

Research Memorandum 79-2

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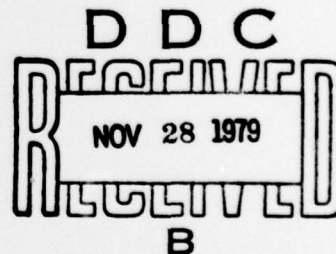
APPLICATION OF LIGHT-ATTENUATING DEVICES (LADs) TO NIGHT RIFLE MARKSMANSHIP TRAINING

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ENGAGEMENT SIMULATION TECHNICAL AREA

AD A 077369

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May 1979

79 11 16 055

Army Project Number

Night Vision

16 2Q162722A765

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14 ARI-RM-79-2

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JOB

APPLICATION OF LIGHT-ATTENUATING DEVICES (LADs) TO NIGHT RIFLE MARKSMANSHIP TRAINING

A 1975 study reported the development of light-attenuating devices (LADs) by the U.S. Army Research Institute (ARI).¹ LADs simulate night illumination levels so that night training and testing can be performed during daylight.

The feasibility of using such devices for aviation and infantry tasks was investigated at Fort Rucker, Ala., and Fort Ord, Calif., respectively. For the aviator tasks, a bidensity lens was used in which the lower part was less attenuating than the upper and thus allowed the pilot to read the instrumentation panel and flight instructions. The results of these preliminary field tests were encouraging, because performances with LADs appeared to be degraded to the same extent as performances during actual night visibility conditions.

This paper reports the results of a series of field tests conducted at Fort Jackson, S.C., that applied LADs to night rifle marksmanship training and testing. This paper also identifies other field evaluations of LADs as applied to different armor and aviation tasks.

Since LADs were designed to simulate various levels of night illumination for training during the day, it was crucial to assess the effects of different degrees of simulated darkness on performance. To simulate these degrees of darkness, LADs use interchangeable light filters that have optical densities approximating the various light levels produced by different phases of the lunar cycle. One purpose of the field tests at Fort Jackson was to determine which optical densities simulated actual night illumination. A second goal was to assess the psychological fidelity of using LADs as a surrogate for night darkness. In this regard, the performance enhancement derived from prior practice with LADs was compared to that obtained from actual night training along two dimensions--immediate transfer and long-term retention.

FIELD TEST RESULTS

Simulation of Moon Phases

Field Test I compared the rifle marksmanship of companies performing under either actual or simulated illumination levels produced by a full, quarter, or new moon. The simulated levels of darkness were

¹Farrell, J. P. Simulating Night Visual Conditions During the Day With Light-Attenuating Filters. Behavior Research Methods and Instrumentation, 1975, 7, 539-541.

created by using different optical densities of LADs. Performance was measured by the percentage of trainees in each company who qualified for record. To qualify for record, trainees had to obtain a total of 10 hits out of 20 trials using targets located 25 m and 50 m away, with at least three of the hits being scored at the greater distance.

Design. Fifteen training companies comprised of males and females participated in the field test, with five companies assigned to each of three phases of the moon cycle (i.e., full, quarter, and new). Each company was divided randomly into five groups. Three groups used LADs with filters that varied so that .03%, .01%, or .005% of daylight illumination was provided to the wearer.² These percentages correspond closely to actual physical illumination levels that have been measured during the full, quarter, and new moon phases, respectively. Two additional groups fired for record under actual nighttime illumination in each of the three phases of the moon. One of these two groups was exposed to targets that had flashing lights to simulate enemy muzzle blasts, whereas the other group did not have such visual cues.

Results. Table 1 shows the percentage of trainees who qualified for record in each of the experimental conditions. The performance of trainees exposed to simulated full and quarter moon illumination did not differ statistically. However, companies using LADs that approximated the new moon phase had a significantly lower percentage of qualifications than did those in the full or quarter moon phases. Thus, the results show a sharp degradation in rifle marksmanship for the trainees who wore the darkest filters as compared to the two lighter ones.

A similar pattern of findings was obtained for trainees who fired at night without the aid of a blinking light on the target. Specifically, trainee performance obtained during the full and quarter moon phases did not differ from one another, but both were higher than those evidenced during the new moon. Thus, the performances obtained under actual moonlight closely paralleled those resulting from the various optical densities of the LADs. In particular, marksmanship was degraded only for trainees who fired for night record under the darkest simulated and actual illumination levels (i.e., .005% and new moon phase). Furthermore, there were no significant differences between the percentages qualifying for record under the three levels of simulated darkness relative to their actual moonlight counterparts. These results validated the comparability of the various optical density LADs and actual moonlight in the specific training environment of the Fort Jackson night-fire range.

² The illumination level of a bright day is about 10^3 (1,000) foot candles (a standard physical measure of illumination). Attenuation by an order of magnitude of $10^{-4.5}$, $10^{-5.0}$, or $10^{-5.3}$ reduces the luminance so that the "apparent" illumination for LAD wearers was either 0.03, 0.01, or .005 of a foot candle, respectively.

Table 1

Rifle Marksmanship Qualifications (%) for LADs Field Test I
(N = 1,523)

Moon phases ^a	Simulated moonlight with LADs	Actual moonlight without target light	Actual moonlight with target light
Full	59	52	53
Quarter	52	60	60
New	37	33	65

^a Full = $10^{-4.5}$, quarter = $10^{-5.0}$, new = $10^{-5.3}$ optical densities.

When flashing lights were used on the targets to simulate enemy muzzle fire, there were no statistically significant differences among the percentages of trainees who qualified for record during the three moon phases. It appeared that the use of flashing lights on the targets eliminated the decline in performance that ordinarily resulted from the reduced illumination of the new moon phase.

Training Transfer

In Field Test II, the immediate training transfer derived from simulated night visibility conditions was compared to transfers resulting from actual night training. An important issue addressed by this test was whether practice with LADs can be substituted for night training without a decrement in subsequent night performance. Moreover, it examined the related question of whether any form of practice (under simulated or actual conditions) will improve night-fire abilities.

Each company was divided randomly into four groups, all of which fired an initial 32 practice rounds during the day using the night rifle fire technique. In two conditions, trainees received additional practice either with LADs during day or at night before being tested during actual darkness. Another group both trained and fired for record under simulated conditions of darkness. In the last condition, trainees did not receive any night practice before being tested for record with the LADs. In this experiment, the visibility levels were maintained at the full and quarter moon phases during actual night training and testing and the quarter moon for LADs (i.e., the .01% filter was used). Also, there were no flashing lights on the targets when trainees tested at night.

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Results. Table 2 shows the mean percentage of trainees who qualified for record in each of the experimental conditions of Test II.

An initial comparison was made between the three groups that fired for record after receiving some form of simulated or actual night practice and the one that did not. This was to determine if the 40 rounds of night training following 32 rounds of day practice (with the night-fire technique) enhanced subsequent performance at night. Analyses revealed that there were no statistically significant differences among the four experimental groups. Thus, it appears that any type of additional night-fire practice under either simulated or actual night illumination levels did not immediately improve marksmanship performance above the level produced by day practice fire.

Long-Term Retention

In addition to immediate training transfer, the Army is concerned with the long-term retention and maintenance of combat skills. Field Test III addressed several important issues related to the retention of marksmanship skills over extended periods. One question was whether night rifle marksmanship skills are retained over time. A related concern was the relative degree of retention according to whether trainees did or did not receive additional night practice; although additional training does not immediately improve performance, it may help to maintain proficiency over an extended period of time. Finally, the field test was designed to assess the comparability of performance retention for trainees who practiced with the LADs relative to performance by those who received actual night practice.

Design. The retention test included only those soldiers who had participated in Field Test II and who still remained at Fort Jackson 2 weeks after their graduation from BCT. This subsample included 130 soldiers out of the original 468 trainees who had participated in Field Test II. About 7 weeks had elapsed between the initial record firing and the retention test. All performers fired 60 rounds for record on the same night during a full moon without the aid of practice fire, target lights, or coaching from instructors.

Results. Table 2 gives the mean percentage of participants in the retention test who qualified for record in each of the experimental groups. Analysis of the results indicated that there was a significant degradation in performance for all groups due to the passage of time. However, this decline was most pronounced for performers who originally had received only 32 rounds of day practice fire without additional night training. Furthermore, trainees who had trained and tested with LADs had maintained the same levels of marksmanship skills as those who had trained and fired for record during actual night.

Table 2

Rifle Marksmanship Qualifications (%) for LADs
Field Tests II and III

Field tests	LADs practice LADs record	Night practice night record	LADs practice night record	No practice LADs record
Immediate transfer (Test II) ^a	80	76	80	73
Retention (Test III) ^b	34	32	20	7

^aBased on a sample of 468 trainees.

^bBased on a subsample of 130 participants.

CONCLUSIONS

The field test ~~at Port Jackson~~ demonstrated that training under either simulated or actual night illumination levels is an essential component of marksmanship training. This is because training under night conditions maintains marksmanship proficiency at a relatively higher level across time than does practicing night rifle techniques only during daylight. Although additional night practice does not immediately influence performance, it does affect long-term retention. In view of the Army's concern with maintaining proficiency over time, it is important to recognize that training either with LADs or during actual night helps to accomplish this goal.

The results of this study show that LADs can be used as an effective substitute or adjunct to training and testing during actual night. This conclusion is based on the similarities in performance of groups that were trained and tested using LADs as compared to those that performed at night. In particular, the comparability in performance between these groups was shown for both immediate training transfer and long-term retention of marksmanship skills. Moreover, the various optical densities of the LADs' filters were found to be effective approximations of the different phases of the moon. This feature of the LADs gives users control over the testing and training situation.

There are many advantages of using simulated rather than actual levels of darkness. In particular, LADs alleviate many safety problems inherent in night training and testing, since individual and group performance is monitored by observers who are in full light. Moreover,

LADs training allows instructors to make more accurate observations, evaluations, and corrective feedback of trainee performance than they can at night. This increased precision could improve training effectiveness. Finally, the use of LADs permits more efficient use of manpower, since time is not wasted waiting for suitable illumination levels to occur.

Manhour Savings

LADs can save manhours in training and testing programs in addition to affording improved safety, evaluative feedback, and scheduling flexibility. The commander of the BCT Committee Group at Fort Jackson, COL Anthony Labrozzi, estimated that over 178,000 manhours would be saved each year by using LADs instead of actual night for rifle marksmanship training. This figure was derived from estimates of the amount of "dead" time that would be eliminated for both the company and the cadre by using LADs. Table 3 gives a more detailed breakdown of this total manhour savings figure according to the personnel involved. These estimates are based on the assumption that about 50,000 men and women will receive 7 weeks of BCT training at Fort Jackson during a given year.

Table 3

Estimated Yearly Savings in Manhours by Using LADs for Night
Rifle Marksmanship Training and Testing

Training	Manhours	Range support	Manhours
Trainees	155,350	Range officer	845
Company commander	845	Instructors	5,070
Executive officer	845	Computer man	845
First sergeant	845	Ammo specialists	1,690
Unit armorer	845	Vehicle dispatcher	845
Drill sergeants	10,140		
Total	168,870		9,295

Source: COL Anthony Labrozzi, Commander, BCT Committee Group, Fort Jackson, S.C.

In the BCT training program, 6 hours is allotted for the instruction, practice, and testing of night rifle marksmanship skills. However, an average of 3 hours usually is spent waiting for suitable levels of darkness to occur before record fire can be conducted. This "dead" time can be as long as 6 hours in summer. By using LADs, the trainees

can fire for record immediately after receiving their instruction and practice. The time saved can be used for other activities designated by the training company commander. Moreover, with LADs the trainees and cadre alike do not have to keep late hours that normally result from having more than one company train on a given night. The manhour savings are readily translated into an estimated financial savings of just under \$500,000. When considering that only 60 sets of LADs, at a cost of \$2,050, were needed to train 50,000 trainees annually, the initial investment is repaid many times over.

Additional Applications of LADs

The potential military applications of LADs are much broader in scope than the night rifle marksmanship application at Fort Jackson. For example, the 1st Training Brigade at Fort Knox, Ky., currently is field testing the feasibility of using LADs to train and test night tank driving and the disassembly/assembly of weapons. It is anticipated that the number of critical incidents that normally occur during night driver training could be reduced by having trainees wear LADs while accompanied by a tank commander/instructor with full vision. Thus, trainees who were negotiating the course could be instructed so as to avoid circumstances that could result in the "deadlining" of vehicles. Moreover, impaired tanks could be retrieved and given routine repair more easily in daylight than at night, thereby reducing maintenance costs in terms of man and equipment hours.

Another application of LADs currently being considered is nap-of-the-earth (NOE) flight training for helicopter pilots. At present, safety considerations preclude the training of inexperienced pilots to fly at treeline altitudes at night. However, the LADs allow the instructing pilot to have unimpaired vision during flight, which makes possible the training of night NOE. These examples represent only a few of the potential applications of LADs in a military context.

ARI is continuing to develop and evaluate the LADs concept. On the basis of current field tests, it appears that LADs could be readily used to train our military units and to help them maintain a high degree of combat readiness. The potential benefits of incorporating LADs into existing or modified training programs is further underscored by the Army's growing awareness of the need for continuous operations under modern warfare conditions. In particular, combat and support functions would be conducted at all times of day and night and, consequently, under all illumination levels. In view of this, combat and support personnel must be trained to rely on reduced visual cues to perform their continuous operation functions successfully. LADs provide a safe, convenient, and cost-effective means for achieving the goal of a thoroughly prepared modern Army.