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Durability Evaluation and Live Firing Exercise for Two 100-round Assault Packs and a Product-improved 200-round Magazine for the M249 Squad Automatic Weapon (SAW)

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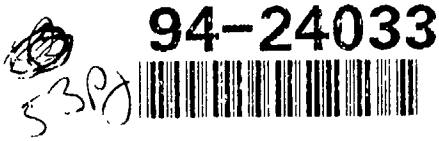

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The Human Research and Engineering Directorate (HRED) of the U.S. Army Research Laboratory (ARL) conducted a durability and live firing exercise of two types of 100-round magazines and the latest product-improved 200-round magazine for the M249 squad automatic weapon (SAW). The purpose of this evaluation was to assess the durability of a reusable 100-round magazine (soft pack), a disposable 100-round magazine (hard pack), and a product-improved version of the 200-round magazine. The primary objectives were to determine if (a) the magazines stayed attached to the SAW during obstacle course maneuvers, (b) any of the magazines adversely affected the integrity of the linked munitions, and (c) the munitions in these magazines could be fed into and fired from the SAW after portability maneuvers. In addition, magazine removal and attachment trials were conducted to determine the ease with which the 100-round magazines could be removed from the ammuntion carrying cases and attached to the SAW.

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The results show that the 100-round reusable magazines (soft packs) stayed attached to the weapon, and no appreciable damage was noted on the dovetail rail assembly of this magazine. However, the rounds tend to get misaligned inside the soft packs and cause weapon stoppages. The 100-round disposable magazine (hard packs) fell off the weapon 10 times in 100 trials and sustained 11 critical failures (ammunition belt separations and rounds siphoning from the magazine). It was noted during the firing exercise that the top two rows of munitions tend to bind against one another inside the disposable magazine and cause weapon stoppages. The 200-round magazine evaluated during this study was not as durable as the 200-round magazine evaluated in 1991 (64% versus 94% trials without failure and 85% versus 97% for trials without critical failure). The 200-round magazines were fired from the SAW without any incidents of failure.

The results of the magazine removal and attachment trials showed that the subjects were able to remove the 100-round reusable magazines from the ammunition cases and attach them to the SAW easier and significantly faster than they could the 100-round disposable magazines.

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DURABILITY EVALUATION AND LIVE FIRING EXERCISE FOR TWO 100-ROUND ASSAULT PACKS AND A PRODUCT-IMPROVED 200-ROUND MAGAZINE FOR THE M249 SQUAD AUTOMATIC WEAPON (SAW)

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June 1994

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DURABILITY EVALUATION AND LIVE FIRING EXERCISE FOR TWO 100-ROUND ASSAULT PACKS AND A PRODUCT-IMPROVED 200-ROUND MAGAZINE FOR THE M249 SQUAD AUTOMATIC WEAPON (SAW)

INTRODUCTION

Statement of the Problem

Since the M249 squad automatic weapon (SAW) was fielded, soldiers have reported that several problems exist with the 200-round ammunition containers. One problem has been that the rail assembly of the container is not strong enough to withstand the weight of the loaded container and the rough handling that occurs during operational use. This problem is exacerbated by repetitive attachments and removals of the container to and from the weapon, which cause the dovetail slide rail of the container to wear. Once the slide rail is worn, the locking tab of the container is not strong enough to retain a fully loaded container on the weapon. Soldiers also have reported that the 200-round container chafes their bodies and that the rounds bounce around in the container, causing excessive noise during maneuvers. These problems are attributable partly to the bulk and weight of the 200-round container.

The M249 SAW is also capable of firing a 30-round rifle magazine. This magazine is smaller and lighter, but there are insufficient rounds to provide an effective base of fire. Experience has shown that at least 80 rounds of ammunition, without reloading, need to be available to suppress an ambush until other elements of the unit can return fire (JSOR, 1982; AMC/TRADOC, 1987).

In an effort to resolve these problems, the U.S. Army Infantry School (USAIS) initiated a requirement for a 100-round ammunition container. It would be smaller and lighter than the 200-round container and would contain enough rounds to provide an effective base of fire. Since the SAW gunner is required to carry 600 rounds of ammunition (one 200-round container on the weapon and two in load-carrying equipment), two 100-round containers will be used in place of one 200-round container. One 100-round container will be attached to the weapon, and the other will be carried by the SAW gunner.

The U.S. Army Armament, Research, Development, and Engineering Center (USARDEC) was tasked to develop 100-round ammunition containers (assault packs) for the M249 SAW. Two concept 100-round containers were developed. One, a soft pack, was intended to be reusable. It was fabricated of a rigid plastic and soft nylon cloth. The second concept container was intended to be used only once and was fabricated of a rigid plastic. USARDEC asked the U.S. Army Combat Systems Test Activity (USACSTA) and the Human Research and Engineering Directorate (HRED) of the U.S. Army Research Laboratory (ARL) to evaluate these ammunition containers. ARL was asked to conduct a limited durability (a series of obstacle course trials) and human factors evaluation for both types of 100-round containers.

This evaluation was conducted by ARL from 8 through 17 July 1991; however, the test was abbreviated because of the numerous shortcomings and deficiencies noted with both 100-round magazine containers. Shortly thereafter, ARL personnel assisted an engineer from USARDEC in conducting a follow-up evaluation to determine the causes of the various deficiencies. This follow-up evaluation was conducted from 13 through 14 August 1991. The findings of these abbreviated evaluations caused USARDEC to implement design changes for both 100-round assault packs.

Once these changes were made, USARDEC asked USACSTA and ARL to evaluate the redesigned 100-round assault packs and a product-improved version of the 200-round SAW magazine. This evaluation was conducted from 5 through 16 April 1993.

OBJECTIVES

Two separate subtests (a limited durability evaluation and magazine attachment and removal evaluation) were conducted to

1. Determine if the 100-round soft packs, the 100-round hard packs, and the 200-round product-improved (PIP) magazines stay attached to the SAW during the obstacle course maneuvers.

2. Determine if the 100-round soft packs, the 100-round hard packs, or the PIP 200-round magazines adversely affect the integrity of the linked munitions or the ease with which the munitions are fed into the weapon after being carried onto the obstacle course.

3. Determine if the 100-round soft packs, the 100-round hard packs, or the 200-round magazines affect the ease with which the containers can be attached to or removed from the SAW.

4. Identify any human engineering problems observed.

SUBJECTS

Ten male soldiers from the Soldier Operator Maintenance Test Group, USACSTA, participated in this assessment.

Medical Screening

Each subject's medical record was reviewed by the Kirk U.S. Army Health Clinic, Aberdeen Proving Ground, Maryland. This was done to assure that no subject had a medical history or profile that would jeopardize his health or personal safety.

Pretest Briefing Orientation

The subjects were given a pretest briefing describing the test. This included a description of test objectives, apparatus, and procedures required to complete each subtest.

Volunteer Agreement Affidavit

The subjects were each given a copy of the affidavit (DA FORM 5303-R) and were instructed to carefully read the elements of informed consent described in Part B. After the subjects read Part B, questions from the subjects were answered. Next, the subjects were instructed to complete Part A(1) of the affidavit and to sign and date the signature block if they agreed to volunteer for this assessment. A copy of the volunteer agreement affidavit is shown in Appendix A.

APPARATUS

ARL 500-Meter Obstacle Course

The obstacle course consists of 17 identical pairs of obstacles spread over a twisting course of about 500 meters. Negotiation of the course requires the soldiers to run, climb, jump, and crawl. A figure of the obstacle course is illustrated in Appendix B. Previous portability and human factors evaluations (Hanlon et al., 1984; Hanlon, Hickey, & Ortega, 1990) have shown that soldier and marine activity on the obstacle course provides the necessary activity and soldier equipment interactions to identify individual equipment durability and human factors problems.

Common Items of Clothing and Equipment

Each subject wore or carried the clothing and equipment items listed in Table 1.

Table 1

Clothing and Equipment Items

Item description	Weight in pounds
Underclothing and socks	0.48
Battle dress uniform	3.80
Belt with buckle	0.44
Boots, DMS[a]	4.10
PASGT[b] helmet (size medium)	3.30
ALICE[c] belt and suspenders	1.50
Canteen with cup, cover, and 1 quart of water	3.32
Individual first aid kit	0.17
Total clothing and equipment weight	17.11

[a]DMS - direct molded sole
[b]PASGT - personal armored system for ground troops
[c]ALICE - Army lightweight individual carrying equipment

100-round Ammunition Containers (Assault Packs)

Two different types of 100-round assault packs were evaluated. One is considered a reusable container and is called the soft pack. The other is a disposable container and is referred to as the hard pack. The soft pack is fabricated from two different materials. The top of the soft pack is rectangularly shaped (6 inches x 2-1/2 inches x 1/2 inch) and is injection molded into a rigid plastic shape. The access opening for the linked munitions and the dovetail slide rail are an integral part of the top. The lower portion of the container is a soft pouch constructed from a nylon cloth. This pouch is riveted around the perimeter of the top. The bottom of the pouch has an access opening for loading munitions. The munitions are secured in the pouch via a zippered closure. The soft pack weighs approximately 0.3 pound.

The hard pack is a rectangular container measuring approximately 6 x 4 x 2 inches and is fabricated of a rigid plastic. The access opening for the munitions and the dovetail slide rail are integrated into the top similar to those of the soft pack. One side of the box incorporates a clear plastic cover (side that faces gunner when container is attached to weapon), which enables the gunner to see how many rounds are left in the container. The hard pack weighs approximately 0.5 pound.

200-round Ammunition Container (SAW 200-round magazine)

The 200-round magazine is basically the same PIP magazine that was previously evaluated by ARL (Hickey & Ortega, 1991) except that the plastic material from which the magazine is molded has been changed. This latest version is made of a softer material to lessen the chance that the magazine itself would damage the rail assembly of the SAW.

Photographs of the 100-round soft pack, the 100-round hard pack, and the 200-round magazines are shown in Appendix C.

SAW Small Arms Ammunition Cases

Each subject carried two of the small arms cases on the ALICE belt. One small arms case was used to carry a standard 200-round SAW magazine that was balanced and weighted to simulate a full 200-round magazine. The other case was used to carry two 100-round soft packs or two 100-round hard packs. All 100-round assault packs carried in the small arms cases were loaded with 100 rounds of live linked munitions. Each of the small arms cases, including the ammunition containers, weighed approximately 7 pounds.

Squad Automatic Weapon

Five identical SAWs were used during the durability test trials.

SAW Gunner Load Configurations

Three different magazine combinations were evaluated. Each subject was required to carry the soft pack, the hard pack, and the 200-round magazine attached to the weapon (see Appendix D). When the subjects carried either of the assault packs (soft pack or hard pack) on the weapon, they were configured as SAW gunners with 500 rounds of ammunition--100 rounds of linked munitions

on the weapon, one 200-round magazine in one small arms case, and two 100-round assault packs in the other small arms case. When the subjects carried the 200-round magazine on the weapon, they were configured as SAW gunners with 600 rounds of ammunition--200 on the weapon and 400 in the small arms cases as mentioned previously. The total weight carried by a SAW gunner with 500 rounds was 48.93 pounds (17.11 pounds for clothing and equipment, 14 pounds ammunition in small arms cases, and 17.82 pounds for the weapon with ammunition). The total weight carried by a SAW gunner with 600 rounds was 52.43 pounds (the difference in weight attributable to a 200-round magazine attached to and carried on the weapon).

PROCEDURES

Training

Training trials were conducted during the first day of the assessment. Each subject was taken on a walk through the obstacle course and shown how to properly and safely negotiate each of the obstacles. Each subject then made four self-paced practice trials configured as a rifleman. Each subject carried two 30-round small arms cases with weighted magazines and an M16 rubber training rifle in addition to the clothing and equipment items shown in Table 1. The total weight of this training load was 35.14 pounds. This training was conducted to enable the soldiers to become familiar with carrying loads on the obstacle course.

Obstacle Course Trial

Ten subjects negotiated the obstacle course configured as SAW gunners. After the completion of each trial, the subjects dropped to a prone firing position and conducted two magazine removals and replacements from and to the weapon.

All weapon-by-magazine-related shortcomings and failures (i.e., magazine separating from weapon, linked munition siphoning from magazines, rounds misaligned in links, munition links separating, etc.) and any other observed problems were noted.

No more than four trials were conducted during any given test day, two trials in the morning and two during the afternoon.

TEST DESIGN

Independent Variables

The independent variables were the different weapon and magazine combinations.

Dependent Variables

The dependent variables were the incidents of failure of the magazines (100-round soft packs, 100-round hard packs, and 200-round magazines) and the linked munitions.

Test Matrix

Each subject carried a SAW and the magazine listed for each of 30 trials as shown in the matrix in Appendix D. Each subject also carried a 200-round magazine (balanced and weighted to equal a fully loaded magazine) in one of the small arms cases and two of the assault packs loaded with 100 rounds of linked munitions in the other small arms cases. These small arms cases were alternated from the left and right side of the user for each trial. Subjects 1 through 5 used two 100-round soft packs in the small arms cases for the first 15 trials and two 100-round hard packs in the cases for the last 15 trials; Subjects 6 through 10 reversed the order.

TEST CRITERIA

The criteria for removing magazines from the test and for determining failures for the magazines and belted munitions were established by the U.S. Army Materiel Systems Analysis Activity and USACSTA. These criteria follow:

1. The 100-round soft assault packs were designed to be loaded and reused 50 times and were therefore tested until they sustained a critical failure.

2. The 100-round hard packs and the 200-round magazines are considered disposable magazine containers designed to be used once and thrown away. These containers were carried on the weapons until they sustained a critical failure or for 10 obstacle course trials, whichever occurred first.

3. The criteria for determining critical failures and removing the magazine from the evaluation were as follow:

a. Any magazine that separated from and fell off the weapon four or more times during any single obstacle course trial

b. Any magazine that separated from and fell off the weapon three times each during two consecutive obstacle course trials.

c. Any magazine that separated from and fell off the weapon nine times.

d. Any magazine that separated from and fell off the weapon and could not be replaced because of excessive damage to the rail and latch assembly.

e. Any occurrence that caused the linked munitions to separate between the links or siphon from the container onto the ground, or to siphon back into the container so that the gunner could not fire 80 rounds without corrective action.

DURABILITY EVALUATION

Results and Discussion

The reusable 100-round magazines were carried on various weapons through the obstacle course until damaged or until the conclusion of the test. Both of the disposable magazines (100 and 200 rounds) were carried on various

weapons for 10 obstacle course trials or until they sustained damage that required removing them from the trials.

In addition to the magazines carried on the weapons, soldiers carried two 100-round magazines (either two reusable or two disposable) in one 200-round small arms case and a weighted 200-round magazine in the other small arms case. The magazines carried by the soldiers were alternated between the left and right cases for each trial. The 100-round magazines were alternated between reusable and disposable each day.

The results of the durability assessment, in which magazines were carried attached to the weapon during the course trials, are summarized in Table 2. Trials completed without critical failures were ones in which the magazine or munitions did not sustain damage that would prevent the gunner from firing 80 rounds. Trials completed without failures were ones in which the magazine did not fall off the weapon, rounds did not siphon from the magazine, or the ammunition belt did not separate. Incidents when rounds of ammunition were misaligned in the links are listed in Table 2, but these were not included in the percentages of failure calculations. A chronology of shortcomings and failures for each magazine evaluated is shown in Appendix E.

Table 2

SAW Magazine Usage, Separations, and Failures Noted During the Durability Trials

	100-round soft pack	100-round hard pack	200-round PIP magazine
Magazines evaluated	5	14	10
Trials completed	113	100	78
Trials completed without critical failure	107	89	66
Trials completed without failure	107	72	50
Times magazine separated and fell off weapon	0	10	22
Times rounds siphoned from magazine	0	4	4
Times ammunition belt separated between rounds	6	7	8
Critical failures	6	11	12
Number of trials rounds misaligned in links	16	11	6
Percentage of trials without critical failures	94%	89%	85%
Percentage of trials without failures	94%	72%	64%

Note. A trial is one time through the obstacle course and two magazine removals and replacements. Critical failures are those described in test criteria.

Ninety-five percent confidence intervals for trials without critical failures and for trials without failures were calculated. The 100-round magazines were compared to each other and the 200-round PIP magazine evaluated was compared to the 200-round PIP magazine evaluated previously (Hickey & Ortega, 1991).

The confidence intervals for critical failures ranged between 89% and 99% for the 100-round soft pack and between 82% and 95% for the 100-round hard pack; therefore, there were no significant differences between the 100-round

assault packs for critical failures. The intervals for trials without failures ranged between 89% and 99% for the soft pack and between 63% and 81% for the hard pack, indicating that the soft pack was significantly better than the hard pack relative to trials without failure. Confidence intervals for critical failures and trials without failure for the 200-round PIP magazines indicated that the magazine evaluated during this study was significantly different (worse) than the 200-round PIP magazine evaluated earlier. The intervals for critical failures ranged between 77% and 90.8% for this 200-round magazine and between 91% and 100% for the previous 200-round magazine. The intervals for trials without failures ranged between 56% and 72% for this 200-round magazine and between 93% and 100% for the previous 200-round magazine.

The first durability assessment for the 100-round assault packs was conducted by ARL from 8 through 17 July 1991. This test was abbreviated because of numerous shortcomings and deficiencies noted with both assault packs. These shortcomings and deficiencies were summarized and are listed in Appendix F. Results from this evaluation indicated that the 100-round soft pack had numerous shortcomings and failures pertaining to the integrity of the linked munitions. There were 22 ammunition-related deficiencies (e.g., rounds siphoning from magazine, ammunition belt separations, etc.) noted during the 27 trials conducted with munitions from the magazine placed into the feed tray of the weapon. The results also indicated that the 100-round hard pack had 21 ammunition-related deficiencies and that its cover fell off or became ajar 21 times. In addition, the 100-round hard packs fell off the weapon 10 times.

The evaluation conducted by ARL during April 1993 was to assess the durability of improved versions of the 100-round assault packs. These assault packs were redesigned to correct shortcomings and deficiencies observed during the initial evaluation. The results indicated that the 100-round assault packs had been improved. The 100-round soft pack never separated or fell off the weapon, and there were no occurrences when rounds siphoned from the magazine. There were six incidents when it was noted that the ammunition belt separated between rounds, but 107 of 113 mobility trials were made without critical failure. Post-trial inspections revealed that one or more rounds were misaligned in their individual links during 16 of the trials. These were only noted for the exposed loop of munitions. It is not known what rounds, if any, were misaligned inside the soft pack.

The results also indicated that the 100-round hard pack was improved but not to the same degree as the soft pack. The problem with the magazines covers becoming ajar and falling off was not evident during this evaluation. There were 10 separate incidents when the magazine separated and fell off the weapon; four were ones when the rounds siphoned from the magazine. The magazine belt separated between linked rounds 7 times, and there were 11 trials in which post-trial inspection revealed misaligned rounds in the links. Overall, only 72% of the trials were completed without failure.

The 200-round magazine evaluated during this study (April 1993) was not as durable as the 200-round PIP magazine evaluated previously (Hickey & Ortega, 1991). It fell off the weapon more frequently, and the percentage of trials without failure was much less (64% versus 94%) than the 200-round magazine evaluated before. This apparently was because of a change in the plastic material used to fabricate the PIP magazine.

FIRING EXERCISES

Procedures

The 100-round assault packs and 200-round PIP magazines carried during the durability evaluation were taken to the small arms range immediately after the last obstacle course trial. Each of these magazines was attached to and fired from a weapon in three- to five-round bursts. Failures that occurred were recorded.

Results and Discussion

Summaries of the failures that occurred during the live firing exercises are shown in Tables 3 and 4. Table 3 is magazines that were carried on the weapon, and Table 4 is magazines carried in the small arms cases. Because only ten 200-round magazines were provided for this test, none were carried in the small arms cases. Ninety-five percent confidence intervals for magazines fired without failure ranged between 18% and 23% for the soft packs and between 76% and 100% for the hard packs, indicating that the hard packs were significantly better than the soft packs. No significance was determined for trials without failure for magazines carried in the small arms cases because of a limited sample size.

Table 3

Failures Observed During the Live Firing Exercises for Magazines That Were Carried on the SAWs During the Durability Trials

	100-round soft pack	100-round hard pack	200-round PIP magazine
Number of magazines evaluated	5	12	8
Magazines fired without failure	1	11	8
Magazines that failed to feed munitions and caused weapon stoppages:	4	1	0
Because of rounds misaligned in magazine	3	0	0
Because of binding of top rows of munitions	0	1	0
Because of undetermined reason	1	0	0
Percentage of magazines fired without failure	20%	92%	100%

Table 4

Failures During the Live Firing Trials for Magazines Carried in the SAWS Small Arms Cases During the Durability Trials

	100-round soft pack	100-round hard pack
Number of magazines evaluated	10	10
Magazines fired without incident	9	7
Magazines that failed to feed munitions and caused weapon stoppages:	1	3
Because of misaligned rounds in magazine	1	0
Because of binding of top rows of munitions	0	2
Because of undetermined reason	0	1
Percentage of magazines fired without failure	90%	70%

Note. No PIP 200-round magazines were carried in small arms cases during this evaluation.

Five of the 100-round soft packs (four of the five carried on weapon and one of ten carried in small arms cases) failed to feed their ammunition from the magazine into the weapon, resulting in weapon stoppages. Four of these incidents were attributable to misaligned rounds within the magazine.

It was also noted during the firing exercise that when the 100-round soft pack was attached to the SAW and the bottom of the magazine rested on top of a sandbag, a failure to feed would result. The weight of the SAW and magazine is enough to bind the ammunition within the magazine and prevent it from feeding into the weapon. When the weight was eased by raising the weapon slightly from the sandbag, the weapon fired without incident. This indicates that the SAW cannot be supported by resting the full weight of the weapon and magazine on top of a sandbag or probably any other object (such as a window sill or top of a berm).

Four of the 100-round hard packs failed to feed and resulted in weapon stoppages. Three of the incidents were attributable to the top two rows of munitions binding against each other inside the magazine.

Although in this assessment, incidents of misaligned rounds were considered as shortcomings during durability, they must be considered as failures when they occur during firing. Each occurrence caused a weapon stoppage and required a corrective action before the gunner could continue firing. Inspection of the soft pack magazines showed that in four cases, the rounds that misaligned were binding or getting caught on the exposed edge, the lower portion where the canvas pouch is attached to the magazine.

All the 200-round magazines used during these exercises were fired without an incident of failure.

MAGAZINE REMOVAL AND ATTACHMENT EVALUATION

Objective

The objectives of this evaluation were to determine (1) the ease with which the fully loaded 100-round magazines can be removed and attached to the SAW and (2) if there were any human engineering problems in the removal and attachment of the magazines.

Apparati

The apparati used were

1. SAW
2. Empty magazines of each design
3. Fully loaded 100-round magazines of both designs
4. Stopwatch

Procedures

Training

Each subject was shown recommended procedures for positioning the SAW for ease of removal and installation of the magazines while in the prone position. The subject was then given the SAW and two fully loaded magazines he was scheduled to use. Each subject practiced until he was able to conduct four consecutive error-free training trials.

Magazine Removal and Attachment

Each subject was configured as a SAW gunner with a magazine pouch containing two 100-round magazines on either the left or the right side of the subject. The subject was given two fully loaded magazines he was scheduled to use. He placed both magazines in the magazine pouches (both on the left or both on the right of his body, depending on the matrix that was assigned to him). The magazines were stacked on top of each other rather than side by side. He was given a SAW and was asked to get in a comfortable prone firing position. An empty SAW magazine (either soft or hard pack) was installed on the SAW. When the subject verbally indicated his readiness, the experimenter gave the start signal by loudly saying "Go!" and a stopwatch was started. The subject then removed the attached empty magazine from the SAW, removed one of the fully loaded magazines from his magazine pouch and attached it to the SAW. The task was considered complete once the magazine was properly inserted in the SAW. The watch was then stopped and the time recorded. The attached magazine was inspected by the experimenters to ensure that the task was properly done. This procedure was repeated for the remaining magazine. Each magazine type was removed and installed twice from the right and left ammunition pouches.

Test Design

Independent Variables

The independent variables were the type of magazines (either soft or hard pack), position of the magazines on the subject (left or right side), and position of the magazines in the magazine pouch (top or bottom).

Dependent Variable

The dependent variable was the time in seconds it took to remove and attach the magazine.

Test Matrix

The matrix design is shown in Table 5.

Results and Discussion

Table 6 contains a summary of the times it took for the subjects to remove and install the SAW magazines of both types on the SAW. A complete record of the individual time data and any observed problems are contained in Table G-1 of Appendix G.

Table 5

Test Design Matrix for Magazine Removal and Attachment

Subject number	SR	SL	HR	HL
1	1	2	3	4
2	2	4	1	3
3	3	1	4	2
4	4	3	2	1
5	3	2	4	1
6	1	3	2	4
7	2	4	1	3
8	4	1	3	2
9	2	4	1	3
10	3	2	4	1

SR = 100-round soft pack, right side, top first, then bottom position
SL = 100-round soft pack, left side, top first, then bottom position
HR = 100-round hard pack, right side, top first, then bottom position
HL = 100-round hard pack, left side, top first, then bottom position

Table 6

Mean Time to Remove and Install 100-round Assault Pack Magazines

Magazine type	Remove and install	SE	Top	SE	Bottom	SE
Soft pack	7.93	0.16	7.66	0.21	8.21	0.24
Hard pack	8.96	0.26	7.71	0.21	10.20	0.38

SE = standard error

There were no magazine containers made specifically to carry two 100-round magazines. Instead, the standard 200-round SAW magazine pouch was used. During the earlier part of the evaluation, the experimenters directed three subjects to position the magazines side by side in the magazine pouch. When these three subjects conducted the magazine change trials, their times were consistently slower than those of the other subjects who had the magazines stacked on top of each other. As a result, the experimenters conducted the magazine change using the magazines stacked on top of each other.

The time data were checked for compound symmetry. The assumption for compound symmetry was not violated; therefore, the Greenhouse-Geisser correction for the degrees of freedom was not conducted. A univariate analysis of variance (ANOVA) was performed and is shown in Table H-1 of Appendix H.

There was a significant difference between magazine types and magazine positions for the removal and installation times. The 100-round soft pack magazine was significantly faster to remove and install than the hard pack magazine. Magazines that were positioned on top of the magazine pouch were significantly faster to install than those at the bottom.

The significant difference between magazine types may be attributable to the ease with which subjects were able to easily grasp the 100-round soft pack magazine. In addition, as the soft pack magazine was pulled from the magazine pouch, it had a tendency to conform to the shape of the magazine pouch, since it was not rigid. The rigidity of the hard pack magazine probably prevented it from being removed easily because it had a tendency to catch under the top flap. The surface finish of the 100-round hard pack magazine also had a tendency to be slippery.

Magazines that were on top of the stack in the magazine pouch were significantly faster to remove from the magazine pouch and install on the SAW. This difference is attributable to the easy access of the top magazine as opposed to one in the bottom that had to be reached for and grabbed. While removing the bottom hard pack magazine, four subjects were noticed grabbing the bottom of the magazine pouch and shaking it to dislodge and raise the bottom magazine. Two subjects kept squeezing and compressing the bottom of the magazine pouch to "walk" the hard pack magazine from the bottom.

CONCLUSIONS

1. None of the 100-round reusable magazines (soft pack) separated or fell off the weapon during the durability trials, and no damage to the dovetail rail assembly was noted.

2. Five of the 100-round reusable magazines (four of five carried on weapon and one of ten carried in small arms cases) failed to feed their ammunition from the magazine into the weapon, resulting in weapon stoppages. Four of these incidents were attributable to misaligned rounds within the magazine.

3. The 100-round disposable magazine (hard pack) fell off the weapon 10 times during the durability trials, and only 72% of the trials were without any incidents of failure.

4. Four of the disposable 100-round magazines failed to feed and resulted in weapon stoppages. Three of the incidents were attributable to the top two rows of munitions binding against each other inside of the magazine.

5. The 200-round magazine evaluated during this study was not as durable as the previous 200-round magazine evaluated (Hickey & Ortega, 1991). It fell off the weapon more frequently and the percentage of trials without failure was much lower (64% versus 94%). Trials without critical failures were also lower (89% versus 97%) than for the previous 200-round magazine evaluated.

6. The 200-round magazines used during the firing exercise were fired from the SAW without failure.

7. Subjects were able to remove and install the 100-round soft pack magazine significantly faster than the 100-round hard pack magazine.

8. Subjects were able to remove and install the magazine positioned on top of the magazine pouch significantly faster than the one at the bottom.

RECOMMENDATIONS

1. The problems associated with misaligned rounds causing weapon stoppages and with linked munitions binding in the magazine should be resolved before these 100-round magazines are fielded.

2. The plastic material used to make the top (dovetail assembly) of the 100-round reusable magazines (soft packs) was very durable. Suggest this material be used for the 100- and 200-round disposable magazines.

3. The failure-to-feed problem associated with resting the 100-round reusable magazine on a sandbag should be further investigated.

REFERENCES

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Hanlon, W.E., Hickey, C.A. Jr., & Ortega, S.V. Jr.(1990). Human engineering laboratory mobility-portability and human factors evaluation of the advanced antitank weapon systems-medium (AAWS-M) candidates (Technical Memorandum 4-90). Aberdeen Proving Ground, MD: U.S. Army Human Engineering Laboratory.

Hickey, C.A. Jr., & Ortega, S.V. Jr. (1991). HEL evaluation of a product-improved (PIP) 200-round magazine for the M249 squad automatic weapon (SAW) (Technical Note 2-91). Aberdeen Proving Ground, MD: U.S. Army Human Engineering Laboratory.

Joint Service Operational Requirement M249 (25 January 1982).

APPENDIX A

VOLUNTEER AGREEMENT AFFIDAVIT

VOLUNTEER AGREEMENT AFFIDAVIT

For use of this form, see AR 70-25; the proponent agency is OTSG

PRIVACY ACT OF 1974

Authority: 10 USC 3013, 44 USC 3101, and 10 USC 1071-1087.

Principle Purpose: To document voluntary participation in the Clinical Investigation and Research Program. SSN and home address will be used for identification and locating purposes.

Routine Uses: The SSN and home address will be used for identification and locating purposes. Information derived from the study will be used to document the study; implementation of medical programs; adjudication of claims; and for the mandatory reporting of medical conditions as required by law. Information may be furnished to Federal, State and local agencies.

Disclosure: The furnishing of your SSN and home address is mandatory and necessary to provide identification and to contact you if future information indicates that your health may be adversely affected. Failure to provide the information may preclude your voluntary participation in this investigational study.

PART A(1) - VOLUNTEER AFFIDAVIT

Volunteer Subjects in Approved Department of the Army Research Studies

Volunteers under the provisions of AR 40-38 and AR 70-25 are authorized all necessary medical care for injury or disease which is the proximate result of their participation in such studies.

I, _____, SSN _____.

having full capacity to consent and having attained my _____ birthday, do hereby volunteer/give consent as legal representative for _____ to participate in HRED Durability Evaluation and Live Firing Exercise for Two 100 Round Assault Packs and A Product Improved 200 Round Magazine for the M249 Squad Automatic Weapon (SAW)

(Research study)

under the direction of Mr. William Hanlon, Charles Hickey, Samson Ortega

conducted at HRED Mobility/Portability Test Facility, Aberdeen Proving Ground, MD

(Name of institution)

The implications of my voluntary participation/consent as legal representative; duration and purpose of the research study; the methods and means by which it is to be conducted; and the inconveniences and hazards that may reasonably be expected have been explained to me by

Mr. William E. Hanlon

I have been given an opportunity to ask questions concerning this investigational study. Any such questions were answered to my full and complete satisfaction. Should any further questions arise concerning my rights/the rights of the person I represent on study-related injury, I may contact

Chief, Patient Administration Branch

at Kirk Army Health Clinic, Aberdeen Proving Ground, MD 21005, (401) 278-2086

(Name, Address and Phone Number of Hospital (Include Area Code))

I understand that I may at any time during the course of this study revoke my consent and withdraw/have the person I represent withdrawn from the study without further penalty or loss of benefits; however, if the person I represent may be required (military volunteer) or requested (civilian volunteer) to undergo certain examination if, in the opinion of the attending physician, such examinations are necessary for my/the person I represent's health and well-being. My/the person I represent's refusal to participate will involve no penalty or loss of benefits to which I am/the person I represent is otherwise entitled.

_____

PART A (2) - ASSENT VOLUNTEER AFFIDAVIT (MINOR CHILD)

I, _____, SSN _____ having full capacity to consent and having attained my _____ birthday, do hereby volunteer for _____ to participate in _____

(Research Study)

under the direction of _____

conducted at _____

(Name of Institution)

(Continue on Reverse)

PART A(2) - ASSENT VOLUNTEER AFFIDAVIT (*MINOR CHILD*) (Cont'd.)

The implications of my voluntary participation; the nature, duration and purpose of the research study; the methods and means by which it is to be conducted; and the inconveniences and hazards that may reasonably be expected have been explained to me by

_____

I have been given an opportunity to ask questions concerning this investigational study. Any such questions were answered to my full and complete satisfaction. Should any further questions arise concerning my rights I may contact

_____

at _____

(Name, Address, and Phone Number of Hospital (Include Area Code))

I understand that I may at any time during the course of this study revoke my assent and withdraw from the study without further penalty or loss of benefits; however, I may be requested to undergo certain examination if, in the opinion of the attending physician, such examinations are necessary for my health and well-being. My refusal to participate will involve no penalty or loss of benefits to which I am otherwise entitled.

_____

PART B - TO BE COMPLETED BY INVESTIGATOR

INSTRUCTIONS FOR ELEMENTS OF INFORMED CONSENT: *(Provide a detailed explanation in accordance with Appendix E, AR 40-38 or AR 70-25.)*

SEE ATTACHED Part B

I do ☐ do not ☐ *(check one & initial)* consent to the inclusion of this form in my outpatient medical treatment record.

SIGNATURE OF VOLUNTEER	DATE	SIGNATURE OF LEGAL GUARDIAN *(If volunteer is a minor)*
PERMANENT ADDRESS OF VOLUNTEER	TYPED NAME OF WITNESS	
	SIGNATURE OF WITNESS	DATE

REVERSE OF DA FORM 5303-R, MAY 88

PART B:

HRED DURABILITY EVALUATION AND LIVE FIRING EXERCISE FOR TWO 100 ROUND ASSAULT PACKS AND A PRODUCT IMPROVED 200 ROUND MAGAZINE FOR THE M249 SQUAD AUTOMATIC WEAPON (SAW)

The objectives of this evaluation are to: (1) determine if the 100 round assault packs and the 200 round magazines stay attached to the SAW during the obstacle course maneuvers; (2) determine if either the 100 round assault packs or the 200 round magazines adversely affects the integrity of the linked munitions or the ease in which the munitions are fed into the weapon; (3) determine if either of the 100 round assault packs or the 200 round magazines affects the ease in which the containers can be attached to or removed from the SAW; (4) identify any human engineering problems observed.

Before the start of this evaluation your medical record will be reviewed to assure that you can participate safely. If you have any leg or back problems, or any other problems that might cause you problems or discomfort, you will not be allowed to participate in this evaluation.

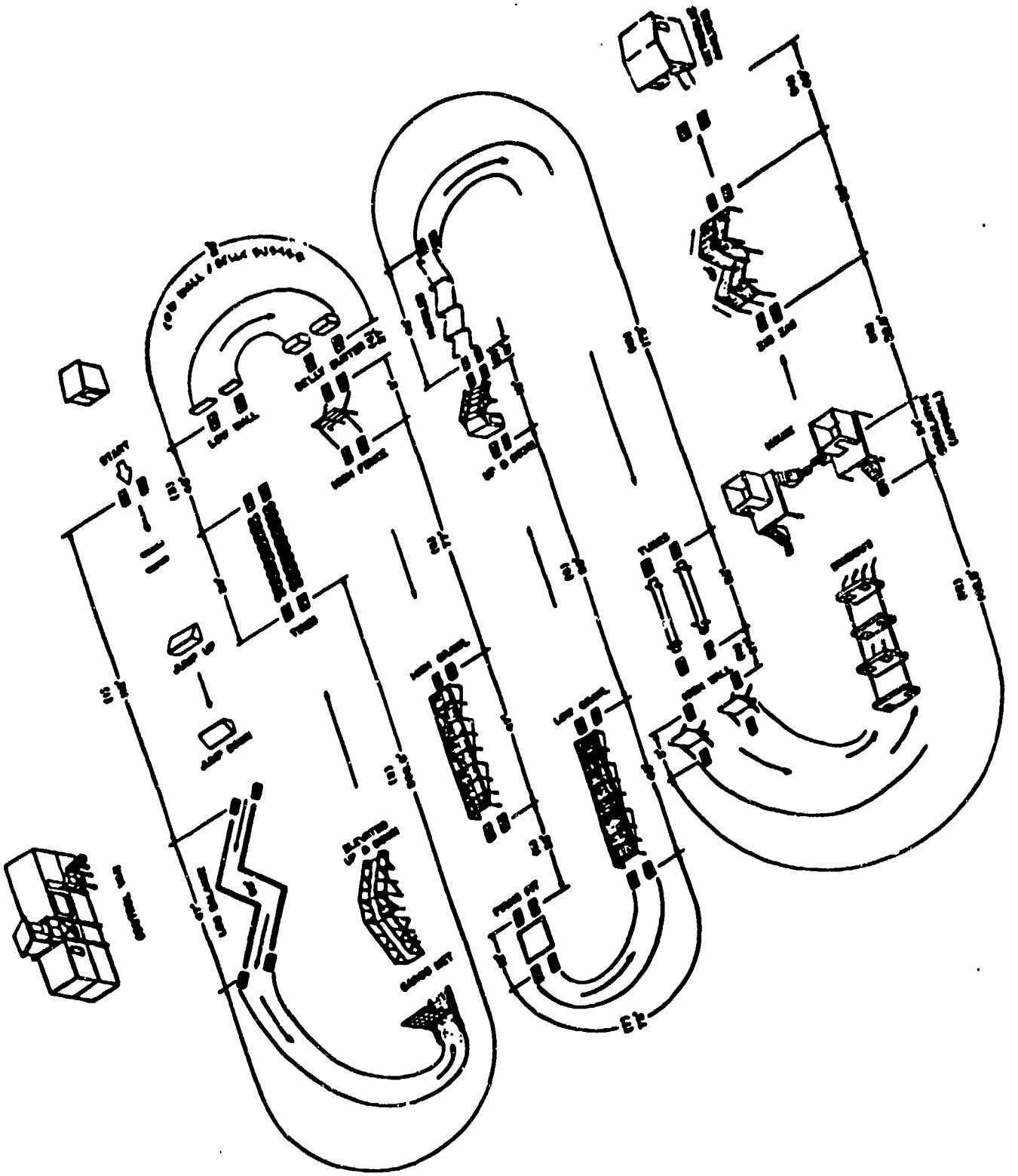
The duration of this evaluation will be two weeks. You will be required to negotiate the obstacle course four times daily during the duration of the test. You will be configured as a SAW gunner. The total weight (including clothing) of the SAW gunner's load configuration will be approximately 54 to 56 pounds. At the completion of each obstacle course trial you will remove and attach the 100 round ammunition container from and to the weapon twice. You will also be asked to participate in a series of container removal and attachment trials where you will remove an empty container from the weapon and replace it with a fully loaded container. This will consist of approximately four time trials for each type container.

You will not be asked to negotiate the obstacle course more than four times per day. If at any time you choose to drop out of this evaluation you may do so without any adverse penalty.

APPENDIX B

HRED OBSTACLE COURSE

HRED OBSTACLE COURSE



HRED. MOBILITY COURSE

APPENDIX C

PHOTOGRAPHS OF 100-ROUND ASSAULT PACKS
AND 200-ROUND MAGAZINE

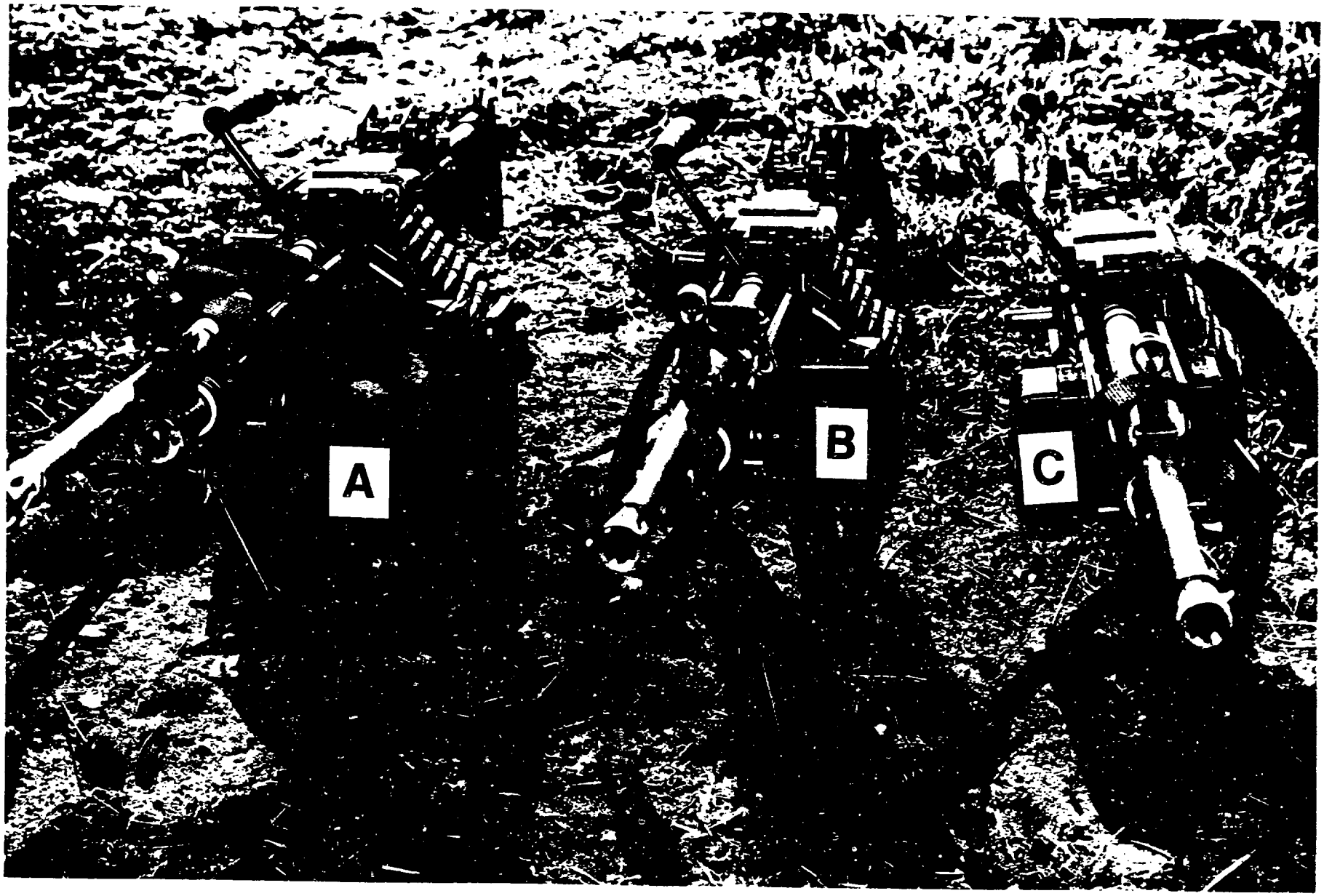


Figure C-1. SAWs with magazines attached: a. PIP b. Soft pack c. Hard pack.

Figure C-2. Rear view of SAWs with magazines attached: a. Hard pack b. Soft pack c. PIP.

APPENDIX D

DURABILITY TEST MATRIX

SAW MATRIX - WEAPON BY MAGAZINE TYPE

TRIAL NUMBERS

SUBJECT#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1A	2B	3C	2C	3A	1B	3B	1C	2A	4A	5B	4C	5A	4B	5C
2	5C	4B	3C	1C	4A	5A	3B	4C	5B	3A	2A	2B	1A	1B	2C
3	5A	2B	3A	1A	2C	5B	1B	2A	5C	1C	4B	4C	3B	3C	4A
4	3C	2A	4C	5C	2B	3A	4A	2C	3B	4B	1A	1B	5A	5B	1C
5	3B	2A	4B	1B	2C	3A	4A	2B	3C	4C	5A	5C	1A	1C	5B
6	3A	4C	1B	5A	4B	3B	1A	4A	3C	1C	2C	2A	5B	5C	2B
7	5B	3A	2B	4C	1B	1A	5A	4B	2C	4A	3C	5C	1C	3B	2A
8	2B	4B	5A	3A	1C	1B	2B	3C	5B	3B	4A	2A	1A	4C	5C
9	1A	4A	4B	1C	5C	5B	2A	2B	3C	3A	2C	1B	4C	3B	5A
10	2C	4A	2B	5B	4C	3C	3B	4B	1C	1B	3A	2A	5C	5A	1A

WPN SN

1
2
3
4
5

MAG TYPE

A - 100 Rd Soft Pack
B - 100 Rd Hard Pack
C - 200 Rd Pip Magazine

MATRIX = Obstacle Course Runs for each Mag Type1

DURABILITY TEST MATRIX

SAW MATRIX - WEAPON BY MAGAZINE TYPE

TRIAL NUMBERS

SUBJECT#	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	3A	4C	1B	5A	4B	3B	1A	4A	3C	1C	2C	2A	5B	5C	2B
2	5B	3A	2B	4C	1B	1A	5A	4B	2C	4A	3C	5C	1C	3B	2A
3	2B	4B	5A	3A	1C	1B	2B	3C	5B	3B	4A	2A	1A	4C	5C
4	1A	4A	4B	1C	5C	5B	2A	2B	3C	3A	2C	1B	4C	3B	5A
5	2C	4A	2B	5B	4C	3C	3B	4B	1C	1B	3A	2A	5C	5A	1A
6	1A	2B	3C	2C	3A	1B	3B	1C	2A	4A	5B	4C	5A	2A	4A
7	5C	4B	3C	1C	4A	5A	3B	4C	5B	3A	2A	2B	1A	5B	3A
8	5A	2B	3A	1A	2C	5B	1B	2A	5C	1C	4B	4C	3B	5C	1C
9	3C	2A	4C	5C	2B	3A	4A	2C	3B	4B	1A	1B	5A	3B	4B
10	3B	2A	4B	1B	2C	3A	4A	2B	3C	4C	5A	5C	1A	3C	4C

WPN SN

1
2
3
4
5

MAG TYPE

A - 100 Rd Soft Pack
B - 100 Rd Hard Pack
C - 200 Rd Pip Magazine

MATRIX = Obstacle Course Runs for each Mag Type

APPENDIX E

CHRONOLOGY OF MAGAZINE SHORTCOMINGS AND FAILURES

CHRONOLOGY OF MAGAZINE SHORTCOMINGS AND FAILURES

SAW Magazine Evaluation - April 1993
Summary of Shortcomings and Failures
for 100-Round Reusable Assault Pack (Soft Assault Pack)

Twenty-five soft assault packs were supplied for this test. Ten soft packs (A1 through A10) were designated as those to be carried on weapons during the durability trials. Each of these assault packs was to be carried on various weapons until it sustained a failure(s) that met the criteria for removal or replacement from this evaluation. Soft packs A1 through A5 were tested until failure. Since none of the original five assault packs met criteria for removal before the end of the evaluation, these five were the only soft packs evaluated on the weapon. Soft packs A16 through A25 were designated as the soft packs carried in the SAW small arms cases attached to the load-carrying equipment belt and carried on the users' bodies. Soft pack magazines A6 through A10 were not evaluated.

The following is a summary of shortcomings and failures that occurred during the obstacle course durability trials:

A1 (26 oc trials)
- Trial 1 - Round 11 misaligned in link
- Trial 3 - Rounds 4 and 5 misaligned in links
- Trial 5 - Rounds 3,4,5, and 8 misaligned in links
- Trial 6 - Round 13 misaligned in link
- Trial 8 - Round 6 misaligned in link
- Trial 9 - Round 12 misaligned in link and complete link separation between rounds 5 and 6 in low crawl
- Trial 12 - Two 1/2-inch holes noted in rear lower side of soft pack. Noted tips of rounds protruding through these holes.
- Trial 26 - New hole noted in bag. Link separation between rounds 11 and 12

A2 (22 oc trials)
- Trial 2 - Round 4 misaligned in link. Zipper tab closure unsnapped and pouch partially open (unzipped)
- Trial 4 - Round 8 misaligned in link.
- Trial 15 - Complete link separations between rounds 6 and 7 and between rounds 16 and 17 (windows)
- Trial 16 - Female portion of snap broke off zipper tab.

A3 (26 oc trials)
- Trial 7 - Round 13 misaligned in link
- Trial 26 - Round 10 misaligned in link

A4 (19 oc trials)
- Trial 3 - Round 4 misaligned in link
- Trial 5 - Round 9 misaligned in link. Complete link separation between rounds 12 and 13.
- Trial 9 - Complete link separation between Rounds 11 and 12
- Trial 10 - Complete link separation between Rounds 7 and 8
- Trial 12 - Round 13 misaligned in link
- Trial 18 - Female portion of snap broke off zipper tab.
- Trial 10 - Round 7 misaligned in link

A5 (20 oc trials)
- Trial 4 - Round 8 misaligned in link
- Trial 6 - Rounds 3 and 5 misaligned in links

Note. No noticeable damage to dovetail rail assembly of the soft assault pack magazines (A1 through A5); only very slight scratching of material - no material deterioration noted. There were no occurrences of a magazine separating and falling off a weapon during any of the oc trials. The soft pack magazines carried in small arms cases of the equipment belt on the subjects' bodies were inspected daily and at the end of the oc durability trials. There were no obvious shortcomings or failures noted on these magazines (A15 through A25).

Firing Trials

The magazines that were carried on the weapons during the oc durability trials were fired. Magazine A5 was the only one that was fired without incident. Magazines A1, A2, and A3 all had failure to feed problems and stopped firing. Investigation of these magazines revealed that misaligned rounds inside the soft pack were snagging on either the plastic ledge on the inside of the magazine or at the opening in the top of the magazine. Magazine A4 failed to feed twice during the firing trial but the cause could not be determined.

Magazines A16 through A25 were carried in small arms cases on the users' bodies during the durability trials. These magazines were all used during the firing trials. Magazine A18 failed to feed and ceased firing twice during the trial. Both of these failures were caused by misaligned rounds hanging inside the bag. The remaining magazines of this group were fired without incident.

Magazines A6 through A15 were also used during the firing trials. Magazines A6 through A12 and A15 were fired without incident. A live round ejected from the weapon and firing stopped when magazine A13 was used. Magazine A14 was fired with the magazine resting on top of a sand bag. This magazine failed to feed because of the weight of the weapon and magazine resting on the sandbag. When the weapon was raised slightly and the weight eased on the sandbag, the weapon fired without incident.

SAW Magazine Evaluation - April 1993
Summary of Shortcomings and Failures
for 100-Round Disposable Assault Packs (Hard Packs)

Twenty-five disposable 100-round assault packs were supplied for this evaluation. Assault packs B1 through B15 were designated to be carried on the weapon during the durability trials. B16 through B25 were the magazines designated to be carried in the SAW small arms cases attached to the equipment belt and carried on the bodies of the users. Assault packs B1 through B15 were tested until failure (met failure criteria for removal) or for 10 oc trials.

The following is a list of shortcomings and failures that occurred during the obstacle course durability trials:

B1 (3 oc trials)
Trial 3 - Complete link separation between Rounds 11 and 12. The remaining rounds (13 through 100) fell back inside hard pack. This magazine was removed because the lid could not be removed to repair.

B2 (3 oc trials)
Trial 1 - Rounds 4, 7, 12, 13, and 16 misaligned in links
Trial 2 - Rounds partially siphoned from box twice during this trial, causing large loop of linked munitions to be exposed. Rounds were fed back into magazine container both times.
Trial 3 - All 100 rounds siphoned from magazine during this trial. Removed magazine from trials because lid requires removal to replace ammunition in hard pack.

B3 (1 oc trial)
Trial 1 - Magazine fell off weapon in hurdles. All 100 rounds siphoned from magazine onto ground. Removed from trials because lid required removal to replace ammunition in magazine.

B4 (7 oc trials)
Trial 2 - Rounds 6 and 7 misaligned in links
Trial 3 - Round 6 misaligned in link
Trial 7 - Magazine struck against window jamb and fell off weapon. The remaining rounds siphoned from magazine. Removed from trials.

B5 (10 oc trials)
Trial 6 - Rounds 5 and 8 misaligned in links
Trial 10 - Magazine removed after this trial because 10 trials the oc were completed.

B6 (10 oc trials)
Trial 6 - Complete link separation between Rounds 13 and 14. Slot in side of magazine that retains tooth clip of plastic cover broke.
Trial 7 - Magazine separated and fell off weapon at high wall. No rounds siphoned or lost because subject caught magazine as it fell off.
Trial 8 - Round 9 misaligned in link.
Trial 9 - Round 6 misaligned in link.

Trial 10 - Round 6 misaligned in link.

B7 (10 oc trials)
Trial 10 - No shortcomings or failures observed during any trial. Removed after 10 successful trials.

B8 (10 oc trials)
Trial 6 - Magazine fell off at windows. Only a few rounds siphoned from magazine.
Trial 7 - Magazine separated and fell off weapon three times--once each at high crawl, tubes and course finish. No siphoning of rounds.
Trial 8 - Magazine reported loose on weapon rail but did not fall off.
Trial 9 - Magazine separated and fell off weapon at high wall.

B9 (10 oc trials)
Trial 5 - Magazine hard to remove during removal and replacement trial conducted after oc.
Trial 8 - Crack in front clip?

E10 (8 oc trials)
Trial 5 - Crack in slotted bracket of magazine the retains tooth clip of magazine cover.
Trial 8 - Magazine separated and fell off weapon in high crawl; complete link separation between rounds 20 and 21.

B11 (10 oc trials)
Trial 6 - Complete link separation between rounds 10 and 11 at high wall.
Trial 8 - Round 10 misaligned in link. Noted crack in retaining clip.

B12 (10 oc trials)
Trial 2 - Round 11 misaligned in clip
Trial 6 - Complete link separation between Rounds 11 and 12 and between Rounds 13 and 14. Also noted link for Round 12 was bent. Replaced clip and repaired linked munitions.
Trial 7 - Round separated and fell off weapon at high wall; rounds partially siphoned from magazine. Also noted Round 12 misaligned in link.
Trial 8 - Complete link separation between Rounds 10 and 11. Toothed clip of cover slide out of bracket; cover was ajar about 1/4 inch at corner where clip slid out.

B13 (7 oc trials)
Trial 6 - Magazine separated from and fell off weapon at windows; approximately 10 rounds siphoned from magazine.
Trial 7 - Link separation between Rounds 4 and 5.

B14 (1 oc trial)
No problems

B16 (Magazine carried in small arms case)
Noted that the retaining bar for the steel spring clip broke away from magazine on one side.

Note. Magazines B13 and B14 were not tested for 10 oc trials because the test concluded.

Firing Trials

Magazines B1 and B2 were not used because of failures that occurred during the oc durability trials.

Magazines B14, B20, and B23 failed to feed (stopped firing) because the top two loops of linked munitions bound together and would not allow the belt to feed. These magazines were removed and the experimenters pulled hard and freed the binding loop of munitions. Once the munitions were pulled free, these magazines were fired without incident.

Magazine B19 stopped firing after about 10 rounds. This was a weapon-related problem and not a magazine failure.

All of the remaining 25 magazines were fired without incident, but magazines B9 and B11 were missing the leading pull tabs.

SAW Magazine Evaluation - April 1993
Summary of Magazine Shortcomings and Deficiencies
for 200-Round Ammunition Containers

Ten each of the latest version 200-round magazines were supplied for testing. These magazines were numbered C1 through C10. The following is a summary of shortcomings and failures that occurred during the obstacle course durability trials:

C1 (10 oc trials)
Trial 10 - Magazine separated and fell off weapon at windows. Excessive damage to dovetail rails.

C2 (10 oc trials)
Trial 08 - Complete link separation between Rounds 11 and 12.

C3 (10 oc trials)
Trial 01 - 8th round misaligned in link.
Trial 02 - Complete link separation between Rounds 15 and 16
Trial 08 - Magazine separated and fell off weapon when Ss got into prone firing position at end of oc.
Trial 10 - Magazine separated and fell off weapon at high wall. All rounds siphoned from magazine onto ground.

C4 (Magazine removed after 9th oc trial)
Trial 01 - 12th round misaligned in link and complete link separation between Rounds 15 and 16 (low crawl).
Trial 02 - Complete link separation between Rounds 6 and 7.
Trial 03 - 5th and 13th round misaligned in links.
Trial 04 - 9th round misaligned in link.
Trial 06 - Link separation between Rounds 11 and 12 (low crawl).
Trial 08 - Magazine separated and fell off weapon when Ss got into prone firing position at end of oc.
Trial 09 - Magazine fell off in low crawl and link separated between Rounds 5 and 6. Repaired and continued oc. Magazine separated and fell off again in hurdles. Removed from test.

C5 (Magazine removed after 4th oc trial)
Trial 01 - Magazine separated from and fell off weapon and all rounds siphoned onto ground at high wall.
Trial 02 - Magazine separated and fell off weapon at start of windows obstacle. Replaced and fell off second time at end of window obstacle.
Trial 04 - Magazine separated and fell off weapon in window obstacle. Removed from study because metal spring retaining tab lost spring tension and appeared twisted.

C6 (10 oc trials)
Trial 03 - Magazine separated and fell off weapon at high wall.
Trial 10 - Magazine separated and fell off weapon when Ss hit prone position at end of oc.

C7 (Removed after 8th trial)
Trial 02 - Magazine separated and fell of weapon at high wall.
Trial 03 - Link separation between Rounds 6 and 7 and 11 and 12. Magazine partially separated from weapon (slide off partially).

Trial 04 - Link separation between Rounds 9 and 10 and 15 and 16.
Trial 07 - Magazine separated and fell off weapon at up and down obstacle. Subject replaced and continued negotiating course. Magazine fell off again at high wall; approximately 100 rounds siphoned from magazine, creating a large loop of ammunition to be exposed.
Trial 08 - Magazine separated and fell off at fence; rounds siphoned onto ground. Subject repaired and continued course - magazine fell off again in high crawl. Removed from test.

C8 (Removed during 6th trial)
Trial 06 - Magazine separated and fell off weapon at belly buster. Noted a crack at the base of dovetail, permitting rail assembly to partially separate from magazine.

C9 (Removed during 1st trial)
Trial 01 - Magazine separated and fell off weapon in low crawl. It was replaced and fell off again in hurdles. Investigation showed there was a crack in the magazine at the base of the dovetail rail.

C10 (10 oc trials)
Trial 03 - Magazine separated and fell off weapon at windows. Noted 13th round misaligned in link at course finish.
Trial 07 - Link separation between Rounds 6 and 7.
Trial 08 - Noted that Rounds 4, 6, and 8 were misaligned in links.

Firing Trials

Magazines C1-C3, C5-C8, and C10

All above magazines had 200 rounds fired without incidents. The other two magazines were not fired because the rounds had siphoned from the magazine earlier during the durability trials and were not available to be used.

APPENDIX F

SUMMARY OF RESULTS FOR FIRST DURABILITY EVALUATION (MAY 1991)

SUMMARY OF RESULTS FOR FIRST DURABILITY EVALUATION
(MAY 1991)

Table F-1

Summary of Magazine Usage and Magazine and Ammunition Failures From Initial Durability Evaluation (May 1991)

	Assault pack (magazine) Soft pack	Hard pack
Total number of trials	67	76
Number of trials conducted in which munitions from the magazine were placed in the weapon	27	29
Number of times the magazine separated from the weapon	2	10
Number of times plastic cover fell off or ajar	NA	21
Number of times ammunition belt (links) completely separated	6	10
Number of times individual rounds noted misaligned in links	5	11
Number of times munitions siphoned completely from magazine	4	2
Number of times munitions partially siphoned from magazine	7	0

Note. A partial siphoning of rounds from the magazine is when an excessive length of linked munitions was exposed, creating a loop between the weapon and the magazine.

APPENDIX G

DATA FOR MAGAZINE REMOVAL AND ATTACHMENT TRIALS

DATA FOR MAGAZINE REMOVAL AND ATTACHMENT TRIALS

Table G-1

Magazine Removal and Installation
(Magazines Stacked in Magazine Pouch)

Subject No.	Magazine Type	Body Location	Magazine Location	Time (seconds) remove/install	Remarks
		Right	Top	8.4	
	Soft	Right	Bottom	8.8	
	pack	Right	Top	8.6	
		Right	Bottom	8.2	
		Left	Top	9.0	
	Soft	Left	Bottom	13.0	
1	pack	Left	Top	8.8	
		Left	Bottom	9.0	
		Right	Top	9.6	
	Hard	Right	Bottom	10.4	
	pack	Right	Top	9.2	
		Right	Bottom	11.0	
		Left	Top	7.0	
	Hard	Left	Bottom	9.0	
	pack	Left	Top	10.0	
		Left	Bottom	11.2	
		Right	Top	10.2	
	Hard	Right	Bottom	11.0	
	pack	Right	Top	9.2	
		Right	Bottom	10.2	
		Right	Top	11.2	
	Soft	Right	Bottom	8.2	
2	pack	Right	Top	7.0	
		Right	Bottom	10.0	
		Left	Top	10.0	
	Hard	Left	Bottom	11.2	
	pack	Left	Top	9.8	
		Left	Bottom	11.0	
		Left	Top	11.0	
	Soft	Left	Bottom	11.2	
	pack	Left	Top	10.0	
		Left	Bottom	8.2	

Table G-1 (Cont'd)

3	Soft pack	Left	Top	5.7	
		Left	Bottom	8.0	
		Left	Top	7.8	
		Left	Bottom	8.4	
	Hard pack	Left	Top	7.0	
		Left	Bottom	10.8	Squeezed magazine pouch to "walk up" magazine
		Left	Top	6.8	
		Left	Bottom	8.2	
	Soft pack	Right	Top	10.2	
		Right	Bottom	10.0	
		Right	Top	10.0	
		Right	Bottom	10.0	
	Hard pack	Right	Top	8.0	
		Right	Bottom	11.0	Rolled on his back for easier magazine access
		Right	Top	7.2	
		Right	Bottom	9.8	
4	Hard pack	Left	Top	5.6	
		Left	Bottom	7.4	Shook up magazine pouch
		Left	Top	6.0	
		Left	Bottom	7.0	
	Hard pack	Right	Top	7.4	
		Right	Bottom	8.4	
		Right	Top	7.0	
		Right	Bottom	7.8	
	Soft pack	Left	Top	7.0	
		Left	Bottom	7.8	
		Left	Top	6.0	
		Left	Bottom	5.0	
	Soft pack	Right	Top	6.0	
		Right	Bottom	5.8	
		Right	Top	6.2	
		Right	Bottom	6.0	

Table G-1 (Cont'd)

		Left	Top	6.0	
	Hard	Left	Bottom	8.6	Shook up magazine pouch
	pack	Left	Top	7.2	
		Left	Bottom	10.2	
		Left	Top	8.0	
	Soft	Left	Bottom	8.2	
5	pack	Left	Top	7.2	
		Left	Bottom	9.0	
		Right	Top	8.0	
	Soft	Right	Bottom	9.8	
	pack	Right	Top	8.0	
		Right	Bottom	10.0	
		Right	Top	7.0	
	Hard	Right	Bottom	14.0	Shook up magazine pouch
	pack	Right	Top	7.0	
		Right	Bottom	11.0	
		Right	Top	8.0	
	Soft	Right	Bottom	8.2	
	pack	Right	Top	6.4	
		Right	Bottom	7.4	
		Right	Top	6.2	
	Hard	Right	Bottom	16.0	Ammo belt pulled out
6	pack	Right	Top	8.0	
		Right	Bottom	18.0	Shook up magazine pouch
		Left	Top	7.2	
	Soft	Left	Bottom	6.2	
	pack	Left	Top	7.0	
		Left	Bottom	7.0	
		Left	Top	5.2	
	Hard	Left	Bottom	7.8	Hung up on magazine pouch
	pack	Left	Top	6.4	
		Left	Bottom	5.6	

Table G-1 (Cont'd)

		Right	Top	7.0	
	Hard	Right	Bottom	8.0	
	pack	Right	Top	8.0	
		Right	Bottom	9.0	Squeezed magazine pouch to "walk up" magazine
		Right	Top	7.2	
	Soft	Right	Bottom	7.2	
7	pack	Right	Top	7.2	
		Right	Bottom	7.8	
		Left	Top	8.0	
	Hard	Left	Bottom	8.0	
	pack	Left	Top	6.2	
		Left	Bottom	8.6	
		Left	Top	6.2	
	Soft	Left	Bottom	7.2	
	pack	Left	Top	7.8	
		Left	Bottom	7.6	
		Left	Top	6.2	
	Soft	Left	Bottom	6.8	
	pack	Left	Top	6.8	
		Left	Bottom	7.0	
		Left	Top	7.0	
	Hard	Left	Bottom	11.0	
8	pack	Left	Top	9.0	
		Left	Bottom	12.0	Shook up magazine pouch
		Right	Top	9.0	
	Hard	Right	Bottom	11.8	
	pack	Right	Top	9.2	
		Right	Bottom	11.0	
		Right	Top	7.0	
	Soft	Right	Bottom	7.2	
	pack	Right	Top	8.0	
		Right	Bottom	7.0	

Table G-1 (Cont'd)

		Right	Top	7.0	
	Hard	Right	Bottom	9.4	
	pack	Right	Top	7.8	
		Right	Bottom	9.2	
		Right	Top	8.0	
	Soft	Right	Bottom	8.2	
9	pack	Right	Top	7.2	
		Right	Bottom	9.8	
		Left	Top	7.0	
	Hard	Left	Bottom	9.8	
	pack	Left	Top	7.8	
		Left	Bottom	9.0	
		Left	Top	7.2	
	Soft	Left	Bottom	7.8	
	pack	Left	Top	6.4	
		Left	Bottom	8.6	
		Left	Top	7.6	
	Hard	Left	Bottom	13.8	Hung up in magazine pouch
	pack	Left	Top	8.0	
		Left	Bottom	12.6	
		Left	Top	8.0	
	Soft	Left	Bottom	9.0	
10	pack	Left	Top	7.0	
		Left	Bottom	9.0	
		Right	Top	7.4	
	Soft	Right	Bottom	7.4	
	pack	Right	Top	6.2	
		Right	Bottom	7.4	
		Right	Top	8.0	
	Hard	Right	Bottom	9.0	
	pack	Right	Top	9.0	
		Right	Bottom	9.0	

Table G-2

Exploratory Magazine Removal and Installation
(Magazines Side by Side in Magazine Pouch)

Subject No.	Magazine Type	Body Location	Magazine Location	Time (seconds) remove/install	
		Left	L side	12.8	
	Soft	Left	R side	11.0	
	pack	Left	L side	13.0	
		Left	R side	11.0	
1					
		Right	L side	13.0	
	Soft	Right	R side	12.8	
	pack	Right	L side	11.2	
		Right	R side	10.0	
		Right	L side	12.4	
	Soft	Right	R side	12.2	
	pack	Right	L side	13.8	
		Right	R side	10.8	
2					
		Left	L side	16.0	Magazine hung up on magazine pouch lip
	Soft	Left	R side	10.2	
	pack	Left	L side	14.0	
		Left	R side	10.0	
		Right	L side	15.2	
	Hard	Right	R side	9.0	
	pack	Right	L side	15.0	
		Right	R side	12.0	
9					
		Left	L side	11.4	
	Hard	Left	R side	9.2	
	pack	Left	L side	10.2	
		Left	R side	10.8	

APPENDIX H

DATA ANALYSIS FOR MAGAZINE REMOVAL AND INSTALLATION

Table H-1. Analysis of Variance for the Magazine Removal and Installation times

Source	SS	df	ms	F	p
subject	122.46	9	13.61		
mag	41.51	1	41.51	11.01	0.009
(mag x subject)	33.92	9	3.77		
b.pos	10.97	1	10.97	1.59	0.239
(b.pos x subject)	61.97	9	6.89		
trial	0.30	1	0.30	0.33	0.589
(trial x subject)	8.12	9	0.90		
mag.pos	91.66	1	91.66	31.48	0.000
(mag.pos x subject)	26.20	9	2.91		
mag x b.pos	5.37	1	5.37	1.42	0.264
(mag x b.pos x subject)	34.06	9	3.78		
mag x trial	1.39	1	1.39	1.09	0.323
(mag x trial x subject)	11.41	9	1.27		
mag x mag.pos	37.35	1	37.35	17.23	0.002
(mag x mag.pos x subject	19.51	9	2.17		
b.pos x trial	0.03	1	0.03	0.07	0.800
(b.pos x trial x subject)	4.38	9	0.49		
b.pos x mag.pos	0.07	1	0.07	0.02	0.904
(b.pos x mag.pos x subject	40.16	9	4.46		
trial x mag.pos	0.66	1	0.66	1.30	0.284
(trial x mag.pos x subject	4.60	9	0.51		
mag x b.pos x trial	0.50	1	0.50	0.28	0.608
(mag x b.pos x trial x subject)	15.80	9	1.76		
mag x b.pos x mag.pos	1.28	1	1.28	0.55	0.479
(mag x b.pos x mag.pos x subject)	21.10	9	2.34		
mag x trial x mag.pos	1.96	1	1.96	2.19	0.173
(mag x trial x mag.pos x subject)	8.04	9	0.89		
b.pos x trial x mag.pos	2.19	1	2.19	2.75	0.132
(b.pos x trial x mag.pos x subject)	7.16	9	0.80		
mag x b.pos x trial x mag.pos	0.83	1	0.47	1.36	0.273
(mag x b.pos x trial x mag.pos x subject)	5.46	9	0.61		

mag = magazine type
b.pos = body position
mag.pos = magazine position