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REPORT TO THE CONGRESS



Need For Management Improvement In Expediting Development Of Major Weapon Systems Satisfactory For Combat Use B-163058

Department of the Army

*BY THE COMPTROLLER GENERAL
OF THE UNITED STATES*

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

B-163058

To the President of the Senate and the
Speaker of the House of Representatives

This is our report on the need for management improvement in expediting development of major weapon systems satisfactory for combat use. Our review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting **and** Auditing Act of 1950 (31 U.S.C. 67).

Copies of this report are being sent to the Director, Bureau of the Budget; the Secretary of Defense; and the Secretary of the Army.

A handwritten signature in cursive script that reads "James B. Peets".

Comptroller General
of the United States

DIGEST

WHY THE REVIEW WAS MADE

The Sheridan is a tank-like weapon system intended to be used as the main reconnaissance item for armor, infantry, and airborne operations and as the main assault weapon for airborne operations, and for combined arms teams not using the heavier Main Battle Tank.

The Sheridan's turret contains a 152mm gun-launcher. The 152mm ammunition would include a completely combustible cartridge case and primer which would eliminate handling of expended cartridge cases--a new weapon concept. The gun-launcher is also capable of firing the Shillelagh missile. The gun-launcher, ammunition, and missile, collectively, are called the Shillelagh Weapon subsystem.

The General Accounting Office (GAO) reviewed the development and production of the Sheridan Weapon System because there were delays in making this important Army combat item available to the operational forces and because over \$1 billion was involved in this program.

GAO also reviewed the M60A1E1 and M60A1E2 tank systems because of Army plans to apply the Shillelagh Weapon subsystem to the M60 tank. GAO also noted that the Shillelagh Weapon subsystem was planned for use in the Main Battle Tank (MBT-70) program.

FINDINGS AND CONCLUSIONS

The Army has purchased Sheridans, M60A1E1 tank turrets, and M60A1E2 tanks which will require substantial modification before they will be fully suitable for operational use. Appreciable quantities have been authorized for production despite known development deficiencies in essential components. As a result, many of these weapons have been put into storage instead of being added to the combat effectiveness of the Army as planned. (See p. 11.)

GAO believes that this situation occurred because of:

- the absence of specific and agreed upon ammunition performance requirements early in the development program (see pp. 12 and 21)

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- insufficient testing prior to limited production (see pp. 12, 31, and 41).
- the development of portions of a weapon system being out of phase with each other (see pp. 13 and 20).
- the desire to minimize the possibility of program fund restrictions as a major factor in approving production authorizations (see pp. 13 and 21).
- the failure to take timely actions to limit or terminate weapon production where warranted (see pp. 13, 27, and 31).
- delay in initiating backup development effort for a deficient weapon system component (see pp. 13 and 27).
- the commitment of unproven weapon concepts to other systems prior to acceptability in the initial application (see pp. 13 and 40).

RECOMMENDATIONS

1 has recommended a series of actions for the Army to current and future development programs to increase the effectiveness of the Army's weapons systems sooner,

- that sufficient testing be conducted before an item is released for limited production and that specific criteria be established as to the degree of testing necessary before this production can be justified (see p. 42).
- that, before a weapon system is made a standard item and approved for full production, final service tests (STs) show conclusively that the overall system is suitable for troop use (see p. 43).
- that timely backup development be conducted in essential portions of a system experiencing continuous development difficulty to ensure availability of the system for scheduled deployment (see p. 45).
- that a new weapon concept, which pushes the state of the art, not be applied to other weapon systems until it has been fully developed and proven acceptable for operational use in its initial application (see p. 46).
- that existing Army regulations be suitably implemented to ensure that performance requirements for weapon systems and subsystems be specified and agreed to as early in the development program as practicable and that these requirements be subject to continual re-validation by the developing, testing, and using agencies as development proceeds (see p. 47).

- that the feasibility of all prime portions of a weapon system be demonstrated prior to committing an overall system to the final phases of development which are to be the basis for production (see p. 47).

AGENCY ACTIONS AND UNRESOLVED ISSUES

The Army concurred in most of GAO's proposals and stated that major actions or improvements had been initiated which should reduce deficiencies in future program management. However, the Army disagreed with some of the proposals. Since GAO believes further action is needed, GAO is recommending to the Secretary of Defense that Army Regulations be revised or established to provide:

- that, before a weapon system or subsystem is approved for full production, tests should show satisfactorily that the overall weapon system, including all essential components, is suitable for operational use;
- that, before a weapon system or subsystem is approved for limited production, it should satisfactorily pass a suitable engineering test (ET) performed by a responsible testing agency; and,
- that development of a new weapon concept must be completed and proven acceptable by suitable tests for troop use in its initial application before it is committed to additional weapon systems. (see p. 49).

The Army also stated that a major assessment of the Main Battle Tank (MBT-70) program has been conducted and that the development, testing, and production sequence as well as schedules are in general consonance with GAO proposals; and that production of the Shillelagh Weapon subsystem will not be initiated for inventory for the MBT-70 and M60A1E2 tanks until these tanks are suitable for troop use. (See p. 49.)

MATTERS FOR CONSIDERATION BY THE CONGRESS

Several committees and many members of the Congress have expressed a strong interest in major weapon systems and how their development and procurement can be improved. To enable the Congress to exercise appropriate legislative controls over the funding of major defense systems, the Congress may wish to require that (1) determination be made by the Secretary of Defense, prior to authorizing production of a new system or major modification of an existing system, that all of its significant components have satisfactorily met all prescribed developmental tests and (2) in any case where the Secretary of Defense considers that authorization of production is essential even though not all developmental

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tests have been satisfactorily completed, a certification to that effect be furnished by the Secretary of Defense to the appropriate congressional committees--such certification to include the reasons for authorizing concurrent development and production and the status of development of each significant component.

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ABBREVIATIONS

ACSFOR	Assistant Chief of Staff for Force Development
AMC	U.S. Army Materiel Command
APG	Aberdeen Proving Ground
ARENBD	Armor and Engineer Board
CDC	U.S. Army Combat Developments Command
CONARC	U.S. Continental Army Command
CRD	Chief of Research and Development, Army Staff
DA	Department of Army
DCSLOG	Deputy Chief of Staff for Logistics
ET	Engineering test
GAO	General Accounting Office
GFE	Government Furnished Equipment
IPR	In-process review
LP	Limited Production (an authorizing action)
MBT	Main Battle Tank (MBT-70)
MUCOM	U.S. Army Munitions Command
SIPR	Special in-process review
ST	Service test
TECOM	U.S. Army Test and Evaluation Command

D I G E S T

WHY THE REVIEW WAS MADE

The Sheridan is a tank-like weapon system intended to be used as the main reconnaissance item for armor, infantry, and airborne operations and as the main assault weapon for airborne operations, and for combined arms teams not using the heavier Main Battle Tank.

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GAO also reviewed the M60A1E1 and M60A1E2 tank systems because of Army plans to apply the Shillelagh Weapon subsystem to the M60 tank. GAO also noted that the Shillelagh Weapon subsystem was planned for use in the Main Battle Tank (MBT-70) program.

FINDINGS AND CONCLUSIONS

The Army has purchased Sheridans, M60A1E1 tank turrets, and M60A1E2 tanks which will require substantial modification before they will be fully suitable for operational use. Appreciable quantities have been authorized for production despite known development deficiencies in essential components. As a result, many of these weapons have been put into storage instead of being added to the combat effectiveness of the Army as planned. (See p. 11.)

GAO believes that this situation occurred because of:

- the absence of specific and agreed upon ammunition performance requirements early in the development program (see pp. 12 and 21)

- insufficient testing prior to limited production (see pp. 12, 31, and 41) .
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- delay in initiating backup development effort for a deficient weapon system component (see pp. 13 and 27).
- the commitment of unproven weapon concepts to other systems prior to acceptability in the initial application (see pp. 13 and 40).

RECOMMENDATIONS OR SUGGESTIONS

GAO has recommended a series of actions for application to current and future development programs to increase management effectiveness and to deploy acceptable weapon systems sooner, namely :

- that sufficient testing be conducted before an item is released for limited production and that specific criteria be established as to the degree of testing necessary before this production can be justified (see p. 42).
- that, before a weapon system is made a standard item and approved for full production, final service tests (STs) show conclusively that the overall system is suitable for troop use (see p. 43).
- that timely backup development be conducted in essential portions of a system experiencing continuous development difficulty to ensure availability of the system for scheduled deployment (see p. 45).
- that a new weapon concept, which pushes the state of the art, not be applied to other weapon systems until it has been fully developed and proven acceptable for operational use in its initial application (see p. 46).
- that existing Army regulations be suitably implemented to ensure that performance requirements for weapon systems and subsystems be specified and agreed to as early in the development program as practicable and that these requirements be subject to continual re-validation by the developing, testing, and using agencies as development proceeds (see p. 47).

- that the feasibility of all prime portions of a weapon system be demonstrated prior to committing an overall system to the final phases of development which are to be the basis for production (see p. 47).

AGENCY ACTIONS AND UNRESOLVED ISSUES

The Army concurred in most of GAO's proposals and stated that major actions or improvements had been initiated which should reduce deficiencies in future program management. However, the Army disagreed with some of the proposals. Since GAO believes further action is needed, GAO is recommending to the Secretary of Defense that Army Regulations be revised or established to provide:

- that, before a weapon system or subsystem is approved for full production, tests should show satisfactorily that the overall weapon system, including all essential components, is suitable for operational use;
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- that development of a new weapon concept must be completed and proven acceptable by suitable tests for troop use in its initial application before it is committed to additional weapon systems. (see p. 49).

The Army also stated that a major assessment of the Main Battle Tank (MBT-70) program has been conducted and that the development, testing, and production sequence as well as schedules are in general consonance with GAO proposals; and that production of the Shillelagh Weapon subsystem will not be initiated for inventory for the MBT-70 and M60A1E2 tanks until these tanks are suitable for troop use. (See p. 49.)

MATTERS FOR CONSIDERATION BY THE CONGRESS

Several committees and many members of the Congress have expressed a strong interest in major weapon systems and how their development and procurement can be improved. To enable the Congress to exercise appropriate legislative controls over the funding of major defense systems, the Congress may wish to require that (1) determination be made by the Secretary of Defense, prior to authorizing production of a new system or major modification of an existing system, that all of its significant components have satisfactorily met all prescribed developmental tests and (2) in any case where the Secretary of Defense considers that authorization of production is essential even though not all developmental

tests have been satisfactorily completed, a certification to that effect be furnished **by** the Secretary of Defense to the appropriate **congressional** committees--such certification to include the reasons for authorizing concurrent development and production and the status of development of each significant component.

INTRODUCTION

The General Accounting Office has made a review of the development and production of the Sheridan Weapon System and the M60A1E1 and the M60A1E2 tanks, covering the period from inception to this date. The review was directed primarily toward an evaluation of management controls during the development of these weapon systems,

Our examination was performed primarily at the Sheridan Project Management Office, U.S. Army Weapons Command, Rock Island, Illinois; the M60 Tank Project Management Office, Warren, Michigan; Picatinny Arsenal, Dover, New Jersey, and the Combat Developments Command, Ft. Belvoir, Virginia. In addition, we discussed the Sheridan Weapon System and the M60A1E1/E2 tank programs with the Vice Chief of Staff, Department of the Army; the Commanding General, Army Materiel Command; and representatives of the Deputy Assistant Secretary of Defense, Installations and Logistics (Materiel). We also performed limited work on the Main Battle Tank program.¹

Internal audits performed by the Army Audit Agency and the Army Weapons Command's Internal Review Office did not include the matters covered by this report.

A draft report on our findings was released to the Secretary of Defense for comment on February 7, 1969. At the request of the Chairman, House Committee on Armed Services, the draft report was made available to the Armed Services Investigating Subcommittee on February 10, 1969,

¹In addition, the Chairman of the Senate Committee on Armed Services, by letter of August 9, 1969, requested that we examine and report on certain aspects of the MBT-70 program. This report (B-163058) was issued to the Committee on September 2, 1969.

and **was** the basis for extensive hearings during March and April 1969. The Subcommittee's report was issued on July 9, 1969.¹

The Army was requested to review our draft report and agency comments thereon for national security purposes. Blank spaces in this report indicate the deletions made to comply with the Army's classification.

¹Report of the Armed Services Investigating Subcommittee of the Committee on Armed Services, House of Representatives, 91st Congress, 1st Session, under authority of H. Res. 105, entitled "'Review of Army Tank Program,'" dated **July 9, 1969.**

BACKGROUND

The Sheridan Weapon System (also called the Sheridan weapon or simply the Sheridan) is an armored reconnaissance/airborne assault vehicle mounting a turret which contains a 152mm gun-launcher with the dual capability of firing the Shillelagh missile¹ and a series of 152mm ammunition rounds. The Sheridan is a fully tracked vehicle designed with inherent air transportability and swimming capability. The ammunition includes a completely combustible cartridge case and primer which will eliminate the need for handling expended cartridge cases.

The Sheridan Weapon System will replace the light tank series (M41) and the airborne assault weapon (M56). It is intended to function as the main reconnaissance weapon for armor, infantry, and airborne operations and as the main assault weapon for airborne operations and for combined arms teams not employing the MBT-70.

The M60A1 tank--roughly 2-1/2 times the weight of the Sheridan--is currently the standard main battle tank in the Army pending development completion of the MBT-70. The M60A1E1/E2 tanks are versions of the M60A1 employing the Sheridan's armament. Photographs of the Sheridan and the M60A1E2 are included in this report as exhibits A and B.

Development of the Sheridan Weapon System was initiated in 1959. The Sheridan weapon was originally scheduled to be approved for service use in January 1963 and for availability to the troops in early 1964. The primary components of the weapon system are the Sheridan vehicle and the Shillelagh Weapon subsystem (the Sheridan's armament) which includes the Shillelagh missile, a series of 152mm ammunition rounds, a gun-launcher, and related fire control and guidance equipment. In addition, there is an XM35 Conduct-of-Fire trainer under development as a device for training in the use of the Shillelagh missile on the Sheridan vehicle.

¹This missile is described on p. 8.

The Shillelagh missile is the Sheridan's primary tank-defeating round. It provides a greater first-round hit probability, particularly at longer ranges against hard targets, than normally associated with gun-type armament systems. Under development as the primary round of ammunition is the high explosive, anti-tank, multipurpose round (XM409). Its objective is to be capable of defeating heavy tanks at battle ranges up to ----- yards and also to provide soft target capabilities (personnel, unarmored vehicles, etc.) at all usable ranges.

Also under development as part of the Shillelagh Weapon subsystem are the white phosphorus round (XM410), which is primarily for screening, marking, and incendiary use, and the target practice/training round (XM411). In addition, development of three more ammunition rounds was initiated late in the Sheridan program. These are the high-explosive round (XM657) which is to be used as an interim round until the XM409 is acceptable; the beehive round (XM617); and the canister round (XM625) which is to be used until the beehive round is developed. The beehive and canister rounds are for use primarily in an antipersonnel role.

During the development phase of a weapon system, certain materiel tests are required to determine whether the product is satisfactory for its intended use and to obtain data needed in determining changes required prior to production. These tests are generally referred to as engineering design tests, the engineering test (ET), and the service test (ST).

The engineering design tests are conducted by or under the control of the design agency. The purpose of these tests is to collect design data, confirm preliminary concepts and calculations, and determine the compatibility of components. Engineering and service tests are conducted by or under the supervision of the Test and Evaluation Command, a subordinate of the Army Materiel Command. The ET provides data for use in any further development required and for determination as to the technical and maintenance suitability of the item or system for ST. The ST provides data to be used to determine whether the item or system is suitable for Army use.

After STs show that an item is suitable for Army use, it may be type-classified Standard A, adopted into the Army supply system, and approved for full production. This type-classification (or standardization) action serves to obtain and record Department of the Army decisions on the current status of the materiel relative to the Army supply system and to facilitate planning for orderly and economical phasing of the item into the supply system.

In exceptional cases, the Army may type-classify an item as "Limited Production" (LP) provided that an urgent operational requirement for the item exists. The item must appear to fulfill an approved qualitative materiel requirement or other Department of the Army-approved requirement and must be promising enough operationally to warrant initiating procurement or production for troop issue prior to completion of development and/or test or adoption as a standard-type item. Any item, subsystem, or weapon system authorized for LP is under development and production concurrently. This procedure involves expedited development under high-risk conditions. No specific amount of testing is required before an item can be type-classified LP. However, a statement of the type and extent of testing conducted on the item, the extent of further testing necessary, and the degree of confidence that the item will successfully complete development are required.

The Sheridan Weapon System and the M60A1E1/E2 tanks are under the direction of Project Managers who have full-line authority over all planning, direction, and control of tasks and associated resources involved in providing an item to using units or to the intended operational destination. This includes all phases of research, development, procurement, production, distribution, and logistic support. The Project Managers report to the Commanding General, U.S. Army Materiel Command, through the Commanding General, U.S. Army Weapons Command.

The Sheridan Weapon System was put under a Project Manager in 1962, and the office is currently located at the U.S. Army Weapons Command, Rock Island, Illinois. In 1964 a separate Project Manager for the Shillelagh missile was appointed and the office is located at Redstone Arsenal, U.S. Army Missile Command, Huntsville, Alabama. The

ammunition remained the responsibility of the Sheridan Project Manager. The M60A1E1/E2 tanks are under the M60 Tank Project Manager located at Warren, Michigan.

The total program cost for development and procurement of the Sheridan Weapon System, through fiscal year 1972, is currently estimated at over \$1.3 billion, of which **about** \$200 million is for research and development. Current program costs of the M60A1E2 Tank System, including only quantities delivered and those authorized for procurement to date and excluding missiles and ammunition, are estimated at approximately \$250 million.

FINDINGS

NEED FOR MANAGEMENT IMPROVEMENT IN EXPEDITING DEVELOPMENT OF MAJOR WEAPON SYSTEMS SATISFACTORY FOR COMBAT USE

Our review of the Sheridan Weapon System and M60A1E1/E2 tank programs showed a lack of effectiveness in the management and control of their development, which, in our opinion, affected the timely and satisfactory fielding of these weapon systems. This lack of management effectiveness permitted premature production and the resultant storage of weapons and trainers which were not suitable for operational use.

The Army purchased Sheridan weapons, M60A1E1 tank turret systems, and M60A1E2 tanks for which no acceptable ammunition was available. Also, the M60A1E1 tank turrets and the M60A1E2 tanks were procured before sufficient testing was performed on these items to adequately evaluate their suitability for operational use. Furthermore, mass production of the Sheridan was permitted to continue although it was apparent that acceptable ammunition would not be developed in time to meet the scheduled deployment of the weapon. This imbalance resulted in many of these weapons being put into storage depots rather than being issued to operational units, which impaired the planned combat effectiveness of the Army.

In addition, the Army purchased trainers for the Sheridan weapon although tests showed that, due to numerous deficiencies, these devices were not suitable for troop training. These trainers required major modification prior to being issued for Sheridan crew training.

We issued a letter report on December 15, 1967, to the Secretary of Defense informing him that the Army was purchasing Sheridan weapons and M60A1E2 tanks for which no suitable ammunition was available. We stated that many Sheridans were being stored in depots until acceptable ammunition was available and that recent test results indicated that acceptable ammunition was not likely to be available for an appreciable period.

The Assistant Secretary of Defense (Installations and Logistics) replied to our report by letter dated March 15, 1968. He stated that the difficulties with the ammunition were well known to the Army and Defense staffs. He stated also that programmed quantities of the weapons in the budgets for fiscal years 1967, 1968, and 1969 had been reduced or canceled and that this reflected their concern for the imbalance between the Sheridan Weapon System and its ammunition.

He stated further that suitable ammunition would be available in quantities to support overseas deployment of the Sheridan in the fall of 1968. As of July 1969 no satisfactory ammunition was available for use with the Sheridan Weapon System or M60A1E2 tanks. Combat use of this ammunition has been authorized only on a conditional basis which provides that the 152mm gun from which it is fired must be equipped with a suitable scavenger system¹ and other restrictions are followed.

We believe that the following management weaknesses existed during the development of these weapon systems and contributed significantly to the resulting imbalances between the availability of the Sheridan weapon, ammunition, and trainers.

1. Specific and agreed upon performance requirements for the ammunition were not established early in the Sheridan Weapon System development program, nor was effective action taken by the development, testing, and using agencies to ascertain these requirements during the development process.

2. Sufficient testing was not conducted on the M60A1E1/E2 tanks and XM35 trainers prior to production release.

¹A scavenger system directs jets of compressed gas--currently air--into the gun-launcher after firing for the purpose of clearing the tube and breech.

3. Mass production of Sheridan weapons under Standard A type-classification was approved before ammunition, which is necessary for the satisfactory fielding of the weapon, was fully developed and acceptable for troop use.

4. The desire to minimize the possibility that program funds might be reduced or discontinued was a major factor in approving type-classification and production of weapons.

5. Timely action was not taken to limit or terminate the production of Sheridan weapons when it became apparent that suitable ammunition would not be available to meet scheduled deployment of the weapon. Neither was action taken to terminate production of training devices when major deficiencies were known to exist.

6. A backup cartridge case development effort for ammunition was not initiated early in the program to ensure availability of acceptable ammunition when the Sheridan Weapon System was scheduled for deployment.

7. The Shillelagh Weapon subsystem, which represents an attempt to advance the state of the art, was committed to other major weapon systems (the M60A1E1/E2 tanks) prior to the completion of its development and acceptability in its initial Sheridan application.

The problem areas which we noted in our review of the Sheridan Weapon System and the M60A1E1/E2 tank programs and which, we believe, would have application to the development of other weapon systems, are described in the following pages. To facilitate this discussion we have divided the remainder of this findings section into four parts, each of which has its own conclusions. These are followed in turn by our report proposals and the agency comments thereon and by our conclusions and our recommendations to the Secretary of Defense and the Congress.

Type classification of the Sheridan Weapon System

The Sheridan Weapon System, less the ammunition, was type-classified Standard A in May 1966 although acceptable ammunition had not been developed for the weapon. Serious deficiencies were being experienced with the ammunition at that time, and considerable doubt was expressed by various Army agencies as to the timely resolution of these problems. The deficiencies related primarily to the performance of the combustible cartridge case and primer. These problems concerned residue remaining in the gun tube after firing, inability of the cartridge case to withstand humidity, smoke obscuration after firing, excessive misfires, and ignition delays. The development history of the Sheridan Weapon System, prior to the May 1966, Standard A type-classification date, follows.

The Army type-classified the Sheridan weapon as LP in May 1965 after awarding a 4-year (fiscal years 1966-1969) multiyear production contract in April 1965 for---of these weapons. On March 29, 1966, the Sheridan Project Manager recommended Standard A type-classification for the Sheridan Weapon System. Prior to his recommendation, the primary round of ammunition for this system, the multipurpose XM409, had entered ET three times since 1962 and had failed each test because of various problems. The ammunition reverted back into engineering development in February 1965 after tests had shown that it met only about 60 percent of the essential characteristics. It failed to satisfy the requirements for ballistic performance, safety release (temperature limit), fuze sensitivity, arming distance, and the humidity phase of the laboratory environmental tests. It was still in the engineering-design stage when the Project Manager requested the cited Standard A type-classification for the Sheridan weapon.

The ammunition test was conducted by the Test and Evaluation Command (TECOM) which is the testing agency for the Army. We discussed the test results with representatives of Picatinny Arsenal, which is the developing agency for the 152mm ammunition. These representatives informed us that they disagreed with the conclusions of TECOM's report. They stated that many of the essential ammunition

characteristics referred to in the report were not specified in the required military characteristics and therefore were not actual requirements at that time. They stated also that, when compared with requirements specified in the originally required characteristics, the XM409 ammunition met the major performance requirements and that the deficiencies cited by TECOM pertained to design objectives which had not been previously identified as requirements.

It was apparent, however, that the performance of the round was not satisfactory in 1965 and 1966 because the Sheridan ammunition remained in the engineering development phase after Standard A type-classification of the Sheridan weapon in May 1966. It was also evident that there was a lack of effective communication and coordination between the developing, testing, and using agencies as to what characteristics the ammunition was required to meet during the cited ETs which were concluded in February 1965,

The lack of effective communication was also apparent in the in-process review (IPR) meetings held during the development of the Sheridan Weapon System. These meetings were attended by the developing, testing, and using agency representatives in order that they might review the status of the development and agree on the resolution of problems and the future course of development effort. During the IPRs various ammunition characteristics were discussed; but, as late as April 1966 which was just prior to the May 1966 Standard A type-classification of the Sheridan weapon, some ammunition requirements were still reported as "not specified."

About 3 months before the Project Manager's March 29, 1966, recommendation to type-classify the Sheridan weapon as Standard A, TECOM reported that, because of the debris left in the tube following firings and because of difficulties encountered in removing stuck and misfired rounds, further development effort was necessary to produce a satisfactory ammunition cartridge case which would eliminate deficiencies. In addition, on March 15, 1966, TECOM reported on engineering and service tests of the Sheridan Weapon System. From the performance of the ammunition in these complete system tests, TECOM concluded that the

XM409E1 and XM411 rounds of ammunition were unsuitable for Army use. TECOM recommended that continued development effort be applied to eliminate susceptibility to humidity, residue from the combustible cartridge case, delayed ignition and misfires, and excessive smoke and/or flash.

On March 14, 1966, in response to inquiries from the Commanding General, U.S. Army Weapons Command, the Headquarters, U.S. Army Munitions Command (MUCOM), which is Picatinny Arsenal's parent Command, reported that, although the state of the art had been advanced considerably with this ammunition, a number of serious problems still existed. These problems consisted primarily of the deficiencies noted above. MUCOM stated that rounds fired after the most recent humidity tests occasionally (about one of every 10 rounds) left smoldering cartridge case residue in the chamber and that this was definitely hazardous because such residue could ignite the next round chambered. MUCOM stated however, that they believed the problem was solved and that this opinion should be substantiated in further engineering and service tests. MUCOM stated also that, although improvement in combustible cartridge case moisture resistance was desirable, a marked improvement over current performance could come only with an advance in the state of the art and such improvement must be sought in second generation combustible case ammunition.

One day later, on March 15, 1966, the same MUCOM official submitted a letter to the Sheridan Project Manager to comment on the status and outlook for the 152mm ammunition in view of the forthcoming Standard A type-classification action for the Sheridan weapon. MUCOM reported that engineering design tests of ammunition rounds employing certain modifications (XM409E2 and XM411E2) had been made and that these tests had verified that the major defects had been eliminated. It was further stated that, on the basis of engineering judgment and tests conducted to that date, MUCOM was highly confident that these rounds would be acceptable. They concluded that the status of the ammunition should not be a delaying factor in the action to type-classify the Sheridan weapon and the Shillelagh missile as Standard A.

A Picatinny Arsenal official informed us that the engineering design tests referred to in the March 15, 1966, letter were made January 25-27, 1966, at TECOM's Aberdeen Proving Ground (APG), Aberdeen, Maryland. Review of the firing record shows that the cartridge cases used were in three categories; i.e., untreated cases, water-repellent-coated cases, and nitrocellulose-lacquer-coated cases. These rounds were subjected to humidity cycling before being fired. The TECOM report on these tests concluded that the untreated cartridge cases gave the best results. However, our examination of the round-by-round data for the test showed that smoldering residue after firing was evident for all three categories of cartridge cases.

These test firings were observed by a Picatinny Arsenal Project Engineer, and his trip report stated that the untreated cases appeared to perform best throughout the test but that smoldering residue particles occurred in 20 percent of the rounds fired and that, therefore, there was serious doubt that an untreated case would be an acceptable solution for surviving temperature-humidity environment.

On April 4, 1966, 6 days after the recommendation of the Project Manager to standardize the Sheridan Weapon System, the Deputy Commanding General, U.S. Army Materiel Command (AMC), informed the Chief of Research and Development (CRD) of the Army Staff that engineering and service tests of the XM409E1 and XM411E1 rounds disclosed certain shortcomings and deficiencies relating primarily to the combustible cartridge case. He further stated that the causes of these failures had been identified, design modifications had been made to overcome them, and additional development tests had been conducted verifying that major defects had been corrected. The General also stated that on the basis of engineering evaluation and tests conducted to date, the modified rounds were expected to perform satisfactorily during the confirmatory test program. He stated, in addition, that delay of Standard A type-classification of the Sheridan weapon and Shillelagh missile would have adverse impacts, both political and budgetary. It was the position of AMC, therefore, that the status of the Sheridan ammunition should not be allowed to delay Standard A type-classification of the Sheridan weapon and Shillelagh missile.,

Only a few days previously, however, on March 28, 1966, the Deputy Commanding General of AMC had disapproved a recommendation to type-classify the M60A1E1/E2 tanks as LP. This disapproval was the result of the insufficient affirmative testing on the vehicle and the unsatisfactory experience with the XM409E1 and XM411E1 ammunition.

On April 26, 1966, APG began engineering design environmental testing on the cartridge case, and on May 6 reported to TECOM that, in some instances, as much as 80 percent of the case remained in the breech chamber after firing the 152mm weapon. In its May 16 report on these tests, APG reported that cases were soft after humidity testing, rounds left 80 percent of the cases after firing, and ignition delays were experienced. Residue problems were also noted by APG in its May 23 report on these tests. Copies of these reports were furnished to the Sheridan Project Manager.

In its monthly feeder reports to the Project Manager for March, April, and May 1966, Picatinny Arsenal reported various problems related to the humidity tests of the XM409 ammunition. In its May report, Picatinny stated that tests on May 1, 1966, of rounds assembled using untreated cartridge cases and subjected to humidity tests for 5 days resulted in the occurrence of excessive residue. Action was initiated to design a removable cover to protect the cartridge case and, after a design was established, orders were placed for 3,500 covers to support delivery of rounds for engineering and service testing, and for initial production of the XM411E2 rounds.

The March 29, 1966, proposal to type-classify the Sheridan weapon as Standard A was concurred in by the Deputy Chief of Staff for Logistics and representatives of the developing agencies, i.e., the AMC and the CRD. However, the proposal was nonconcurrent in by the Army elements representing the user, i.e., the Assistant Chief of Staff for Force Development (ACSFOR), the Combat Developments Command (CDC), and the Continental Army Command (CONARC). ACSFOR and CDC requested that the LP classification for the Sheridan weapon be extended until munition had been proven and engineering and service tests satisfactorily accomplished.

On April 29, 1966, CRD notified the Army Chief of Staff that ACSFOR nonconcurred in the recommendation to type-classify the Sheridan as Standard A because of deficiencies in the 152mm ammunition and the night-fighting capability and the lack of a range finder. It was further stated that the Deputy Commanding General, AMC, had assured CRD that the causes of the deficiencies in the ammunition had been identified, design modifications had been made, and development tests had verified that the major defects had been corrected. CRD concluded that, on the basis of the Deputy Commanding General's confidence, ammunition by itself should not bar Standard A type-classification of the Sheridan weapon.

Attached to the April 29 correspondence were various documents relating to the Sheridan weapon and the M60A1E1/E2 tanks. Included in these documents was a statement from the Office of the Deputy Chief of Staff for Logistics (DCSLOG) that to continue type-classification LP on the Sheridan would create an unfavorable position going into apportionment in May 1966. Further, this position would reflect a lack of confidence in the system, which could generate reexamination by the Bureau of the Budget and the Department of Defense and which could influence them to cut the quantity of the 2d-year buy.

The Vice Chief of Staff requested that he be given a briefing relating to the Sheridan weapon and M60A1E1/E2 tanks. The briefing was given on May 9, 1966, by CRD and AMC. We requested a copy of this briefing and were given a copy of CRD's presentation. However, AMC's presentation, which, according to CRD, discussed the ammunition in detail, was not made available to us. We were informed by representatives of AMC that this document could not be located,

Because we were not provided a copy of AMC's presentation to the Vice Chief of Staff, we were unable to evaluate its content. At the time the briefing was given, however, test reports had shown a continuous problem with the ammunition including residue, misfires, premature detonations, smoke obscuration, and the inability of the cartridge case to withstand humidity. The modifications to solve these problems had not undergone engineering and service tests

but had been tested solely in engineer design tests and the results of these tests showed that the cartridge case humidity and residue problems had not been solved.

Picatinny Arsenal representatives informed us that cartridge case residue and humidity problems were not considered sufficiently serious to prevent Standard A type-classification of the Sheridan weapon. They stated that small amounts of smoldering residue had not been considered significant and were not recognized as a problem until December 1966. With regard to humidity, they told us that in 1966 the primary criterion was that the cartridge case maintain dimensional stability. After recognition of the seriousness of the smoldering residue problem, however, the major concern had been exposure of the cartridge cases to wet environments and the increased probability of obtaining smoldering residue ■

Our review disclosed that cartridge case residue and humidity problems were considered sufficiently serious by Army testing agencies to cause them to include these problems in test reports dated prior to May 1966. In addition, major Army elements representing the user had expressed a lack of confidence in the ammunition. Furthermore, as noted before in this report, MUCOM stated on March 14, 1966, that rounds fired after the most recent humidity tests left smoldering residue and that this was definitely hazardous because such residue could ignite the next round chambered. We believe, therefore, that the statement made by Picatinny Arsenal representatives that residue and humidity problems were not considered serious was not justified.

On May 21, 1966, the Army approved Standard A type-classification of the Sheridan weapon and thus an item which was not suitable for its intended operational use because of the lack of acceptable ammunition was mass-produced.

Conclusions

We believe that, inasmuch as acceptable ammunition had not been developed for the Sheridan Weapon System, the

decision to type-classify the Sheridan as Standard A was premature and resulted in the mass production and storage of weapons that were not suitable for their intended use.

We believe further that budgetary considerations were a major factor in the decision to type-classify the Sheridan weapon as Standard A. As stated previously, the likelihood of a reexamination of the Sheridan Weapon System program by the Department of Defense and/or the Bureau of the Budget and a possible withdrawal or limitation of funds, were cited as reasons for this decision. However, the continuous problems experienced during the development of the ammunition and the results of tests conducted on the ammunition prior to the Standard A type-classification of the Sheridan weapon, did not, in our opinion, support the position taken by the Army.

In addition, we believe that there was lack of effective communication and coordination between the developing, testing, and using agencies, especially in relation to the ammunition development. The essential performance requirements for the ammunition were not specified or agreed upon by all agencies of the Army which were involved in the Sheridan Weapon System program. In our opinion, essential performance characteristics should be specified and agreed upon early in the development program, and these requirements should be continuously revalidated as development progresses so that the developing, testing, and using agencies are aware of, and in full agreement on, the performance to be attained.,

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Continued development and production
of the Sheridan Weapon System

The Army approved Standard A type-classification of the Sheridan weapon in May 1966 with assurances from the developing agencies that the major deficiencies in the ammunition were solved and that the ammunition would be type-classified as Standard A in the first quarter of fiscal year 1967. However, engineering and service tests conducted on the modified ammunition in June and July 1966 showed that major deficiencies still existed and that the ammunition continued to be unsuitable for troop use. In spite of the problems being experienced with the ammunition, the Army continued full-scale production of the Sheridan until December 1967 when the third-year buy (FY 1968) was reduced from --- to --- units. As of mid-September 1968 (first production deliveries were made in June 1966), the Army had produced about --- Sheridans, of which --- were stored in depots and at the production site. The remaining weapons had been issued to active units, training centers, and other installations for training, testing, and other purposes. As of November 1968, however, no Sheridan Weapon Systems had been deployed for use in an operational theater due to the lack of acceptable ammunition.

As cited above, the XM409E2 ammunition entered ETs at APG and STs at Fort Knox, Kentucky, in June 1966, about 1 month after the Sheridan was type-classified Standard A. After some testing, APG recommended that the tests be suspended until the problems of cartridge case residue and premature detonation of the shell were solved.

In January 1967 CDC, in commenting on a request for LP extension for the XM409 and XM411 ammunition rounds stated that there was nothing in the interim test reports to indicate that any significant improvements had been made regarding the ammunition deficiencies noted in the Sheridan Weapon System engineering and service test report of March 15, 1966. CDC recommended that no further procurement of the ammunition rounds be made for other than test and evaluation purposes until improvements could be made and until test results had established that there were no safety hazards to the tank crew or accompanying infantry and support troops and that the standards required for

field use under environmental conditions of high temperatures, high relative humidity, and heavy rainfall, as prevails in the areas of most likely conflict during the foreseeable future, had been met.

In February 1967, TECOM stated that the ammunition was not suitable either for troop training in quick-fire gunnery problems or for deployment to an operational theater.

Premature detonations occurred during the firing of XM409 rounds on November 16, 1966, and February 15 and March 4, 1967. Extensive tests were conducted in an attempt to determine the cause of the premature detonations, and in April 1967 the Project Manager reported to CDC that investigations to that date had been inconclusive despite the fact that many of the tests had been conducted at excessive overpressure in the 152mm gun-launcher following severe environmental conditioning of the ammunition.

A scavenger system was developed for the Sheridan 152mm gun-launcher to eliminate flarebacks, toxic fumes, and cartridge case residue from the gun tube and breech chamber after firing. The scavenger system directs jets of compressed gas--currently, air--into the gun-launcher after firing for the purpose of clearing the tube and breech. Initially, an open-breech scavenger was developed which functioned subsequent to the firing operation and after the gun breech was opened. In April 1967, however, TECOM withdrew the rapid-fire safety release on all 152mm combustible case ammunition because of excessive burning residue remaining in the gun after firing, and the inadequate performance of the open-breech scavenger system. In the final report on ET of the open-breech scavenger, TECOM reported that the system failed to overcome the ammunition residue problem and that smoldering residue was blown about the crew compartment, creating a secondary safety hazard. Therefore, in April 1967 development of a closed-breech scavenger system was initiated to replace the open-breech scavenger. This system functions immediately after the round is fired and prior to the opening of the breech and thus eliminates the problem of smoldering residue being blown into the crew compartment.

In June 1967 TECOM reported on the tropic trial of the Sheridan weapon and stated that live, flaming and smoldering residue was left by 39 percent of the rounds fired. TECOM also reported that, on the basis of about 4 years' test experience with this ammunition and the reemphasis of the problems by the tropic trial, it was recommended that serious consideration be given to the concurrent development of a metallic cartridge case for the 152mm ammunition. TECOM stated that the relative advantages of the combustible cartridge case, i.e., elimination of the case disposal problem and decreased round weight, were insignificant in comparison with its disadvantages; and, although solution of the residue problem would be a big improvement, this in itself would not make the combustible case better than a metallic case.

In a report dated August 8, 1967, the Armor Agency stated that the combustible case ammunition being developed for the Sheridan was unsuitable for further consideration at that time because of various deficiencies. The Agency concluded that the combustible case might never be acceptable in the current tank turret environment. CDC concurred in this statement.

At an Army Combat Vehicle Program Review in October 1967, CDC made a presentation to the Vice Chief of Staff relating to requirements for a backup 152mm ammunition program. CDC informed him that, during ET of the ammunition, premature detonations had occurred resulting in rescission of the safety release. Also, the ammunition left smoldering or flaming residue after firing, and devices introduced by the Project Manager to overcome these deficiencies had adversely affected the operational capability of the vehicle and compounded a serious safety hazard as the scavenging action blew smoldering residue around the turret. CDC also stated that the neoprene bag (cover), developed to protect the ammunition cartridge case from humidity, required too much time to remove and that this could result in the tank crew's electing to remove the bags early and expose themselves and the vehicle to the hazards associated with exposed combustible cartridge cases. Because of these serious problems, CDC recommended that a program be funded and initiated to develop a noncombustible case for the 152mm ammunition. This recommendation was approved and

feasibility studies of a metal cartridge case were initiated in October 1967.

Wemet with the Vice Chief of Staff in November 1967 to discuss the existing imbalance between the Sheridan production and its developmental ammunition. We proposed, at that time, a reexamination of production and deployment schedules for this system. In December 1967, the Army reduced the third-year buy of Sheridans from ~~1000~~ to ~~1000~~ units, resulting in a cutback of deliveries from ~~1000~~ to ~~1000~~ units a month. However, the total number of Sheridans to be delivered under the contract remained the same, as production was stretched out into fiscal year ~~1968~~. We were informed that the stretch-out was due to funding limitations and to the lack of acceptable ammunition for the weapon system.

In early 1968 a slow-fire safety release was reinstated for the ammunition after tests showed that the problem of premature detonation for the XM409 ammunition had been solved. This safety release was limited to Sheridan weapons and M60A1E2 tanks having the closed-breech scavenger system. The release required that all combustible case ammunition stowed in the vehicles must have the neoprene moisture barrier bags in place during firing exercises. In addition, the barrier bag could not be removed from the cartridge case of a succeeding round to be fired until it had been ascertained that the *gun* barrel and breech cavity were clear of residue.

In July 1968 TECOM reported on the tropic test of the closed-breech scavenger system and ammunition using the Phase D combustible cartridge case. The report concluded that the scavenger eliminated the smoke and toxic gas problems and significantly reduced the incidence of burning residue left in the *gun*. It was further concluded that the Phase D ammunition with the removable neoprene bag left a lower percentage of burning residue but a higher percentage of nonburning residue than ammunition whose cartridge case was not covered by the neoprene bag.

On September 4, 1968, TECOM issued a modified safety release to allow stowage of ammunition and missiles during firing operations in Sheridan weapons equipped with

open-breech scavenger systems and in those not equipped with scavengers. The safety release contained the following conditions: Phase D cartridge cases had to be used; neoprene moisture barrier bags had to be installed on all ammunition; nine-ply, soft, ballistic bags had to be on all ammunition; and both types of protective bags had to be retained on the ammunition until immediately prior to being loaded in the gun for firing. In addition, the requirement for a thorough inspection of the *gun* and breech chamber for residue after firing each round was still maintained.

On September 10, 1968, almost 2-1/2 years after the Sheridan weapon was type-classified Standard A, TECOM issued a safety release for the XM409 (multi-purpose) ammunition round with the following restrictions. Firing would not be conducted when ammunition temperature exceeds 125 degrees Fahrenheit; rounds damaged in handling could not be fired; rounds dropped from a height of 5 feet or greater would not be fired; firing through brush or trees closer to the weapon than 100 feet should be avoided; and the procedures related to the stowage and firing of the ammunition, as discussed above, would be required.

In our opinion, the current combustible cartridge case ammunition is, at best, an interim solution to the ammunition requirement for the Sheridan weapon. This ammunition (XM409 and XM411) was originally type-classified LP in December 1964 and this type-classification was extended three times. Production of more than ----- rounds was authorized at a cost of \$90 million. Current production deliveries of these rounds are being made under these authorizing actions. The restrictions placed on this ammunition seriously limit its potential effectiveness for use in combat, and failure by the weapon crew to fully comply with these restrictions could represent a serious safety hazard.

The Army has initiated a program for a second-generation cartridge case which is intended eventually to overcome the smoldering residue and flammability hazards of the current combustible cartridge case. Development of the metal cartridge case for the Sheridan weapon was terminated on October 6, 1968, due to the developmental risks, time, and costs involved. The Department of the Army directed that efforts be devoted to improving the current combustible

cartridge case and to developing second-generation noncombustible case systems.

We were informed in November 1968 that the initial deployment of Sheridan weapons with closed-breech scavengers to the Southeast Asia operational theater was scheduled for January 1969. We were advised that, as of January 10, 1969, this schedule had been met. This deployment is being supported with currently available ammunition rounds to be used only under the stipulated restrictions previously described. The Sheridan's combat effectiveness, and the question of the capability of these ammunition rounds, will be subject to future determination.

Conclusions

We believe that the **Army** should have reevaluated the Sheridan weapon contract in 1966, with a view toward decreasing or terminating production, when it became apparent that ammunition would not be available to meet scheduled deployment of the Sheridan weapon. We believe also that, on the basis of the continuous problems experienced with the combustible cartridge case throughout its development, the Project Manager should have initiated development of an alternative cartridge case at an earlier date to ensure that the weapon and acceptable ammunition would be available concurrently. In our opinion, a backup effort is especially applicable when a major state-of-the-art advance is being attempted and the program represents the first application of a new concept such as the combustible cartridge case.

Premature production of training devices

The XM35 Conduct-of-Fire Trainer simulates firing and tracking of the Shillelagh missile to the target. The Army type-classified the XM35 trainer as LP and purchased the item before sufficient testing was performed to evaluate whether it was promising enough, operationally, to warrant production. Furthermore, a letter contract for additional trainers was awarded and later definitized although tests showed that the trainers being procured under the initial contract were not suitable for crew training because of numerous deficiencies. Consequently, the XM35 trainers will require modification to correct the deficiencies before they can be issued for troop use.

The XM35 trainer was first type-classified LP in October 1965, approximately 3 months before it was subject to engineering tests (ETs). The recommendation for LP type-classification action was based primarily on results of feasibility studies and engineering design tests conducted by the developing agency. TECOM started engineering and service tests of the trainer in January 1966, and a production contract for 67 units at a cost of about \$3.2 million was awarded in February 1966.

In September 1966 TECOM reported on the ET of the prototype trainer and recommended that it be considered unsuitable for Army use until durability and reliability of the item could be improved and the necessary corrections made to satisfy certain characteristics. TECOM reported further that, inasmuch as a new model of the XM35 trainer would be available for testing at the Armor and Engineer Board (ARENBD), ST of the prototype should be discontinued and the complete ST (check test) be performed on this new trainer.

This check test was initiated and on November 4, 1966, TECOM, at the request of the Sheridan Project Manager, submitted an interim report on the trainer. TECOM reported that, on the basis of testing to that date, the trainer did not meet required durability, reliability, and maintainability characteristics and that the trainer, in its present state of development, was unsuitable for Army use. On

November 25, 1966, the Project Manager terminated the check test because of technical difficulties which required extensive troubleshooting and repairs. The Project Manager also directed that the check test be continued on another unit after it had undergone certain modifications.

On December 1, 1966, the Project Manager requested an extension of the LP type-classification from ACSFOR to cover procurement of 127 additional XM35s at a cost of approximately \$4 million. In his request for LP extension, the Project Manager stated that a check test of deficiencies noted in the engineering and service tests should be completed by January 1967 and that a procurement contract should be awarded in early December 1966 to ensure no break in production and availability of trainers consistent with Sheridan deliveries scheduled for fiscal year 1967.

The request to procure additional trainers was nonconcurrent in by CONARC and CDC, pending correction of deficiencies. Therefore, on December 27, 1966, ACSFOR deferred the extension of LP until a thorough evaluation of the XM35 program could be made. A meeting of the various commands concerned with the XMB program was held on January 5, 1967, and it was decided that additional testing was required before a valid recommendation concerning extension of LP could be made. Testing was scheduled to continue until March 15, 1967, and it was expected that an appropriate recommendation could be made at that time. The Sheridan Project Manager in the meeting of January 5, 1967, stated that failure to approve the LP action authorizing the additional 127 XM35 trainers would probably cause the Department of the Army Staff to reprogram the funds, which would result in a loss of the quantities programmed for fiscal year 1967. It was the position of the Project Manager and AMC that the request for the extension of LP be approved immediately.

The Project Manager subsequently obtained information from the contractor regarding termination costs of the proposed additional procurement, in the event that the trainer proved to be unsatisfactory after further testing. He found that, in case of termination of the proposed contract by April 30, 1967, the termination costs would amount to about \$225,000 and that, in case of termination by

May 15, 1967, these costs would be about \$300,000. The Project Manager forwarded this information to ACSFOR and recommended that the extension of LP for **the** trainer **be** approved immediately. The LP extension was approved on January 19, 1967, and a letter contract was awarded on January 25, 1967, for the additional 127 trainers and related items. However, in its approval for extension of LP, ACSFOR stipulated that tests on the trainer would continue and that the contract could be terminated as stated above if, after further testing, the device proved unsatisfactory.

Testing of the trainer was completed in March 1967 by the Armor and Engineering Board. The tests showed that the XM35 trainer was unacceptable from a durability and reliability standpoint. In April 1967, the Armor School informed the Commanding General, CONARC, of the unsuitability of the XM35 and stated that the procurement of the trainer should be stopped until the known deficiencies were corrected and the corrections were verified by testing. CONARC forwarded this information to ACSFOR and requested that procurement of the trainers be delayed until deficiencies were corrected and adequately tested.

From ARENBD's test and various meetings, a joint "Armor community"¹ position was composed and forwarded to ACSFOR, also in April 1967, stating that the XM35 was completely unacceptable; production should be halted; and those on hand should be issued only to training centers and schools.

As a result of this position, ACSFOR directed that a joint AMC/user meeting be held during April 1967 to resolve the future of the XM35 program. From this meeting, a memorandum of agreement developed which stipulated that (1) no further trainers be issued and those issued to date be turned back to the developer, (2) a series of technical change proposals made by the manufacturer be accomplished, and (3) when all proposed changes were completed, a 2-month confirmatory test be conducted.

¹Army agencies interested in Armor

On June 30, 1967, the contract for 127 additional XM35 trainers and related items was definitized in the amount of \$4,241,316. We found no documentation showing why this contract was definitized in view of the serious deficiencies still existing and in view of the provisional approval for LP extension given by ACSFOR in January 1967.

From April to October 1967, a major design program was conducted to correct the deficiencies in the trainer. In October 1967 a check test was begun on the redesigned trainer, and in December 1967 ARENBD reported that lack of reliability of the trainer precluded accomplishing the test objectives and recommended that testing be terminated. ARENBD also recommended that extensive engineering design be conducted to establish whether there was sufficient reliability in the device before any further service-type testing was attempted. The Project Manager concurred in the recommendation and on December 21, 1967, he suspended the test.

According to the Army, test results in March 1969 indicated that the latest trainer design was then suitable for use. We were informed that the modifications required on the trainers prior to their being issued for training use would cost about \$5,000 a unit.

Conclusions

We believe that the XM35 Conduct-of-Fire Trainer was procured before sufficient testing had been performed to demonstrate that the item was promising enough, operationally, to warrant such action.

We believe further that, in view of the serious problems existing with the XM35 trainers produced under the first contract, additional procurements should not have been approved until test results satisfactorily showed that the trainer was suitable for crew training. We believe, in addition, that the Project Manager was remiss in not terminating the follow-on contract when test results showed that the trainers continued to have major deficiencies. This action would have been in accordance with the instructions from ACSFOR when they approved the request for additional procurement.

Application of the Shillelagh
Weapon subsystem to the M60 tank

The Army applied the Shillelagh Weapon subsystem to the M60 tank although this subsystem was a new concept which was still under development and was unproven in its initial application on the Sheridan Weapon System. Furthermore, the Army approved LP type-classification and awarded production contracts for the M60 tanks when serious deficiencies were known to exist in the ammunition and when sufficient testing had not been performed on the overall tank system to adequately evaluate its suitability for operational use.

In 1964 the Secretary of Defense approved a proposal to apply the Shillelagh Weapon subsystem to a compact turret under development for the M60 tank. Under this program, existing M60 tanks were to be retrofitted with the 152mm gun-launcher. The new tank system was designated as the M60A1E1, and development was initiated on a crash basis to permit use of the Shillelagh subsystem (152mm gun-launcher, Shillelagh missile, and ammunition) on the M60 tank and to provide the tank to the ----- as soon as possible. It was later decided to apply the Shillelagh Weapon subsystem to a new M60 chassis. This tank system was designated as the M60A1E2.

A letter contract in the amount of about \$10 million was awarded on January 24, 1966, for 243 M60A1E1 tank turrets. The target date for definitization of the contract was scheduled for September 1, 1966. The letter contract for the turrets was issued 4 months prior to LP type-classification of the M60A1E1 tank in order for the contractor to initiate procurement of long-lead-time components and to acquire special tooling. Because of a delay in obtaining an adequate technical data package and various other problems, including lack of funds caused by an increase in estimated costs of the turret procurement from \$23.8 million to \$44.7 million, the turret contract was not definitized until December 22, 1967, almost 2 years after the award of the letter contract, at a contract price of about \$44 million.

Type-classification of the
M60A1E1/E2 tanks as LP

The Army type-classified the M60A1E1/E2 tanks as LP in May 1966, after considerable controversy between major Army elements over the suitability of the M60A1E1/E2 tanks for LP. At the time this action was taken, the tanks had completed only about 10 percent of their engineering and service tests; problems existed in the areas of the fire control/turret interface and hydraulic stabilization system; the test vehicles had just undergone extensive reworking and reconfiguration; and unsolved problems existed with its 152mm ammunition.

AMC did not initially approve the recommendation to type-classify the M60A1E1/E2 as LP. On March 28, 1966, the Deputy Commanding General, AMC, notified CRD that, on the basis of an evaluation of a special in-process review (SIPR) held on March 14-15, 1966, AMC concluded that insufficient affirmative testing had been accomplished on the M60A1E1/E2 to support the SIPR-formulated recommendation to type-classify the system as an LP item. This AMC conclusion was based primarily on the lack of adequate test results, to that date, on the fire control/commander station and turret interfaces, and experience with the main armament ammunition.

AMC further informed CRD that, by September 1966, sufficient experience in both these areas should be available to knowledgeably support a recommendation to type-classify the M60A1E1/E2 as LP items. The Deputy Commanding General, AMC, recommended that current M60A1E1/E2 procurement actions projected for fiscal years 1966 and 1967 be continued on a waiver basis to ensure no break in the tank program as then planned.

On March 30, 1966, the Commanding General of the Armor Center informed the Commanding General, CONARC, that the -Armor Center representatives who attended the SIPR had objected to LP type-classification of the M60A1E1/E2 on the following reasons.

1. Inadequate testing.
2. Thorough service testing needed because of problem already encountered in the turret.
3. Unsolved problems in the 152mm ammunition.
4. Reservations about the night-fighting capability.
5. Limited gun-tube life.

The Commanding General of the Armor Center concluded his letter by stating that he was not sure if the political climate would allow the limited production of the tank program to be delayed. He recommended that, as a minimum, CONARC urge that a thorough service testing and correction of deficiencies be completed prior to issuance of the tanks to units.

On April 12, 1966, the Commanding General, CONARC, forwarded the cited letter of March 30, 1966, to the Army Chief of Staff, stating that he fully agreed with the Armor Center's analysis of the current status of the M60A1E1/E2 program and urged that, because of the long list of major deficiencies, the tanks be produced only in ST quantities until they passed their engineering and service tests. The Commanding General also stated that plans to apply modification after production was of questionable validity, because experience had shown that programs of major modifications after production were costly and, for the most part, an unsatisfactory method of alleviating design deficiencies for fighting equipment. The General concluded by recommending that the tanks not be produced for field use nor be deployed until they had satisfactorily completed all their testing programs.

A review of documentation, presented in April 1965 by CRD to the Vice Chief of Staff for his review, relating to LP type-classification of the M60A1E1/E2 tanks showed that there were basically three alternatives considered:

1. Type-classify the M60A1E1/E2 as LP at that time.
2. Waive the requirement for LP type-classification until September 1966 and continue the procurement actions.

3. Delay M60A1E1/E2 procurement actions for fiscal years 1966 and 1967, pending type-classification in September 1966.

There was considerable apprehension concerning alternatives two and three within the Department of Army (DA) that these alternatives would reflect a lack of confidence in the system which could cause reexamination by the Bureau of the Budget and the Department of Defense and could possibly result in canceling part or all of the program. There was also apprehension within DA that alternative one would place DA staff in the position of overriding the recommendation of AMC, the developing agency, and, should the system fail engineering and service tests, DA would be in the embarrassing position of having directed procurement against the advice of the developer.

On the basis of this documentation, CRD concluded that, from an urgent military requirement standpoint, the M60A1E1/E2 program should continue but that, from a purely research and development standpoint, the safest course of action would be to agree with the developer and not classify the tanks LP until sufficient test data had been accumulated. CRD recommended that DA reject the AMC proposal to continue with procurement for fiscal years 1966 and 1967 on a waiver basis pending LP type-classification of the tanks in September 1966 and that DA direct the type-classification of the tanks as LP.

The Vice Chief of Staff requested a briefing on the principal issues relating to LP type-classification of the M60A1E1/E2 tanks; and on May 9, 1966, this briefing was given to him by CRD and AMC. CRD stated that, on the basis of the urgent operational requirement for the -----, the Sheridan and M60A1E1 development results, and the fact that no uncorrectable deficiency had been encountered thus far nor was anticipated, the DA staff recommended the LP type-classification.

At this briefing, AMC discussed the points included in the Armor Center letter of March 30 to the Commanding General, CONARC. As mentioned earlier in this report, we requested a copy of AMC's presentation but were informed that this document could not be located.

On May 10, 1966, the Deputy Commanding General, AMC, reversed his position on LP type-classification of the M60A1E1/E2 tanks and notified CRD that, in confirmation of advice given orally on May 6, 1966, by the Commanding General, AMC, to representatives of CRD during a review of the M60A1E1/E2 program prior to its presentation to the Vice Chief of Staff on May 9, AMC supported the CRD view that LP classification of the M60A1E1/E2 tanks was appropriate.

On May 21, 1966, DA approved LP type-classification for the M60A1E1/E2 tanks. CRD stated that the approval was limited to the procurement of 243 turrets for the M60A1E1 program (retrofit of existing M60 tanks) with fiscal year 1966 funds and 300 new M60 tanks to be so fitted (designated the M60A1E2) with fiscal year 1967 funds. Type-classification as Standard A remained scheduled for March 1967.

Additional testing
required

In July 1966 TECOM recommended that active testing of the M60A1E1/E2 be extended through April 1, 1967, and that the IPR for type-classification Standard A be postponed until June 1967. To meet this recommended schedule, however, the following conditions had to be met:

1. Minimum modification.
2. Suitable ammunition
3. Suitable maintenance ratio.
4. Immediate response to support requirements.
5. Availability of test personnel.

On October 5, 1966, TECOM reported at a special status review on the M60A1E1/E2 that none of the listed requirements had been met and that TECOM considered engineering and service tests approximately 10 percent complete. TECOM stated that, since June the tanks had been available for test only 24 percent of the time due to modification and unscheduled maintenance. Further, the ammunition had continued to exhibit problems such as misfire, flareback, and premature detonation. TECOM estimated that engineering and

service tests would be completed in the first quarter of fiscal year 1968 and that the problems of system reliability and ammunition remained as the principal obstacles to test completion.

CBC stated at this October 1966 review that the lack of successful ammunition for the 152mm gun-launcher was considered most serious and that 6 months had passed since the SIPR in March 1966 and new deficiencies had been discovered. CDC stated also that it was very disappointed with the progress made in the program to that date and that the development of a new turret required a dependable fire control system and ammunition. They concluded that, if the technological know-how could not produce the required results, this should be so stated in order that those who were directly concerned with recommendations or decisions affecting combat capabilities would be provided with the correct information.

A letter contract was awarded by the Army on September 2, 1966, for 300 M60A1E2 tanks plus related items. This contract was definitized on June 30, 1967. The total cost of this procurement, including government furnished equipment (GFE), was estimated to be about \$95 million. At the time this contract was awarded, the M60A1E1/E2 system had completed only about 10 percent of its engineering and service tests and the problems with the 152mm ammunition remained unsolved.

At an Army Vehicle Program Review in December 1966, CDC informed the Vice Chief of Staff of the user's areas of concern relating to the M60A1E1/E2 tanks. CDC stated that the lack of satisfactory 152mm ammunition was the most serious deficiency in the program.

In its position statement dated March 1967, CDC discussed the tank turret stabilization problem as noted in equipment failure reports. CDC stated that the Project Manager believed that the corrections applied to the advance production models, numbers one and two, would improve this situation, but that these models had not been sufficiently tested to determine the adequacy of the corrections.

In March 1967 the M60 Tank Project Manager stated that the estimated date of type-classification of the M60A1E1/E2 tanks as Standard A would be delayed 1 year to March 1968. Inasmuch as production of these tanks was to begin in the first Quarter of fiscal year 1968, it appeared that the DA staff believed it would be more economical to produce the tanks as scheduled, hold them in a storage area, and retrofit as necessary to correct any deficiencies discovered during STs .

Extension of LP

On April 11, 1967, the Project Manager requested CDC's concurrence on extending LP classification for the M60A1E1/E2 tanks. CDC agreed to the LP extension but did not agree to a proposal to procure 300 additional M60A1E2 tanks (beyond the original 300 authorized on May 21, 1966) until a favorable evaluation of completed M60A1E1/E2 test results could be obtained or until TECOM could report that M60A1E1/E2 engineering and service testing was favorable to the extent that risks resulting from the impending type-classification would be acceptable to the user. A copy of this nonconcurrence was forwarded to ACSFOR.

On July 21, 1967, the M60 Project Manager requested approval from ACSFOR to extend the LP classification of the M60A1E1/E2 tanks, including procurement of the additional 300 M60A1E2 tanks. The Project Manager stated that engineering and service test completion on the M60A1E1/E2 was scheduled for May 1968 and that, therefore, type-classification as Standard A would be obtained in June 1968. ACSFOR approved this LP extension on August 5, 1967, but authorized the procurement of 270 rather than 300 additional M60A1E2 tanks.

A letter contract was awarded on August 21, 1967, for 300 M60A1 (with 105mm gun and no missile capability) and 270 M60A1E2 tanks plus related items. At the time this contract was awarded, various Army testing agencies had reported on the 152mm ammunition engineering and service test results. These reports showed that there had been little or no improvement in solving the major problems existing at the time the M60A1E1/E2 was type-classified in May 1966 as LP. In fact, TECOM had withdrawn the rapid-fire safety

release on all 152mm ammunition. In addition, serious problems still existed with the tank turret stabilization system.

A CDC position statement in September 1967 reiterated the turret stabilization problems reported in its position statement of March 1967. CDC added that the M60 Project Manager had requested funds to be used for the procurement of a backup tank turret and cupola stabilization system for testing.

Contract cancellations

In October 1967 DA canceled the fiscal year 1966 M60A1E1 retrofit program for mounting the turrets on the existing M60 chassis but directed that production of the M60A1E1 tank turrets continue. This action resulted in the completion of this production and the storage of about \$44 million worth of turrets. In addition, DA directed that 95 M60 tanks at the Anniston Army Depot, which were in various stages of teardown ready to be retrofitted with the compact turret for the Shillelagh Weapon subsystem, be restored to a serviceable condition.

The M60 turrets and the 105mm guns which had been removed from the M60 tanks to accomplish the retrofit program had been scheduled for installation on the M48 tank to update this tank system. Therefore, the cancellation of the M60A1E1 retrofit program also caused a cancellation of the M48 retrofit program.

In November 1967, the Army canceled the additional 270 M60A1E2 tanks programmed for fiscal year 1968. The contractor was notified of this action and was directed to terminate all parts and services except those related to procurement of long-lead-time optics. We were informed that these optics were not applicable to the M60A1 tank but would probably be used as GFE on the next M60A1E2 buy.

We discussed the reasons for the above contract terminations with DA officials. We were informed that, because of the problems being experienced with the ammunition for these tanks, the programs were given a lower priority and

were among the first to be cut when funding restrictions were imposed on the Army.

In September 1968 a letter contract was awarded for additional quantities--243 M60A1E2 tanks and 117 M60A1 tanks (the standardized version). Under this contract, the 243 turrets, previously produced under the canceled M60A1E1 retrofit program, will be used for the M60A1E2 production. In addition, inventory remaining from the terminated 1968 buy of 270 M60A1E2 tanks will be utilized when possible. Contract definitization was scheduled for May 1969, and production deliveries were scheduled to begin in June 1969.

The fiscal year 1967 procurement (the first buy) of 300 M60A1E2 tanks has been completed and is being retained at the tank plant until ammunition is available and other problems are solved. A retrofit program for these 300 tanks was scheduled to begin in February, 1969 to provide closed-breech scavenger systems and ammunition racks which would reduce the hazard of storing the ammunition. The retrofit program has been delayed due to problems with the hydraulic-electrical turret stabilization system which are still under study.

Application of the Shillelagh Weapon
subsystem to the Main Battle Tank
(MBT-70)

The Army has also approved the application of the Shillelagh Weapon subsystem to the MBT-70 which is currently in development. This tank will use an automatic loader which is the key to a three-man crew concept. However, the automatic loader is dependent upon the acceptability of the ammunition's combustible cartridge case.

Conclusions

We believe that the type-classification and production of the M60A1E1/E2 tanks was premature because the Shillelagh Weapon subsystem had not been proven suitable for operational use in its initial application on the Sheridan Weapon System. We agree with the Army's policy to update existing weapons with the newest, most effective armament available. In our opinion, however, this should not be

attempted until the new weapon concept has been **fully** tested and proven acceptable for operational use in its initial application.

We believe further that the testing conducted on the M60A1E1/E2 tanks was not sufficient to adequately evaluate their operational suitability **or** to support **the** type-classification and production decisions made on these tanks. In our opinion, before an item is approved **for** type-classification and production, sufficient testing should be accomplished to demonstrate that the item **will** be suitable for troop issue.

Proposals and agency comments

We forwarded a draft report on our findings to the Secretary of Defense on February 7, 1969, proposing a series of actions which, we felt, would contribute to improved management of development programs and the more timely fielding of satisfactory weapon systems. The Army, on behalf of the Secretary of Defense, provided its comments to us in classified form on June 13, 1969, and subsequently furnished them in a declassified version on July 9, 1969. The declassified version is included in this report as Appendix I.

The Army agreed in general that the GAO report was factual, but stated that pertinent facts should be added. The Army did not agree that the facts supported all the conclusions and proposals that we had made. The Army contended that we did not give adequate consideration to the significance assigned to the threat at the time major program decisions were made. The Army stated that an understanding of this factor was essential before any valid conclusions could be drawn concerning the wisdom of major decisions affecting development, production, and fielding of the Sheridan weapon and the M60A1E1/E2 tanks.

Although we are not in a position to comment on the significance of the threat at the time that decisions were made to authorize production of these programs, we feel that such threats could be met more effectively through good management practices which would improve the development of major weapon systems satisfactory for combat use.

The Army agreed with most of our **proposals** and indicated that action had been or would be taken to implement them. These proposals with pertinent Army comments and our position thereon are discussed below.

We proposed:

1. That, before a weapon system or subsystem is approved for LP type-classification and released for production, sufficient testing be performed to determine whether the weapon system is developed to

the point of warranting this action. In this regard, specific criteria should be established as to the degree of testing necessary before LP type-classification and production of weapon systems or subsystems can be justified.

Agency comments (see p. 62)

The Army concurred in our proposal for sufficient testing prior to LP classification and release for production but stated that it was not always possible to establish specific criteria for the degree and amount of testing necessary before LP type-classification or production could be justified. The Army stated that the decision to assign LP type-classification to the M60A1E1/E2 tanks prior to proving feasibility by completion of all tests was based on the Army's concern over the threat. This permitted production of those weapons.

We believe that, to provide reasonable assurance that such a threat will be met, specified minimum performance requirements should be established and met before a weapon is committed to production or retrofit. In this regard, the Army should assure itself through sufficient testing that a weapon is suitable for operational use before LP type-classification is approved. We believe that, as a minimum, a successful ET, performed by the responsible testing agency, should be mandatory prior to LP classification and production. However, the ET to which we refer should be distinguished from the joint engineering test/service test, or the service test (ST), which is performed as the basis for Standard A type-classification action.

As noted in this report, only about 10 percent of the testing had been completed on the M60A1E1/E2 when LP was approved. In our opinion, this is not sufficient testing to permit an adequate evaluation of the suitability of a weapon system for operational use.

2. That, before a weapon system is type-classified Standard A and approved for full production, tests should satisfactorily show that the overall weapon

system is suitable for operational use. We believe that the weapon system should remain in the LP classification until all essential subsystems necessary for fielding the weapon have satisfactorily passed their STs. Leaving the system in the LP classification would indicate to higher authority, such as the Department of the Army, Department of Defense, Bureau of the Budget, and the Congress, that the entire weapon system has not completed its development and would enable review of the suitability of the weapon before additional procurements are made.

Agency comments (see p. 63)

The Army agreed with the general philosophy of this proposal but did not agree in its rigid application as a matter of general policy. The Army admitted that in retrospect the classification of the Sheridan vehicle as Standard A and its production without ammunition resulted in the storage of the vehicles. The Army, however, contended that procurement of long-lead-time components of a system should not be delayed because of problems which are associated with a different component and which are considered to be correctable.

We recognize the value of making timely procurement of long-lead-time components. The Army has established procedures whereby weapon systems, or components thereof, can be produced in limited quantities prior to completion of full testing, when an urgent requirement exists. This can be accomplished by type-classifying an item as LP and thus permit production to be initiated and conducted on a limited scale. Retention of this LP type-classification permits continued limited production of the weapon vehicle but also serves to indicate to higher authority that the overall weapon system is not yet fully acceptable.

Items classified as LP are subject to review at least on an annual basis when the LP classification is submitted for extension or when a change in type-classification is proposed. If vehicle production had continued under LP

type-classification actions, sufficient Sheridans would have been available to meet the January 1969 deployment to Vietnam. We believe, therefore, that the Sheridan weapon, or components thereof (including the Sheridan vehicle and the Shillelagh missile), should have remained under LP type-classification until the entire system was capable of meeting its intended operational use.

It is our position that the Sheridan vehicle should not have been type-classified Standard A and that full production should not have been conducted until the overall weapon system, including all essential components and subsystems, was proven acceptable, by suitable tests, to meet all of its prime operational objectives. We noted that the Sheridan system was originally scheduled to be operational in early 1964. In our opinion the delay of 5 years in reaching this objective was caused to some degree by the overemphasis on early and large-scale production at the expense of adequate high-level management attention directed to the prior solution of development difficulties.

3. That, when an essential portion of a weapon system is experiencing continuous development difficulty, as was the case with the ammunition for the Sheridan weapon and the M60A1E1/E2 tanks, timely action should be taken to initiate development of a backup subsystem to ensure that an acceptable item will be available to meet the scheduled deployment of the weapon system.

Agency comments (see p. 64)

The Army agreed on the need for a backup development program when a high degree of risk is involved but contended that, because of the long period spent in developing the ammunition, the risk was not considered to be high enough to warrant a backup program.

We do not feel that the length of time devoted to the development effort is material in determining whether a backup program is needed. Rather, it would seem that the ability of the development program to meet its goals should

be the governing factor. In this case, the ammunition problem continued for many years, and it would have been prudent to have initiated a backup development effort at an earlier date, particularly in view of the need to meet the reported threat.

4. That the development of a new weapon concept be completed and its acceptability for operational use be proven in its initial application before the new concept is committed to other weapon systems.

Agency comments (see p. 64 bottom)

The **Army** did not agree with this proposal. The Army stated that compliance with this recommendation would severely restrict the Army's ability to upgrade its combat readiness through early use of new technology. The Army stated that state-of-the-art advances would have to be withheld from new applications, even if they appeared favorable in all respects, until they had actually been proven through usage.

We are not proposing that the acceptability of a new weapon concept must be proven through "usage" before the concept is adapted to other weapon systems. We believe that the effectiveness of a new weapon concept should be proven by "suitable tests" in its initial application before it is applied to additional weapons. Any other practice would be more likely to downgrade combat readiness through early use of new technology that has not been demonstrated to be acceptable.

The Army stated also that it was aware of the **problems** associated with the use of combustible case ammunition prior to initiation of the **M60A1E2** program but felt that lead time for resolution of the problem would require less time than development of the **M60A1E2** tank. The Army also pointed out the tactical and logistical advantages expected to result from application of the combustible cartridge concept to the **M60A1E2** tank.

We recognize that there are judgmental factors involved in deciding on the appropriate point at which to implement a new concept. In our opinion, and as borne out by the actual results as described in this report, it seems obvious that the basic factor leading to the decision to adapt a new concept should be evidence that the new concept will be of benefit, as shown in actual tests, rather than assuming that known problems will be overcome within an estimated period. We are pleased to note that the Army states that it will not initiate production for inventory for the MBT-70 or the M60A1E2 "until the systems are suitable for troop use."

5. That existing Army regulations be suitably implemented to ensure that performance requirements for weapon systems and subsystems under development are specified and agreed to as early in the program as practicable and that these requirements be continuously revalidated during the development process so that necessary changes will be known and acted upon by all agencies concerned.

Agency comments (see p. 65)

The Army concurred with this proposal and cited a group of five **major** actions or improvements already initiated to reduce deficiencies in future program management .

6. That the feasibility of all prime portions of a weapon system be satisfactorily demonstrated prior to committing an overall system to the final phases of development which are to be a basis **for** production.

Agency comments (see p. 66)

The Army concurred with this proposal but stated that the feasibility of the combustible case ammunition had been demonstrated during the early development effort and that the more serious problems of flareback and smoldering residue which delayed the program were not reported until July 1966,

approximately two months after the Sheridan vehicle was type-classified Standard A.

As noted in our report, the ammunition failed a succession of tests, starting in 1962 and continuing through the 1966 date cited. Among the reasons for failure were susceptibility to humidity--the cause of smoldering residue. We found no data in the tests which verified that feasibility had been demonstrated. As of this date no satisfactory ammunition is available for combat use with the Sheridan or M60A1E2 tanks. Such use of this ammunition has been authorized only under conditional release provided that the 152mm **gun** from which it is fired is equipped with a suitable scavenger system and other restrictions are followed.

Conclusions and recommendations

The Army has advised us that a major assessment of the MBT-70 tank program has been conducted and that the development, testing, and production sequence as well as schedules are in general consonance with the GAO proposals. The Army has advised us also, as stated previously, that, with regard to further development efforts, several improved management measures are now being implemented along the lines we suggested. We plan to examine into the implementation of these improved management measures in future audit work. We believe that these measures, properly implemented, should improve the management of development programs. We feel, however, that further actions are needed.

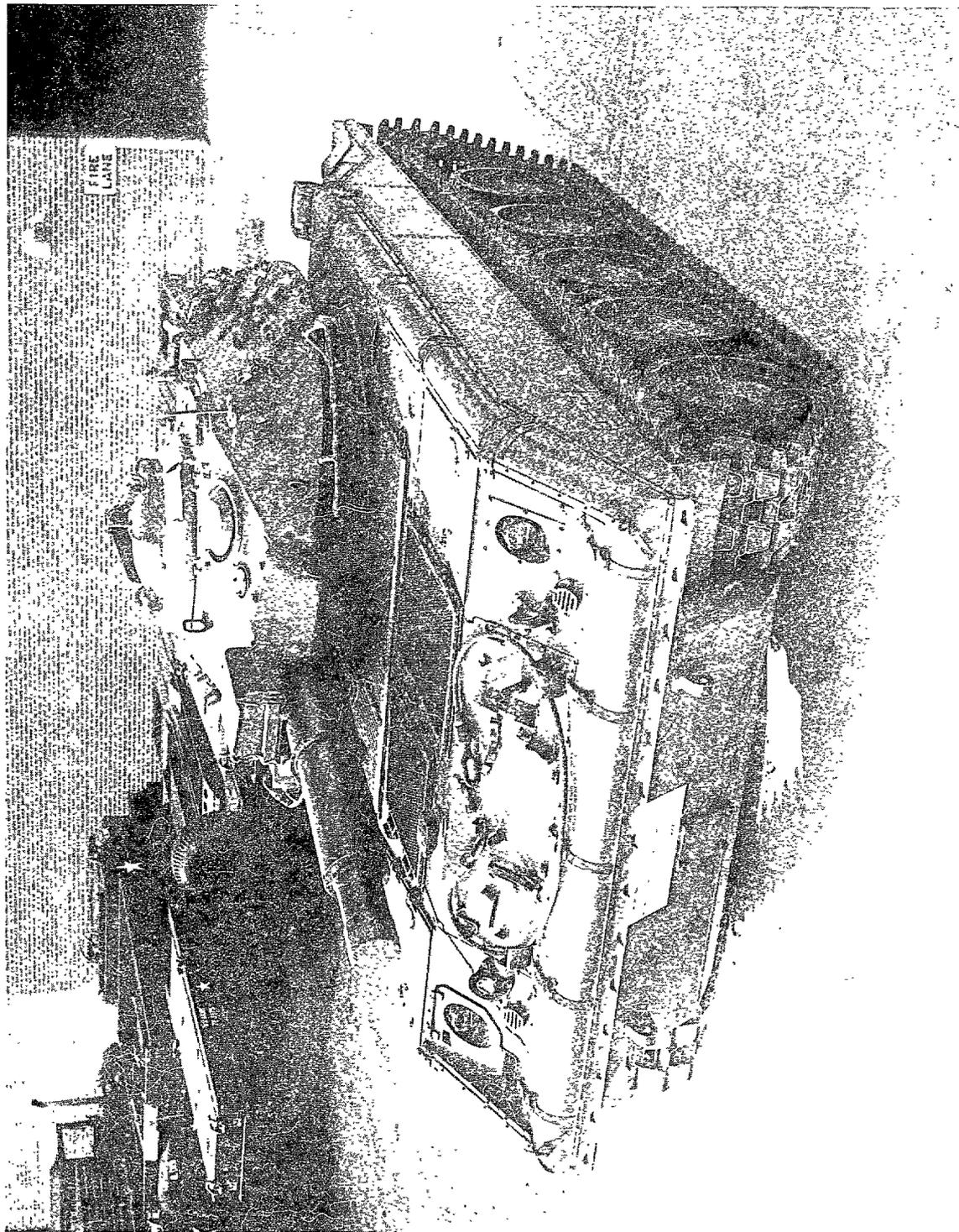
We are therefore recommending to the Secretary of Defense that actions be taken, as follows:

1. That Army regulations be revised to require that, before a weapon system or a subsystem thereof is type-classified Standard A and approved for full production, tests should satisfactorily show that the overall weapon system, including all essential components, is suitable for operational use.
2. That Army regulations be revised to require that, before a weapon system or subsystem is approved for LP type-classification and is released for limited production, that the weapon system or subsystem satisfactorily pass a suitable ET performed by a responsible testing agency.
3. That Army policies and regulations be established to ensure that development of a new weapon concept be completed and its acceptability for operational use be proven by suitable tests in its initial application before the new concept is committed to other weapon systems.

We are also suggesting that, as a means of exercising appropriate legislative controls over pending major weapon systems, the Congress may wish to require that (1) determination be made by the Secretary of Defense, prior to

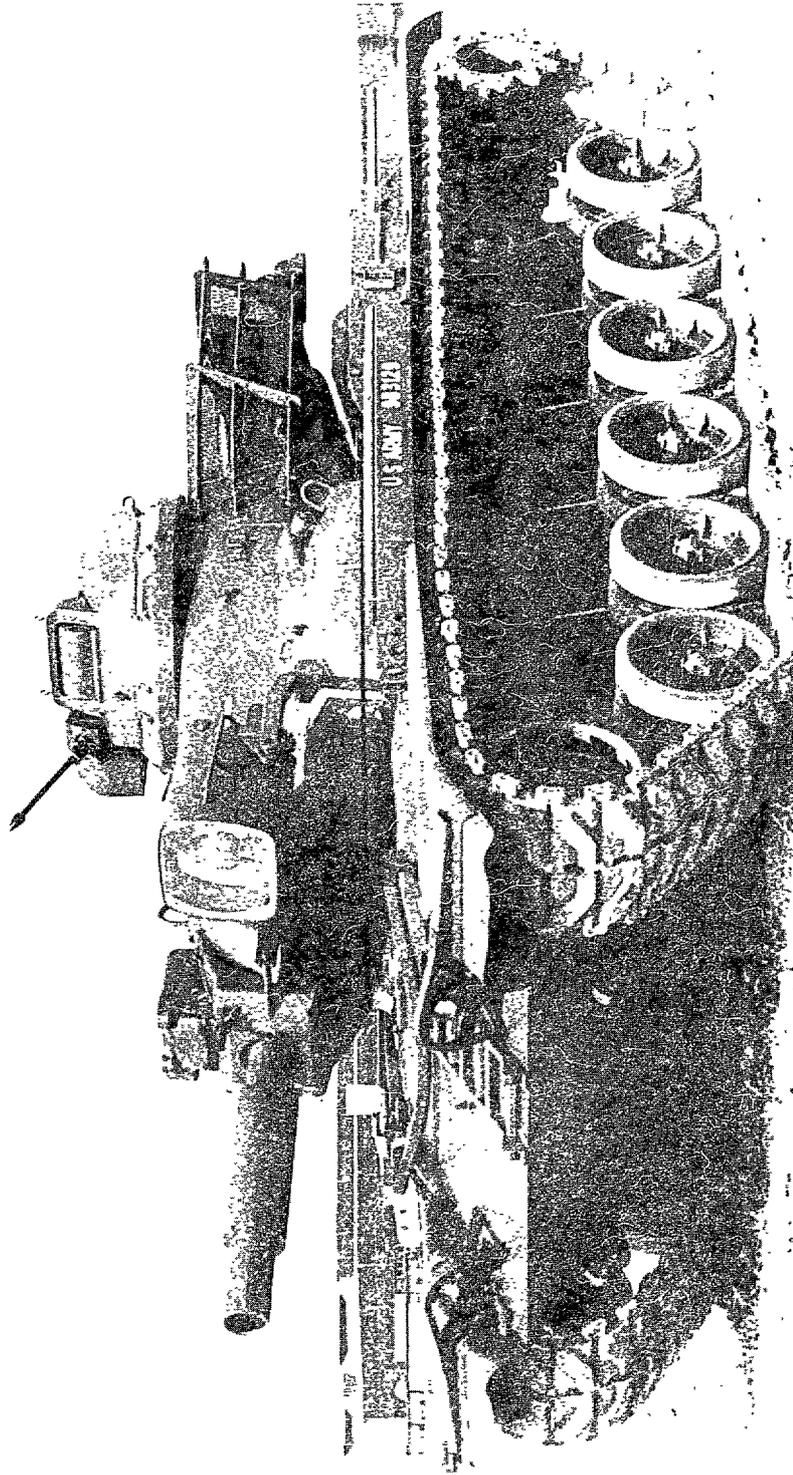
authorizing production of a new system or major modification of an existing system, that all of its significant components have satisfactorily met all prescribed developmental tests and (2) in any case where the Secretary of Defense considers that authorization of production is essential even though not all developmental tests have been satisfactorily completed, a certification to that effect be furnished by the Secretary of Defense to the appropriate congressional committees--such certification to include the reasons for authorizing concurrent development and production and the status of development of each significant component.

EXHIBITS



SHERIDAN WEAPON SYSTEM

M60A1E2 TANK



M60A1E2 TANK SYSTEM

APPENDIXES



DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, D.C. 20310

13 JUN 1969

Mr. Charles M. Bailey
Director, United States
General Accounting Office
Washington, D. C. 20548

Dear Mr. Bailey:

This is in reply to your letter of 7 February 1969 forwarding your draft report to the Army on the "Need for Management Improvement in Expediting Development of Major Weapon Systems Satisfactorily for Combat Use," Department of the Army (OSD Case 82895). By separate correspondence a copy of your report, with prescribed security markings indicated for those portions which are classified, was forwarded to Congress on 7 March 1969.

The inclosed statement provides the Department of the Army position on your report. This reply is made on behalf of the Secretary of Defense.

Sincerely,

A handwritten signature in cursive script that reads "G. B. Russell".

G. B. Russell

1 Incl
Department of the Army Position Deput Assistant Secretary of the Army (I&L)
Supply, Services and Installations

GAO note: This is the declassified version of the agency responses, furnished on July 9, 1969. Portions of the response are not included in this report.

ARMY POSITION

ON

GAO DRAFT REPORT RD-31 DATED FEBRUARY 1969

"NEED FOR MANAGEMENT IMPROVEMENT IN EXPEDITING

DEVELOPMENT OF MAJOR WEAPON SYSTEMS

SATISFACTORY FOR COMBAT USE"

(OSD CODE 2895)

I. POSITION SUMMARIES

A. GAO POSITIOX SUMMARY

1. GAO review of the Sheridan Weapon System and M60A1E1/E2 tank programs indicated a lack of effectiveness in the management and control of program development. In the opinion of the GAO, this affected the timely and satisfactory fielding of these weapon systems, and resulted in the premature production and storage of weapons and weapon trainers which were not suitable for operational use.

2. The Army purchased major weapons and trainers which will require substantial modification before they will be fully suitable for operational use. Appreciable quantities were authorized for production despite known development deficiencies. As a result, many of these weapons were put into storage rather than issued to operational units and therefore did not add to the combat effectiveness of the Army as planned.

3. GAO believes that the above situation occurred because of:

- a. The absence of specific and agreed upon weapon subsystem performance requirements early in the development program.
- b. Insufficient testing prior to limited production.
- c. The development of portions of a weapon system out of phase with each other.
- d. The use of budgetary considerations as a major factor in approving production authorizations.
- e. Untimely actions to limit or terminate weapon production where warranted.

f. The lack of back-up development effort.

g. The commitment of unproven weapon concepts to additional systems prior to acceptability in the initial application.

B. ARMY POSITION SUMMARY

1. In arriving at these conclusions, the GAO has amassed a significant amount of detailed information concerning technical deficiencies and engineering problems encountered in development of an acceptable conventional round of ammunition for the **SHERIDAN** and **M60A1E2** weapon systems. Similar problems were identified in connection with the development of a trainer which realistically simulates **SHILLELAGH** missile firings.

2. Although the Army agrees in general that the draft GAO Report is factual, there are pertinent facts which are omitted; this distorts the overall picture. Further, the Army does not agree that the facts support all the conclusions and recommendations that have been drawn. The Army's primary disagreements with the report as written concern the absence of adequate consideration by the **GAO** of the significance assigned to the Pact tank threat when major program decisions were made. The view that there was an urgent requirement to counter the threat was the basis for many of the Army decisions. An understanding of this factor is essential before any valid conclusions can be drawn concerning the wisdom of major decisions affecting development, production and fielding of these two weapon systems. The principal concern of the Army was and is the U. S. military posture.

3. Decisions made by the Army were arrived at using the best information available at that time. In each development program the Army must weigh the delay associated with a conservative approach to technical problems versus the urgency of countering the threat. The quantitative disparity between **US** forces and the armor threat has, on a number of occasions, lead the Army to accept a degree of technical risk that would otherwise be avoided. In the case of the **SHERIDAN** weapon system, had the Army not taken the risk of continuing production despite conventional ammunition problems, it would have been December, 1968, before we could have initiated quantity production and the vehicle would not be operational in Vietnam today.

[See GAO note]

[See GAO note]

5. The development of the SHERIDAN/SHILLELAGH weapon system was initiated in 1959 with the objective of fielding a lightly armored, highly mobile strike force in our armored cavalry regiments and reconnaissance units. The primary armament was to be the SHILLELAGH missile that could provide a high first round kill potential out to extremely long ranges. As an augmenting capability, the SHERIDAN was also designed to fire a conventional round to supplement the missile. Technical considerations were considered to favor the use of a combustible case which had shown promise in supporting research and development conducted over a ten-year period. It was judged that there was no apparent need on the basis of the feasibility supported by that effort for a back-up development program.

6. By 1965, the SHERIDAN, from an automotive point of view, had already proven to be a worthy vehicle, however, the weapon system was experiencing problems primarily with the conventional ammunition. The Army had high confidence that it possessed solutions to the combustible ammunition problems that had been identified at that time. Decisions to type classify new materiel, produce and release it, often involve acceptance of some risk that existing problems might not be completely resolved through continued engineering effort prior to the planned date of issue of the item. The problems associated with the conventional ammunition were considered to be correctable in making the decision to type classify the vehicle Standard A in May 1966.

7. In mid-1966, a tentative plan was developed to deploy the SHERIDAN to Southeast Asia in response to the increasing military commitment in that area.

[See GAO note]

In October 1966, Exercise MUDLARK, conducted in Thailand, proved that the SHERIDAN possessed far superior mobility on marginal terrain than any other combat vehicle in the Army inventory.

8. The most serious conventional ammunition problems of flareback and smoldering residue, which later delayed the program, were not reported until introduction and testing of XM409E2 and XM411E2 rounds began in July 1966. At that time, it was not apparent how much effort would be required to solve these problems or that they would necessarily interfere with deployment.

9. With the XM409 in-bore prematures in November 1966 plus failure of the open breach scavenger in Panama in April 1967, it became apparent that an extended effort would be required to solve these problems. This slipped the plan for Southeast Asia deployment to January 1968 initially and subsequent delays in obtaining satisfactory corrections caused further slippage to January 1969. The slippage in Southeast Asia deployment attributable to conventional ammunition problems totaled 17 months. While there were various shades of concern expressed about the ammunition problems and various opinions of what would constitute an acceptable solution, there was general agreement in the view that deployment to Southeast Asia be deferred until demonstrations of satisfactory performance were complete.

[See GAO note]

III. ARMY POSITION ON GAO RECOMMENDATIONSA. GAO RECOMMENDATION

"That before a weapon system or subsystem is approved for LP type classification and released for production, sufficient testing be performed to determine whether the weapon system is developed to the point of warranting this action. In this regard, specific criteria should be established as to the degree of testing necessary before LP type classification and production of weapon systems or subsystems can be justified."

1. ARMY POSITION

(U) a. The Army concurs in the primary recommendation that sufficient testing be performed to determine whether the weapon system is developed to the point of warranting LP type classification and release for production. However, it is not always possible to establish specific criteria for the degree and amount of testing necessary before LP type classification or production can be justified. Such criteria must be established on a case-by-case basis. AR 700-20 states that LP type classification is restricted to exceptional cases to meet operational requirements. A statement of the extent of testing accomplished, future testing planned and the level of confidence in successful completion of development is now required by regulation for all LP items.

b. The decision to assign LP type classification to the M60A1E2 tank prior to proving feasibility by completion of all tests was again based on the Army's concern over the threat in Central Europe. Effectiveness studies and war games have consistently demonstrated a strong advantage to armored forces equipped with tanks having a high first round kill potential at extended ranges. The SHILLELAGH weapon system was intended to provide this capability.

c. The decision to authorize type classification Limited Production of ammunition in December 1964 (XM409 and XM411) was necessary to insure proper interface by 1966 of ammunition and SHERIDAN vehicle. The Army considered that sufficient testing had been accomplished to justify this authorization although it was known that certain tests had not been completed and that unresolved problems remained. It appeared that those problems which were unresolved could be corrected within the time frame required for initial production. Also, several of the changes to resolve the problems were compatible with production plans.

B. GAO RECOMMENDATION

"That before a weapon system is type classified Standard A and approved for full production, tests should conclusively show that the over-all weapon system is suitable for operational use. In this regard, the weapon system should remain in the LP classification until all essential subsystems necessary for fielding the weapon have satisfactorily passed their service tests."

1. ARMY POSITION

a. While the Army agrees with the general philosophy of this recommendation, it must nonconcur with the rigid application of this concept as a matter of general policy. Type classification Standard A should not always be a prerequisite to initiating full production of a weapon system. The SHERIDAN weapon system was in production under type classification Limited Production Type as a result of special authority granted by the Army in May 1965. This was based on the previously mentioned judgements concerning the significance of the Pact Tank threat. In July 1965, the first year increment (FY 66) of a SHERIDAN multi-year production contract was implemented. The Army decision to type classify Standard A is a final administrative action which identifies the item as the primary piece of equipment available to the Army in the role for which it was designed. Normally, type classification Standard A will not be delayed in order to conduct tests in extreme environments.

b. In retrospect, the classification of the SHERIDAN weapon system as Standard A and going into production without conventional ammunition resulted in the storage of the vehicles. However, in order to satisfy an urgent operational requirement, it is sometimes necessary to initiate procurement of an item on which testing or correction of deficiencies has not been fully accomplished. All the risks and limitations of the equipment were fully documented in the type classification recommendation. Furthermore, procurement of long lead time components of a system which has a reasonable probability of success should not be delayed because of problems associated with a different component that is considered to be correctable.

c. SHERIDAN is currently undergoing troop, product improvement, and Quality Assurance tests. USARAL is in the midst of a year long Intensified Confirmatory Test, and a Troop Test was recently conducted at Ft. Riley, Kansas. The results of these tests confirm that the decisions made in 1967 were correct concerning certain system changes required to improve the SHERIDAN weapon system suitable for troop use.

d. At the time of production release the considered decision was that testing was sufficiently complete to justify the technical risk inherent in approving a limited production. Limits were imposed on both first year production and ultimate rate of production (per month). The production rate of per month was later reduced to per month by the Army when the non-availability of conventional ammunition became apparent.

C. GAO RECOMMENDATION

"That when an essential portion of a weapon system is experiencing continuous development difficulty, as was the case with the conventional ammunition for the SHERIDAN weapon and the M60A1E1/E2 tanks, timely action should be taken to initiate development of a back-up subsystem to insure that an acceptable item will be available to meet the scheduled deployment of the weapon system."

1. ARMY POSITION

a. The Army does agree on the need to initiate a back-up development effort when a high degree of risk is associated with the preferred concept. The GAO report notes that a combustible case program was selected after studies in 1958 and 1959 concluded this approach to be feasible. The GAO report states that a back-up development program was not started in sufficient time to be applied to vehicle production. Actually, the Army had been developing the combustible case since early 1949. As a result of this long period of study, analysis, and research, the risk associated with the development of combustible case ammunition was not considered to be high enough to warrant a back-up program.

b. Although a back-up program was not initiated concurrently with early development, the Army did initiate several concept programs for a second generation cartridge which, in effect, constituted back-up programs. Two of these programs have been terminated due to time schedules and risk considerations, while six concepts are still being pursued.

D. GAO RECOMMENDATION

"That the development of a new weapon concept be completed and its acceptability for operational use be proven in its initial application before the new concept is committed to other weapon systems."

1. ARMY POSITION

a. The Army nonconcurrs with this recommendation. Compliance with this recommendation would severely restrict the Army's ability to upgrade its combat readiness through early use of new technology. State-of-the-art advances would have to be withheld from new applications, even if they appeared favorable in all respects, until they had actually been proven through usage. The adaptation of the SHILLELAGH weapon system to the MBT-70 is a case in point. Feasibility of the usage of SHILLELAGH on the MBT-70 has been demonstrated and no problems have developed to date from the application of the missile to this vehicle.

b. The Army was aware of the problems associated with the development of combustible ammunition prior to initiation of the M60A1E2 program. The decision to initiate this vehicle program was based on a judgement that the lead time for resolution of the ammunition problems would require less time than development of the M60A1E2 tank.

c. In support of this decision the combustible cartridge case was judged to be essential to the concept of a compact turret for the M60A1E2 tank. Reduced silhouette and increased crew efficiency were made possible by the combination of a compact turret and combustible ammunition. The crew is no longer required to cope with hot cases, disposal of spent brass, and can reload immediately to engage a target. The silhouette afforded by this new turret design reduces tank vulnerability to enemy tank fire.

d. Final consideration in planning for the use of the SHILLELAGH missile in the M60A1E2 concerned logistics. The advantage inherent in the use of common components by SHERIDAN, M60A1E2, and MBT-70, particularly in the fields of supply, support and training, is a desirable goal. The Army will not initiate production for inventory for the MBT-70 or the M60A1E2 until the systems are suitable for troop use.

E. GAO RECOMMENDATION

"That existing Army regulations be suitably implemented to assure that performance requirements for weapon systems and subsystems under development are specified and agreed to as early in the program as practicable, and that these requirements be continuously revalidated during the development process so that necessary changes will be known and acted upon by all agencies concerned."

1. ARMY POSITION

a. The Army concurs with this recommendation. The following major actions or improvements have been initiated within the past year and one-half which should reduce deficiencies in future program management.

(1) Life Cycle Model. Recent Army reviews of weapon system programs led to major revisions in procedures. Implementing documents include AR 11-25, The Management Process for Development of Army Systems, dated April 1968; AR 70-10, Test and Evaluation During Research and Development, dated April 1968. In addition, a Life Cycle Management Model for Army systems has been developed and is described in DA Pamphlet 11-25 dated October 1968.

(2) Coordination of Coordinated Test Plan (CTP). Army developers are required by AR 70-10 to prepare a CTP. This plan portrays the schedule of all tests that must be performed during the course of development and culminates in the service test to be performed by the USA Test and Evaluation Command (USATECOM). The developer is required to coordinate the CTP with the US Army Combat Development Command (USACDC) and USAIBCOM.

(3) Coordination of USATECOM Test Plans and Test Reports with USACDC. As a standard practice, USAIBCOM has been transmitting, through formal channels, all engineering/service test plans to USACDC for comment and concurrence. In addition, AR 70-10 requires that Engineering and Service Test (ET/ST) reports be sent to USACDC for review and comment.

(4) Modifications to Type Classified Items. The Army requires that after a major or secondary item has been type classified no changes, modifications or improvements will be made to the end item which significantly changes its performance, characteristics, effectiveness, and capabilities, until the proposed action has been staffed and concurred in by all interested DA staff and technical agencies.

(5) Advanced Materiel Concepts Agency (AMCA). Another major effort designed to improve communications and coordination between the developer, the tester, and the user in the early stage of concept formulation has been the establishment of the Advanced Materiel Concepts Agency (AMCA) of the USAMC, the Institute of Land Combat (ILC) of the USACDC, and the Intelligence Threat Analysis Group (ITAG) of ACSI. The mission of the AMCA, ILC, ITAG is to forecast long range materiel requirements and doctrinal concepts through the close cooperation of the three new organizations.

F. GAO RECOMMENDATION

(U) "That the feasibility of all prime portions of a weapon system be conclusively demonstrated prior to committing an overall system to the final phases of development as a basis for production."

1. ARMY POSITION

a. The Army concurs that feasibility of all prime portions of a weapon system must be demonstrated prior to committing an over-all system to the final phases of development as a basis for production. In this regard, concept formulation, which precedes a decision to carry out engineering and development, determines system feasibility which is then demonstrated during expanded contract definition. All new major items of equipment developed by the Army will proceed through the concept formulation and contract definition phases of Life Cycle Management prior to award of a production contract.

b. The feasibility of the combustible cartridge case ammunition had been demonstrated during the early development effort. The more serious problems of flareback and smoldering residue, which have delayed the program, were not reported until July 1966, approximately two months after the vehicle was type classified Standard A.

PRINCIPAL OFFICIALS OF THE
DEPARTMENT OF DEFENSE AND THE
DEPARTMENT OF THE ARMY
RESPONSIBLE FOR ADMINISTRATION OF
ACTIVITIES DISCUSSED IN THIS REPORT

Tenure of office
From To

DEPARTMENT OF DEFENSE

SECRETARY OF DEFENSE:

Melvin R. Laird	Jan. 1969	Present
Clark M. Clifford	Mar. 1968	Jan. 1969
Robert S. McNamara	Jan. 1961	Feb. 1968

UNDER SECRETARY OF DEFENSE:

David Packard	Jan. 1969	Present
Paul H. Nitze	July 1967	Jan. 1969
Cyrus R. Vance	Jan. 1964	June 1967

DIRECTOR OF DEFENSE RESEARCH AND
ENGINEERING:

Dr. John S. Foster, Jr.	Oct. 1965	Present
Dr. Harold Brown	May 1961	Sept. 1965

ASSISTANT SECRETARY OF DEFENSE
(INSTALLATIONS AND LOGISTICS) :

Barry J. Shillito	Jan. 1969	Present
Thomas D. Morris	Sept. 1967	Dec. 1968
Paul R. Ignatius	Dec. 1964	Aug. 1967
Thomas D. Morris	Jan. 1961	Dec. 1964

DEPARTMENT OF THE ARMY

SECRETARY OF THE ARMY:

Stanley R. Resor	July 1965	Present
Stephen Ailes	Jan. 1965	July 1965

PRINCIPAL OFFICIALS OF THE
DEPARTMENT OF DEFENSE AND THE
DEPARTMENT OF THE ARMY
RESPONSIBLE FOR ADMINISTRATION OF
ACTIVITIES DISCUSSED IN THIS REPORT (continued)

Tenure of office	
From	To

DEPARTMENT OF THE ARMY (continued)

UNDER SECRETARY OF THE ARMY:

Thaddeus R. Beal	Mar. 1969	Present
David E. McGeffert	July 1965	Mar. 1969
Stanley R. Resor	Mar. 1965	July 1965
Vacant	Dec. 1964	Mar. 1965
Paul R. Ignatius	Mar. 1964	Dec. 1964

ASSISTANT SECRETARY OF THE ARMY
(RESEARCH AND DEVELOPMENT) :

Vacant	Jan. 1969	Present
Russel D. O'Neal	Oct. 1966	Jan. 1969
Willis M. Hawkins	Oct. 1963	Oct. 1966
Vacant	Aug. 1963	Sept. 1963
Finn J. Larson	Aug. 1961	July 1963

ASSISTANT SECRETARY OF THE ARMY
(INSTALLATIONS AND LOGISTICS) :

J. Ronald Fox	June 1969	Present
Vincent P. Huggard (acting)	Mar. 1969	June 1969
Dr. Robert A. Brooks	Oct. 1965	Feb. 1969
Daniel M. Luevano	July 1964	Oct. 1965

CHIEF OF STAFF, UNITED STATES ARMY:

Gen. William C. Westmoreland	July 1968	Present
Gen. Harold K. Johnson	July 1964	July 1968

PRINCIPAL OFFICIALS OF THE
DEPARTMENT OF DEFENSE AND THE
DEPARTMENT OF THE ARMY
RESPONSIBLE FOR ADMINISTRATION OF
ACTIVITIES DISCUSSED IN THIS REPORT (continued)

	Tenure of office	
	From	To
<u>DEPARTMENT OF THE ARMY</u> (continued)		
OFFICE OF CHIEF OF RESEARCH AND DEVELOPMENT:		
Lt. Gen. A. W. Betts	Apr. 1966	Present
Lt. Gen. W. W. Dick, Jr.	Sept. 1963	Mar. 1966
Lt. Gen. D. Beach	July 1962	Aug. 1963
ASSISTANT CHIEF OF STAFF FOR FORCE DEVELOPMENT :		
Lt. Gen. Arbor S. Collins, Jr.	Jan. 1967	Present
Lt. Gen. Harry W. O. Kinnard	Nov. 1966	Jan. 1967
Lt. Gen. Polk	Mar. 1966	Nov. 1966
Lt. Gen. Davidson (acting)	Feb. 1966	Mar. 1966
Lt. Gen. Conway	Aug. 1965	Feb. 1966
Lt. Gen. Davidson (acting)	May 1965	June 1965
Lt. Gen. Harrell	Feb. 1963	May 1965
COMMANDING GENERAL, UNITED STATES ARMY MATERIEL COMMAND:		
Gen. Ferdinand J. Chesarek	Mar. 1969	Present
Gen. Frank S. Besson, Jr.	July 1962	Mar. 1969
COMBAT DEVELOPMENTS COMMAND:		
Lt. Gen. Harry W. O. Kinnard	July 1967	Present
Lt. Gen. Ben Harrell	May 1965	June 1967
Lt. Gen. Dwight E. Beach	Aug. 1963	May 1965