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OFFICE OF THE INSPECTOR GENERAL

DOD CASED TELESCOPED AMMUNITION
AND GUN TECHNOLOGY PROGRAM

Report No. 96-164

June 14, 1996

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Acronyms

JMAT
O&M
RDT&E

Joint Medium-Caliber Automatic-Cannon Technology
Operation and Maintenance
Research, Development, Test and Evaluation



INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
400 ARMY NAVY DRIVE
ARLINGTON, VIRGINIA 22202-2884



Report No. 96-164

June 14, 1996

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR ACQUISITION
AND TECHNOLOGY
ASSISTANT SECRETARY OF THE NAVY (FINANCIAL
MANAGEMENT AND COMPTROLLER)
ASSISTANT SECRETARY OF THE AIR FORCE
(FINANCIAL MANAGEMENT AND COMPTROLLER)
AUDITOR GENERAL, DEPARTMENT OF THE ARMY

SUBJECT: Technical Evaluation of the DoD Cased Telescoped Ammunition and Gun
Technology Program (Project No. 5PT-8016)

Introduction

We are providing this report for information and use. We evaluated the long-term DoD efforts to develop cased telescoped ammunition and gun technology. Our evaluation was in response to a Defense Hotline complaint, alleging that DoD has been wasting money on cased telescoped ammunition and gun technology for 41 years.

Evaluation Results

Our evaluation did not substantiate the allegation that funds were wasted, in the sense of program mismanagement. The goal of cased telescoped ammunition and gun programs has been to increase weapon system lethality and the technology long held reasonable promise. However, the DoD expenditure of \$213 million over 41 years has not resulted in a viable weapon system because several major problems have not been resolved. Despite the ultimate disappointing failure to move the technology to the battlefield, we did not identify any information to suggest that the pursuit of weapon system lethality using cased telescoped ammunition technology was not a worthwhile research and development endeavor for the DoD.

As a result of DoD investment, the state-of-the-art of cased telescoped ammunition and gun technology has been improved. The initial cased telescoped ammunition concept has been refined and advanced and now has such features as compacted, consolidated propellant; a control tube; a compartmented propellant charge; sequential combustion; and an erosion inhibitor. Research efforts have also partially demonstrated automatic cased telescoped guns and yielded computer simulation programs that allow for the analytical study of the combustion process and interior ballistics of the cased telescoped ammunition.

The complainant identified inherent technical problems associated with the cased telescoped concept. Our evaluation substantiated the inherent technical problems that prevent the successful development and fielding of a cased telescoped ammunition and gun system. Cased telescoped ammunition is ballistically inefficient with inherent performance, weight, volume, and cost problems. Cased telescoped guns have not been fully demonstrated and possess inherent operational and barrel-life problems.

In addition to the technical problems, the technology faces cost and Service requirements problems. The life-cycle costs of a cased telescoped ammunition and gun weapon system are significantly greater than those for a conventional weapon system. Further, no known Service requirements provide the impetus to pursue cased telescoped ammunition and gun technology.

The DoD has not approved funding to further investigate cased telescoped technology. Zero funding is appropriate in view of the now clearly understood inherent technical problems, life-cycle cost problems, and lack of requirements.

The inherent technical, life-cycle cost, and requirements problems with this concept are discussed in Enclosure 1.

Evaluation Objectives

Our objective for this evaluation was to determine the validity of the allegation that the Department of Defense has been wasting Government funds on cased telescoped ammunition and gun technology for 41 years. We also evaluated claimed inherent technical, cost, and requirements problems associated with cased telescoped ammunition and gun technology.

Scope and Methodology

The scope of the evaluation included a review of the state of development of cased telescoped ammunition and gun technology (Enclosure 1). Our evaluation was initiated in May 1995 and completed in December 1995. We reviewed available program data and technical reports from the inception of the concept in 1954 to the present. We did a detailed review of the program from the mid-1980s through the present planning cycle. The level of funding by the DoD through the Services was estimated and tabulated for the approximately 41 years (Enclosure 2). We reviewed the various cased telescoped ammunition and gun technology programs with respect to research and development categories. We also reviewed the Services' weapon systems' user requirements that would be essential to validate continued research and development of this technology.

We reviewed medium-caliber gun technology planning, under which cased telescoped technology would be pursued. The Office of the Director, Defense Research and Engineering, provided us with medium-caliber gun technology planning data. For FY 1995, 1 percent of all funds available for the conventional weapons guns are applied to medium-caliber weapons. The remaining funds are applied to large-caliber (45 percent), small-caliber (13

percent), technology demonstrations (12 percent), and future generic gun technology (29 percent). The 1 percent of funding for medium-caliber weapons for FY 1995 is approximately \$1 million. The Army has invested this funding in generic technology base efforts and has not allocated funds to cased telescoped technology. No funding has been approved for cased telescoped ammunition and gun technology for FY 1996 and beyond. The Office of the Director, Defense Research and Engineering, and the Services indicated that the funding level for medium-caliber weapons and cased telescoped technology is not expected to change. The list of organizations visited or contacted is in Enclosure 3.

Background

The Complaint. Before submitting the allegation to the Inspector General, Department of Defense, the complainant raised the allegation in letters to two Congressmen. We reviewed these letters, the response from the Congressmen, and other supporting data as part of the evaluation.

Congress asked the Department of the Army to comment on the issues the complainant raised. In the response to Congress, the Army contended that cased telescoped technology had achieved significant technological milestones. One milestone indicated that the Marine Corps had type-classified the M885 cased telescoped ammunition. The Marine Corps has pursued a 75mm cased telescoped ammunition and gun technology program. However, the program did not yield a fieldable weapon system and, contrary to the statements the Department of the Army made to Congress, the ammunition was not type-classified for introduction to the inventory.

Cased Telescoped Ammunition and Gun Technology. Air Force laboratory personnel conceived the cased telescoped ammunition concept in 1954. The cased telescoped concept places the ammunition projectile completely within the cartridge, instead of protruding from the top of the cartridge as in conventional ammunition. Further, the cased telescoped ammunition cartridge is formed into a right-circular cylinder, instead of a tapered cylinder as in conventional ammunition. Detailed schematics of this concept and conventional ammunition are in Enclosure 1. Enclosure 1 also discusses the issues involved in the development of cased telescoped ammunition and gun technology.

The cased telescoped ammunition concept has been improved and refined during the intervening 41 years through the research and development efforts of the Army, Navy, Air Force, and Marine Corps. Estimated funds expended on various cased telescoped ammunition and gun technology research and development programs from FYs 1954 through 1995 are \$213.2 million. A detailed funding chart is in Enclosure 2.

Organizational Background. The DoD laboratories and technical organizations provide the technical leadership within the DoD to develop weapon systems to support DoD needs. Research and development for new

technologies are grouped mainly into the Science and Technology mission area, which is under the oversight of the Director, Defense Research and Engineering, and managed through the Services and other Defense agencies.

The Director, Defense Research and Engineering, published the Defense Science and Technology Strategy (September 1994) and the detailed Defense Technology Area Plan for Conventional Weapons (May 5, 1995). The Defense Technology Plan compiled individual plans into 19 technology areas that are responsive to the Science and Technology Strategy. Conventional Weapons is one of these technical area plans. The Conventional Weapons Technology Area Plan is broken into sub-areas. The Guns Sub-Area includes small, medium, and large caliber efforts. Cased Telescoped Ammunition and Gun Technology is within the medium-caliber category of the Guns Sub-Area. Medium-caliber cannons fall within the 12.7mm to 75mm caliber range.

With the support of the Office of the Director, Defense Research and Engineering, a Joint Medium-Caliber Automatic-Cannon Technology (JMAT) Master Plan was established. This JMAT Master Plan is prepared by the JMAT Working Group of the Medium-Caliber Guns Sub-Sub-Panel of the Conventional Guns Sub-Panel of the Joint Directors of Laboratories, Technology Panel for Conventional Air/Surface Weaponry. The JMAT Working Group consists of Service and contractor personnel involved in the research, development, test, evaluation, procurement, fielding, and operation of medium caliber automatic cannons. In developing the JMAT Master Plan, the JMAT Working Group considers the inputs and concerns of industry. The American Defense Preparedness Association, Gun and Ammunition Section, provided industry input.

The Army is the designated executive for all conventional gun system technologies under the joint-Service planning process. The Army Armaments Research, Development and Engineering Center is the lead laboratory charged with developing medium-caliber automatic-cannon ammunition and gun technology of which cased telescoped ammunition and gun technology is an element.

Discussion

DoD research and development efforts in the medium-caliber automatic-cannon category have been aimed at improving effectiveness. The effectiveness of this category of weapon is related to the time of flight of the projectile. By increasing muzzle velocity for a given projectile, the time of flight is reduced, increasing the probability of a hit and kill. The goal of cased telescoped ammunition and gun programs has been a muzzle velocity of about 5,000 feet per second. Conventional ammunition and gun systems achieve a muzzle velocity of approximately 2,800 to 4,800 feet per second. Although cased telescoped ammunition guns have achieved a higher muzzle velocity than conventional guns, several inherent technical problems prevented the fielding of such a gun.

We reviewed the allegation in the context of the funding DoD expended and the advances gained in the technology. As indicated in Enclosure 2, DoD has expended approximately \$213.2 million on cased telescoped ammunition and gun technology from 1954 through 1996. This cost equates to an average yearly expenditure of approximately \$5.2 million. Our review of DoD programs and resulting technical reports indicated that substantial improvements have been realized beyond the initial concept. In essence, the state-of-the-art of cased telescoped ammunition and gun technology has been improved as a result of DoD investment. The knowledge gained in these programs and the improvements demonstrated in cased telescoped ammunition, cased telescoped gun systems, and modelling and simulation of interior ballistics are of value to the DoD. However, we observed several technical, cost, and requirements problems associated with the cased telescoped ammunition and gun system concept. These technical problems were examined for each program reviewed. Although the expenditure of DoD funds has improved the state-of-the-art of this technology over the past 41 years, problems remain with the concept. A detailed discussion is in Enclosure 1.

Most research and development efforts we reviewed were funded through the 6.2, Exploratory Development, or 6.3, Advanced Development, budget categories. In two instances, the GAU-7 and Marine Corps 75mm Programs, cased telescoped ammunition and gun development moved beyond the 6.2 and 6.3 funding categories to the initial phase of Engineering Manufacturing and Development, the 6.4 program element. Despite moving to the engineering development category, cased telescoped ammunition and gun concepts were not selected for full development, procurement, and incorporation to the platform of interest for these two programs. The significance of the two programs is that their consideration of medium-caliber automatic cannons was based on existing user requirements. User requirements coupled with the state-of-the-art and cost-effectiveness of a given technology determine whether such technology merits consideration for engineering development and subsequent fielding.

The DoD has not approved funding to further investigate cased telescoped ammunition and gun technology. Zero funding is appropriate in view of the inherent technical problems, life-cycle cost problems, and lack of requirements. Because no future funding is being sought, we are not making any recommendation based on this evaluation.

Management Comments

We provided a draft report to management on April 26, 1996. Because this report contains no findings or recommendations, written comments were not required, and none were received. Therefore, we are publishing this memorandum report in final form.

We appreciate the courtesies extended to the staff. If you have questions on this report, please contact Mr. Kenneth H. Stavenjord, Technical Director, at (703) 604-8952 (DSN 664-8952) or Mr. Ramon Garcia, Project Leader, at (703) 604-8948 (DSN 664-8948). See Enclosure 4 for the report distribution. The evaluation team members are listed inside the back cover.



Robert J. Lieberman
Assistant Inspector General
for Auditing

Enclosures

Technical, Cost, and Requirements Issues and Evaluation

General Discussion. The initial concept has been refined and improved and has such features as compacted, consolidated propellant; a control tube; a compartmented propellant charge; sequential combustion; and an erosion inhibitor (see Figure). Research efforts have partially demonstrated automatic cased telescoped guns systems and have yielded computer simulation programs that allow for the analytical study and understanding of the combustion process and interior ballistics of the cased telescoped ammunition.

Although a greater understanding exists and improvements have been made to the cased telescoped ammunition and gun concept, several major problems remain. Without a resolution of these major problems, the cased telescoped ammunition and gun concept cannot be successfully developed and fielded. The nature of the research and development necessary to solve these problems falls into the 6.2 and 6.3 funding categories. Examining cased telescoped ammunition and gun systems beyond these research categories is not viable given the present maturity level of the technology and lack of requirements.

The significant technical, cost, and requirements problems affecting cased telescoped ammunition and guns are discussed in the subsequent issue paragraphs.

Issue 1. Cased telescoped ammunition is ballistically inefficient with inherent performance, weight, volume, and cost problems.

Evaluation Comments. As presently configured, cased telescoped ammunition contains compacted, consolidated propellant in the annular volume between the casing and the projectile. Compacting and consolidating the propellant increase the weight per unit volume, or density, of propellant by 30 to 40 percent. Cased telescoped cartridge designs are larger in diameter than conventional cartridges, thus providing a larger volume for propellant. Therefore, in the programs reviewed, typical cased telescoped ammunition contained two to three times the weight of propellant charge compared to the baseline conventional ammunition for a given caliber. Table 1-1 shows the conventional and cased telescoped ammunition data obtained from the Services.

Table 1-1 indicates that the higher muzzle velocity achieved by cased telescoped ammunition as compared to conventional ammunition is a function of higher propellant charge weight. A comparison of the muzzle velocity between conventional ammunition and cased telescoped ammunition with respect to projectile weight and propellant charge weight indicates that cased telescoped ammunition is less ballistically efficient than conventional ammunition. For a given caliber, a cased telescoped cartridge weighs more and occupies more volume than a conventional cartridge of the same caliber.

As a result of the higher propellant loads in cased telescoped ammunition, a significantly higher temperature and heat input is imparted to the gun barrel and

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barrel life is significantly reduced. To mitigate the deleterious effects of cased telescoped ammunition on barrel life, cartridge designs have incorporated an erosion inhibitor. The erosion inhibitor reduces the heat generated by the burning propellant and heat input to the barrel. The erosion inhibitor also reduces muzzle velocity of the cartridge as compared to a cased telescoped cartridge with no erosion inhibitor. Therefore, the inherent ballistic inefficiency of a cased telescoped cartridge is further magnified by incorporating erosion inhibitors. The incorporation of the erosion inhibitor within the cartridge also raises ammunition costs.

The cased telescoped cartridge contains a larger number of components and larger propellant weight compared to conventional cartridge design. The larger number of components, complexity of assembly, and greater materials usage make the cased telescoped cartridge inherently heavier and more costly to produce than a conventional cartridge.

For the cased telescoped concept to work properly, the projectile must move from the cartridge to the forcing cone of the barrel in almost perfect alignment with the axis of the barrel in order to obturate the barrel. In all research and development programs to date, obturation of the barrel with the projectile has been a problem and blowby of propellant gases has occurred. The resultant ballistic inefficiency prevents consideration of fielding such a system.

The rotating band materials studied have not performed as well as in conventional systems, resulting in obturation problems, balloting of the projectile within the barrel causing barrel damage and wear, reduced projectile ballistic performance, and undesirable muzzle debris. Muzzle debris is unacceptable in fixed-wing and rotary-wing applications.

The process by which the propellant is compacted and consolidated to form the annular volumes for inclusion in the cartridge has not been adequately demonstrated. The cost-effective transition of the compaction and consolidation process from the laboratory environment to the production environment has not been demonstrated.

Most cased telescoped ammunition testing has been conducted at ambient conditions. Testing has demonstrated that ballistic performance can be degraded at the temperature extremes that fielded ammunition is expected to encounter.

To reduce cartridge weight and cost, plastics and composite materials have been considered for use in the casing and end seal components. The ease of substitution of these materials for conventional steels or aluminums has met with limited success.

The large volume of propellant consumed by a cased telescoped cartridge has led to the secondary burning of combustion gases as they exit the barrel. For air vehicles' applications, the installation of muzzle device is necessary to suppress muzzle flash and prevent the ingestion of combustion gases by the engines.

In some research programs, unburned propellant has been ejected from the barrel. The ejection of a significant amount unburned propellant is inefficient.

Issue 2. Cased telescoped guns have not been fully demonstrated and possess inherent operational and barrel-life problems.

Evaluation Comments. Research and development efforts refined and improved the cased telescoped ammunition that was fired in laboratory single-shot research fixtures known as Mann barrels, or Mann guns. As the ammunition was improved and better understood, programs were initiated or concurrently executed to examine gun mechanisms that could take advantage of the right-circular cylindrical shape of the ammunition.

These gun mechanisms use a rotating chamber to align the ammunition with the barrel. A key feature of cased telescoped gun designs is that a new cartridge is used to push a fired cartridge from the chamber. Using this push-through concept to replenish a chamber while simultaneously extracting a spent cartridge reduces the number of steps in the firing cycle. For low rate of fire weapons, such as 200 shots per minute, a single chamber and single barrel arrangement have been demonstrated in a laboratory setting. For high rate of fire weapons, such as up to 6,000 shots per minute, multiple chamber and multiple barrel arrangements have been demonstrated in a laboratory setting. High rate of fire weapons use the Gatling gun concept, although at a reduced level of gun mechanism complexity and reduced parts count. These designs offer the potential to improve the reliability and reduce the weight of the gun compared to a conventional approach.

Although gun mechanisms have been developed and partially demonstrated, several problems have not been resolved.

The higher propellant charge of the cased telescoped ammunition produces higher temperatures and heat input to the barrel. These conditions have reduced barrel life of conventional barrel material to an unrealistically low level. Barrel life is reduced mainly by melting and erosion. Whereas the minimum replacement schedule of a conventional gun is approximately 10,000 to 15,000 rounds, cased telescoped ammunition guns with state-of-the-art barrel technology yield a barrel life of about 200 rounds. The difference in barrel life between a conventional and cased telescoped ammunition gun is two orders of magnitude.

Incorporating an erosion inhibitor in the cartridge design has made minor improvements in barrel life. Nonconventional barrel materials have been examined as a solution to barrel wear. The alternative barrel materials considered have not significantly improved barrel life and are not readily applicable to the production environment.

As these guns were researched further, laboratory test data indicated that barrel wall thickness should be increased. Wall thickness is increased to improve the heat sink capabilities of the gun barrel. By increasing wall thickness to increase

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heat absorption capabilities, gun weight grows. The weight savings benefits of the original cased telescoped gun concept is mitigated as weight is added for these purposes.

The large volume of propellant in a cased telescoped cartridge leads to a large volume of combustion gas that is vented as the projectile exits the barrel. The venting of a large volume of combustion gas has resulted in the secondary burning as it exits the barrel. For air vehicles' applications, the installation of a muzzle device is necessary to suppress muzzle flash, reduce signature, reduce recoil forces, reduce gun power consumption, and prevent the ingestion of combustion gases by the engines. The addition of the muzzle device adds complexity, components, and weight.

A cased telescoped gun produces recoil forces that are larger than the recoil forces of a conventional gun. Larger recoil forces result from the larger propellant load of the cased telescoped ammunition for a given caliber. To attenuate the recoil forces, recoil adaptors must be added to the gun. These adaptors add complexity, weight, and cost.

The push-through concept has been demonstrated in a laboratory setting. However, issues concerning a hang fire, missing ammunition in the feed mechanism, and clearing the chamber have not been fully addressed.

As research has progressed, complexity and weight have increased over the original gun designs. The inability to resolve the barrel life problem decreases reliability and cost-effectiveness.

Issue 3. No known Service requirements provide the impetus to pursue cased telescoped ammunition and gun technology.

Evaluation Comments. Medium-caliber automatic cannons are used on a variety of platforms for a variety of missions. Medium-caliber automatic cannons are mounted on fixed-wing aircraft, rotary-wing aircraft, land vehicles, and surface ships. The mission areas for which medium-caliber automatic cannons are employed are close combat, close air support, tactical air defense, deep strike/interdiction, and special operations. The DoD presently uses medium-caliber automatic cannons on the following target types: infantry/personnel, materiel, fortified positions, soft vehicles, lightly armored vehicles, armored vehicles, high-speed boats, rotary-wing aircraft, fixed-wing aircraft, and missiles.

For the platforms examined, the medium-caliber automatic cannon is not used for the primary mission, with the exception of the special operations AC-130 Gunship. Further, for a given mission, the automatic cannon may not be the primary weapon. For example, naval surface ships use the Phalanx Close-In Weapon System as the last layer of defense against a missile threat. Medium-caliber automatic cannons, although versatile and widely applied, are typically not used for primary missions or as the primary weapon for a given mission.

We reviewed DoD requirements for medium-caliber automatic cannons with personnel from the Office of the Director, Defense Research and Engineering,

and the Services. Basically, no requirements exist to either upgrade an existing system or develop a new system that would require the use of the cased telescoped concept. Requirements documents rarely specify the use of a particular technology to achieve an improvement in capability. Conventional approaches satisfy existing generic requirements and the consideration of cased telescoped weapons is not viable in this context.

The lack of requirements has been acknowledged in the JMAT Master Plan as a major funding and user support problem in trying to develop a cased telescoped weapon system. The JMAT Working Group has aggressively marketed the cased telescoped concept to the Services' user community to obtain support. Aggressive marketing has resulted in "endorsement" letters from various organizations. However, no requirements have been identified nor has any funding been obtained from these sources to support the continued development of this technology.

Issue 4. The life-cycle costs of a cased telescoped ammunition and Gun weapon system are significantly greater than for conventional weapon systems.

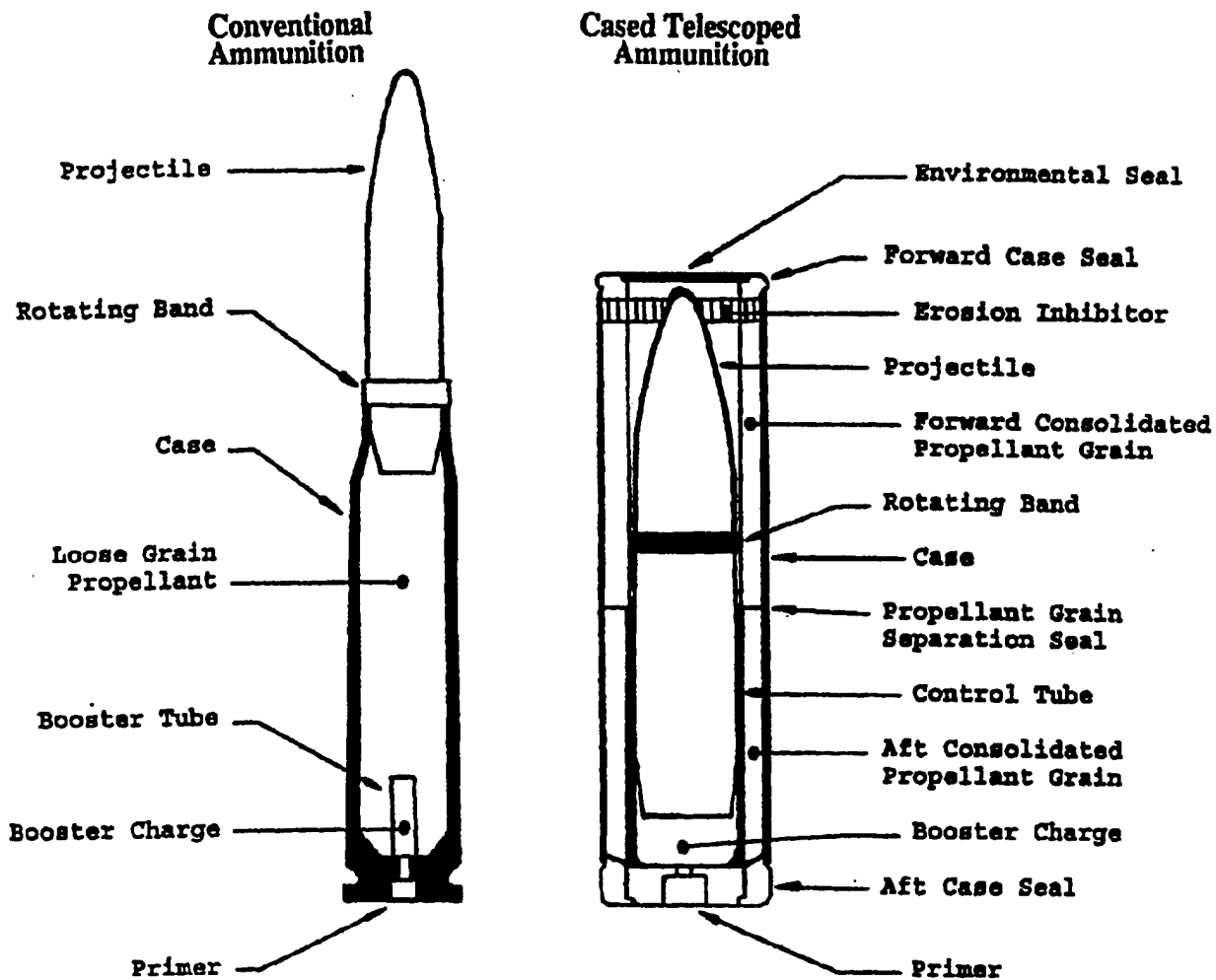
Evaluation Comments. As the cased telescoped ammunition and gun system concept was developed, the costs and benefits of fielding such a system were analyzed. Life-cycle cost estimates have been conducted for cased telescoped ammunition and gun systems and compared to conventional systems.

Cased telescoped ammunition inherently contains a larger number of components than conventional ammunition. The higher materials usage, coupled with a more complicated and demanding load/assemble/pack sequence, results in higher cost ammunition as compared to conventional cartridges. The higher cost of cased telescoped ammunition is clearly evident in the cost analyses performed by the Naval Surface Weapons Center, Dahlgren Division. The Naval Surface Weapons Center managed the 75mm cased telescoped ammunition and gun development program for the Marine Corps. The Marine Corps was considering an assault gun variant of the Light Armored Vehicle. Several weapon options were considered including a modified conventional 105mm cannon and the developmental 75mm cased telescoped cannon. As the 75mm ammunition and gun development program progressed, a cost analysis compared the system to the modified conventional 105mm system (Table 1-2). Of all cased telescoped ammunition and gun system research and development programs conducted by the DoD, this program came closest to fielding. However, the Marine Corps never type classified the 75mm ammunition developed for this program.

The 75mm research, development, test, and evaluation (RDT&E) costs in Table 1-2 reflect the costs to complete the development of the system and qualify it for fielding. The 105mm RDT&E costs are for adapting and qualifying existing conventional technology. The ammunition costs are the costs to develop the ammunition through development testing and to provide inventory for the fielded system. Operation and maintenance (O&M) costs are self-explanatory. The over-riding cost element for both systems is the cost of ammunition. The cost to produce the 75mm cased telescoped ammunition is approximately 2.7

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times greater than the cost of the conventional 105mm ammunition. The RDT&E costs of the 75mm system is 10.9 times greater than the RDT&E costs of the 105mm system. The total combined cost to develop and field the 75mm system is 3 times greater than the total combined costs for the 105mm system. The full-scale development of the 75mm cased telescoped ammunition and gun system was terminated in 1988.



Schematic Comparison of Cased Telescoped Ammunition and Conventional Ammunition

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Table 1-1. Characteristics of Conventional and Cased Telescoped Ammunition

<u>CAL</u>	<u>System</u>	<u>CTG Size (Inch)</u>	<u>CTG</u>		<u>Prop Mass (GM)</u>	<u>Launch Mass (GM)</u>	<u>Muzzle Velocity (FT/S)</u>	<u>CTG Type</u>
			<u>Volume (Cubic inch)</u>	<u>CTG Mass (GM)</u>				
.50CAL	Various	0.80 X 5.45	2.74	118	15	46	2800	Conv
.50CAL	Ares (IRAD)	1.00 x 3.50	2.75	122	32.5	45	3600	CTA
20mm (M56A3)	Vulcan	1.18 x 6.61	7.23	256	38	101	3379	Conv
20mm	AGT	1.66 x 5.50	11.9	453	112	90.7	5000	CTA
25mm (M791)	Bushmaster	1.50 x 8.78	15.5	463	98	136	4412	Conv
25mm (M919)	Bushmaster	1.50 x 8.78	15.5	455	97	132	4687	Conv
25mm	AF-Generic	1.82 x 6.00	15.6	***	179	149	5000	CTA
30mm (AP)	GAU-8	1.73 x 11.42	26.8	440	152	427	3240	Conv
30mm	COMVAT	2.13 x 8.16	28.9	1043	304	245	4800	CTA
40mm (L70)	CV90	2.56 x 19.2	102.9	2300	550	700	4822	Conv
ONV								
45mm	COMVAT	2.75 x 12.1	71.9	3175	615	755	4430	CTA
76mm	Navy Mark 75	4.49 x 35.45	****	12300	****	6400	2999	Conv
75mm	MC-LAV	5.2 x 19.0	403.5	12655	3488	3052	4800	CTA

Legend

AF	- Air Force	CTG	- Cartridge
AGT	- Air Force Advanced Gun Technology Program	FT/S	- Feet per second
AP	- Armor Piercing	GM	- Gram
CAL	- Caliber	IRAD	- Independent Research and Development
COMVAT	- Army Combat Vehicle Armament Technology Program	LAV	- Light Armored Vehicle
CONV	- Conventional	MC	- Marine Corps
CTA	- Cased Telescoped Ammunition	PROP	- Propellant

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**Table 1-2. Life-cycle Cost Data for a 75mm Cased Telescoped Weapon
and a 105mm Conventional Weapon**
(\$ in 1,000)

Fiscal Year	Cased Telescoped - 75MM XM-274 Cannon				Conventional - 105MM EX-35 Cannon			
	RDT&E	Ammunition	Gun	O&M	RDT&E	Ammunition	Gun	O&M
Pre-1988	105,000*	-	-	-	-	-	-	-
1988	1,800	0	0	0	1,150	50	0	0
1989	3,599	0	0	0	4,306	46	0	0
1990	17,118	0	0	0	2,535	1,800	0	0
1991	5,212	0	0	0	3,040	254	3,400	0
1992	5,809	4,044	6,985	1,242	1,236	5,469	8,817	1,242
1993	0	21,031	6,930	2,997	0	23,730	6,329	2,714
1994	0	62,602	7,713	3,396	0	23,133	6,809	3,006
1995	0	63,091	6,417	2,883	0	23,133	5,193	2,334
1996	<u>0</u>	<u>68,373</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1,938</u>	<u>0</u>	<u>0</u>
Totals	133,309	219,141	28,045	10,518	12,267	79,553	30,548	9,296

*NOTE: Marine Corps and Army RDT&E funds expended on 75mm before 1988.

Estimated DoD Expenditures on Cased Telescoped Ammunition and Gun Technology

The table provides the estimated DoD expenditures on cased telescoped ammunition and gun programs from FYs 1954 through 1995.

Estimated DoD Expenditures on Cased Telescoped Ammunition and Gun Technology

<u>Cased Telescoped Ammunition and Gun Programs</u>	<u>Fiscal Years</u>	<u>Estimated Cost (\$Million)</u>
T-154 (Multi-Service)	1954-1957	0.9
Air Force GAU-7	1968-1974	62.8*
Air Force CTA General R&D	1977-1986	4.3
Army 75mm CTA	1973-1985	30.0
Marine Corp 75mm CTA	1985-1988	75.0*
Army COMVAT (45mm)	1986-1991	11.4
Air Force AGT	1982-1992	22.6
Air Force CTCA	1991-1993	2.6
CTAGT (Multi-Service)	1992-1995	<u>3.6</u>
Total Estimated FYs 1954 through 1995 Expenditures		213.2

*NOTE: These programs were based on user requirements and were funded through the 6.4 budget program element. All other programs were funded through the 6.2 or 6.3 budget program element.

Legend

CTAGT - Cased Telescoped Advanced Gun Technology Program
CTCA - Cased Telescoped Combat Ammunition Program
R&D - Research and Development

Organizations Visited or Contacted

Office of the Secretary of Defense

Office of the Director, Defense Research and Engineering, Washington, DC

Department of the Army

Armaments Research, Development and Engineering Center, Picatinny Arsenal,
Dover, NJ
Training and Doctrine Command, Fort Monroe, Hampton, VA

Department of the Air Force

Wright Laboratory - Armament Directorate, Eglin Air Force Base, FL

Department of the Navy

Naval Surface Warfare Center, Dahlgren Division, Dahlgren, VA

Marine Corps

Marine Corps Systems Command, Quantico, VA

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