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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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RELEASED

JUL 26 1973

B-163058

The Honorable F. Edward Hebert
Chairman, Armed Services Investigating Subcommittee
Committee on Armed Services
House of Representatives

Dear Mr. Chairman:

As requested in your letter (see enclosure) of October 11, 1972, we made a spot check of three minor weapons systems being developed by the Army and three by the Air Force to determine whether problems similar to those noted in our report[1] to the Congress on Navy minor weapon systems existed.

Our review was not intended to be broad enough in scope to permit an overall assessment of minor systems management by the Army and Air Force; we believe, however, that systems in these services, much like those we reviewed in the Navy, were going from advanced development to full-scale development (also referred to as engineering development) before sufficient work was completed.

Some of the indications that full-scale development started prematurely include (1) establishing new specifications during full-scale development without their feasibility being proven during earlier work, (2) insufficient testing of the system during advanced development to insure that the desired performance requirements would be met, (3) not performing enough work before full-scale development to insure that desired reliability would be met and (4) providing incomplete, contradictory, and possibly misleading information to decisionmakers to support the start of full-scale development.

Summaries on the minor systems which, we believe, entered full-scale development prematurely are presented below.

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[1]"Better Management Needed Over Decisions to Start Full-Scale Development of Minor Weapons Systems" (B-163058, Oct. 6, 1972).

ADVANCED CONCEPT EJECTION-SEAT SYSTEM

The objective of the Air Force's advanced concept ejection-seat program was to design, develop, and qualify an improved automatic ejection-seat system for future high-speed aircraft. The desired improvements included better stability; fewer entanglements of the parachute with the ejection seat and the crew member; a low level, adverse attitude capability; and reliable sequencing of the ejection events.

The program entered full-scale development in September 1968, when the Air Force awarded a $2.7 million contract for a study to design, fabricate, and test an ejection-seat system. Although development was planned to be completed within 24 months, the contract was later extended by 19 months at an additional cost of about $2.2 million. Support costs of over $744,000 brought the total program cost to over $5.8 million.

New performance specifications were added to the program during full-scale development which required advancing the state of the art. Achieving these new specifications had not been proven before starting full-scale development. The new specifications included (1) deploying the main recovery parachute from the ejection seat so that the shock load of the chute opening would be absorbed by the seat, rather than the crew member, (2) using an electronic system, rather than explosives, for sequencing the ejection events, and (3) having a harness which releases at a single point, rather than at several points.

Problems were encountered during full-scale development in each of these areas, which, in turn, caused a schedule slippage and contributed to the cost overrun. Although an improved ejection seat was developed, the Air Force considered it too heavy and costly for use in future aircraft.

In early 1970, before development was completed, Air Force officials expressed concern over whether this seat could be used on the F-15 aircraft. As a result, a weight/cost reduction study was added to the contract. The study concluded that weight could be reduced by 67 pounds and estimated that the unit cost could be reduced by about $10,000 if the requirements for having a harness which releases at a single point and deploying the main parachute

from the ejection seat were eliminated. This was done and a second contract for $1.95 million to redesign and develop a seat for use in the F-15 aircraft was awarded in February 1972 to the same contractor.

IMPROVED 8-INCH, SELF-PROPELLED HOWITZER SYSTEM

The Army's M110E2 howitzer is intended to be an improved version of the standard M110 howitzer, is to replace both the M110 howitzer and the M107 175mm gun, and is to fire the Army's standard propelling charges and most of the projectiles currently fired by the M110 howitzer. The improvement consists of a longer range cannon or tube--designated XM201--which will use the same vehicle, gun mount, and fire control system as the M110 howitzer.

The improved howitzer system consists of five components: the gun, the propelling charge, and three different projectiles. At the time of our review, the gun, the propelling charge, and two of the three projectiles were in full-scale development. The other projectile had not yet entered advanced development. The cost to develop the gun was estimated at $11.5 million.

We reviewed the documentation supporting the completion of experimental work on the four components which were in full-scale development. Testing was not sufficient to show that certain performance requirements would be achieved, and reliability characteristics were not adequately considered.

For example, requirements for the improved system were that the tube and ammunition were to be designed so that the tube would last for at least 6,000 full-service rounds. In May 1971, as part of advanced development, a wear evaluation test was conducted during which 370 rounds of ammunition were fired, using a propelling charge of 38.45 pounds. On the basis of this test, the Army believed that the required tube life could be met.

After completing the May 1971 wear test, the Army determined that a 43.65-pound propellant was necessary to meet ballistic requirements; however, it did not make additional wear tests before full-scale development although it knew at the time of the full-scale development decision that the increased weight was necessary.

Recent wear tests during full-scale development using the 43.65-pound propellant indicated a tube life of only about 1,500 rounds. These tests should have been conducted before full-scale development was started because obviously the evaluation of tube life made in May 1971 was no longer valid for determining whether required tube life would be met. The reduced tube life, in turn, impacts on the life-cycle costs of the system.

Full-scale development of one of the projectiles to be used with the gun--the 8-inch, high-explosive, rocket-assisted projectile called the XM650--was started in January 1971 under an accelerated program authorized by the Chief of Research and Development, Department of the Army.

In August 1970 the development cost of the XM650 projectile was estimated at $8.9 million. As of December 31, 1972, the estimated cost had risen to about $12.4 million, an increase of about $3.5 million. About $1.9 million of this increase is attributable to not having a firm design for the projectile until nearly 18 months after the start of full-scale development. The Army expects to complete development of this projectile by June 1976.

Requirements for the XM650 projectile were that it be compatible with standard fuzes already in use and with fuzes being developed. The XM650 projectile was to be more effective than the projectile now being used against personnel and materiel targets.

The projectile was not tested for reliability before beginning full-scale development. Reliability includes compatibility with the standard and the development fuzes and includes effectiveness as an antimateriel and antipersonnel weapon. Project officials believed that testing was not necessary because of their experience with other similar projectiles.

In our opinion, without testing there was no reasonable assurance that the projectile and fuzes would be compatible or that the weapon would have an antimateriel effectiveness. Testing of an earlier developed projectile showed that it was not compatible with the standard fuze. Also, earlier developed projectiles did not have similar requirements for antimateriel effectiveness.

Certain required quantitative data on existing howitzer systems was not available when the decision to enter full-scale development of the M110E2 howitzer was made. The requirement document for the M110E2 howitzer stated that:

> "The installation of the improved armament on the existing M107/M110 carriage shall not cause a degradation in overall system reliability, durability, and maintainability below levels attained by the existing product improved versions of the M107/M110 self-propelled-howitzer system."

When the decision to enter full-scale development was made, there was no quantitative data available on these characteristics for the current systems then in use. Without this data, decision-makers could not assure themselves that the required levels for these characteristics would be obtained in developing the improved system.

Both the U.S. Army Logistics Doctrine, Systems and Readiness Agency, and the Combat Developments Command have recently expressed the need for reevaluating the system in view of the projected shorter tube life and known reliability characteristics. At the time of our review, however, the Army had not reevaluated the System.

LIGHTWEIGHT COMPANY MORTAR SYSTEM

This system--the XM224--is being developed as a conventional 60mm mortar to replace the M29A1 81mm medium mortar used by ground, airmobile, and airborne rifle companies.

The development program's objective is to develop a mortar system weighing less than one-half the current mortar system and thus increase mobility and portability in terms of the weapon weight and the number of rounds that could be carried.

The system consists of a mortar, sight unit, high-explosive cartridge, illuminating cartridge, smoke-screening cartridge, and multioption mortar fuze. It was formally approved to start full-scale development in February 1973, based on data in the Concept

Formulation Package--the documentation used to provide evidence that necessary work has been completed and that the system is ready for full-scale development--which was submitted to Army headquarters in September 1972. The package indicated that, with the exception of the illuminating and smoke-screening cartridges, all components would complete advanced development by the end of September 1972.

Although the system was not formally approved to start full-scale development until February 1973, about $1.4 million of full-scale development funds had been made available and about $800,000 had been obligated prior to that time.

We reviewed the Concept Formulation Package and other supporting documents and found that necessary experimental work had not been done and that some supporting data was inaccurate, misleading, and contradictory. In our opinion, the package did not contain proof that the system was ready to start full-scale development.

For example, feasibility of the technical approach should have been proven prior to requesting approval to start full-scale development so that effort during full-scale development would be primarily engineering, rather than experimental. However, the package stated that, although much of the experimental effort had been completed for the weapon, ammunition, and multi-option fuzing, more experimental effort was required to fully show that the necessary technology was in hand. It stated also that advanced development work on the illuminating and smoke-screening round would be completed at a later date. Development of these two rounds was suspended in March 1973 due to funding constraints and the limited effectiveness of the smoke and illuminating fires which could be delivered by 60mm ammunition. According to Army officials, completing development of the mortar, fire control, and high-explosive round will be emphasized.

The cost information in the package was only preliminary data which did not identify the recurring investment and operational costs. This data submitted by the Watervliet Arsenal was not accepted by the Army Weapons Command because of numerous inadequacies, including the lack of support for the costs shown. Also a cost and operational effectiveness analysis showing whether the proposed system was favorable in relationship to the

effectiveness of competing systems had not been completed. This analysis had been requested by the Army Weapons Command in January 1973.

In December 1972, subsequent to submission of the Concept Formulation Package, the Army estimated that development costs for the XM224 mortar, including ammunition and fuzing, would be $22.2 million. This was an increase of about $6.1 million over the June 1972 estimate. About $2.3 million of this increase was for developing a time fuze for the illuminating round which had not been included in the June 1972 estimate. The remaining $3.8 million can be attributed to increases in hardware requirements and engineering and testing costs.

40mm WEAPON-LAUNCHED SIGNAL SERIES

The Army's 40mm weapon-launched signals are ground signals intended to be fired from either the M79 grenade launcher or a launcher attachment to the M16A1 rifle. The original development plan included 20 signal items to be developed by June 30, 1975, at a cost of about $2.8 million. Because of substantial changes in requirements, the latest plan shows only nine items to be developed by December 31, 1974, at a total cost of $2.1 million. The series of nine signals consist of two star parachutes, three smoke canopies, and four ground smoke markers. The items produce either light or smoke of various colors for visual communications.

Full-scale development of the star parachutes and smoke canopies was started in July 1971 and the ground markers in June 1972. All are expected to remain in full-scale development through December 1974. In our opinion, full-scale development of the star parachutes and smoke canopies was started prematurely.

Prior to the start of full-scale development on the star parachutes and smoke canopies, only limited functional reliability tests had been completed. Many tests that should have been done before full-scale development--such as performance, safety, durability, and maintenance--were not done until 1 to 3 months after full-scale development was started.

Officials at the Army's Picatinny Arsenal agreed that full-scale development started prematurely. They considered the entire

series of items as low risk and were optimistic that future tests would prove satisfactory because full-scale development on similar items had been substantially completed and because technical knowledge acquired in developing these items was being applied to the new developmental items.

AGENCY COMMENTS ON EARLIER RECOMMENDATIONS

By letter dated January 3, 1973, the Department of Defense commented on our October 6, 1972, report to the Congress. In that report we recommended that the Secretary of Defense require key decisionmakers to submit formal certifications that the prerequisites for entering full-scale development have been met or justify any exceptions in writing. We also recommended that he apply spot checks and other management-by-exception techniques to insure that the management principles which are specifically applicable to major systems are also applied to the far more numerous and, in total, more costly minor systems.

The Department said that certification by key decisionmakers as to the completeness of the prerequisites for entering full-scale development was not required in view of the military departments' implementation of DOD Directive 5000.1 dated July 13, 1971. The Department said also that it tended to monitor the military departments' implementations of the cited directive by using program memorandums and management reviews at the Office of the Secretary of Defense level for larger minor systems and by spot checks and reviews for smaller programs. We plan to appraise the effectiveness of these actions in future reviews.

VISIBILITY FOR CONGRESSIONAL CONSIDERATION

We suggested that the Congress obtain information from the Secretary of Defense on the development status of individual items when funds are initially budgeted for full-scale development. Availability of such information would help the Congress to decide the extent of funds to be appropriated for further development of the system.

Although the Department of Defense agreed that our suggestion had merit, it commented that such action might cause as much as a

year's delay in program funds because advanced development and related testing would not always be completed in conformance with the budget cycle.

We believe, however, that appropriate congressional control could be exercised--without delaying the development program--if the budget request were approved to the extent considered appropriate and either an appropriation limitation or a reporting requirement were added.

The appropriation limitation could prohibit the use of full-scale development funds for any new project until the Secretary of Defense submits a statement that (1) all necessary experimental work has been done and the proposed system is ready for full-scale development or (2) authorization of full-scale development is essential even though all prescribed conditions have not been met. In the latter situation, the reasons for the decision for premature authorization should be explained and areas in which experimental work has not been completed should be identified.

An alternative approach would be to require that the Secretary of Defense submit a periodic report to the Congress, such as each quarter, on all minor weapons systems reaching the stage where full-scale development funds are being authorized. The report should include statements as to the status of the weapons systems as described above.

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As requested by your office, we have not furnished a draft of this report to the Department of Defense for its advance review and comments, but we have discussed the issues with Department officials. Also, we have discussed the specific cases with Army and Air Force officials at the installations responsible for these development programs and have considered their informal comments in the report preparation. Also, as agreed with your office, we are sending copies of this report to the Chairmen of the House and Senate Committees on Appropriations and Government Operations and to the Chairman of the Senate Committee on Armed Services. We are also sending copies to the Secretary of Defense and to the Secretaries of the Army and the Air Force.

We do not plan to distribute this report further unless you agree or publicly announce its contents.

Sincerely yours,

Elmer B. Staats

Comptroller General
of the United States

ENCLOSURE

JOHN T. M. REDDAN
COUNSEL

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October 11, 1972

Honorable Elmer B. Staats
Comptroller General of the United States
General Accounting Office
Washington, D. C.

Dear Mr. Staats:

Your report of October 6th relative to the need for better management of minor weapons systems development is most interesting and timely.

I am greatly concerned with the problems and waste caused by premature approval of full-scale development and wonder whether you intend to continue your examination of the problem to determine the extent to which it may exist in the other services. It occurs to me that perhaps by using your broad examination of the Navy as a basis, a spot check of two or three minor weapons systems developed by each of the other services might permit solid conclusions of general applicability.

I would be very happy to have your views on this.

Sincerely,

F. Edw. Hebert
Chairman

FEH/jrd