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AVHDO-DO (7 AUG 1971) 1st Ind
SUBJECT: Final Report - Cartridge, 40mm: High Explosive Extended Range
XM683. (ENSURE 181) (ACTIV Project No. ACA-7/701)

DA, Headquarters, U.S. Army Vietnam, APO San Francisco 96375 7 AUG 1971

THRU: Commander-in-Chief, U.S. Army Pacific, APO San Francisco 96558

TO: Assistant Chief of Staff for Force Development, Department of
the Army, Washington, D.C. 20310

1. Subject final report is submitted for review and approval.
2. This headquarters concurs in the conclusions and recommendations as written.
3. Request one copy of all forwarding and approval indorsements be furnished this headquarters.

FOR THE COMMANDER:

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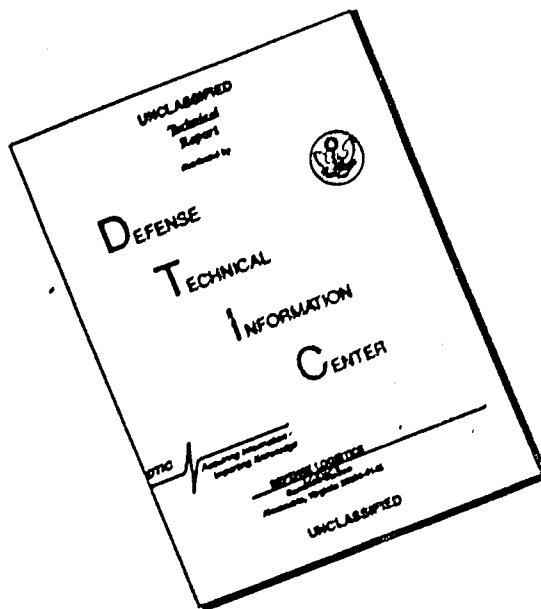
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13. ABSTRACT

The Cartridge, 40mm, High Explosive Extended Range, XM683 was evaluated by the Army Concept Team in Vietnam from 4 June to 13 July 1971. The evaluation was terminated prematurely on 13 July 1971 following three incidents involving the critical malfunction of the ammunition which resulted in damage to two XM29 weapons subsystems and the nose cone of one AH-1G attack helicopter; therefore only 2,735 of the 3,700 rounds issued for the evaluation were expended. The purpose of the evaluation was to determine the military worth of the XM683 cartridge for use in airborne 40mm weapon systems in the operational environment of RVN. The evaluation concluded that prior to the malfunction incidents, the XM683 cartridge provided a significant increase in the combat effectiveness of 40mm ammunition in airborne weapon systems in RVN; no significant changes in employment techniques are needed with this ammunition; and control system (sight) modifications are unnecessary for the effective employment of this ammunition. Because of multiple malfunctions of the XM683 ammunition however, the ammunition is considered unsafe to fire in its current state. The report recommends that the current cartridge XM683, 40mm not be type-classified at this time and that an analysis of the malfunctions described in this report be undertaken to determine their cause and to effect the necessary modifications to preclude future malfunctions of this nature. Following cartridge improvement, it is recommended that a follow-on evaluation be conducted and if this evaluation proves successful that the XM683 cartridge be considered for type-classification as Standard A.

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1. 40mm Airborne Weapons Systems
2. XM683 40mm High Explosive Extended Range Cartridge
3. M384 40mm High Explosive Cartridge
4. AH-1G Attack Helicopter
5. Rocket motor
6. Muzzle velocity 600 ft/sec
7. Rocket burnout projectile velocity 1,035 ft/sec



DEPARTMENT OF THE ARMY
ARMY CONCEPT TEAM IN VIETNAM
APO SAN FRANCISCO 96384

IN REPLY REFER TO:

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2 AUG 1971

SUBJECT: Final Report - Cartridge, 40mm: High Explosive Extended Range
XM683. (ENSURE 181) (ACTIV Project No. ACA-7/701)

Commanding General
US Army, Vietnam
ATTN: AVHDO-D
APO 96375

1. REFERENCES

a. Message, AVHGV-DH, Headquarter US Army, Vietnam, 051107Z March 1967, CONFIDENTIAL, subject: Development/Improvement of 40mm Ammunition (ENSURE) (U).

b. DF, AVHGC-DST, Headquarters, US Army, Vietnam, 25 November 1969, subject: 40mm Armament System (ENSURE 181).

c. Letter AVIB-AAD, Headquarters Army Concept Team in Vietnam, 29 May 1971, subject: Final Report - Cartridge, 40mm High Explosive, Tracer, XM677 (ENSURE 181) (ACTIV Project No. ACA-7/701).

d. DTM 1310-220-12 (PA-DB7) Operator's and Organizational Maintenance Draft Technical Manual, Cartridge, 40mm: High-Explosive, XM683, December 1969.

e. TI-16 (PA-DB7), Army Technical Instructions, XM28 Helicopter Armament System, Modification of Fire Control System for Use with HE 40mm Cartridge XM683, Picatinny Arsenal, Dover, New Jersey, February 1971.

2. BACKGROUND

In March 1967, US Army, Vietnam (USARV) initiated an ENSURE request for development/improvement of 40mm ammunition (reference a). This request, later validated by DA as ENSURE 181, stated an urgent operational requirement to increase the effectiveness of ammunition used with 40mm armament subsystems for helicopters. Munitions approved as part of ENSURE 181 were a 40mm cartridge containing a tracer element and an extended-range 40mm

cartridge. On 25 November 1969 USARV tasked ACTIV (reference b) to conduct an evaluation of ENSURE 181 items. The results of the evaluation of the XM677 high-explosive tracer (HET) cartridge were reported earlier (reference c). This report covers only the evaluation of the 40mm high-explosive, extended-range, cartridge, XM683.

3. DESCRIPTION

a. Cartridge Characteristics

The 40mm XM683 cartridge is designed for use with the XM28 helicopter armament subsystem and to be fired from the 40mm grenade launcher, XM129. The XM683 cartridge is an antipersonnel, fixed-ammunition cartridge. The projectile consists of a steel warhead fastened to an aluminum rocket motor by screw threads. The aluminum cartridge case contains a case-propellant charge which, in combination with the rocket motor, constitutes the cartridge propulsion system. The overall length of the complete cartridge is 4.39 inches; total weight is 0.83 pounds. The fuze is a base-detonating fuze (XM725) which has a minimum arming distance of 45 feet from the launcher muzzle. The fuze functions on graze or impact.

b. Complete Round Functioning

The launcher firing pin strikes the percussion primer through the cartridge case sealing disk. The primer, in turn, ignites the rocket propellant charge. The rocket exhaust gases ignite the case-propellant charge. When the gases reach sufficient pressure, the projectile is freed from the case and propelled forward. The projectile's rotating band engages the rifling of the launcher barrel, imparting a spin of approximately 9,000 RPM at the muzzle. The projectile attains a muzzle velocity of 600 ft/sec. After emergence from the muzzle, rocket propulsion continues for 400 feet. At rocket burnout, the projectile velocity is 1,035 ft/sec. Canted rocket nozzles increase the spin rate to 14,400 RPM at burnout. Upon impact, the XM725 fuze detonates the high-explosive charge in the warhead which breaks into a number of fragments. Additional descriptive data is contained in reference d.

c. System Modification Requirements

Since the ballistics of the XM683 cartridge differ from the standard 40mm cartridges (M364), the compensator of the XM28 subsystem was modified on two aircraft by use of kits provided to accommodate the new ballistics. This modification permits utilization of the existing compensator by proper rescaling of the range and airspeed inputs. A new range knob assembly was installed, containing both the standard range scale (white numbers) and the new range scale for the XM683 cartridge (orange numbers). This range knob assembly consists of a mounting bracket, an end plate, and a range knob, and hardware for mounting. Approximately

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30 minutes were required by the unit aircraft armament supervisor to complete the installation. Additional data pertaining to this modification is contained in reference e.

4. PURPOSE

To determine the military worth of the XM683 cartridge for use in airborne 40mm weapon systems in the operational environment of the Republic of Vietnam (RVN).

5. OBJECTIVES

a. Objective 1 - To evaluate the operational performance of the XM683 cartridge in the combat environment of RVN.

b. Objective 2 - To determine whether use of the XM683 cartridge requires any change in the techniques of employment of the 40mm airborne weapon system.

6. SCOPE

a. This evaluation employed the XM683 cartridge in combat operations. A variety of targets were engaged in determining the capabilities of the XM683 cartridge. All ammunition was fired from the XM129 grenade launcher located in the chin turret of the AH-1G attack helicopter.

b. The evaluating unit was C Troop, 3rd Armd. Cav. Sqdn., 17th Air Cav. located in Vinh Long, Military Region (MR) 4. A total of 3,700 rounds of XM683 40mm ammunition were issued to the unit on 3 June 1971. Of these, 2,735 rounds were expended between 4 June and 13 July 1971 during operational missions. The evaluation was terminated on 13 July following three incidents involving malfunction of the ammunition which resulted in damage to two XM129 weapon subsystems and the nose cone of one AH-1G attack helicopter. The remaining 965 rounds were collected and prepared for retrograde to CONUS for technical analysis.

c. No comparisons of lethality were conducted between the XM683 cartridge and the standard M384 cartridge because of the combat environment and lack of facilities for measuring fragmentation. There were no night operational missions conducted during the evaluation; therefore, all data contained in this report pertain only to daytime use.

7. ENVIRONMENT

The evaluation was conducted in MR 4. This region, which includes the Mekong Delta, begins southwest of Saigon and continues southwesterly to the Gulf of Siam. The region is flat and is inundated during most of the year. The majority of the land is or has been under cultivation, and the major crop is rice. Two exceptional areas are the U-Minh Forest and the Plain

of Reeds. The U-Minh Forest is an almost impenetrable swamp of mangrove and similar types of vegetation. The Plain of Reeds is a perennially wet marsh area which is inundated from one to five feet during the wet season. Since the Southwest Monsoon season extends from mid-May through mid-October, the evaluation was conducted under its influence. Rainfall occurs in amounts ranging from 10 to 20 inches per month during this season. Adequate ceilings and visibility to permit helicopter operations exist approximately 98 percent of the time. Surface winds are generally from the southwest. Airmass-type rainshower activity occurs during the afternoon and evening hours; however, circumnavigation is possible. During the evaluation period the average daily high and low temperatures were 88 and 75 degrees Fahrenheit respectively.

8. METHOD OF EVALUATION

The participating unit appointed one chief evaluator who collected data during the evaluation period. He provided data to the ACTIV project officer for analysis and reduction which provided the basis for evaluation. Questionnaires completed by aviators and interviews with selected members (i.e.: commanding officer, operations officer, platoon leaders and aircraft armament personnel) of the evaluating unit were used as the source of data. Tactics and techniques employed were at the discretion of the unit commander. Data were collected following each mission on which the XM683 cartridge was employed.

9. DISCUSSION AND FINDINGS

a. Objective 1 - To evaluate the operational performance of the XM683 cartridge in the combat environment of RVN.

(1) Loading and Handling

Aviators noted that, when using standard M384 cartridge handling procedures, no differences or problems arose in handling the XM683 cartridge. Aircraft armament supervisory personnel reported that the XM683 cartridge was more rapidly and easily inserted through the ammunition feed system while loading. They expressed the opinion that this was attributable to the smoother exterior surface of the round. Consequently, all personnel stated that when compared to the standard cartridge, the XM683 cartridge reduced rearming time by two to three minutes.

(2) Effects of Fire

Pilots experienced in the firing of both types of ammunition agreed that the effects of the XM683 cartridge apparently equalled that of the M384 cartridge.

(3) Reliability

All pilots agreed that the dud and stoppage rate were the same as, or less than, those for the standard cartridge. No maintenance

problems were encountered which were attributed to the XM683 ammunition. Aircraft armament supervisors indicated that the chambers of the XM129 weapon appeared to remain cleaner when firing the XM683 cartridge than when firing the standard cartridge.

(4) Fire Control and Adjustment

Pilots unanimously agreed that the XM683 cartridge significantly expedited effective fire adjustment. Because of the greater velocity of the round and its flatter trajectory, fire control was considered by all pilots to be far superior to the standard M384 ammunition. The rocket-burn of the XM683 cartridge was clearly visible to the pilot, and after rocket burnout the smoke trail acted as a tracer. This enabled the pilot to follow the round visually to the target and to adjust rounds onto the target with greater rapidity and accuracy than with the standard cartridge.

(5) Safety

(a) Tactical

Because of the increased velocity of the XM683 cartridge, the tracer effect of the rocket motor, and the flatter trajectory, all pilots stated that the ammunition could be more safely employed in the close support role. Pilots were reluctant to fire standard M384 cartridges in the close support role because of the necessity to observe the explosion on the ground before making corrections. Pilots reported that, when firing the XM683 cartridge, even the last round fired prior to the firing break could be seen (In firing the standard cartridge, pilots said it was not unusual for several rounds to still be in trajectory at the time of firing break, and because of this lag, extreme care was required when firing the standard cartridge in the vicinity of ground troops).

(b) Aircraft

No safety hazards or problems were encountered prior to 12 July 1971, by which time over 2,700 rounds of XM683 ammunition had been expended. On 12 and 13 July 1971, however, three incidents occurred which involved damage to the weapon systems and the aircraft from which the ammunition was fired. Information relative to these incidents is contained in Incl 1. As a result of these incidents the evaluation was prematurely terminated.

b. Objective 2 - To determine whether use of the XM683 cartridge requires any change in the techniques of employment of the 40mm airborne weapons system.

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(1) Effective Range

Pilots were able to follow the trajectory of the cartridge and to make immediate adjustments on the target; therefore, they were able to begin firing runs at greater slant ranges, with increased accuracy. This permitted effective target engagement without overflying the target. Based upon averaged pilots' estimates, the most effective engagement range for the ammunition was 1,200 meters.

(2) Types of Targets Engaged

All respondents indicated that they fired the XM683 ammunition over flat terrain with dense, low foliage or into treelines. Type of targets against which the XM683 cartridge was employed were troops with cover, sampans, and structures, and in preparation of landing zones.

(3) Tactics

Essentially there were no changes required in tactics of employment between the standard M384 and the XM683 cartridge. Pilots reported that they were able to place effective fires, safely, closer to friendly troop locations when using the XM683 ammunition. Because of the increased range, velocity, and the tracer-like effect of the round, point targets could be engaged more rapidly and accurately at greater ranges than with standard ammunition. Consequently, both the ammunition expenditure required for target neutralization and the vulnerability of the aircraft to hostile ground fire were reduced. In addition, because of the greater altitude from which targets were engaged, a greater area of the target could be covered. Targets which were out of the range of standard ammunition were successfully engaged with the XM683 cartridge.

(4) Fire Control and Adjustment

Pilots agreed that the weapon system sight was used only during the firing of the first few rounds of a burst. Subsequent adjustment did not require use of the sight. All pilots stated that the adjustment of fire using the XM683 cartridge was faster and easier than with standard ammunition, and that less pilot experience was necessary for effective engagement of targets. Personnel who had experienced difficulty in effective target engagement using the standard cartridge reported having no difficulty engaging targets with the XM683 ammunition. Pilots further indicated that the recoil effect of the XM129 weapon system, when using the XM683 ammunition, was less than that experienced with the use of standard ammunition. In firing standard ammunition, the more violent recoil effect caused the aircraft to pitch upward and yaw away from the direction of fire, complicating the firing of the fixed weapon systems on the aircraft. With the use of the XM683 cartridge this problem was not as pronounced.

(5) Use of Standard Sight

XM683 cartridge was issued initially only to the two AH-1G attack helicopters which had been modified with the new range knob assembly. However, use of this ammunition was subsequently extended to include its use in unmodified aircraft. Pilots reported having no difficulty in effectively engaging targets from unmodified aircraft. The standard sight was simply set at 1,000 meters (rather than the standard 1,200 meters) to achieve the same range compensation that is achieved by setting 1,200 meters on the additional scale of the modified sight. According to pilots this procedure was accurate and required no additional pilot training in its use.

c. Findings ^{1/}

(1) No problems were encountered in loading or handling the XM683 cartridge using standard procedures [9a(1)].

(2) The dud and stoppage rates of the XM683 cartridge were similar to those of the standard cartridge [9a(3)].

(3) Because the burning rocket motor and the subsequent smoke trail could be easily followed, accurate fire could be placed on the target more quickly than with the standard ammunition [9a(4)].

(4) Because of the increased velocity, the tracer-like effect, and the flatter trajectory, pilots stated that the XM683 ammunition could be more safely and dependably employed in the close support role than could the standard cartridge [9a(5)(a)].

(5) Three incidents involving XM683 cartridge malfunctions resulted in premature termination of the evaluation [9a(5)(b)].

(6) Pilots' estimates of the most effective engagement range with XM683 ammunition averaged 1,200 meters [9b(1)].

(7) The use of the XM683 cartridge enabled safe placement of supporting fires closer to friendly troop locations than was possible with standard ammunition [9b(3)].

(8) Targets were engaged at greater ranges with the XM683 cartridge than with standard ammunition [9b(3)].

(9) Pilots stated that the adjustment of fire using the XM683 cartridge was faster and easier than with standard ammunition and that less pilot experience was necessary for effective engagement of targets [9b(4)].

^{1/} Numbers in brackets refer to the paragraph of the report which supports each finding.

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(10) Pilots reported no difficulty in effectively engaging targets when using aircraft which were not modified with the compatible sight designed for use with the XM683 cartridge [90(5)].

10. CONCLUSIONS

a. The XM683 cartridge, prior to the malfunction incidents, provided a significant increase in the combat effectiveness of 40mm ammunition in airborne weapon systems in RVN.

b. No significant changes in employment techniques are needed with this ammunition.

c. Control system (sight) modifications are unnecessary for the effective employment of this ammunition.

d. Because of multiple malfunctions of XM683 ammunition during the latter stages of the evaluation, the ammunition is considered unsafe in its current state, pending results of investigation.

11. RECOMMENDATIONS

a. That the current cartridge XM683, 40mm not be type-classified at this time.

b. That an analysis of the malfunctions described in this report be undertaken to determine their cause(s), and to effect any modifications necessary to prevent future malfunctions of this nature.

c. That an evaluation be conducted following cartridge improvement; if subsequent evaluation of the improved cartridge proves successful, the XM683 cartridge should be considered for type-classification as Standard A.

David H. Thomas

2 Incl

1. Malfunction Incidents
Involving XM683 Ammunition
2. Distribution List

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Commanding

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(U) MALFUNCTION INCIDENTS INVOLVING XM683 AMMUNITION

On 12 and 13 July 1971, three incidents involving XM683 ammunition malfunction caused damage to the aircraft from which these rounds were being fired. In two cases the XM129 weapon system was damaged; in the third, only the nose cone of the AH-1G aircraft itself. No personnel were injured in any of the incidents. When the first two incidents were reported on 12 July, the ACTIV project Officer, considering them to be indicative of critical malfunction, ordered all use of the ammunition to cease (in compliance with reference d). He directed that all XM683 ammunition be collected, repacked and, pending disposition instructions from DA, prepared for shipment to COMUS agencies for investigation and testing of the remaining rounds. However, the XM129 weapon system on one AH-1G was still loaded with XM683 rounds which were overlooked during this collection. The following day, 13 July, this aircraft was involved in the third incident of XM683 malfunction. Details of the individual incidents are as follows:

a. The incidents on 12 July occurred within several minutes of each other, at about 1600 hours. The two AH-1G aircraft involved were working together in preparation of a landing zone (LZ). XM129 weapon systems on both aircraft were loaded with XM683 ammunition exclusively and were being employed in heavy, but routine, LZ preparatory fires. Both aircraft were firing long, continuous bursts which both pilots estimated as about 10 seconds each; assuming an average cyclic rate of 400 rounds per minute from the XM129 weapon system, each aircraft would have fired approximately 66 rounds during each 10-second burst. The two malfunctions and damage caused by each were as follows:

(1) During the second firing pass, after aircraft A had expended approximately 125 rounds, there was an explosion; the weapon system immediately failed to continue firing. After receiving an inspection for damage by the crew of the accompanying AH-1G, who advised him that the only apparent damage to the aircraft was in the turret fairing area, the pilot returned to Vinh Long. Subsequent detailed inspection indicated damage to the drum drive assembly, receiver, tube assembly, and chamber of the XM129, as well as severe damage to the turret fairing. A large portion of a cartridge casing was found embedded in the receiver of the weapon.

(2) After having visually inspected aircraft A (a pause of about 2 minutes) the pilot of aircraft B made another firing pass over the LZ. On this (the third) pass, aircraft B experienced an explosion; however, the weapon system in this case continued to function normally. A fourth pass was completed, with some 100 rounds fired subsequent to the explosion. (Since about 50 rounds of ammunition remained in the drum, approximately 200 rounds had been fired - in a pilot-estimated four bursts, within a

time frame of about 4 minutes). The aircraft then flew to Long Tan for refuelling and rearming, at which time damage to the nose cone of the aircraft was discovered. A single piece of shrapnel, less than 1 inch square, was found inside the damaged nose cone. There was no other damage to the aircraft. Close visual inspection by the unit armament system maintenance supervisor indicated no apparent damage to the XM129 weapon system, and this was confirmed by a detailed technical inspection on 14 July.

b. The third incident, occurring at 1500 hours, 13 July, involved that XM683 ammunition inadvertently left in the ammunition drum of one AH-1G. The pilot of this aircraft was unaware that his XM129 weapon system was loaded with XM683 until he reached the mission area and fired three rounds in initial adjustment. He then fired a single burst, which stopped abruptly when the (estimated) sixth round exploded in the weapon. The extent of damage was verified visually by the pilot of the accompanying AH-1G aircraft, and, since there was no obvious damage to the aircraft itself, the pilot continued the mission. Switching to the rocket subsystem, he fired rockets on the target and completed the mission. When the aircraft was inspected at Vinh Long, the damage incurred was found to be similar in type and extent to that sustained in the first incident the day before; that is, the drum drive assembly, receiver, tube assembly, and chamber of the weapon were damaged, as well as the turret fairing. There was no damage to the aircraft.

c. Additional details related to all three incidents include the following factors:

(1) Weather conditions during all three incidents were: broken-to-overcast cloud cover at 2,000 feet; visibility, 5 to 6 miles; local rain showers, but not in the immediate vicinity; wind from the southwest at approximately 15 knots.

(2) At the time of the first incident, the weapon involved was being fired at an elevation of -30 degrees and near-zero deflection, from an aircraft being flown at about 150 knots IAS. Conditions were similar at the time of the second incident, only a few minutes later. The third malfunction occurred with the aircraft at 80 knots IAS, 1,500 feet AGL, and the weapon being fired from about -50 degrees elevation and 90 degrees left deflection.

(3) Pilots of all three aircraft involved in the above incidents described the flight of an aberrant round shot from the XM129 concurrent with the sound of the explosion. Each reported the round's appearance as erratic, i.e., travelling much faster and with a flatter trajectory than other rounds from the burst.

(4) The XM683 ammunition (3,700 rounds) had been delivered to the using unit ("C" Troop, 3/17th ACS) on 3 June 1971 and immediately stored in CONEX containers on dunnage. Although the CONEX containers were rather damp, the ammunition was protected by its packing (see reference d) and appeared normal, clean, and dry when opened for use.