target area was acquired and lock-on achieved were recorded. In addition, the time from reaching wings-level to lock on, was also recorded.

AFTEC reported that "visual only acquisition resulted in an average acquisition range of Where acquisition was aided by Pave Penny, Pave Tack, APR-38 and INS, the average acquisition range was [10] (11, p. 21) This only represents valid target acquisition passes, not all passes. AFTEC also reported that this represented a in acquisition range.

Table 9 shows the target area acquisition ranges by aircraft and acquisition aid. The percent improvement over visual acquisition is presented for the cases where a comparison is possible. The

in acquisition range existed for the A-10 Pave Penny passes. A in acquisition range existed for the A-10 INS passes. The F-16 INS passes resulted in a in acquisition ranges. No other comparisons existed.

---

[10] A re-examination of AFTEC documentation for this analysis suggests that the figure of If this is the case, this would not represent a in acquisition range, but a

Table 8

IOT&E Valid Target Acquisition Rates by Acquisition Aids

Aircraft	Mission a/	Acquisition Aid				
		Visual	Pave Penny	INS	APR-38	Pave Tack
A-10	CAS I					
	CAS II					
	BI					
F-4E	BI					
F-4G	DS					
F-16	BI					
	HK					
F-111F	BI					
	HK					
	PPI					
	TOTAL	VISUAL	ALL OTHER AIDS			

Notes: a/Abbreviations for missions are described in footnote a to Table 3.
b/No. of simulated launches/no. of valid targets acquired.
c/Valid target acquisition rate per launch.

Table 9
TARGET AREA ACQUISITION RANGES
BY AIRCRAFT AND ACQUISITION AIDS

Aircraft	Aid	Average range (ft)	No.	% improvement over visual acquisition
A-10	Pave Penny INS Visual			
F-4E	INS			
F-4G	APR-38 Visual			
F-16	INS Visual			
F-111	Pave Tack INS			

Notes: a/Pave Penny is a sensor for acquiring laser-designated targets.
INS is the intertial navigation system.
APR-38, also known as Wild Weasel, is a sensor for locating radar emissions.
Pave Tack is a forward-looking infrared system.

Based upon AFTEC test documentation, the average lock-on range for all valid target visual only acquisition passes was feet. The lock-on range for valid target passes when acquisition was aided by the Pave Penny, Pave Tack, APR-38 and INS was This represented a in lock-on range when acquisition was aided.

Table 10 shows the lock-on ranges by aircraft and acquisition aid. Four comparisons are provided. A in lock-on range existed for A-10 Pave Penny passes and a for A-10 INS passes. The other two comparisons are based on a small number of passes. A in lock-on range existed for F-4G APR-38 passes and a for F-16 INS passes.

AFTEC stated that it was their opinion that the reason whythe increase in lock-on ranges with acquisition aids was not as great as the increase in target area acquisition ranges, was due to poor forecasting of lock-on ranges. In other words, the pilots were not given accurate ranges at which lock-on could be achieved.

AFTEC also found that lock-on and simulated launch ranges for the IR Maverick were greater than for the TV Maverick under most conditions. Table 11 presents the average lock-on and launch ranges for the IR Maverick based upon the IOT&E results and for the TV Maverick based upon the operational TV Maverick ranges compiled by TAWC and published in their periodical, Tactical Analysis for Systems, Weapons and Training. Aircrew comments indicated that the TV Maverick performance exceeded that of the IR Maverick in the daytime desert.[11]

Based upon AFTEC test documentation, the average time from wings-level to lock-on for all valid-target, visual-only acquisition passes was The amount of time from wings-level to lock-on is important in terms of aircraft survivability. The average time from wings-level to lock-on for valid target passes when acquisition was aided by the Pave Penny, Pave Tack, APR-38 and INS was

---

[11] A comparison of the IOT&E Ft Riley CAS day visual acquisition passes to the TV Maverick passes in TASVAL (ajoint test and evaluation which examined the A-10 in a CAS scenario) show that the average launch range in the IOT&E Ft. Riley CAS passes with the IR Maverick was in comparison to an average launch range of with the TV Maverick in TASVAL. However, in the TASVAL test scenario, in the Ft. Riley test scenario.

Table 10

LOCK-ON ACQUISITION RANGES
BY AIRCRAFT AND ACQUISITION AIDS

Aircraft	a Aid	Average range(Ft)	N	% improvement over visual acquisition
A-10	Pave Penny			
	INS			
	Visual			
F-4E	INS			
F-4G	APR38			
	Visual			
F-16	INS			
	Visual			
F-111	Pave Tack			
	INS			

Notes: a/Aids are described in footnote a to Table 9.

Table 11

COMPARISON OF IR/TV EMPLOYMENT RANGES

Conditions	Time of day	Ranges: Combined AGM-65A/B[a]	Ranges: AGM-65D[b]
Lock-on	Day		
	Night		
Launch	Day		
	Night		

Notes:
a. TV Maverick
b. IR Maverick

Source: AGM-65D Infrared Maverick Initial Operational Test and Evaluation FINAL REPORT, December 1982, p. 42.

A more detailed examination of wings-level to lock-on time is presented in Table 12. Only three comparisons between visual and other aids can be made. The A-10 passes with Pave Penny were than the visual passes. The A-10 passes with the INS were than the visual passes. The F4G-APR-38 passes took than the visual passes.

d. Missile dome covers

Missiles were not flown with dome covers during the IOT&E. The missiles were boresighted with acquisition aids by the aircrew prior to takeoff. In other words, the pilots would align the missile with the acquisition aid. During the nearly 300 hours of captive flight in the IOT&E, the missile domes were not damaged. AFTEC has stated that "With dome covers installed this highly desirable capability will be lost and boresight errors could put the target outside the FOV." (11, p. 26) The requirement for dome covers is currently being studied by the System Program Office.

e. Breaklocks

In order to kill the enemy, a pilot carrying the IR Maverick missile must acquire a valid target and launch the missile, and the missile must stay locked onto the target until it intercepts it. Loss of contact with the intended target is called breaklock.

The technical definition of breaklocks in the IOT&E differed from the Ft. Polk and European tests. Thus, it is not possible to compare, the IOT&E breaklock rate to past testing. In the European test a breaklock was defined as, "the tracker losing the target (tracking gate drifts off the target) without pilot action." (14, p. 55) In the IOT&E breaklocks were categorized as intentional or unintentional. Intentional breaklocks were not counted against missile performance. "Intentional breaklocks were those that were test induced (i.e., resulted from improper aircraft simulation of missile flight), pilot initiated, or software induced (e.g., captive missile software reacted differently than free-flight software). . .Unintentional breaklocks were those caused by environmental conditions and missile deficiencies. Only one category of unintentional breaklocks was not counted against missile performance. Breaklocks caused by obscuration by a terrain feature but which occurred after a free-flight missile would have impacted were not counted." (11, p. 28)

Overall, in the IOT&E, the probability of maintaining lock, based upon the number of unintentional breaklocks was This the threshold of and demonstrated satisfactory performance.

Table 12

WINGS LEVEL TO LOCK-ON TIME
BY AIRCRAFT AND ACQUISITION AID

Aircraft	Aid[a]	Average time (seconds)	N	% improvement over visual acquisition
A-10	Pave Penny INS Visual			
F-4E	INS			
F-4G	APR-38 Visual			
F-16	INS Visual			
F-111	Pave Tack INS			

Notes: a/Aids are described in footnote a to Table 9.

f. Battlefield and environmental factors

The effects of several kinds of battlefield and environmental conditions on IR Maverick performance was also addressed in the IOT&E. The effects of
in the IOT&E due to the inability to orchestrate the test.

Table 13 shows the effects of the
on IR Maverick performance. AFTEC reported that, "After the Ft. Riley phase, thresholds in the seeker
were changed by the contractor to improve performance. No improvement was seen during the remainder of the testing where the seeker maintained track times." (11, p. 32) AFTEC concluded that, "Although the sample size was limited, test data showed that IR Maverick system performance was significantly

(11, p. 35). Although, AFTEC and TAC agree that performance of the IR Maverick can be affected by

because a HQ USAF Studies and Analysis report states that there is an expected low frequency of occurrence of in situations where the IR Maverick would be employed.

The CAS scenarios in the IOT&E did not include
The Ft. Polk and European CAS scenarios did include
The effects of were also examined.
on IR Maverick performance. However, AFTEC reported that ". . .

" (11, p. 33) AFTEC concluded that,

(11, p. 35) AFTEC concluded that

(11, p. 35)

According to the SOC, "IR performance is improved over TV MAV in that it is less affected by
(20, p. 6-1) In the IOT&E, battlefield realism was provided through the use of

were used. The System Threat Assessment Report on the Imaging Infrared Maverick reports that,

Table 13

Effect of on IR Maverick Performance

Test Site:	Passes	Maintained Track	Broke Lock
Ft. Riley: 1/			
Eglin:			
UTTR:			

Notes
1/

Source: AFTEC, IOT&E Final Report, p. 33.

[12](10, p. II-12)

AFTEC concluded that the effects of rain, snow and fog were undetermined in the IOT&E. However, they did report that three missions were flown in a light drizzle and that a total of seven passes were made. The target was located "The light drizzle had the effect of greatly reducing both thermal clutter and visual navigation cues." (11, p. 33) According to the Threat Assessment Report on the IR Maverick, ". . .weather in Germany is generally cold and wet. Though there are sunny, warm days in summer and snow conditions in winter, the predominant climate is a low overcast with rain." (10, p. II-6) AFTEC does conclude the following about the IR Maverick, "The missile is more capable in but the limits of these capabilities are yet to be defined." (11, p. 83)

Visibility on all IOT&E test missions was with one exception. Ground visibility on one countermeasure mission was between Of nine passes flown on this mission, the target area was located A light fog and an errant INS contributed to the difficulties encountered on this mission.

AFTEC reported that the effects of snow on IR signatures are a function of time and environmental conditions. "Falling snow will reduce thermal clutter and attenuate those signatures present. Snow already on the ground can either enhance or reduce the IR capability depending on past and present environmental conditions and snow depth." (11, p. 34)

Various heating effects were also reported, ". . .the dry grass background of Ft. Riley the target area. . .At UTTR, " (11, p. 34)

Thirty-two missions were flown in the IOT&E when the absolute humidity was equal to or greater than that expected for a German summer. As absolute humidity increased, the probability of acquisition decreased.

---

[12]A FAC is a forward air controller who provides target information to the attack aircraft.

An assessment of the IR Maverick under adverse weather conditions was planned in DT&E. It was to be accomplished through tower testing. However, due to problems in implementing this test, it was stopped after three months of unsuccessful testing. No plans currently exist for a DT&E adverse weather assessment of the IR Maverick.

g. Countermeasures

AFTEC reported that the operational performance of the IR Maverick against infrared countermeasures (IRCM) was undetermined pending publication of a report by the Electro-Optical Guided Weapons Countermeasures/Counter-Countermeasures Joint Test and Evaluation Group. Tentative findings on IRCM are presented in Table 14. Two types of countermeasure testing were performed,

" (30, p. 1) The preliminary results show that use of

In other words, in situations where

AFTEC concluded that,

(11, p. 82)

h. Multiple launch passes

Due to problems in implementing single-pass,multiple-launch, captive-carry missions, the capability to perform multiple launches on a single pass was demonstrated by an F-16 live launch mission. AFTEC reported that "multiple launch of IR MAV missiles on a single pass was satisfactorily demonstrated." However, AFTEC qualified their conclusion with the following,

> "While both missiles hit their assigned targets, pitch and yaw changes caused by the first launch forced the pilot to reacquire the second target. This resulted in excessive exposure time for the launch aircraft. It should also be noted that multiple launches on a single pass could not be accomplished without workarounds due to incomplete integration between the missile launcher and the F-16 and

Table 14

Countermeasure Test Results

TYPE	TECHNIQUE	DEVICE	NO. OF ATTEMPTS	PROJECTED TRUE TARGET KILLS	KILLS/ ATTEMPTS

F-111 aircraft. For full multiple launch capability, further integration and testing of the LAU-88A/A with the F-16 and F-111 are required." (11, p. 83)

2. Compatibility of the IR Maverick with other onboard aircraft systems

IR Maverick compatibility with operational ECM pods and aircraft gunfire was rated excellent based on IOT&E results. Compatibility of the IR Maverick with the TV Maverick was also rated satisfactory. However, AFTEC concluded that "Aircrew comments indicated that while both TV and IR missiles could be employed successfully on the same aircraft; employing a mixed load could add confusion in high threat environments due to the differences in cockpit displays." (11, p. 42) AFTEC recommended that this issue be evaluated further in FOT&E.

3. Interoperability of the IR Maverick

The interoperability of (i.e., the ability to use) the IR Maverick with the various aircraft and various target acquisition aids was rated satisfactory because the observed problems appeared correctable. One such problem, as reported by AFTEC, was the current night attack capability of the aircraft,

" (11, p. 44)

AFTEC recommended that,

low altitude capability should be enhanced in order to fully exploit the increased night time capability provided by IR MAV." (11, p. 46)

4. Survivability of the aircraft during weapons delivery

AFTEC reported that survivability was to be addressed by USAF Studies and Analysis. No analysis has been conducted at this time.

OSD officials have commented that they do not feel that the aircraft, based on the attack profiles flown in the IOT&E would have a very good chance of survival.

TAC officials stated that they considered of wings-level-to-launch time to be a survivable amount of time. In the IOT&E pilots were told to fly as if there were air defense units, but none were simulated. A quick-look at the wings-level to launch times for all A-10 CAS passes where launch occurred, shows that approximately of those passes had wings-level-to-launch times of

5. The accuracy and utility of weather forecasting

The accuracy and utility of weather forecasts as potential aids for operational decisions for the IR Maverick was addressed in the IOT&E. The accuracy of temperature-contrast between target and background (ΔT) forecasts was rated deficient and the accuracy of acquisition and lock-on range forecasts was undetermined. In other words, it was difficult to predict how hot or cold a target would be in comparison to its background. The utility of the forecasts was rated satisfactory. In other words, the aircrews felt that these forecasts would be good tactical aids. "The aircrews stated that target polarity and acquisition and lock-ranges were essential forecast requirements. They also desired prediction of the occurrence of seeker saturation caused by high ΔTs in the background, as well as aid in selecting the optimum ΔT attack aspect." (11, p. 53) AFTEC recommended that IR forecast techniques should continue to be developed and should definitely be tested during FOT&E. This could be an important issue of IR Maverick employment since research on IR signatures has demonstrated,

> "Tank signatures were found to be highly dependent on environmental and operating conditions, both present and recent past. The differences in the signatures due to these varied conditions are greater than differences due to the types of vehicle, tank or other." (42, p. 1)

E. Operational Suitability and Engineering Design Changes

Since the utility of the IR Maverick depends on its operational suitability, the IOT&E evaluated these five features of the system's operation:

- --its reliability,
- --its maintainability,
- --its availability,
- --its logistics supportability, and
- --the supportability of its software.

The test results show the IR Maverick as deficient in reliability, which was measured as incoming reliability, logistics reliability, and mission hardware reliability

(including live launches). They also show it to be deficient in qualitative maintainability and the supportability of its software. We discuss these results below. (We do not discuss quantitative maintainability, availability, and logistics suportability, which were all found to be satisfactory as reported in Table 1.) We also discuss issues that were examined in the combined DT&E and IOT&E that directly influenced engineering design changes incorporated in the IR Maverick missiles to be tested in the RMVP and the FOT&E, as well as the Hughes Aircraft design-to-cost engineering change proposal ECP 604, which is expected to identify changes that might reduce the IR Maverick's production costs.

1. Reliability

"Incoming reliability" was defined in the IOT&E as the probability that the system would pass a visual and operations inspection when first received from the contractor. An acceptance threshold for incoming reliability of the "mature" system set at "Maturity" was defined as the configuration of the system at the end of FOT&E. IOT&E missiles failed the inspection, and this acceptance rate did not meet the maturity threshold.

"Logistics reliability", is a measure of a system's ability to operate according to specific operational and support concepts. It was defined in the IOT&E as the number of hours that the IR Maverick can fly (captive-carry) with a probability of not requiring corrective maintenance. The mature system threshold value for logistics reliability was set at The IOT&E results show that the IR Maverick attained a probability of before corrective maintenance was required. AFTEC performed a reliability growth analysis, by analyzing the test results from 1981 to 1982, and concluded that the threshold of will not be met at maturity. Specifically, the analysis indicated that the IR Maverick missile system can be expected to reach about percent of the stated maturity requirement.

The missile clocked 291.5 hours of captive-carry time and 233.7 hours of power-on time, during which 28 relevant corrective maintenance actions occurred. They included correction of repetitive failures-- with the rotation band, with the cooling loop, with the auto-focus, and with switching the sensor field-of-view. Air Force officials informed us that 14 of the 15 IR Maverick missiles tested required corrective maintenance at least once.

"Mission hardware reliability" is a probability, the product of prelaunch and launch reliability. Prelaunch is the time between the aircrew's arrival at the aircraft and the

decision to launch the missile; launch begins with the intention of launching the missile and ends when it hits the target with its warhead functioning properly. The maturity threshold for this mission hardware reliability was set at probability of completing a captive-carry mission followed by missile launch, guidance, and impact without hardware failure. In the IOT&E, missiles performed properly after launch, attaining only launch reliability. Specifically, there were failures of various types, including the problems with the cooling loop and the dome cover squib circuit. AFTEC did not project the system's reliability at maturity because of the small number of missiles that were launched.

2. Qualitative maintenance

"Qualitative maintenance" criteria include accessibility, serviceability, safety, and the ability to perform maintenance tasks. The IOT&E results show the IR Maverick to be deficient because of problems with its design of the guidance control section rotation band and the questionable need for the missile dome cover and the need to boresight the missiles to the aircraft acquisition aid. The report states that "the severity of these problems was considered sufficient to cause major support and mission generation problems in the operational environment if the current system is fielded." (11,p. 63) Maintenance personnel in the IOT&E submitted 48 service reports on the IR Maverick system, 22 of which were for deficiencies that prevented the success of a mission. They include problems with the interoperability of the missile and the F-4G aircraft and the integration of the missile with the F-16 aircraft as well as a safety problem having to do with stray voltage from the infrared target simulator.

By February 1983, 10 of the 22 deficiencies had not been resolved. Twelve deficiencies were found to be causing marginal or degraded system performance. Four remain open.

3. Supportability of software

To test the supportability of the IR Maverick software, the maintainability of the operational flight programs (OFP's) and the automatic test equipment software (ATE) were evaluated. Evaluators from the Air Force Logistics Command (AFLC) and Headquarters Tactical Air Command assessed the software product specifications and computer support resources for the IR Maverick and the triple-rail launcher (the LAU-88A/A) operational flight programs. They found that the modularity, descriptiveness, consistency, and instrumentation characteristics of both software programs were below the maturity threshold.

The contractor's software support facility was unable to properly program the seeker for the missile's expected operational environment and consequently had to modify the program on the basis of flight testing. The Ogden Air Logistics Center (ALC) did not have sufficient personnel, support resources, and facilities or plans or programs for them to maintain the OFPs. The maintainability of the OFP's of both the IR Maverick and the LAU-88A/A was found to be deficient so that support for them will have to reside with the developer contractor or a second source production contractor unless the Ogden ALC develops its own capability.

To evaluate the maintainability of the IR Maverick automatic test equipment software, evaluators from AFLC assessed the field-level infrared target test set (IRTS), the depot-level A/F 24T-16 single rail launcher (LAU-117A) test set, and the software support facilities for the two test sets. Hughes could not provide the software documentation for the IRTS to IOT&E, and consequently the requirements for Ogden ALC support could not be identified. Thus, the maintainability of the IRTS software was rated as deficient because there was no documentation available for it.

However, the Varol Corporation delivered the A/F 24T-16 test set and its software support facilities and specifications late in the IOT&E, and a partial assessment was made. It was found that: the test set software was incomplete, the test set did not have a self-test capability, the unit that was tested had been delivered with parameter errors, and some fault detection results were different for automatic and manual models of operation. Moreover, the A/F 24T-16 test set software had been written in MOSTEK, in a nonstandard high-order language rather than in a DOD-standard language, and the training that was given in the use of the language and the test set was too short and insufficient in detail. The result was that the maintainability of the A/F 24T-16 test set and the software support facility could not be determined.

Basing its conclusion on the IOT&E results, AFTEC recommended that the software specifications for the OFPs of both the LAU-88A/A and the IR Maverick be rewritten in a different form and that an interim contractor support the OPFs until the Air Force can develop its own capability. In addition, AFTEC recommended acquisition of the IRTS software and identification of the provisions for the software support. Theyalso recommended that a detailed evaluation of the remaining test equipment software and the associated support facilities be conducted during FOT&E.

4. The Reliability/Maintainability Validation Program (RMVP)

The RMVP was to determine whether modifying the IR Maverick missile to correct the DT&E and IOT&E field test problems will improve its operational suitability. According to the RMVP test plan,

> "a minimum of 100 hours captive-carry time will be accumulated on four (4) AGM-65 the [IR Maverick missile] and one TGM-65 [the IR Maverick training missile]. The captive-carry missions will be structured like a tactical training mission to the extent possible." (12, p. I-1)

This program also included a laboratory demonstration using three guidance control sections. The RMVP was to address the deficiencies that were reported in the IOT&E results, including the IR Maverick missile system's incoming reliability, its logistics reliability, the prelaunch reliability component of its mission hardware reliability (no live firings), and its qualitative maintainability. In particular, the RMVP was to verify whether the fixes that were made to the missile system, based on field test problems encountered during the combined DT&E and IOT&E, have corrected the problems.

During the combined DT&E and IOT&E, 115 field reports were issued--on problems which occurred with the missile during testing. The IOT&E problems consisted of the two missile failures on incoming reliability, the four live launch failures, the 28 corrective maintenance actions and a few problems with test equipment. Problems occurred at several points between the initial inspection and the live launches. According to both the program office and the prime contractor, corrections were proposed, made, and verified in the same test. However, it should be noted that while AFTEC agrees that the corrections have been made, they feel that it is very important to verify these corrections further in the FOT&E.

The solution to eight of the field test problems remained unverified at the conclusion of the combined OT&E and IOT&E. Three of the problems, one from DT&E and two from IOT&E, consisted of having no video and the seeker moving up and down uncommanded. The causes for these problems were not found and no fixes were incorporated. The corrections that were attempted included design changes for the guidance control section (to fill it with nitrogen-argon gas), the software, the rotation joint and the cryoengine.

The SPO stated that the 70-hour cryoengine was not acceptable for a tactical missile and that a 200-hour engine is

needed. As a result, Cryogenic Technology Inc. is under contract to design a brushless cryoengine to the Air Force by November 1983; meanwhile, the RMVP missile will continue with the brush design.

In the captive-carry hours that were flown at Nellis AFB between December 20, 1982, and January 21, 1983, only 5 RMVP missiles were used and no launches were made. The RMVP results were presented in a briefing, but by March 1, 1983, no Air Force test report had been written.

In the briefing, AFTEC made the summary statement "significant improvement was seen in all areas evaluated during RMVP". Although the sample size [of 5 missiles] is small, AFTEC believes the trend to be valid and positive. This is primarily due to the validity of the fixes incorporated and increased management emphasis on improving reliability during the move toward production in a single facility.

As for logistics reliability during RMVP, "one corrective maintenance action occurred during 103 hours of captive flight," resulting in a probability of flying hours captive-carry hours before the missile requires corrective maintenance. The result was the same as the one that was rated deficient in the IOT&E flight hours yielding probability).

5. Engineering Change Proposal 604

Hughes proposed a design-to-cost engineering change, ECP 604, to design, implement, and test changes that would reduce the cost of the common IR guidance subassembly for the Maverick and the GBU-15 missiles. According to the March 1982 statement of work,

> "the design changes shall not in any way jeopardize product integrity nor will they cause an inability to meet the exiting requirements for performance, reliability, maintainability or safety." (41, p. 3)

Air Force officials told us that ECP 604 is a study whose purpose is to identify changes that can reduce its production costs. The Air Force has stated that ECP 604 is necessary because the design-to-cost goal of the missile had been overrun by 20 percent after 3 years of engineering development. The Air Force expects to receive three or four specific engineering change proposals before May 1, 1983, that will be considered by the Air Force SPO and the Configuration Control Board.

If these ECPs are approved, they will become part of the missile's technical data package which will be provided to the second source. The production changes will be slowly

incorporated into the next 900 missiles to be purchased. According to the Air Force SPO, all the proposed engineering changes will have been incorporated by the eighth month of Segment II of production. The FOT&E also to be completed before the end of Segment II, will test only the missiles purchased in Segment II and, therefore, will not test a missile with all the engineering changes included.

ECP 604 calls for the contractor to do the following: (1) redesign 11 of 27 hybrid microcircuit modules types, changing resistors from thick film to thin film, using multifunction instead of single function microcircuits, and eliminating devices no longer needed because of design changes; (2) redesign 3 of the 14 electronic circuit cards in order to eliminate hybrids by substituting discrete components for them and to replace bipolar transistors with field-effect power transistors; (3) develop a way of making the facetted scan mirror other than by single-point diamond flycutting; (4) redesign the ball-bearing support and the gyro-optics assembly. Hughes is to incorporate all the design changes into two IR Maverick guidance and control sections, which will be qualified and tested according to test plans to be developed by Hughes.

III. IR MAVERICK COST GROWTH

As we discussed in our December 14, 1982, letter report to Senator John Tower entitled Evaluation of Maverick Missile System Unit Cost (GAO/MASAD-83-7), projections of cost savings were included in the December 31, 1981, and the June 30, 1982, Selected Acquisition Report (SAR) for the IR Maverick program. The Air Force asserted that it expects the projected savings to result from multiyear procurement-contracting and competitive second-sourcing. In our report, we noted that "if for any reason competition on a multiyear contract cannot be accomplished, a substantial growth of program cost could be expected." (34, p. 2)

A. Summary of Program Cost Growth

In table 15, we show a summary of the IR Maverick's program cost, with an emphasis on recent cost growths. The most significant change through September 1981 was the nearly doubling of the quantity of missiles to be procured, which was first reported in the December 31, 1980, SAR. According to TAC officials, the additional missiles are meant for use by the Rapid Deployment Force. The "estimating" and "schedule" changes were also important.[13]

---

[13]Definitions for "estimating" and "schedule" changes can be found in footnotes "d" and "c" to table 15.

Table 15
Summary of TIR Maverick Cost Growth 1975-82

Selected acquisition report	Program cost (in millions of dollars) and time	Quantity	Unit cost in (dollars)	Breakdown of cost variance (in millions of dollars)				
				Economic a/	Quantity b/	Schedule c/	Estimating d/	Support e/
Base year 1975	1,592.9 1975-86	31,113	51,200	—	—	—	—	
September 1981 f/	4,128.7 1975-90	60,697	68,000	+166.3	+1,563.3	+267.5	+393.1	+145.6
December 1981	4,794.5 1975-90	60,697	79,000	+371.9	—	+8.4	+371.2	-85.7
March 1982	4,940.8 1975-90	60,697	81,400	+170.2	—	—	-23.9	—
June 1982	6,170.8 1975-91	60,697	101,700	—	—	+601.7	+585.7	+42.6
September 1982	6,170.8 1975-91	60,697	101,700	—	—	—	—	—
December 1982	5,847.2 1975-90	60,697	96,300	-345.9	-	-219.5	+133.4	+108.4

Notes:

a/Economic Change - A change due solely to the operation of the economy. This includes changes resulting from actual escalation different from that previously assumed and revision of the assumption regarding future escalation.

b/Quantity Change - A change in quantity of an item of equipment. Ordinarily, categorization as a Quantity Change will be limited to those end items for which unit cost reporting is required and for which cost quantity curves are prepared.

c/Schedule Change - A change in a procurement or delivery schedule, completion date or intermediate milestone for development or production.

d/Estimating Change - A change in program cost due to a correction in preparing the initial estimates or a change in program or cost estimating assumptions not provided for in the quantity, schedule or support change categories.

e/Support Change - This will generally include all cost changes associated with training and training equipment, peculiar support equipment, data, operational/site activation, and initial spares and repair parts.

f/Breakdown of cost changes is cumulative from 1975 through September 1981.

In December 1981, major revisions resulted from "economic" [14] changes (which increased the cost by $371.9 million) [15] and "estimating" changes. Another significant cost growth was reported in the June 1982 SAR, under "schedule" change, which described an extension of the program for an additional year and a rescheduling of the number of purchases each year, contributing $601.7 million to costs. Nearly the same amount, or $585.7 million, resulting from "estimating changes", increased the program's costs still further. One significance of the increases in the estimating category is the potential they have for leading to additional cost growths. The cost reduction reported in the December 1982 SAR resulted from "economic" and "schedule" changes.

In the following sections, we report where and when the expected, but not clearly identified, savings were included in the SAR's. We also present conditions that may determine the extent of the savings that can be achieved.

B. Expected savings reported in the SAR's

The expected savings were included in the "estimating" category of the "changes since previous report" section of the December 1981 and June 1982 SAR's. We present these in table 16. Under "as reported. . ." we show the SAR explanation for the amounts that included the expected savings. Under "detail. . ." we show the cost items that Air Force personnel explained had been included in the reported figures. The expected savings are underlined in the table.

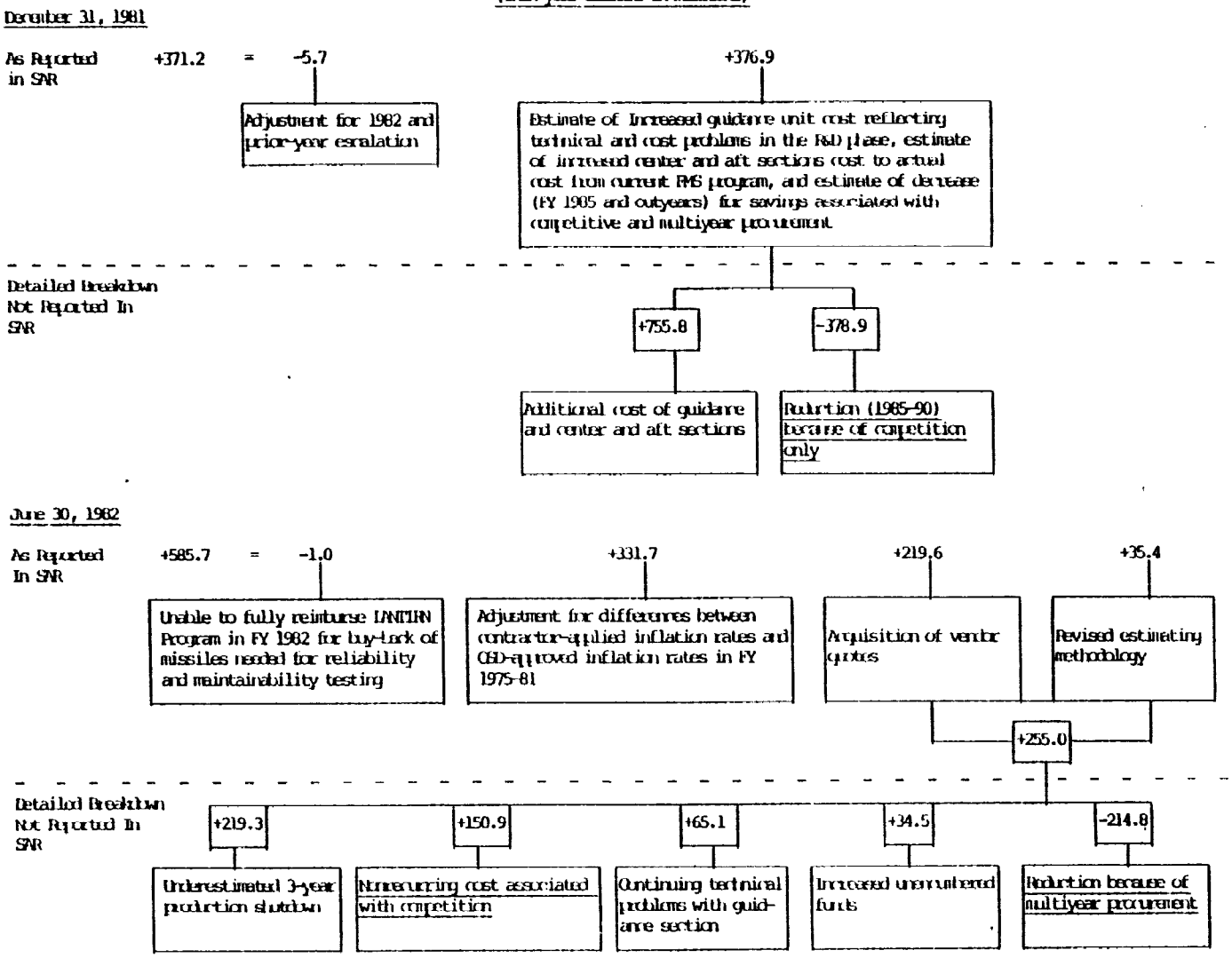
The December 31, 1981, SAR described a $371.2 million "estimating" change as being the net of two items; a $5.7 million adjustment for 1982 and prior-year escalation, and a $376.9 million cost increase resulting from increased cost for the guidance and center and aft sections and the estimated decrease for savings associated with competitive or multiyear procurement. The "detail. . ." components of this $376.9 million increase are $755.8 million additional cost for the guidance and center and aft sections minus $378.9 million, the cost reduction expected from competitive procurement. Savings expected from multiyear procurement were included in the June 30, 1982, but not in the December 31, 1982, SAR.

---

[14] The definition for "economic" changes can be found in footnote "a" to table 15.

[15] All dollar figures cited in this discussion are for then-year dollars.

Table 16
Selected Acquisition Report Estimating Changes
(Then-year dollars in millions)



The June 1982 SAR included savings expected from multiyear procurement in the $585.7 million "estimating" change, but it did not identify them in any of the four items that explained this change. They are included in the total of two of the items; "acquisition of vendor quotes" and "revised estimating methodology," and as they are "reported" they amount together to $255.0 million. The "detail. . ." figures show that this $255.0 million is the net of five cost items. These include a $214.8 million reduction expected from multiyear procurement and a $150.9 million increase from costs associated with competition. The expected savings from competition were thus reduced by $150.9 million to $228.0 million. Therefore, the total expected saving included in the SAR amounted to $442.8 million--that is, the $228.0 million from competition plus the $214.8 million from multiyear procurement.

In the remainder of this section, we examine the two expected-savings categories, competition and multiyear procurement, in terms of the basis for the specific estimates and the conditions that may affect the accomplishment of savings.

1. Competition

The original estimate of saving expected from competition, $378.9 million, was based primarily on a study conducted by The Analytic Sciences Corporation, reported on August 7, 1981, under the title An Analysis of the Impact of Dual Sourcing of Defense Procurements (TASC, EM-171-WA). Having looked at 45 military equipment contracts and the savings reported as resulting from competition, the study reported a range of savings from +67.7 percent to -16.1 percent--that is, a 16.1 percent cost increase--with an average saving of 33 percent.

For the purpose of estimating a percentage for the IR Maverick, officials in the program office selected from those 45 contracts the 8 missiles that were included in them, calculating an average saving of 22 percent. [16] The range was from 59.2 percent saving to 5.6 percent cost increase. For a conservative estimate, they settled for about half of the 22 percent, or 10 percent saving. The choice of 10 percent brought the estimate close to the 11 percent that had been predicted by Analytic Services in its February 24, 1982, study, The Economic Aspects of Second Sourcing the IIR Maverick.

---

[16]The 8 missiles were Standard Missile MR RIM 66A, TALOS, Standard Missile ER RIM 67A, BULLUP 12B, TOW, SHILLELAGH, and Sidewinders AIM-9G and AIM-9B.

It will be recalled that the December 1981 SAR reported the original estimate of a $378.9 million saving and that this was reduced by $150.9 million in the June 1982 SAR. This reduction in savings was based on an estimate the program office made of the additional cost of qualifying the competitive sources. The total saving expected from competition, as reported in the two SAR's, amounts, therefore, to $228.0 milion.

The Air Force has stated that the expected savings are in line with its previous experience with competitive procurement. However, certain conditions may operate to reduce those savings still further. For example, to meet the expected figures, firm data packages that are transferable to the second source must be available, but they will not become available until the middle of 1984.

Furthermore, only 28 percent of the total IR Maverick program is in the hands of prime contractors, and of this amount half, or 14 percent of the total program, is for support. Therefore, there is little room for cost improvement at the level of primary contracting. If savings cannot be accomplished at the subcontractor level then the total saving will not be significant.

Finally, as stated in the previously mentioned TASC study (P. 1-3) "program specific characteristics [17] play a significant role in determining the magnitude of the potential benefits of competition." That study, as we mentioned above, reported an overall range from 67.7 percent savings to 16.1 percent cost increase, and a missile programs range from 59.2 percent savings to 5.6 percent cost increase. The assumption, consequently, that competition in the IR Maverick program will necessarily result in savings is not substantiated. The effect of competition on cost could well be no effect at all, or even an additional cost growth or a saving which does not equal the projected saving. In any event, an increase in the cost of the IR Maverick program over that persently estimated would result.

2. Multiyear procurement

The estimate of 4.2 percent saving, or $214.8 million, to be expected from multiyear procurement that was included in the June 1982 SAR was an assumption. It was based on the undocumented experience of the Air Force with the A-10 gun, which is said to be the only item under multiyear procurement

---

[17] (GAO footnote) "such as type of equipment, start-up costs, production rate and ultimate quantity, and the timing of completion", TASC, p. 5-1.

that has been added to ongoing competition. The IR Maverick program office stated that the Air Force realized an 8.4 percent saving in the A-10 gun contract. Since the IR Maverick is more complex than the A-10 gun, this figure was cut in half, yielding the assumption that multiyear procurements would result in a saving of 4.2 percent for the IR Maverick program.

While the SAR figures have been tacitly accepted, there are no other indications from OSD or Air Force Headquarters that either one is actively considering IR Maverick for multiyear procurement. Program office officials have said that they realize that it is too early to know whether multiyear procurement is possible for the IR Maverick, since they do not know whether it will meet the requirements of Public Law 97-86 (enacted December 1, 1981), which states that

--the Secretary of Defense must find that the use of a multiyear contract for any given product will promote national security and reduce total costs;
--there must be a reasonable expectation that funding will be stable enough to avoid contract cancellation;
--the need for the product must remain substantially unchanged during the contract period with regard to production and procurement rates and total quantities;
--the product must have stable design with minimum technical risk; and
--both contract cost and the anticipated cost avoidance must be realistic.

ENCLOSURE II-A

BIBLIOGRAPHY

1. Analytical Sciences Corporation." An Analysis of the Impact of Dual Sourcing on Defense Contracts." Arlington, Virginia: August 7, 1981.

2. -----. "Evaluating the Impact of Quantity, Rate and Competition" Prepared by Larry W. Cox and Dr. Jacques S. Gansler. Arlington, Virginia.

3. -----. "Predicting the Cost and Benefits of Competitive Production Sources" Prepared by J.W. Drinnon and J.S. Ganler, Arlington, Virginia. Presented at the 9th Annual Acquisition Review Sympasium, 1980.

4. Analytical Services, Inc. Briefing on "The Economic Aspects of Second Sourcing the IIR Maverick" Arlington, Virginia.

5. Defense Intelligence Agency "Intelligence Report for Imaging Infrared (IIR) Maverick Program Review" , SECRET. March 9, 1983.

6. Department of the Air Force. Air Force Regulation 80-14, Research and Development Test and Evaluation. Washington, D.C.: July 19, 1976.

7. -----. Briefing on the IR Maverick presented at DSARC III program review, SECRET. Washington, D.C.: September 21, 1982.

8. -----. Decision Coordinating Paper No. 154. August 23, 1976.

9. -----. Test and Evaluation Master Plan (TEMP) for Imaging Infrared Maverick. April 15, 1980.

10. Department of the Air Force. Air Force Systems Command, Foreign Technology Division, Imaging Infrared Maverick System Threat Assessment Report , SECRET, Prepared by Threat Integration Branch.

11. Department of the Air Force. Air Force Test and Evaluation Center. AGM-65D Infrared Maverick Initial Operational Test and Evaluation Final Report, Project 81-AFTEC-117 , SECRET. Prepared by Alfred L. Freathy and Jessie K. Beavers. Kirkland Air Force Base, New Mexico: December 1982.

12. -----. AGM-65D IR Maverick Initial Operational Test and Evaluation Plan and Annex, Project 81-AFTEC-117 , LIMITED. Plan prepared by T. Patrick Flanagan. Kirkland Air Force Base, New Mexico: October 1, 1980.

13. -----. Imaging Infrared (IIR) Maverick Joint Operational Test and Evaluation (JOT&E) , CONFIDENTIAL. Prepared by James A. Madison and Augustine R. Letto. Kirkland Air Force Base, New Mexico: July 1977.

14. -----. Imaging Infrared (IIR) Tracker European Test and Evaluation, Project 78-AFTEC-100 , CONFIDENTIAL. Prepared by James R. Martin and Michael T. Reich. Kirland Air Force Base, New Mexico: September 1978.

15. -----. Message #092002, Subject: IR Maverick IOT&E Launch, SECRET, October 1981.

16. Department of the Air Force, Office of Assistant Chief of Staff, Studies and Analysis. Saber Challenge, Alpha II-Imaging Infrared Maverick Effectiveness and Cost-Effectiveness Analysis SECRET, June 1982.

17. Department of the Air Force, Office of the Assistant Secretary "IR Maverick FOT&E Plan - INFORMATION MEMORANDUM" Memorandum for Director, Defense Test and Evaluation, Office of the Under Secretary of Defense for Research and Engineering, April 1, 1983.

18. Department of the Air Force. Office of the Secretary, Unit Cost Exception Report AGM-65D Maverick June 30, 1982.

19. -----. Independent Cost Analysis of the AGM-65D Maverick, June 1982.

20. Department of the Air Force, Tactical Air Command. System Operational Concept for the AGM-65 Maverick , SECRET, Prepared by Concepts Division, Directorate of Mission Area Analysis and Planning, Deputy Chief of Staff, Plans, October 30, 1979.

21. -----. Message #1222002, Subject: Revision of the Employment Section of the Maverick System Operational Concept, SECRET. January 1983.

22. -----. Message #2513002, Subject: Revision of the Employment Section of the Maverick System Operational Concept, SECRET. February 1983.

23. Department of Defense, Office of the Secretary. "Imaging Infrared (I^2R) MAVERICK" , Memorandum for the Secretary of the Air Force. Washington, D.C: September 29, 1982.

24. -----. Selected Acquisition Report: IR Maverick AGM-65D, RCS DD-COMP(Q) 823, CONFIDENTIAL. Prepared by Department of the Air Force. Washington, D.C.: September 30, 1981.

25. -----. Selected Acquisition Report, IR Maverick AGM-65D, RCS DD-COMP(Q) 823, CONFIDENTIAL. Prepared by Department of the Air Force. Washington, D.C.: December 31, 1981.

26. -----. Selected Acquisition Report, IR Maverick AGM-65D, RCS DD-COMP(Q) 823, CONFIDENTIAL. Prepared by Department of the Air Force. Washington, D.C.: March 31, 1982.

27. -----. Selected Acquisition Report, IR Maverick AGM-65D, RCS DD-COMP(Q) 823, CONFIDENTIAL. Prepared by Department of the Air Force. Washington, D.C.: June 30, 1982.

28. -----. Selected Acquisition Report, IR Maverick AGM-65D, RCS DD-COMP(Q) 823, CONFIDENTIAL. Prepared by Department of the Air Force. Washington, D.C.: December 31, 1981.

29. Department of Defense, Office of the Test Director, Joint Services Electro-optical Guided Weapons Countermeasures Test Program. Countermeasures Evaluation of the IR Maverick, Ft. Riley, KS. Testing, OTD-TR-3-82 , SECRET. Prepared by L. Dennis Latta. White Sands Missile Range, New Mexico: February 8, 1982.

30. -----. "IR Maverick IOT&E Electro-Optical (EO) Countermeasures (CM) Test Series" , SECRET. Memorandum for the Deputy Director Defense Test and Evaluation, September 7, 1982.

31. -----. Test Directive for AGM-65D IR Maverick IOT&E Dynamic Testing at the Utah Test and Training Range (UTTR). , CONFIDENTIAL. White Sands Missile Range, New Mexico: January 11, 1982.

32. Department of Defense, Office of the Under Secretary of Defense, "Test and Evaluation Assessment of Imaging Infrared MAVERICK for OSD Program Review," Memorandum for the Under Secretary of Defense for Research and Engineering: February 22, 1982.

33. General Accounting Office. Critical IR Maverick Issue Remain Unresolved After Five Years of Operational Testing, C-IPE-82-1, SECRET. Washington, D.C.: June 25, 1982.

34. -----. Evaluation of MAVERICK Missile System Unit Cost Report Submitted under Public Law 97-86, Sectin 917, MASAD-83-7, Washington, D.C.: December 14, 1982.

35. -----. GAO Analysis of Projects Proposed by the Department of Defense for Multiyear Contracting in its Fiscal Year 1983 Budget Requests, PLRD-82-73, Washington, D.C.: April 29, 1982.

36. Hughes Aircraft Company, Missile Systems Group, Canoga Park, California, Design-to-Cost Data. DD Form 1423, Sequence No. AO2D, HAC Reference E2561, Report No. 7-1635-7, October 30, 1981.

37. -----. Design-to-Cost Engineering Change Proposal (ECP) No. 604, Reference 81-50-02932/E2561, September 1981.

38. -----. Reliability/Maintainability Validation Program (RMVP) Compatibility Testing, HAC Reference E2561, Report No. MAV 7-AOIQ-3, March 3, 1983.

39. -----. Reliability/Maintainability Validation Program (RMVP Final Test Report, HAC Reference E2561, Report No. MAV 7-AOIQ-4, March 11, 1983.

40. -----. Reliability/Maintainabilty Validation Program (RMVP) Reliability Demonstration Laboratory Tests, HAC Reference E2561, Report No. MAV-7-AOIQ-2, March 3, 1983.

41. -----. Statement of Work for Design-to-Cost Engineering Change Proposal (ECP) No. 604, March 5, 1982.

42. Massachusetts Institute of Technology, "Infrared Signature Measurements of Tank Targets" SECRET. Prepared by Thomas W. Johns, Lexington, Massachusetts, October 1, 1979.

43. System Planning Corporation Joint Operational Test and Evaluation of the Imaging Infrared Maverick System, Report 317 , SECRET. Prepared by F.G. Stahl et. al. Arlington, Virginia: August 1, 1977.

44. -----. Tank Infrared Signatures, Report 414 ,CONFIDENTIAL. Prepared by M.H. Crowell et. al. Arlington, Virginia: July 1979.

45. -----. Testing of the Imaging Infrared Maverick System: Issues and Analyses, Report 413 , SECRET. Prepared by F.G. Stahl, M.H. Crowell, and L.M. Silvester. Arlington, Virginia: July 1979.

ENCLOSURE II-B

INTERVIEWS

During the course of our review we met with officials at the following locations:

Air Force Test and Evaluation Center, Kirkland AFB, New Mexico.

Defense Intelligency Agency, Rosslyn, Virginia.

Hughes Aircraft Company Plant #44, Tucson, Arizona.

Office of the Secretary of Defense, Washington, D.C.

System Program Office for IR Maverick, Wright Patterson AFB, Ohio.

Tactical Air Command, Langley AFB, Virginia.

U.S. Air Force Headquarters, Washington, D.C.

30314

DAVID PRYOR
ARKANSAS

SR. RUSSELL SENATE OFFICE BUILDING
WASHINGTON, D.C. 20510
(202) 224-2353

ARKANSAS OFFICE
2538 FEDERAL BUILDING
LITTLE ROCK, ARKANSAS 72201
(501) 378-6336

United States Senate

WASHINGTON, D.C. 20510

COMMITTEES:
AGRICULTURE, NUTRITION, AND FORESTRY
GOVERNMENTAL AFFAIRS
SPECIAL COMMITTEE ON AGING
SELECT COMMITTEE ON ETHICS

October 27, 1982

Mr. Charles Bowsher
Comptroller General
General Accounting Office
Room 7000-A
441 G Street
Washington, D.C. 20548

Dear Mr. Bowsher:

I am requesting a follow-up review of the IR Maverick program as a result of the October 20, 1982 response by the Department of Defense to the General Accounting Office's letter to the Secretary of Defense dated June 25, 1982, entitled, "Critical IR Maverick Issues Remain Unresolved After Five Years of Operational Testing," GAO/C-IPE-82-1.

I am concerned that the Air Force made the decision to go ahead with a limited pilot production of the IR Maverick as approved by the Secretary of Defense of September 21, 1982, despite the Department of Defense's admission that "several operational issues remain unresolved." It is my understanding that since the issuance of the GAO report, further developmental and operational tests have been completed and should have addressed the issues which GAO had earlier raised. For these reasons, I believe that it is of the utmost necessity to do a follow-up review which would include a thorough analysis of the new test results. Specifically, what are the critical operational issues? How have they been resolved? What issues remain unresolved?

A recent briefing provided my staff by Air Force officials raised the following related questions:

Will the proposed engineering design changes of the missile affect its operational capability? Will these changes also affect the maintainability and the reliability of the missile?

How will these design changes improve the producibility of the missile?

To what extent, if at all, will these changes reduce the overall cost of the program?

931116

I am also very concerned about the recent disclosure of the program cost growth (from $4.9 billion to $6.2 billion) since the issuance of the GAO report and I would like information on this subject.

Because of the importance of this review and DOD's tentative scheduling of a full-scall production decision on February 1, 1983, I would appreciate a briefing as soon as possible. It would be helpful if the responsibility for this review were assigned to the division which produced the letter report, the Institute for Program Evaluation.

If you have any questions regarding this request, please contact Knox Walkup of my staff at 224-2353.

Sincerely,

David Pryor

DP/mk