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ANALYSIS OF PROPOSED SOLUTIONS TO THE 5.56MM BLANK CARTRIDGE (M200) MALFUNCTION RATE

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JANUARY 1976

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US ARMY ARMAMENT COMMAND

SYSTEMS ANALYSIS DIRECTORATE

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The objective of this study was to compare alternative solutions to correct the 5.56mm Blank Cartridge (M200) malfunction rate.

Several alternatives were evaluated to determine the expected time and cost to correct the problem. These alternatives included: redesign the 5.56mm Blank Cartridge using brass, steel, and aluminum; increase the length of the present M200 blank cartridge; modify the 20-round magazine; or use the 30-round magazine.

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Redesigning and/or increasing the length of the M200 Blank Cartridge are the most expensive alternatives in terms of cost and time. The modified 20-round magazine is likely to solve the stubbing problem, but the introduction of another item into the inventory has met with user opposition. Based on limited test data, the 30-round magazine has demonstrated an acceptable stubbing rate (3%). This is the low cost alternative because the 20-round magazine is currently being phased out and replaced by the 30-round magazine.

It is recommended that a confirmation test should be performed by the user to verify the low stubbing rate of the M200 Blank Cartridge used with the 30-round magazine.

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OBJECTIVE

The objective of this study is to compare alternative solutions to correct the 5.56mm Blank Cartridge (M200) malfunction rate.

INTRODUCTION

The current 5.56mm Blank Cartridge (M200) is a crimped 5.56mm ball brass cartridge case used in field training. The M200 is currently produced at Lake City Army Ammunition Plant at an average yearly production rate of 110M rounds. The operational history of the M200 since its inception in 1968 shows a high malfunction rate (10%-23%)[1] when it is used with the M16 rifle, Blank Firing Attachment (BFA), and the 20-round magazine. The high malfunction rate is primarily caused by stubbing of the blank cartridge (during feeding, the blank cartridge jams on the upper receiver adjacent to the feed ramp of the barrel extension). Engineers associate the M200 stubbing rate to two causes: (1) the shortness of the blank cartridge round and (2) the failure of the 20-round magazine to feed the blank cartridge properly.

This study was first initiated[2] to review a cost/schedule risk analysis performed by Frankford Arsenal on blank cartridges development programs to solve the stubbing problem[3]. These blank cartridge programs considered cartridge cases made from various materials: steel, aluminum, brass, and plastic--which would be designed similarly to the 7.62mm M82 Blank Cartridge at a length comparable to the 5.56mm ball round. During the course of this reveiw, three other alternatives were identified as possible solutions: (1) increase the length of the present M200 about 1/8 of an inch, (2) adopt a modified 20-round blank magazine for field training, or (3) use the 30-round magazine.

The following section summarizes Frankford's cost/schedule analysis on the proposed cartridge case development programs (steel, aluminum, brass, and plastic). The next section presents the results of the review of Frankford's cost/schedule analysis and proposed blank cartridge development programs. This is followed by a discussion of a proposal, suggested by Rodman Laboratories, to increase the M200 length by 1/8 of an inch. The sections "Modified 20-Round Blank Magazine" and "Thirty-Round Magazine" describes alternative solutions to the M200 stubbing problem, identified by this study.

This study is a portion of a decision analysis leading to an ARMCOM recommendation of alternate solutions to the M200 Blank Cartridge

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[1] Letter (3rd Ind) from SARFA-MDS-S to ATCL-MM, subject: Evaluation of Cartridge, 5.56mm, Aluminum, Blank Development Test III, TECOM No. 8-M4-001-200-001, dated 11 Oct 73.

[2] DF, from AMSAR-RDG to AMSAR-SA, subject: Cartridge, 5.56mm Blank, 15 July 1975.

[3] Frankford Arsenal Memo No. 29, subject: 5.56mm Blank Cartridge Risk Analysis, Aug 1975.

(stubbing) malfunction rate. This analysis considers time-to-solution, cost (avoidance and savings), probability of success, and logistic support of each alternative.

BLANK CARTRIDGE DEVELOPMENT PROGRAMS

In May 1975, Frankford Arsenal was requested to provide a plan for a brass development program to increase the length of the M200 Blank Cartridge similar in configuration to the 7.62mm M82 Blank Cartridge[4]. A cost/schedule risk analysis was performed by Frankford, considering development programs of M82 type cartridge cases made from brass, aluminum, steel and plastic[3]. The steel development program was considered in the analysis because of the potential cost savings in using the lower cost material. The aluminum and plastic blank cartridge programs were offered because of earlier requirements: conservation of copper and a design to deter tampering[5]. However, the plastic blank cartridge was found to be technically not feasible in its present state of development, primarily because of problems in material, process, and dimensional shortcomings. Therefore, it was excluded from the analysis.

The analysis performed on the development programs considered cost and schedule burdens in completing engineering development, conversion of the present M200 production line, and production of the developed cartridge case. However, the cost of additional equipment and facilities was not included. Frankford did not consider it equitable to assess the development program with the cost of equipment and facilities when future programs of different caliber or material will, in all likelihood, use the equipment and/or facilities[6].

Table 1 summarizes the engineering costs, times-to-production, estimated production, cost per 1,000 rds, and probability of success for each development program based on a mobilization production rate of 208M rounds per year. These results do not include costs of equipment and facilities. The estimated production cost of 1,000 rounds is $38.75 for brass, $36.04 for aluminum, and $32.30 for steel. The estimated current production cost of the M200 Brass Blank Cartridge is $34.03 per 1,000 rounds. The estimated time-to-production is 3 years for the steel, 2 years for the brass, and 3½ years for the aluminum.

The steel program assumes the new electrophoresis coating process is successful; if not, the current spray coating process will be used. The spray coating process will incur higher costs of equipment and facilities as discussed in the following section.

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[3] Ibid.

[4] Letter from AMSAR-RDG to SARFA-MDS-RDG to SARFA-MDS-S, subject: Cartridge, 5.56mm Blank, 28 May 1975.

[5] Trip report by AMSAR-RDG, subject: Trip report of L.F. Moore, TO #3152, 14 Dec 73.

[6] Letter from SARFA-TD-MD to AMSAR-RD, subject: Cartridge, 5.56mm Blank, 18 July 1975.

TABLE 1. 5.56MM M82 DEVELOPMENT PROGRAMS COST/SCHEDULE ANALYSIS

	Steel[a]	Brass	Aluminum
Engineering Costs (90% certainty)	$480K	$300K	$491K
Time-To-Production[b] (80% certainty)	38 months	26 months	42 months
Cost per 1000 Rds[c]	$32.30	$38.75	$36.04
Probability of Success	0.91	0.97	0.88

[a]Assumes the electrophoresis coating process is successful (estimated 99%).

[b]Includes conversion time of the M200 production line; 13 months for steel, 8 months for brass, and 13 months for aluminum.

[c]Includes only recurring production costs.

REVIEW OF DEVELOPMENT PROGRAMS COST/SCHEDULE ANALYSIS

The review surfaced two areas of disagreement with the analysis: (1) the exclusion of the cost of equipment and facilities and (2) the estimation of the mobilization production rate of 117M rounds per year instead of the estimated 208M rounds per year.

It is the opinion of the reviewers that cost of equipment and facilities must be included in any cost analysis programs to indicate cash flow options and total expenditures. These costs cannot be amortized on future or unforeseen programs that may use the equipment of facilities. The estimated costs of equipment and conversion, facilities, and engineering costs for each of the development programs are listed below:

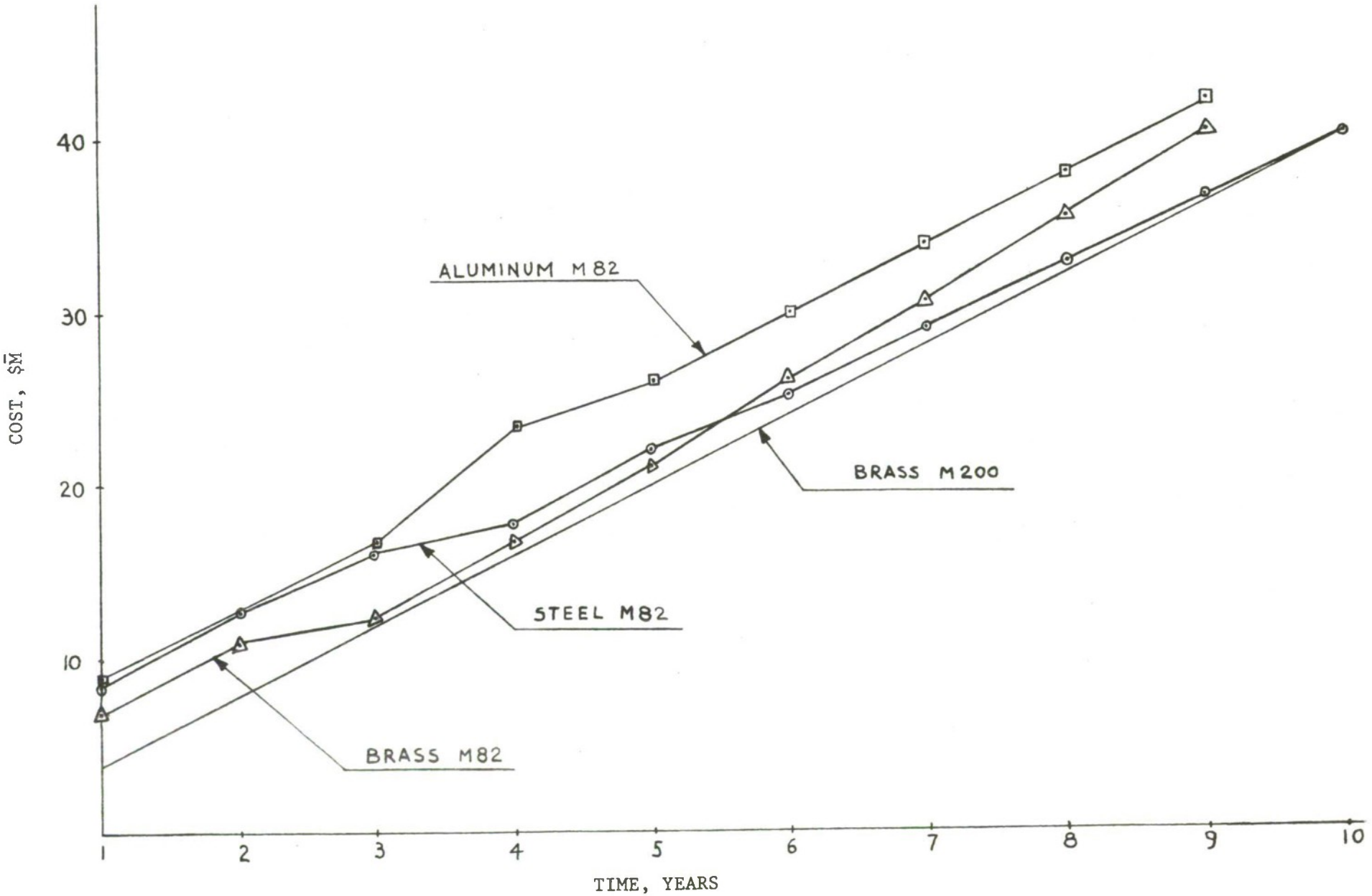
	Cost ($K)		
Development Programs	Equipment & Conversion	Facilities	Engineering
Brass	435	-	300
Aluminum	4750	750	126
Steel (electrophoresis coating)	795	1000	480
Steel (standard coating)	1450	2500	480

Figure 1 presents the cash flow of the development programs based at the current estimated mobilization rate of 117M rounds per year. Due to the high probability of success (99%) of the electrophoresis coating process, the steel program with the standard coating process was not included. The difference in cost of the developmental programs from the M200 program is presented in Figure 2.

The cost of the steel program breaks-even with the M200 brass after 10 years based on a production rate of 117M rounds per year, at which time the steel program shows a savings. The aluminum program is the most expensive because of the high one-time costs and high material and production cost. The brass program production costs are higher than those of the M200 program because of the increased brass material used in the cartridge case.

M200 INCREASED LENGTH PROPOSAL

A program proposed by Rodman Laboratories to increase the current M200 blank cartridge length was based on layout drawings; engineers advised that satisfactory functioning may be obtained by increasing the length about an 1/8 of an inch (the exact increase has not been determined). This proposal was presented because of the potential reduction in time-to-production of 1 to 2 years. However, this length increase would extend the blank cartridge case into the rifling of the barrel and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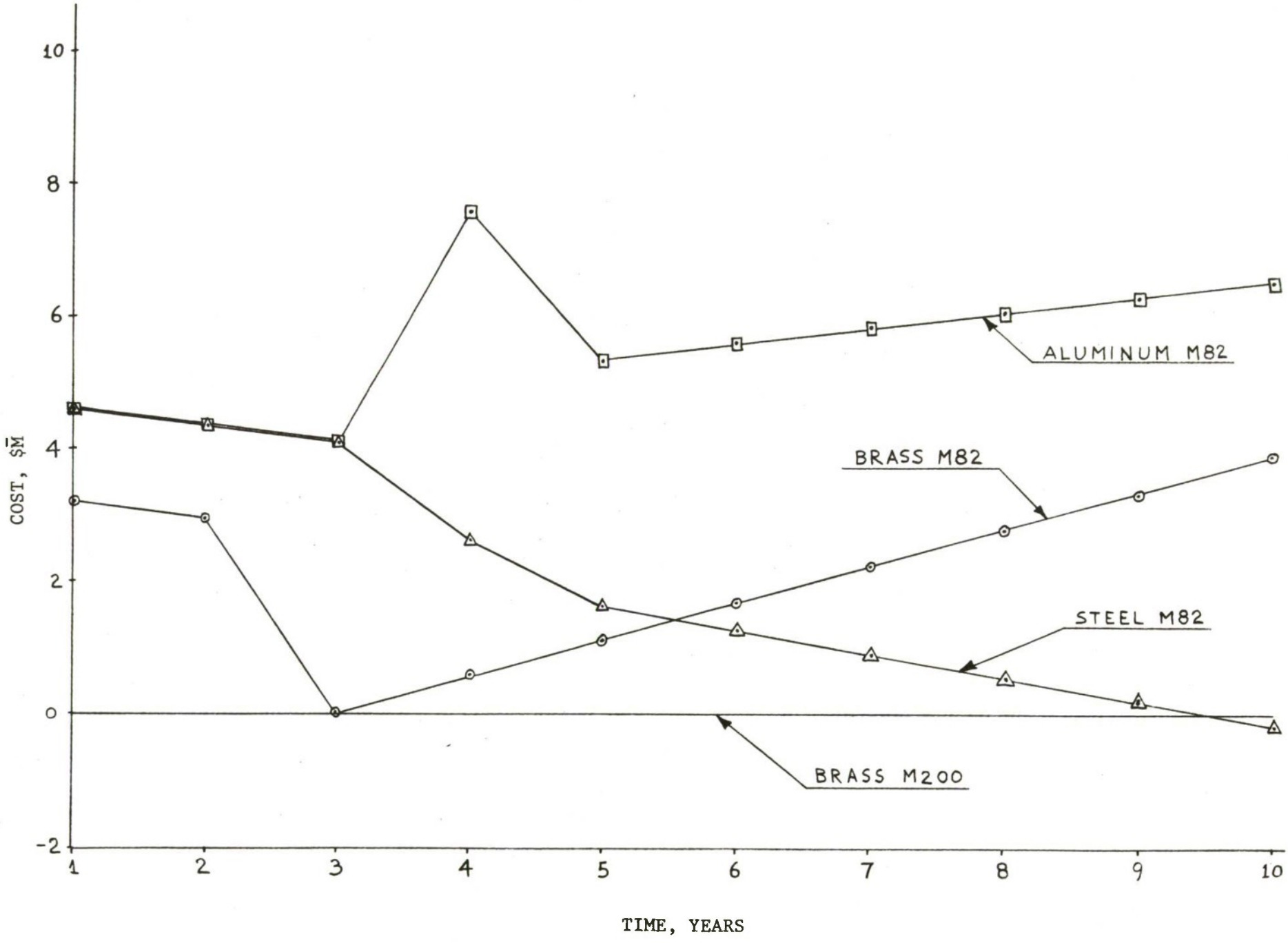
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TIME, YEARS
ALUMINUM M82
BRASS M82
STEEL M82
BRASS M200

may cause increased wear at the origin of the rifling. The length increase would also incur engineering development costs and production line conversion costs to convert cups, belts, and conveyors on the present M200 line.

MODIFIED 20-ROUND MAGAZINE

In addition to the development programs, a modified 20-round magazine was offered to the user in October 1969 as a solution to the stubbing problem[7]. This modified 20-round magazine (see Figure 3) consisted of a filler and a new follower, replacing those in the current magazine. The filler forced the blank cartridges to the rear of the magazine and decreased the stubbing rate below 3%. (Tests have indicated that when blank cartridges were placed to the rear of the 20-round magazine, the stubbing rate decreased.) In April 1969[8], and again in October 1975[9], the user rejected the modified 20-round magazine, citing logistic cost and increased training burdens.

The current cost of a kit, composed of a filler and a follower, to modify the existing 20-round magazine is estimated at 18 to 25 cents for the produced items. The modification of a magazine is considered well within a field soldier's capability.

This solution has beneficial attributes associated with it as follows:

1. Safety - Used in training, the modified 20-round magazine, painted red with the work "BLANK" in white, has several safety aspects: (1) a live round cannot be loaded into the modified magazine (2) a quick inspection can insure that only the modified blank magazines and blank rounds are used.

2. Logistics - The 20-round magazine is currently being phased out by the 30-round magazine; the last production occurred in the early 70's. The 20-round magazine can be given to training areas, modified, and used for training purposes.

3. Cost - Cost savings can be affected by utilizing the 20-round magazine to their fullest life.

4. Time - Modification kits can be fielded within 60-90 days (estimated). This is a time savings of several years compared to the blank round development programs.

The user cited logistic costs and increased training as arguments against the 20-round blank magazine. However, each of the developmental

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[7]Granely, A.J., Improved Blank Firing System for the Rifle, 5.56mm M16A1, Frankford Arsenal, Philadelphia, PA., October 1969.

[8]Letter (2nd Ind) from AJIIS-I to ATOPS-TNG-TSN, subject: Magazine for Blank Cartridge, 5.56mm: M200, 17 March 1969.

[9]Letter from ATSH-CD-MS-F to ATCD-CM-I, subject: 5.56mm Blank Cartridge for the M16A1 Rifle, 1 October 1974.

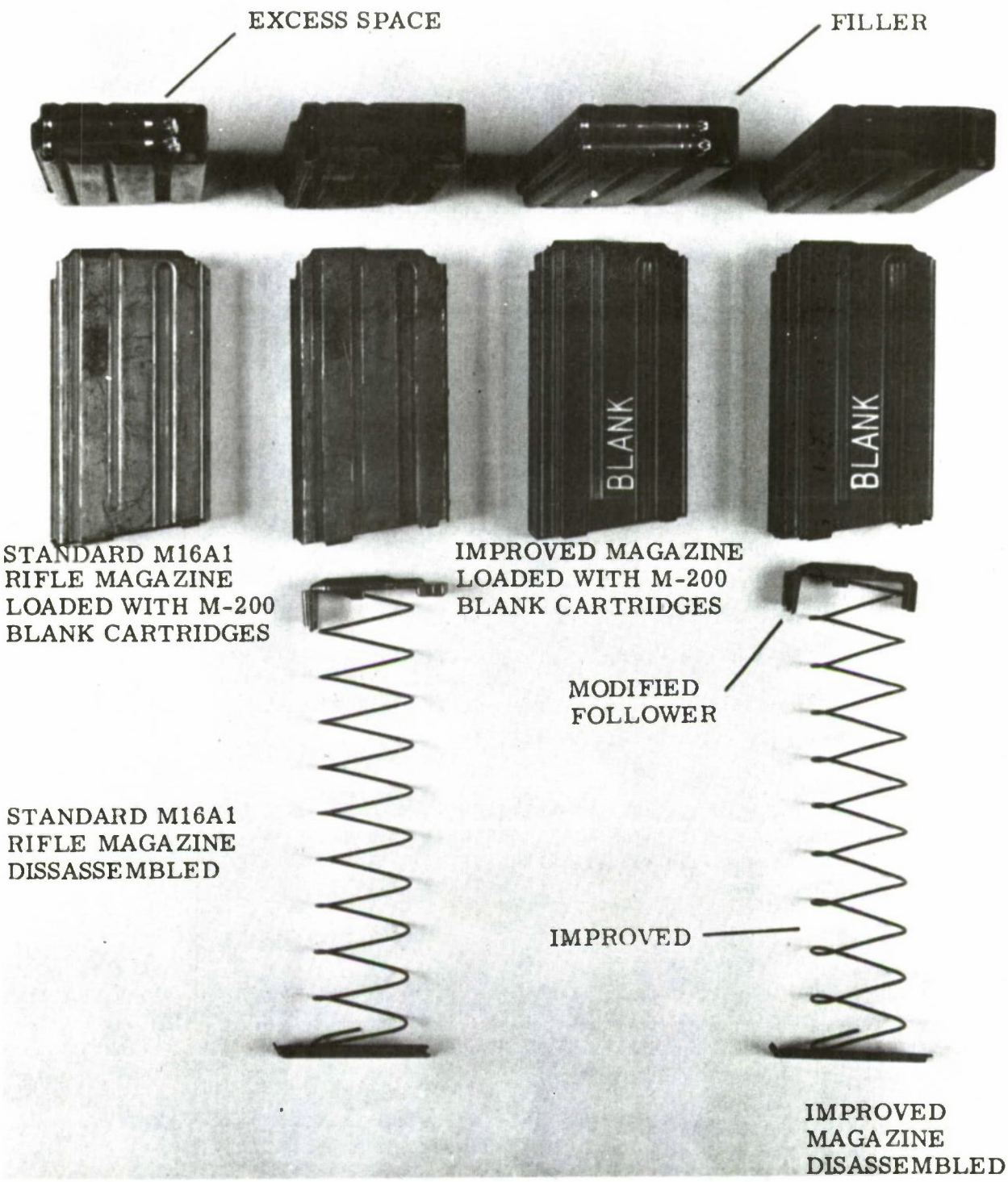

Figure 3. Standard and Improved Magazines
With M200 Blank Cartridge for Rifle 5.56mm M16A1

programs discussed previously, will incur logistic costs: the cost of a new round in the logistic system, and the logistic problems and cost associated with having stockpiles of the current M200 round mixed with the new developed blank round. The increased training burdens should be no more than the current safety checks and inspections now occurring, insuring that no live rounds are used during training exercises. The time and cost associated with these safety checks can be reduced with the modified blank magazines.

THIRTY-ROUND MAGAZINE

The 30-round magazine, developed in the late 60's, is currently replacing the 20-round magazine in the field. The 30-round magazine was considered as a solution to the stubbing problem, based on a test report published in May 1971[10]. This test report indicated a stubbing rate of less than 3% was obtained when the 30-round magazine and M200 blank cartridges were used.

The purpose of the May 1971 test report was to perform a check test on a blank-firing attachment (XM15E1) for the M16A1 rifle. It was conducted by the Material Testing Directorate of Aberdeen Proving Ground during December 1970 to April 1971. When the M200 was used, the report indicated stubbing rates of 22.6% for the 20-round magazine and 2.9% for the 30-round magazines. However, their recommendation was to lengthen the M200 Blank Cartridge to the standard 5.56mm ball cartridge length.

In addition, the report also indicated a difference of stubbing rates occurring between manufacturers of M16A1 rifles. The H&R M16A1 indicated a lower stubbing rate than the GM rifles. The Colt-produced rifles were not tested. This difference in stubbing rates was thought to be due to a difference in the position of the feed ramp lips between the two produced rifles.

The design of the 30-round magazine is different from that of the 20-round magazine in that the first three rounds are stacked with a greater design angle (>30°) than the following rounds ($\leq$ 30°). The design angle, (see Figure 4) is the intended angle between two succeeding cartridges[11]. This greater design angle holds the round firmer and guides the round into the receiver for a more satisfactory functioning. Figure 5 presents the round-stacking in the 30-round magazine.

During the early 70's, several 30-round developmental magazines were produced. Since the May 1971 test report did not indicate which design configuration of these 30-round magazines was used, the authors initiated a check test on the current 30-round magazine. This test was performed

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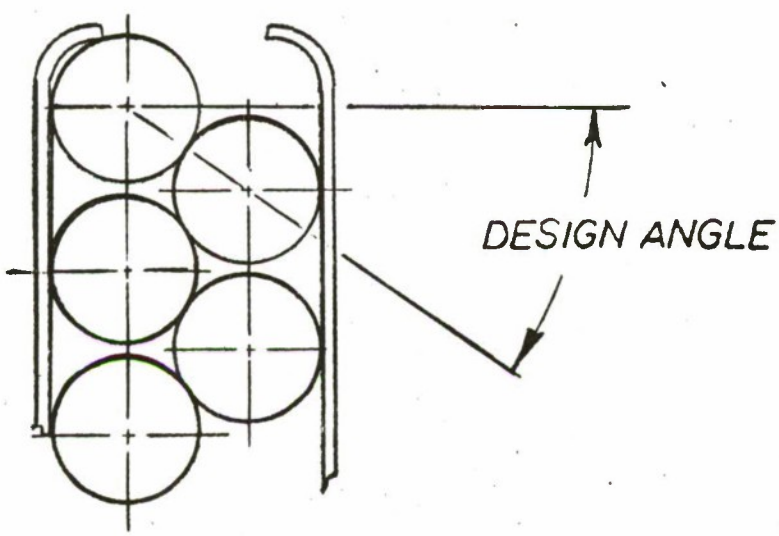
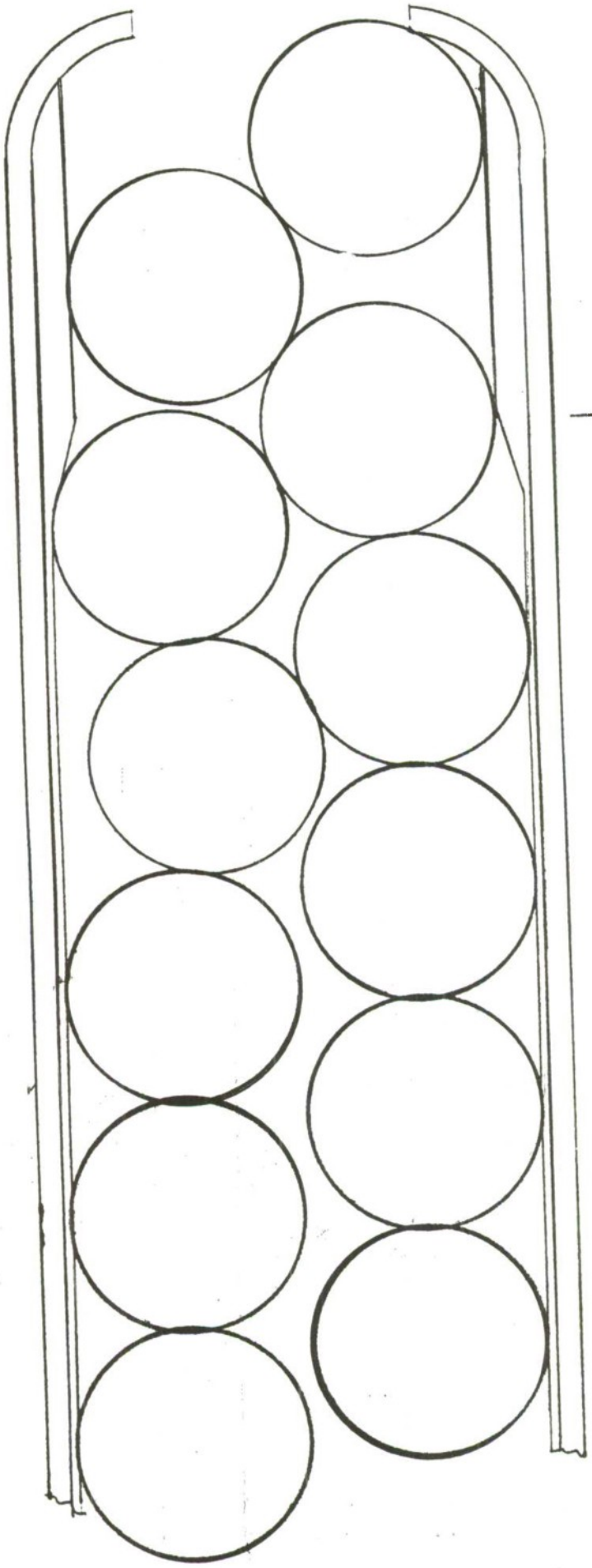
[10] Chimel, Daniel, and Orzech, Phillip, Check Test of Blank-Firing Attachment, XM15E1 for M16A1 Rifle, Aberdeen Proving Ground, MD, May 1971.

[11] Blankert, Robert R., Magazine Design, N-RK-N-3-39-73, Rock Island Weapons Laboratory, April 1973.



20 ROUND MAGAZINE
DESIGN ANGLE $\leq$ 30°

Figure 4. Design Angle



DESIGN ANGLE > 30°

DESIGN ANGLE < 30

STACKING IN THIS REGION DOES NOT ALWAYS STACK AS SHOWN

by Rock Island in Sept 1975. The tested items consisted of 3 weapons (produced by Colt), 300 rounds of M200 blank cartridges, six 30-round magazines and five 20-round magazines. The test results, presented in Table 2, show a 0% stubbing rate for the 30-round magazines and at least a 30% stubbing rate for the 20-round magazines. There was a large amount of difficulty in firing the blank cartridges from the 20-round magazines. Weapon #1 was unable to fire consecutive rounds without stubbing.

CONCLUSIONS

1. Increasing the length of the M200 Blank Cartridge is the most expensive alternative considered in terms of cost and time.

2. The modified 20-round magazine is likely to solve the stubbing problem but the introduction of another item into the inventory has met with user opposition.

3. Based on limited test data, the 30-round magazine has demonstrated an acceptable stubbing rate (below 3%). This is the low cost alternative as the 20-round magazine is currently being phased-out and replaced by 30-round magazines.

RECOMMENDATION

A confirmation test should be performed by the user to verify the low stubbing rate of the M200 Blank Cartridge used with the 30-round magazine.

TABLE 2. CHECK TEST ON 30-ROUND MAGAZINE

(Performed at Rock Island Arsenal, Sept 75)

Weapon	Rounds Fired With[a] 30-Round Magazine	# of Stubs	Rounds Fired With[a] 20-Round Magazine	# of Stubs
1	90	0	9[b]	8[b]
2	90	0	11[c]	1
3	80	0	20	0
Total	260	0	40	9

[a]The M200 Blank Cartridge Rounds were loaded randomly; several magazines were used, six 30-rounds and five 20-round magazines.

[b]Three 20-round magazines were used in firing the 9 rounds from weapon #1. There were 8 stubs recorded; however, the rounds stubbed continuously after the 9th round (stubs were not recorded). Therefore, the testing of the 20-round magazine with that weapon was discontinued. Three 30-round magazines were then used with weapon #1; no stubbing occurred. Visual inspection of the weapon and the 20-round magazine indicated no problems.

[c]The 20-round magazine used with #1 was used in weapon #2 to finish the 11 rounds.

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REFERENCES

1. Letter (3rd Ind) from SARFA-MDS-S to ATCL-MM, subject: Evaluation of Cartridge, 5.56mm, Aluminum, Blank Development Test III, TECOM No. 8-M4-001-200-001, dated 11 Oct 73.

2. DF, from AMSAR-RDG to AMSAR-SA, subject: Cartridge, 5.56mm Blank, 15 July 1975.

3. Frankford Arsenal Memo No. 29, 5.56mm Blank Cartridge Risk Analysis, Aug 75.

4. Letter from AMSAR-RDG to SARFA-MDS-RDG to SARFA-MDS-S, subject: Cartridge, 5.56mm Blank, 28 May 1975.

5. Trip report by AMSAR-RDG, subject: Trip report of L.F. Moore, TO #3152, 14 Dec 73.

6. Letter from SARFA-TD-MD to AMSAR-RD, subject: Cartridge, 5.56mm Blank, 18 July 1975.

7. Granely, A.J., Improved Blank Firing System for the Rifle, 5.56mm M16A1, Frankford Arsenal, Philadelphia, PA., October 1969.

8. Letter (2nd Ind) from AJIIS-I to ATOPS-TNG-TSN, subject: Magazine for Blank Cartridge, 5.56mm: M200, 17 March 1969.

9. Letter from ATSH-CD-MS-F to ATCD-CM-I, subject: 5.56mm Blank Cartridge for the M16A1 Rifle, 1 October 1974.

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11. Blankert, Robert R., Magazine Design, N-RK-N-3-39-73, Rock Island Weapons Laboratory, April 1973.

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