



U. S. ARMY AUDIT AGENCY  
 NORTHEASTERN DISTRICT  
 1421 CHERRY STREET  
 PHILADELPHIA, PENNSYLVANIA 19102

IGAA-NED

10 JUL 1975

SUBJECT: Armor Penetration Requirements  
 for Medium Caliber Weapon Systems

THRU:

~~HQDA (IGAA ZA)~~

*M. (copy)  
 11/10/75*

TO:

HQDA (DAMO-ZA)

1. ~~(S)~~ INTRODUCTION. As part of the audit of research and development at Frankford Arsenal, the U. S. Army Audit Agency reviewed the development of two medium caliber weapon systems, one for the Advanced Attack Helicopter (AAH) and the other for the Mechanized Infantry Combat Vehicle (MICV). Current plans are to introduce both weapon systems in the 1980's to combat lightly armored targets such as armored personnel carriers. Armor penetration requirements for the vehicle weapon system were about one-third greater than armor penetration requirements for the helicopter weapon system. The question arose, therefore, as to whether the armor penetration requirement is understated for the helicopter weapon system or overstated for the MICV weapon system. So far, about \$20 million has been spent on developing both systems. About \$18.5 million more will be needed to complete the development of ammunition for both systems. Current plans are to authorize contractors to perform additional development work on both systems. However, we believe that extensive additional development work should not be authorized until the armor penetration requirements are reevaluated.

2. (U) BACKGROUND. The planned helicopter weapon system includes a 30mm automatic cannon and the XM552 round, which has both a high explosive and an armor piercing capability. Separate high explosive rounds and armor piercing rounds will be used in the planned vehicle weapon system, which has a 25mm automatic cannon with a dual feed capability.

~~Classified by CDR, ARMOOM  
 Exempt from GDS of EO 11652  
 Exemption Category 3  
 Declassify on 31 December 1985~~

DECLASSIFIED UNDER AUTHORITY OF THE  
 INTERAGENCY SECURITY CLASSIFICATION APPEALS PANEL,  
 E.O. 13526, SECTION 5.3(b)(3)

ISCAP APPEAL NO. 2013-027, document no. 9  
 DECLASSIFICATION DATE: September 29, 2014

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a. Helicopter Weapon System. Development of the XM140 30mm automatic cannon and XM552 round began in 1963. The weapon system was initially proposed for use with the Cobra helicopter and later with the Cheyenne helicopter. The weapon system was not fielded because the XM140 30mm automatic cannon was too heavy for the Cobra helicopter; and development of the Cheyenne helicopter was terminated. Before termination, actions were initiated to improve the XM140 30mm automatic cannon and the XM552 round; however, termination of the Cheyenne helicopter development also led to termination of efforts to improve the XM140 30mm automatic cannon. Efforts to improve the XM552 round that passed engineering tests in 1969 were continued because the round had a potential use with other 30mm cannons. Contractors developing the AAH were required to field an automatic cannon capable of firing the original and improved versions of the XM552 30mm round, and two 30mm automatic cannons, the XM188 and XM230, are under consideration. Improvement of the XM552 round began in 1971 and has cost about \$5 million. Completion of the XM552 improvement was estimated to cost another \$3.5 million, and type classification was projected for 1980.

b. Vehicle Weapon System. Initial plans for the Bushmaster Weapon System were made in 1966 and revised in 1968. The Bushmaster Weapon System was planned for use as the primary armament of the MICV and development of a 20mm to 30mm automatic cannon with a dual feed capability, for firing both high explosive rounds and armor piercing rounds was initiated. In May 1972, contracts were awarded to three firms to fabricate and provide weapons and ammunition for development testing. Initial development tests were conducted by the U. S. Army Test and Evaluation Command from March to July 1973 for the candidate weapon systems, two 25mm weapon systems and one 27.5mm weapon system. Test results showed that the 25mm weapon systems made by Philco Ford Corporation was most satisfactory. However, approval to enter engineering development was delayed to permit a reevaluation of the threat and consideration of other alternate weapon systems. About 2 years later, in March 1975, the Defense System Acquisition Review Council approved the selection of the 25mm Bushmaster Weapon System. However, permission to enter engineering development was approved for the ammunition only. Engineering development of the ammunition was estimated to cost \$15 million and type classification is forecast for October 1979.

3. ~~(S)~~ RESULTS OF AUDIT. New helicopter and vehicle weapon systems are planned for introduction to the field in the 1980's to combat lightly armored targets. But the armor penetration requirements for the vehicle

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weapon system are one-third greater than the armor penetration requirements for the helicopter system. The approved requirements document for the helicopter weapon system, including the XM552 round, requires penetration of 3/4 inch rolled homogenous armor plate at 60° obliquity while the approved requirements document for the vehicle weapon system requires penetration of 1 inch rolled homogenous armor plate at the same angle. If the requirement to penetrate 1 inch armor plate is essential to combat lightly armored targets in the 1980's, the helicopter weapon system using the XM552 round may be unable to defeat the threat. Conversely, the 1 inch penetration requirement for the Bushmaster weapon system may be overstated. If so, the research to date and the plans for further development may be more than the effort needed to develop a weapon system to defeat a lesser threat.

a. Armor Penetration of XM552 Round. The XM552 round that passed engineering tests in 1969 only marginally met the 3/4 inch armor plate penetration requirement at 60° obliquity. Performance of the XM552 round was optimized at 1,000 meters and anti-armor performance fell off rapidly above and below the optimum range. For example, penetration data<sup>1/</sup> from engineering tests show the following significant degradation of performance:

<u>Number of Rounds Fired</u>	<u>Range (Meters)</u>	<u>Penetration</u>	
		<u>Complete</u>	<u>Partial</u>
10	1,000	10	0
10	800	6	4
10	300	1	9

The design of the projectile and the rate of spin resulted in optimum penetration of armor at 1,000 meters. Variations in the rate of spin were the primary reason that performance (penetration) was degraded at distances other than 1,000 meters. Subsequent efforts to improve anti-armor performance included two feasibility studies to determine whether the affect of spin could be reduced by making design changes in the projectile's liner.

(1) Alternate designs in the liner were tested at spin rates equivalent to those experienced when rounds are fired at ranges from 0 to 1,500 meters. Based on test results, the contractor recommended

<sup>1/</sup> Engineering Tests of Gun 30mm, Automatic XM140 and Associated Ammunition (Formerly Helicopter Subsystem XM30) (U) Volume II Ammunition Tests, Final Report June 1970 - TECOM.

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replacing the existing liner with a recessed 42° fluted liner. Test data<sup>2/</sup> showed that the XM552 round with the recessed 42° fluted liner improved penetration. The tests were made at 0° angle and the equivalent penetration of armor plate at a 60° angle was determined mathematically. The test results showed that the round would penetrate 3/4 inch armor plate at a 60° angle at ranges of 600 and 1,500 meters. But the average armor-plate penetration of five of the ten rounds fired at 1,000 meters was less than 3/4 inch and the average penetration of the other five rounds exceeded 1 inch.

(2) Another effort to improve the armor penetration of the XM552 round considered the use of a shallow cone liner. It was believed that the XM552 round, using a shallow cone liner was insensitive to spin; and, therefore could provide effective penetration over a greater range. Also, the cost to produce the shallow cone liner was thought to be lower than that of the recessed 42° fluted liner. Preliminary tests<sup>3/</sup> indicate that the use of a shallow cone liner may improve the armor penetration capability of the XM552 round. However, further development work on the design of the shallow cone liner is needed. At present, it has not been proven that the XM552 round using either the recessed 42° fluted liner or the shallow cone liner can penetrate 1 inch armor plate at 60° obliquity. Thus, it appears the XM552 round may have limited potential for defeating targets with 1 inch armor plate in the 1980's.

b. Armor Penetration of the Bushmaster Armor Piercing Round.

The 25mm armor piercing round is capable of penetrating 1 inch rolled homogenous armor plate at 60° obliquity. Test conducted by the U. S. Army Test and Evaluation Command showed that the Philco Ford Corporation candidate for the Bushmaster weapon system rated highly in reliability and accuracy and that its armor piercing round had no problem penetrating 1 inch rolled homogenous armor plate at 60° obliquity. If a 1 inch armor penetration requirement will not be needed to combat lightly armored targets in the 1980's, then the research to date and the plans for further development may be more than the effort needed to develop a weapon system to defeat a lesser threat.

<sup>2/</sup> Report DRD-59, Development of a 30mm Shaped Charge Liner, Robert Vincent, Firestone Tire and Rubber Company, Defense Research and Products Division, Akron, Ohio, January 1975, Summary Report, Contract DAAA21-73-C-0240.

<sup>3/</sup> Fourth Letter Progress Report, Evaluation Shallow Cone Shaped Charge, 30mm, Contract DAAA25-74-C-0657, Aug-Dec 74, Firestone Tire and Rubber Company, Defense Research and Products Division.

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4. ~~(C)~~ RECOMMENDATION. Initiate a review to determine the armor plate penetration requirements needed to defeat lightly armored targets in the 1980's.

a. If a 1 inch armor plate penetration capability is required:

(1) Change the 3/4 inch armor plate penetration requirement for the XM552 to 1 inch.

(2) Have the development efforts to improve the XM552 round redirected toward achieving 1 inch armor plate penetration.

(3) If efforts to achieve 1 inch armor penetration by the XM552 round are not successful, reevaluate the entire helicopter weapon system program before additional development is performed.

b. If less than 1 inch armor plate penetration capability is required:

(1) Have a determination made as to whether a round other than the Bushmaster 25mm armor piercing round can satisfy the lower penetration requirement at less cost.

(2) If an alternate round is not selected, have a determination made as to whether changes can be made in the Bushmaster armor piercing round to reduce performance and cost.

5. (U) REQUEST FOR COMMAND COMMENTS. Although our review of research and development is continuing, we would appreciate your written comments within 15 working days of the date of the report, including a statement of concurrence or nonconcurrence, with the recommendation and identification of any action taken or proposed. This letter is not subject to the reply procedures outlined in AR 36-5. The contents of this letter, along with your comments, will be considered for formal reporting at a later date.

  
ROBERT J. SANTORO  
District Manager

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