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U.S. Army Environmental Center

Bullet Trap Feasibility Assessment and Implementation Plan

Evaluation Criteria Report

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April 1996

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SFIM-AEC-ETD
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EVALUATION CRITERIA REPORT

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13. ABSTRACT

The U.S. Army Environmental Center (USAEC) is evaluating the feasibility of using bullet traps on Army small arms ranges. Currently on outdoor ranges, shooters fire small arms into earthen berms or far down range into the soil. This deposits lead and other heavy metals in the soil and may lead to regulatory restrictions that might include closing the ranges. This Evaluation Criteria Report (ECR) reviews the types of ranges most representative of the family of Army ranges suitable for bullet traps. In addition to an extensive literature search, numerous site visits were made to discuss bullet traps with range management professionals, commercial manufacturers, and subject matter experts. This ECR identifies the appropriate criteria to apply in selecting a bullet trap to meet the needs of the range operator without degrading training. Bullet traps may be a feasible solution to mitigate the potential build-up of heavy metals on Army ranges if applied within the limits of the design parameters of the trap and the training environment.

14. SUBJECT TERMS

Bullet Trap, Range, Small Arms, Firing Range, Lead, Shooting, Environment, Backstop, Erosion, Heavy Metals, Inorganics

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DISCLAIMER

This Evaluation Criteria Report represents our best effort to identify criteria than be used to evaluate all commercially available bullet traps and traps capable of being manufactured locally, that can reasonably be used on outdoor small arms ranges. This set of criteria is not presented as exhaustive as local conditions and missions will have a great influence on bullet trap selection.

The views, opinions, and/or findings contained in this report should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation. This report may not be cited for purposes of advertisement.

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EXECUTIVE SUMMARY

A number of Department of Defense small arms ranges have the potential to build-up lead and other metals in soils. In some cases, these inorganics may become mobile and migrate into the surrounding environment. The U. S. Army Environmental Center (USAEC) is seeking ways to reduce the potential for off-site migration of lead and other heavy metals from Army small arms ranges.

Currently the Army fires small arms on a wide variety of ranges to meet training needs. This varies from a narrow cone of fire and short distance on the 25 meter zero range to 300 meters and a more widely dispersed pattern of fire on Field Fire and Record Fire ranges. On ranges where the cone of fire is fairly predictable, based either on target scoring or a clearly defined beaten zone behind the targets, it is reasonable to assume that a large percentage of bullets may be trapped. Evaluation criteria have been developed to assist the range manager in determining which bullet traps will work on what ranges. These criteria address the functional and operational performance parameters that bullet traps must meet to be successfully used on the various types of small arms ranges. The functional criteria look at the trap's physical performance, such as its ability to capture and contain rounds, durability, load-up rate, and maintenance requirements. The operational criteria refer to the trap's effect on training, particularly training realism. Four types of ranges were selected as representative of the majority of most often used ranges in the Army inventory. Development of functional and operational criteria for these four types should cover most variations encountered. The selected ranges and their associated evaluation criteria are summarized in Table ES-1.

There are commercially available bullet traps that appear to be able to capture and contain small arms projectiles of the type used by the Army. These devices may provide a means to help recover and recycle the projectile material, prevent ricochets, and prevent the build up of heavy metals in the soil on the range. Bullet traps would also mitigate the soil erosion experienced on outdoor ranges from the impact of the rounds. Erosion control on the ranges would help prevent

the migration of heavy metals off range and would help reduce the recurring costs of berm rehabilitation on the ranges.

Bullet Trap Evaluation Criteria

	PERFORMANCE						MAINTENANCE				EXPOSURE
RANGE	*Capture rate*	*Ricochet prevention*	*Ammunition*	*Refurbish/ replace*	*Lead leaching*	*Weather*	*Major maintenance cycle*	*Maintain-ability*	*Periodic maintenance*	*Time required*	*PPE required*
25 Meter	98%	Capture all rounds entering the trap	Up to 7.62mm	150,000 rounds +	None	minus 10 deg. F to 120 deg F	15,000 rounds	Range personnel/ Special tools by the vendor	Monthly Semi-annually	2-3 hours 3 days	Respirator and rubber gloves
Automated Field Fire (AFF)	80%	Capture all rounds entering the trap	Up to 7.62mm	100,000 rounds +	None	minus 10 deg. F to 120 deg F	10,000 rounds	Range personnel/ Special tools by the vendor	Monthly Semi-annually	2-3 hours 3 days	Respirator and rubber gloves
Automated Record Fire (ARF)/ Modified Record Fire (MRF)	60%	Capture all rounds entering the trap	Up to 7.62mm	30,000 rounds +	None	minus 10 deg. F to 120 deg F	3,000 rounds	Range personnel/ Special tools by the vendor	Monthly Semi-annually	2-3 hours 3 days	Respirator and rubber gloves
Combat Pistol Qualification Course/ MPFQC	80%	Capture all rounds entering the trap	Military handgun ball ammunition	30,000 rounds +	None	minus 10 deg. F to 120 deg F	3,000 rounds	Range personnel/ Special tools by the vendor	Monthly Semi-annually	2-3 hours 3 days	Respirator and rubber gloves

Bullet Trap Evaluation Criteria

	ENVIRONMENTAL					OPERATIONAL				
RANGE	*Contain-ment*	*Air emissions*	*Runoff water*	*Regulatory concerns*	*Recycle*	*Distract the shooter?*	*Reveal the target?*	*Masking*	*Realism*	*Maintenance Requirements*
25 Meter	All heavy metals	None	Will contain no contaminants	No new concerns	Trap materials and lead	No	N/A	N/A	N/A	Only minor changes
Automated Field Fire (AFF)	All heavy metals	None	Will contain no contaminants	No new concerns	Trap materials and lead	No	N/A	No	N/A	Only minor changes
Automated Record Fire (ARF)/ Modified Record Fire (MRF)	All heavy metals	None	Will contain no contaminants	No new concerns	Trap materials and lead	No	No	No	Must not affect realism	Only minor changes
Combat Pistol Qualification Course/ MPFQC	All heavy metals	None	Will contain no contaminants	No new concerns	Trap materials and lead	No	N/A	No	N/A	Only minor changes

SECTION 1

INTRODUCTION

1.0 INTRODUCTION

This report describes the study of various types of training missions and their associated range designs. It details the development of the functional and mission specific operational evaluation criteria that will be applied to the bullet trap technologies to guide the Army's evaluation and selection of existing bullet traps for outdoor small arms ranges. The evaluation criteria will serve as the basic design objectives to support modification of existing bullet traps or the development of new ones for use on Army small arms ranges.

1.1 BACKGROUND

Numerous Department of Defense (DOD) small arms ranges have the potential to build up lead and other metals in soils. In some cases, those inorganics may become mobile and migrate to the surrounding environment. The Army currently operates approximately 1400 outdoor small arms ranges in the Continental U.S. (CONUS). The Navy operates approximately 270 outdoor small arms ranges (including Marine Corps ranges), and the Air Force, approximately 200. The U.S. Army Environmental Center (USAEC) is seeking ways to reduce the potential for off-site migration of lead and other heavy metals.

An effective technology for destroying lead and heavy metals deposited in soil does not exist. Techniques, such as bullet traps, that limit the volume of heavy metals deposited in the soil will provide significant cost avoidance should these sites require some type of response action.

There are commercially available bullet traps that appear to be able to capture and contain small arms projectiles of the type used by the Army. These devices may provide a means to help recover and recycle the projectile material, eliminate ricochets, and prevent the build-up of heavy metals in the soil on the range. Bullet traps would also mitigate the soil erosion experienced on

outdoor ranges from the impact of the rounds. Erosion control on the ranges would help prevent the migration of heavy metals off range and would help reduce the recurring costs of berm rehabilitation on the ranges.

This report is a component of an overall project to assess the feasibility of using bullet traps on Army small arms ranges. In the course of this project, a number of tasks were performed to allow the development of evaluation criteria by which bullet traps could be judged. Those tasks included:

- Identifying and describing commercially available bullet trap designs. This task is documented in the Technology Identification Report, SFIM-AEC-ET-CR-96005.

- Studying the various types of training missions and their associated range designs. Developing functional and operational criteria for various range designs.

- Assessing the feasibility of using each of the bullet trap designs previously identified. The bullet trap designs will be evaluated using the functional and operational evaluation criteria. Bullet trap designs will be identified that can be installed on specific range types without compromising the realism necessary for effective training. Possible design modifications to existing designs will be identified to allow bullet traps to be incorporated into ranges without impacting training objectives. The specific range types for which there are no feasible commercial bullet traps available will be identified. Possible methods of capturing the rounds for recycling in these cases will be identified and discussed for possible future study.

- Development of an implementation guidance document that integrates feasible bullet trap technology with training doctrine.

1.2 OBJECTIVES

This report describes the various types of training missions and their associated range designs and develops functional and operational evaluation criteria for various range designs. The evaluation criteria will serve as the basic design objectives to support the modification of existing bullet traps or the development of new bullet trap technologies for use on Army ranges. The overall objective of this Subtask Order is to assess the feasibility of using bullet traps on Army outdoor small arms ranges and to develop implementation guidance for the use of bullet traps on various types of outdoor training ranges.

The objectives of this report are to:

- identify and explain the process used to select the evaluation criteria for bullet trap use on Army small arms ranges

- describe how the four representative range types were chosen and what criteria were applied to their selection

- explain the criteria, both functional and operational, and how they are relevant to each of the four major types of ranges selected for study.

- provide guidelines for evaluation and selection of bullet traps for use on specific Army small arms range types

SECTION 2

RANGE DESIGN SELECTION FOR BULLET TRAP EVALUATION

2.1 BACKGROUND

At least 29 different range designs are currently in use to accommodate an even wider array of operational scenarios. Of these ranges, 14 are specifically designed for small arms training. The ranges are identified as follows:

- 25 meter
- Automated Field Fire (AFF)
- Automated Record Fire (ARF)
- Modified Record Fire (MRF)
- Infantry Squad Battle Course (ISBC)
- Infantry Platoon Battle Course (IPBC)
- Multi-purpose Training Range (MPTR)
- Multi-purpose Range Complex (MPRC)
- Combat Pistol Qualification Course (CPQC)
- Military Police Firearms Qualification Course (MPFQC)
- Sniper Field Fire
- Machine Gun 10 meter
- Multi-purpose Machine Gun Range (MPMR)
- Military Operations on Urbanized Terrain (MOUT) Assault Course (MAC)

Small arms training may be conducted on other types of ranges, however, the great preponderance of training is conducted on these 14. The types of training which produce the greatest number of rounds fired on these ranges are:

- Marksmanship instruction
- Weapon zero
- Sustainment/Practice
- Qualification/Record firing
- Army Training and Evaluation Program (ARTEP) Live-Fire Exercise (LFX)
- Combined Arms Live-Fire Exercise (CALFEX)

To provide a basis for the development of evaluation criteria, the various types of training missions and range designs were studied to select the operation and range design scenarios that best represent the full spectrum of Army ranges and operational scenarios.

2.2 METHODOLOGY

Investigation of training range design and use included both a review of range standards and visits to Army training installations to conduct interviews and observe training evolutions. Interviews were conducted with range managers, trainers, troop commanders, and troops, as well as Army Training Support Center (ATSC) and Training and Doctrine Command (TRADOC) representatives.

Army Training Circular 25-8 provides the basic design requirements for the various Army training ranges. However, the site visits conducted showed that a number of factors dictated modifications to individual ranges. These factors include:

- Topography - accommodating the range and target locations to the layout of the land
- Soil Characteristics - stability, color, and density of the local soil
- Hydrology - depth at which water was encountered, proximity of streams and lakes
- Vegetation - density, type, and abundance, or lack thereof
- Man-made obstacles - structures, roads, power lines, or other factors which restrict the extent of the range or the types of ammunition which can be used

Site specific terrain features must be incorporated into range designs in order to minimize costs, ensure target visibility, and meet training requirements. All of the ranges visited demonstrated this accommodation to one degree or another, but the differences were most noticeable on Record and Field Fire ranges. Standardization of bullet trap designs for use on those ranges may be difficult because of target placement dictated by terrain features. For example, at one range, the topography of the range was such that one target had to be placed on a 30 foot tower in order to be visible from the firing line.

Investigation of training range designs and use included a review of the range standards, visits to training installations, and interviews with range managers, trainers, troop commanders and troops, and TRADOC representatives. Site visits attempted to study the most heavily used facilities by type, as well as a wide variety of ranges. Installations selected for study included both troop (FORSCOM) and training (TRADOC) installations. Additionally, an attempt was made to include a variety of climactic and soil types in the study. Training Circular 25-8 provides the basic design requirements for Army ranges. However, site visits showed that climate, terrain, and available space dictated significant modifications, in some cases, to range designs. Regardless of design modifications, though, the functions of the various ranges remained constant.

A number of installations were visited where live fire training was observed and interviews were conducted. Trip reports from these visits are included in Section 5. The TRADOC and FORSCOM installations visited included:

Ft. Hood, TX
Ft. Jackson, SC
Ft. Knox, KY
Ft. Benning, GA
Ft. Drum, NY
Ft. Pickett, VA
Ft. Sill, OK
Ft. Leonard Wood, MO

The major concerns expressed during the course of the interviews were that:

- The bullet traps not impact the effectiveness of training by distracting the shooter or revealing the location of the target, which would impact training realism,
- The bullet traps should improve training realism by eliminating the soil erosion caused by the bullet impact,
- The bullet traps should not conceal target arrays or in any way affect the line of sight to the targets on the ranges,
- The bullet trap's maintenance cycles must fall within the current normal range maintenance cycles,
- The bullet traps not be labor intensive, and
- the bullet traps not generate a waste stream that will be difficult to dispose of.

Site visits attempted to study the most heavily used ranges by type as well as a wide variety of ranges. Installations selected for study included both troop (FORSCOM) and training (TRADOC) installations. Additionally, an attempt was made to include a variety of climatic and terrain conditions in the study. Among the range designs visited were:

- 25 meter
- Combat Pistol Qualification Course (CPQC)/Military Police Firearms Qualification Course (MPFQC)
- Automated Field Fire (AFF)
- Automated Record Fire (ARF)
- Modified Record Fire (MRF)
- Machine Gun 10 meter
- Military Operations on Urbanized Terrain (MOUT) Assault Course (MAC)

2.2.1 25 Meter

This range is used to achieve a properly sighted-in rifle and for familiarization firing with a variety of firearms. Targets are mounted in fixed wooden frames and are always visible. This range is used to teach soldiers how to shoot groups that can be used to evaluate the sight setting on their

rifles, and to adjust the sights on the rifle to achieve a battle sight setting. An average of 30 rounds are fired during these two events. (Figure 6-1).

2.2.2 Combat Pistol Qualification Course/Military Police Firearms Qualification Course (CPQC/MPFQC)

This is a dual purpose pistol range that employs pop up silhouette targets. The targets are fired at from a fixed position (CPQC), and by advancing up a center lane and firing behind barriers (MPFQC) (Figure 6-2). The purpose of the range is to teach the soldier how to engage targets with the personal sidearm. Because the distances to the targets are short compared to the rifle ranges, target detection is not as important a factor as is rapid acquisition and engagement of the target.

2.2.3 Automated Field Fire

This range has pop-up targets at three ranges: 75, 175, and 300 meters. Its purpose is to transition the soldier from the fixed paper targets and short distances of the 25 meter zero range to reactive targets (these targets fall over when hit) at longer, varying distances. The soldier learns to adjust his point of aim to compensate for the different distances. A variation on this range is the LOcation, Miss And Hit (LOMAH) range. Targets are at the same locations as the Field Fire range, but each target has a sensor array in front of it which detects the passage of the bullet, whether the bullet hits or misses the target. That information is relayed to a video terminal located at each firing point and provides immediate feedback to the soldier where his rounds are going and how consistently he is shooting. The number of rounds fired per target is the same for both the LOMAH and the Field Fire ranges. 10 rounds are fired at the 75 meter target, 20 rounds at 175 meters, and 10 rounds at 300 meters. (Figure 6-3)

2.2.4 Automated/Modified Record Fire

This is the range where the soldier fires for record (qualifies for a marksmanship rating, such as marksman, sharpshooter, or expert). It is equipped with pop-up targets at six different distances. Unlike the Field Fire range, where the target distances and locations are known, there is an attempt to blend the targets into the natural terrain. This requires the shooter to detect one or two targets when they are exposed, estimate the range(s), aim, and hit the exposed targets in a finite period of time. A total of 40 rounds is fired with 23 hits being required as the minimum to qualify. (Figure 6-4, 6-5).

2.2.5 10 Meter Machine Gun Range

This range uses reduced scale paper target panels to test the gunner and crew's ability to use the traverse and elevation mechanism to control distribution of fire in tightly grouped patterns. The short range allows efficient scoring of the hits and diagnosis of gunner errors (Figure 6-6).

2.2.6 MOUT Assault Compound

This is a live fire individual and unit training facility designed to simulate combat in an urban environment. It consists of mock buildings with pop-up targets in fixed locations that train the unit to operate as a team while clearing buildings. This facility allows the use of rifle, pistol, and Squad Automatic Weapons (Figure 6-7).

2.3 REPRESENTATIVE RANGE DESIGNS

Site visits attempted to study the most heavily used facilities by type, as well as a wide variety of ranges. Installations selected for study included both troop (FORSCOM) and training (TRADOC) installations. Additionally, an attempt was made to include a variety of climatic and terrain conditions in the study. Of the 14 different types of small arms ranges, four were considered to have the heaviest usage and to have characteristics among them that would be

present on most of the other ranges. Although the Army range standards are published in Training Circular 25-8, the realities of climate, terrain, and available space dictate some modification to range design. As a result, no two ranges in the Army are identical. Those differences are most noticeable on record and field fire ranges. The differences are least on 25 meter ranges.

Development of standard evaluation criteria or performance standards is necessary in order to accurately determine which, if any, bullet traps will function effectively on Army outdoor ranges. These criteria will differ depending on the type of range on which the bullet trap may be used. Based on the criteria of heaviest use, widest applicability throughout the Army, and high probability of bullet capture by the trap, four types of ranges are considered the most likely candidates for successful bullet trap integration. These ranges were selected for intensive study and evaluation for potential bullet trap use. The four range designs selected are:

2.3.1 25 Meter

The 25 meter range, with its variety of uses for instructional fire, zero, familiarization, and other training, is universally applicable throughout Army installations. Virtually every installation has a 25 meter range and it is the most heavily used of the small arms ranges. Bullet traps are considered to be most applicable to this type of range because the concentrated area and large volume of fire on this range presents the highest probability of capturing rounds. The large backstop type application of bullet traps is also the application for which most bullet traps are designed.

2.3.2 Automated Field Fire

The automated field fire (AFF) range receives heavy usage throughout the Army for sustainment, practice, and record fire training events. Bullets impact on this type range are primarily concentrated around target emplacements. The visible installation of bullet traps on the AFF

range would not adversely affect the types of training conducted on this range. This range is found on virtually all TRADOC installations and most FORSCOM installations.

2.3.3 Automated/Modified Record Fire

The record fire range is the is the standard qualification course on which each soldier must qualify yearly. This range is second only to the 25 meter range is frequency of use. Bullet impacts are concentrated around the target emplacements which are located on the range at 50 meter intervals up to 300 meters. The qualification training conducted on this range focuses on target acquisition and marksmanship. Bullet traps deployed on this type of range must be capable of being camouflaged or designed to pop up with the target in a manner that does not make target acquisition easier.

2.3.4 Combat Pistol Qualification Course/Military Police Firearms Qualification Course (CPQC/MPFQC)

This range is the standard handgun qualification course. It consists of 7 targets at varying ranges from 10 meters to 31 meters. Given the concentration of fire in the small area of the range, the problems encountered by the angle of fire (shooting from standing position instead of prone as on the rifle ranges) causing impacts on the target berms behind the one being fired at, and the fact that target locations are already known, make this a good application for bullet traps. It provides a study opportunity for handgun round performance and is amenable to the installation of bullet traps, both at each target, and at the terminus of the range.

SECTION 3

TECHNOLOGY EVALUATION CRITERIA FORMULATION

3.1 BACKGROUND

In order to evaluate each of the bullet trap designs, objective criteria needed to be selected. These criteria fell into two categories, functional, meaning the physical performance of the trap measured by how well it captures and retains the bullet, and operational, or the impact the trap has on training and maintenance. It is conceivable that a bullet trap could perform well in one category and not in the other.

3.2 FUNCTIONAL EVALUATION CRITERIA

Functional criteria address the actual operation of the trap itself. In other words, does it capture bullets effectively and reliably? Functional evaluation criteria identified include:

3.2.1 25 Meter Range

3.2.1.1 Installation

- Site preparation requirements: Some site preparation is acceptable and may include providing a level base, which can include grading of soil, an impermeable membrane, gravel foundation, and/or concrete pad. Some traps require electric power for vacuum systems, bullet recovery, or lubricant pumps.

- Personnel installation requirements: If range personnel are required to install the trap, they should be able to install it in a period acceptable to the range manager. At some installations, this could be as little as two days while at others, two weeks or more is acceptable. The other option is to have it installed by the vendor. Special tools should not be required for range personnel, but may be supplied by the vendor.

3.2.1.2 Performance

- 98 percent of rounds captured. Almost all rounds pass through the target and in a very small area compared to the longer ranges. There are occasional mishaps, but those are quite rare. This figure should be achievable, and probably can be exceeded without much effort.

- The trap must capture and retain every round entering it and not allow ricochets.

- All standard military small arms ball ammunition, with the exception of .50 caliber, must be handled successfully. All types of small arms are fired on this range, either for zero or for familiarization.

- The trap must capture 150,000 rounds before requiring major refurbishment or replacement. This provides approximately a 5 year life-cycle for the trap on this range. This number was calculated by assuming a high volume range with 250 training days per year and 4 shooters per firing lane per day. Each shooter is assumed to fire 30 rounds. Not all installations will achieve this volume of fire, but many will come close. Major refurbishment is defined as that maintenance required to allow the trap to be safely used, such as replacement of initial impact plates in deceleration type traps.

- The trap must operate in the wide range of climates and weather conditions found in the family of Army ranges, including a temperature range of 10° F to 120° F and 5 to 100% humidity.

3.2.1.3 Maintenance

- A preliminary goal is that 15,000 rounds must be captured before major maintenance is required. This equates to approximately 6 months of firing and matches existing maintenance schedules.

- The trap must be maintainable with currently assigned range personnel and tools.

- Periodic maintenance will be no more frequently than monthly and will not require major maintenance more than semi-annually, in keeping with current range maintenance practices.

- Periodic maintenance will require no more than 2-3 hours; semi-annual maintenance will require closing the range for no more than 3 days. These times are in keeping with current range practices.

3.2.1.4 Exposure

- Operational exposure for range personnel and users will not exceed limits currently experienced.

3.2.1.5 Environmental

- Leaching of heavy metals or emission of heavy metals vapors or dust is not acceptable.

- There will be no hazardous air emissions associated with using or maintaining the trap.

- Runoff water from the trap will not contain heavy metals or other objectionable constituents.

- Trap materials and spent rounds will be recyclable.

3.2.2 Automated Field Fire Range

3.2.2.1 Installation

- Site preparation requirements: Some site preparation is acceptable and may include providing a level base, which can include grading of soil, an impermeable membrane, gravel foundation, and/or concrete pad. Some traps require electric power for vacuum

systems, bullet recovery, or lubricant pumps. Since the targets are scattered over a wide area, vacuum systems and lubricant reservoirs requiring electric power will cause some maintenance problems, particularly the vacuum systems. Anything that can be damaged by a bullet will be hit. This is Murphy's law of rifle ranges.

- Personnel installation requirements: If range personnel are required to install the trap, they should be able to install it in a period acceptable to the range manager. At some installations, this could be as little as two days while at others, two weeks or more is acceptable. The other option is to have it installed by the vendor. Special tools should not be required for range personnel, but may be supplied by the vendor.

3.2.2.2 Performance

- 80 percent of rounds captured. Trainers estimate that only three of the ten rounds fired at the 300 meter target hit, but more are within a foot or two. The misses at this range generally are in the dirt below the target, caused by the soldier not aiming high enough on the target to compensate for the increased range. A trap behind the target and a smaller one in front could catch these rounds. An estimated 60 percent of the rounds (12 out of 20) fired at the 175 meter target hit with more than 90 percent within a foot or two. Most misses at the 175 meter target are wide, caused by jerking the trigger, since this range is very close to that for which the rifle is set during the zero process. No additional compensation is needed, as in the case of the 300 meter target. A slightly wider bullet trap should capture at least 18 of the 20 rounds fired at this target. The 75 meter target is hit by an estimated 7 out of ten rounds, with most of the rest of the rounds being very close. Almost all of the round fired at this target should be captured by a trap.

- The trap must capture and retain every round entering it and not allow ricochets.

- Generally only 5.56mm ammunition is fired on this range. It is possible that 7.62 could be fired though, so the bullet trap needs to have that capability.

- The trap must capture 100,000 rounds before requiring major refurbishment or replacement. Although the 175 meter target receives twice as many rounds fired on it at the 75 meter or the 300 meter, the additional problems introduced by having different bullet traps with different life-cycles and maintenance schedules are not worth the trade-off. This provides approximately a 5 year life-cycle for the trap on this range. This figure was reached by assuming 250 training days per year and 4 shooters per lane per day, each firing 20 rounds at the 175 meter target for a worst case. Major refurbishment is defined as that maintenance required to allow the trap to be safely used, such as replacement of initial impact plates in deceleration type traps.

- The trap must operate in the wide range of climates and weather conditions found in the family of Army ranges, including a temperature range of 10° F to 120° F and 5 to 100% humidity.

3.2.2.3 Maintenance

- A preliminary goal is that 10,000 rounds must be captured before major maintenance is required. This equates to approximately 6 months of firing and matches existing maintenance schedules.

- The trap must be maintainable with currently assigned range personnel and tools.

- Periodic maintenance will be no more frequently than monthly and will not require major maintenance more than semi-annually, in keeping with current range maintenance practices.

- Periodic maintenance will require no more than 2-3 hours; semi-annual maintenance will require closing the range for no more than 3 days.

3.2.2.4 Exposure

- Operational exposure for range personnel and users will not exceed limits currently experienced.

3.2.2.5 Environmental

- Leaching of heavy metals or emission of heavy metals vapors or dust is not acceptable.

- There will be no hazardous air emissions associated with using or maintaining the trap.

- Runoff water from the trap will not contain heavy metals or other objectionable constituents.

- Trap materials and spent rounds will be recyclable.

3.2.3 Automated/Modified Record Fire Range

3.2.3.1 Installation

- Site preparation requirements: Some site preparation is acceptable and may include providing a level base, which can include grading of soil, an impermeable membrane, gravel foundation, and/or concrete pad. Some traps require electric power for vacuum systems, bullet recovery, or lubricant pumps.

- Personnel installation requirements: If range personnel are required to install the trap, they should be able to install it in a period acceptable to the range manager. At some installations, this could be as little as two days while at others, two weeks or more is

acceptable. The other option is to have it installed by the vendor. Special tools should not be required for range personnel, but may be supplied by the vendor.

3.2.3.2 Performance

- 60 percent of rounds captured. A total of 40 rounds for record is fired on this range. Targets appear at 50 meter increments from 50 (2 targets, one left and one right) to 300 meters. 23 hits are needed to qualify. Since the attempt here is to inject some realism into the process, bullet traps will need to be as unobtrusive as possible and will be smaller than for comparable range targets on the field fire range. An assumption was made that 24 out of the 40 rounds fired, on average across all shooters, could be caught by bullet traps without adversely impacting training. This results in the lower percentage. In reality, many more may pass close enough to the target to trapped, but there are no data for record fire ranges to confirm that.

- The trap must capture and retain every round entering it and not allow ricochets.

- All standard 5.56mm military ball ammunition must be handled successfully.

- The trap must capture 30,000 rounds before requiring major refurbishment or replacement. This provides approximately a 5 year life-cycle for the trap on this range. This number was reached by assuming 250 training days per year and 4 shooters per lane per day. Each shooter will fire 40 rounds total, but that total is divided among 7 targets. The assumption was also made that 6 rounds would be the maximum fired at any one target. Major refurbishment is defined as that maintenance required to allow the trap to be safely used, such as replacement of initial impact plates in deceleration type traps.
- The trap must operate in the wide range of climates and weather conditions found in the family of Army ranges, including a temperature range of 10° F to 120° F and 5 to 100% humidity.

3.2.3.3 Maintenance

- A preliminary goal is that 3,000 rounds must be captured before major maintenance is required. This equates to approximately 6 months of firing and matches existing maintenance schedules.

- The trap must be maintainable with currently assigned range personnel and tools.

- Periodic maintenance will be no more frequently than monthly and will not require major maintenance more than semi-annually, in keeping with current range maintenance practices.

- Periodic maintenance will require no more than 2-3 hours; semi-annual maintenance will require closing the range for no more than 3 days.

3.2.3.4 Exposure

- Operational exposure for range personnel and users will not exceed limits currently experienced.

3.2.3.5 Environmental

- Leaching of heavy metals or emission of heavy metals vapors or dust is not acceptable.

- There will be no hazardous air emissions associated with using or maintaining the trap.

- Runoff water from the trap will not contain heavy metals or other objectionable constituents.

- Trap materials and spent rounds will be recyclable.

3.2.4 Combat Pistol Qualification Course/Military Police Firearms Qualification Course

3.2.4.1 Installation

- Site preparation requirements: Some site preparation is acceptable and may include providing a level base, which can include grading of soil, an impermeable membrane, gravel foundation, and/or concrete pad. Some traps require electric power for vacuum systems, bullet recovery, or lubricant pumps.

- Personnel installation requirements: If range personnel are required to install the trap, they should be able to install it in a period acceptable to the range manager. At some installations, this could be as little as two days while at others, two weeks or more is acceptable. The other option is to have it installed by the vendor. Special tools should not be required for range personnel, but may be supplied by the vendor.

3.2.4.2 Performance

- 80 percent of rounds captured. Although shooting is done with a handgun, the distances to the targets is correspondingly closer. Consequently, most rounds hit the target. Since revealing target location is not a critical factor, bullet traps in front of and behind the targets should easily capture this percentage of rounds. A bank of traps at the back of the range in place of a berm should capture most strays.

- The trap must capture and retain every round entering it and not allow ricochets.

- All standard military handgun ball ammunition must be handled successfully.

- The trap must capture 30,000 rounds before requiring major refurbishment or replacement. This provides approximately a 5 year life-cycle for the trap on this range. It was assumed that there were 250 training days with 4 shooters per lane per day.

Each shooter fires 40 rounds, divided among 7 targets. We assumed a maximum of 6 rounds fired at any one target per shooter

- The trap must operate in the wide range of climates and weather conditions found in the family of Army ranges, including a temperature range of 10° F to 120° F and 5 to 100% humidity.

3.2.4.3 Maintenance

- A preliminary goal is that 3,000 rounds must be captured before major maintenance is required. This equates to approximately 6 months of firing and matches existing maintenance schedules.

- The trap must be maintainable with currently assigned range personnel and tools.

- Periodic maintenance will be no more frequently than monthly and will not require major maintenance more than semi-annually, in keeping with current range maintenance practices.

- Periodic maintenance will require no more than 2-3 hours; semi-annual maintenance will require closing the range for no more than 3 days.

3.2.4.4 Exposure

- Operational exposure for range personnel and users will not exceed limits currently experienced.

3.2.4.5 Environmental

- Leaching of heavy metals or emission of heavy metals vapors or dust is not acceptable.

- There will be no hazardous air emissions associated with using or maintaining the trap.

- Runoff water from the trap will not contain heavy metals or other objectionable constituents.

- Trap materials and spent rounds will be recyclable.

3.3 OPERATIONAL EVALUATION CRITERIA

Operational criteria address the effect of the trap on the training mission. The trap could function perfectly, capture every bullet that came near it, last forever, never need maintenance, and still be unsatisfactory from an operational viewpoint. The operational criteria will vary for each type of range, but generally include:

- The trap should not create a distraction to the shooter. Its color, shape, and other characteristics should not impinge on the shooter's ability to concentrate on the fundamentals of marksmanship.

- The trap should not reveal the location of the target.

- The trap must not adversely impact the effectiveness or realism of training.

- The trap cannot mask any other target downrange.

- Range personnel should experience only minor changes in maintenance operating procedures.

3.3.1 25 Meter Range

- **The trap should not create a distraction to the shooter. Its color, shape, and other characteristics should not impinge on the shooter's ability to concentrate on the fundamentals of marksmanship.** - Since most shooters at basic training installations are experiencing Army ranges for the first time, anything that is on the range when they arrive will be considered normal and the probability of distracting the shooter will be low. At FORSCOM installations, this criterion may be a factor because shooters will not be used to bullet traps on the range. However, if the trap is not unduly intrusive, have a distracting color or shape, or some other distracting factor, shooters will adapt readily. It is a factor that should be considered in the selection of a specific bullet trap design for this range.

- **The trap should not reveal the location of the target.** - The 25 meter range is designed to have targets always visible at a known location and distance. This criterion should not be a factor.

- **The trap must not adversely impact the effectiveness or realism of training. -** Realism is not a factor on the 25 meter range. The purpose of the range is to provide visible targets at a known location and distance that are used to obtain a grouping of shots for a zero on the weapon. This criterion should not be a factor.

- **The trap cannot mask any other target downrange.** - Only one bank of targets is on a 25 meter range. Therefore, there are no targets downrange that bullet traps could mask. Placement of the bullet traps is flexible depending upon the desires of the range manager, the amount of space available, and the needs of the trainers. This criterion should not be a factor.

- **Range personnel should experience only minor changes in maintenance requirements.**

3.3.2 Automated Field Fire Range

- **The trap should not create a distraction to the shooter. Its color, shape, and other characteristics should not impinge on the shooter's ability to concentrate on the fundamentals of marksmanship. -** The same reasoning applies here as on the 25 meter range.

- **The trap should not reveal the location of the target. -** Targets are at three known distances and locations. Although the targets are not always visible, the location is known. This criterion should not be a factor.

- **The trap must not adversely impact the effectiveness or realism of training. -** Realism is generally not a factor on these ranges. Targets are of the pop-up type, but at a known location and distance. The purpose of the range is to teach the soldier to compensate for differing ranges and to fire the round in a finite amount of time. This criterion is generally not a factor.

- **The trap cannot mask any other target downrange.** - Although there are targets placed further downrange from closer targets, the layout of the range is such that the probability of masking another target is low. On those rare ranges where lack of space dictates closer horizontal spacing of targets than standard, this may be a factor that needs to be considered.

- **Range personnel should experience only minor changes in maintenance requirements.**

3.3.3 Automated/Modified Record Fire Range

- **The trap should not create a distraction to the shooter. Its color, shape, and other characteristics should not impinge on the shooter's ability to concentrate on the fundamentals of marksmanship.** - On this range the trap should not be noticeable. Anything about the trap that distracts the shooter also affects the other factors listed below and is not acceptable.

- **The trap should not reveal the location of the target. -** The purpose of the range is to have the shooter demonstrate the ability to acquire (find) the target, sight the rifle, and fire a well-aimed shot that hits the target before the target disappears. To be effective, the trap must not give the shooter advance knowledge of where the target will appear. For basic trainees, this is less of a factor than for FORSCOM units. The difficulty of sighting the rifle at the target and hitting it in the time allotted generally overwhelms the capabilities the trainee and reduces the need to emphasize the ability to find the target in a natural setting. This criterion is a factor, but will vary among installations as to its importance.

- **The trap must not adversely impact the effectiveness or realism of training. -** The same comments are valid as for giving away target location. For TRADOC installations, realism is of lesser importance, generally, than is the concentration on the fundamentals of marksmanship. For FORSCOM installations, this criterion will be given greater weight.

- **The trap cannot mask any other target downrange. -** Targets are staggered the length of the range and the possibility of masking targets at the longer ranges with a trap placed behind one of the closer targets is a very real one. Great care should be taken in selecting and installing bullet traps on this range to ensure that does not happen. In this case, those traps that can operate horizontally or rise with the target, rather than standing vertically behind the target will probably be preferable.

- **Range personnel should experience only minor changes in maintenance requirements.**

3.3.4 Combat Pistol Qualification Course/Military Police Firearms Qualification Course

- **The trap should not create a distraction to the shooter. Its color, shape, and other characteristics should not impinge on the shooter's ability to concentrate on the fundamentals of marksmanship.** - Shooting on this range is done at ranges of 10 to 35 meters with the personal sidearm. Any distractions to the shooter that adversely impact the ability to qualify with the weapon are unacceptable.

- **The trap should not reveal the location of the target.** - Since ranges are short, the target locations are known or easily detectable prior to the target appearing. This criterion should not be a factor.

- **The trap must not adversely impact the effectiveness or realism of training. -** Realism is not as great a factor here as on the Record Fire range. However, some attempt at realism is made, though the design of the range and the distances to targets does not allow great emphasis. Any characteristics of the trap that further degrade the attempt to maintain some realism in the training should be carefully considered in the trade-off analysis of bullet trap designs.

- **The trap cannot mask any other target downrange. -** This is a very real problem on this range. Even though firing is done from an erect position, as opposed to prone on the rifle ranges, closer targets can mask more distant targets. Like the Record Fire Range, consideration should be given to traps that either operate horizontally or rise with the target. The other possibility, moving the masked targets, may not be feasible or may not be cost-effective.

- **Range personnel should experience only minor changes in maintenance requirements.**

3.3.5 Summary

Although training missions and emphasis varied from installation to installation, all used the 25 meter zero range as the first step in live fire small arms training. After that, however, there was a divergence of views between FORSCOM and TRADOC units. TRADOC units were generally dealing with inexperienced shooters. Training unit cadres estimate that less than 5 percent of recruits have ever fired a weapon before entering the Army. Of those who have, only about 10 percent (or 1/2 of 1 percent of all recruits) have any proficiency. TRADOC units, therefore, were concerned with achieving some rudimentary level of skill in the fundamentals of marksmanship and were less concerned with training realism. Revealing target location was of less importance than teaching breathing, sight alignment, and trigger control. FORSCOM units, on the other hand, generally consisted of more experienced shooters. They were concerned with instilling and improving those skills, such as rapid target detection and engagement, that would enhance the soldier's ability to survive on the battlefield. Consequently, anything that detracted from training realism, such as bullet traps that revealed target locations, were not looked upon with favor.

SECTION 4

CONCLUSIONS

Based upon the site visits, discussions with the Army Training Support Center (ATSC) and TRADOC representatives, range and training personnel at the sites, and other concerned organizations, there was consensus that 25 meter zero ranges could benefit from bullet traps. These ranges are used by almost all shooters for everything from basic rifle marksmanship to familiarization firing. Because the range is so short and the purpose of the range is to zero weapons, no impact on training realism is anticipated. The capture rate should approach 100 percent.

The CPQC/MPFQC pistol range is another candidate for bullet traps. Target detection is not adversely affected because the ranges to the targets are so short that the target locations are known. The issue of target masking, however, needs to be addressed.

The LOMAH, Field Fire, and Record Fire ranges have pop-up targets at varying distances out to 300 meters, but may still provide an opportunity to capture a substantial number of bullets. The exact application of traps to these ranges will need to be addressed on a case by case basis because of the realities of topography, climate, and mission.

It appears that many opportunities exist for application of bullet trap technology to existing and planned Army ranges. Exactly which traps and which ranges must be determined by the feasibility analysis that follows this report and by live-fire demonstrations of selected bullet traps to verify information obtained in the course of this study. If the existing data are supported by independent test and evaluation, life cycle costs for selected Army ranges are anticipated to drop significantly, with an attendant cost avoidance for compliance with regulatory issues.

SECTION 5

TRIP REPORTS

Subject:	**Date:**	**From:**
Meeting with Gene Fabian, AEC	April 27, 1995	D.D. Evans

To:	**cc:**	**Location/Phone:**
Mike Murphey	Bonnie Packer	FP1/3122 (703) 803-5471

Bob Thompson and I met with Gene Fabian on Wednesday, 4/26/95, to kick off the Bullet Trap Feasibility study. Gene provided initial guidance, points of contact, and outlines of the reports (attached) he wants. The activities anticipated are:

1. Identify existing bullet trap designs and manufacturers. This is primarily a literature search with supplemental phone calls. It also includes talking to foreign sources, probably the military attaches at the German, French, Swiss, and Swedish embassies. It might involve foreign travel.

2. Develop evaluation criteria. Address what the contamination problems are with each weapon. For example, does the M-16 create more of a problem than the 9 mm pistol? Does the .50 cal. machine gun cause more damage to the bullet trap but represent a much smaller contamination problem?

3. Develop functional and operational criteria such as maintenance requirements, total life cycle cost, durability, impact on training realism, etc.

Subject:	**Date:**	**From:**
Meeting at Ft. Eustis, 5/24/95	May 25, 1995	D.D. Evans

To:	**cc:**	**Location/Phone:**
Mike Murphey	Bonnie Packer	AV10/202
	Bob Thompson	(703) 413-3132

Bob Thompson and I met with Joan VanDervort, Gene Fabian, and a number of range people at the Army Training Support Center (ATSC) at Ft. Eustis, on Wednesday, 5/24/95. Subject of the meeting was to discuss the Bullet Trap Feasibility task and to get recommendations on sites to visit. Other attendees were:

Larry Chenkin, ATSC
Capt. Skip Seabolt, ATSC
Jim Turner, ATSC - Range visit coordinator
Jim Bowser, ATSC

The major topics of discussion were the types of data we wanted to get from the range visits, information sources available, recommended sites and dates, and points of contact. This first meeting was primarily to get acquainted with the players at ATSC and let them do most of the talking.

The preliminary list of sites to be visited includes:

Ft. A.P. Hill, VA
Ft. Knox, KY (Louisville)
Ft. Benning, GA (Columbus)
Ft. Jackson, SC (Columbia)
Ft. Hood, TX (Killeen/Austin)
Ft. Ripley, MN (Brainerd/Minneapolis)
Camp Atterbury, IN (Indianapolis) and possibly Camp Robinson, AR (Little Rock)

It was also suggested we contact PRO-ACT, the environmental information clearinghouse run by the Air Force at Brooks AFB, TX, and Mark Fleming of the Corps of Engineers at Huntsville.

Jim Turner will draft a letter to all MACOMs (Major Commands) giving them a heads up on what we want to do. He will also schedule the site visits.

After the meeting, Joan VanDervort, Gene Fabian, Bob Thompson, and I met in Joan's office to discuss the overall program and try to come up with approaches to solve differing interpretations of the direction of the various tasks. Joan also mentioned the program was funded at $7.2 million. She asked if Bonnie and I could arrive at Ft. Rucker early to allow us time to meet with her and discuss what she thought needed to be done on the berm re-engineering task. I have changed my reservations to accommodate that request. Bonnie has a conflict caused by a summons for jury duty and may not be able to make it as early. She and Joan will try to get together on the phone tomorrow. Our proposal for a meeting of all players involved in the berm task was endorsed by Joan, who said she would contact Tony Perry to see why he objected to one. She believes it is absolutely vital that everyone participating be of one mind and understand the goals of the overall program. Gene Fabian echoed Joan's endorsement. Joan has the action to set that up.

Subject:	**Date:**	**From:**
Meeting with NRA Range Technical Operations Team	June 8, 1995	D.D. Evans
To:	**cc:**	**Location/Phone:**
Mike Murphey	Bonnie Packer	AV10/202 (703) 413-3132

Bonnie Packer and I met with the NRA Range Technical Operations Team on Thursday, 8 June. Also attending were Rick O'Donnell, Tony Perry, and Gene Fabian of AEC, and Capt. Russ Feldkamp of the Marine Corps Weapons Training Battalion, Quantico.

The early part of the meeting was occupied with trying to get the NRA to understand that we did not make Army policy. We only are interested in the pure science and engineering of the problem. We then got down to technical discussions with the remaining NRA staffers. John Joines, NRA Range Engineer, provided a number of good suggestions for bullet traps and will provide points of contact for both berm design and bullet trap design next week. Capt. Feldkamp offered to host a visit to Quantico for us to see the range design and bullet trap evaluation work they have done. Mr. Charles Sevier, CEO of Best Environmental Services and Technology, who is under contract to the NRA for soil contamination studies, offered several interesting suggestions on berm and range design and agreed to allow us to look at his data from the past two years of research. This was a preliminary get acquainted meeting and will be followed by more detailed technical discussions with both the NRA and the Marines.

Subject:	**Date:**	**From:**
Bullet Trap Trip to Ft. Hood 6/21/95	June 26, 1995	D.D. Evans

To:	**cc:**	**Location/Phone:**
Gene Fabian	Owen Hoskins	AV10/202
	Mike Murphey	(703) 413-3132

Bob Thompson, Joan VanDervort and I met with III Corps and Ft. Hood personnel on Wednesday, June 21. Mr. Leslie R. "Red" O'Neal, Deputy Science Advisor to the Commanding General, III Corps and Ft. Hood, was our point of contact and host.

Before touring selected ranges, BG James O'Neal, III Corps Chief of Staff, wanted to meet with us. We spent a little over half an hour with him and COL Burke, III Corps G-3. BG O'Neal is slated to become Deputy CG, 1st Armored Division, in Germany at the end of the month. COL Burke will become on the Chief of Staff on BG O'Neal's departure.

General O'Neal and COL Burke were very knowledgeable about the potential problems caused by lead buildup in berms and accumulation downrange, and offered the full support of the Chief of Staff's office, the G3, and the CG. We were given carte blanche to talk to anyone or visit anything we wanted to see on Ft. Hood. General O'Neal pointed out that Ft. Hood has roughly 80,000 troops, 10 percent of the Army, and probably 20 percent of all its armor. Ft. Hood gets a very high volume of VIP visitors and any activities there would receive high visibility. The problem is the Army is planning to spend almost all construction funding over the next 5 years on new barracks and family housing. There is almost no money available for posts to put toward range construction or reconstruction. They are not able to provide range repair and maintenance funding to all ranges that need it. We saw a number of ranges that were pretty chewed up.

Following the meeting with BG O'Neal, we met with Mr. Billy Piper, head of Range Control Division, and Mr. Andy Pogen, the Range Safety Officer. Mr. Pogen acted as our guide and entree to all the ranges we wanted to visit.

On the Record Fire ranges (M-16), each target is a computer controlled and scored, polyethylene, pop-up 3-D silhouette. Their locations are marked by an earthen berm in front of the target coffin. Many of the targets are situated in the line of fire of another target and, consequently, more distant targets take hits in their berms from rounds fired at closer targets. This is in addition to the misaimed rounds that impact the berms also. Placing a bullet trap behind a target, with the current layout, could screen one or more targets behind that one. There is no backstop behind the targets and, with the exception of one range, bullets just travel downrange until they run out of steam. The exception range has a hill approximately 800 meters behind the last target where a number of rounds impact. All ranges have extensive vegetation downrange. Given that targets are fired at from both prone and standing positions (from an above-ground foxhole), it may not be practical to try to put a bullet trap or berm at the periphery of the range. This needs further study.

The 25 meter zeroing range receives heavy use. Everyone shoots there before going to the Record Fire range. It currently uses an earthen berm and would be a good candidate for bullet traps.

Ft. Hood has one range, the Sportsmen's Range, that is used for training during the week and is open to the public for recreational shooting on weekends and holidays. This range is probably the most heavily used on Ft. Hood and has the greatest variety of bullets fired on it.

The Combat Pistol Qualification Course has many of the same problems as the Record Fire ranges. However, since this is a fairly short range, it might be possible to put a bullet trap or berm at the periphery of the range, around 50 to 75 meters from the firing points. Most of the berms in front of the targets were pretty badly chewed up. A bullet trap in front would prevent that and would not screen targets behind.

Most of Ft. Hood's ranges have surface mounted targets with raised berms because of the shallow water table. Ft. Hood is a very hot and dry environment, with limited rainfall, so the shallow water table is surprising. This could present some interesting problems. The advantage, however, is that it might be easier to reposition targets than it would be if the target coffins were in a pit. It will be interesting to compare what we saw at Ft. Hood with Ft. Jackson and the other posts we are scheduled to visit.

Subject:	Date:	From:
Trip to Thunder Ranch, 7/10/95	July 17, 1995	D.D. Evans

To:	cc:	Location/Phone:
Gene Fabian	Owen Hoskins	AV10/202
	Mike Murphey	(703) 413-3132
	Bonnie Packer	

Thunder Ranch is a commercial operation that provides graduate level training in rifle, pistol, and shotgun to law enforcement, the military, and civilians. Since their potential liability is much greater than the government's, they take special pains to ensure the minimum risk to their students. Terry Kenney is the Operations Officer. He is a retired law enforcement officer and a former instructor at the DOE C.T.A. (I think that is the Central Training Academy).

Most shooting into bullet traps is done with handguns at Thunder Ranch. Terry had done extensive investigation into the types of bullet traps that could be employed at Thunder Ranch before settling on the design currently being used. Tires were considered, tested, and rejected because of a number of factors. Among these were the high incident of bounce back (different from ricochet, if I understand correctly), gaps between tires which could let bullets through, particulates, the fact that tires do not self seal with many types of ammunition, the weight, and the maintenance required. For many of their ranges, they use the standard dirt berm with a few additions, such as runoff control channels and collection areas. The combination of the type of soil they have and the climate of that area minimizes the problems experienced with erosion. Hence, the earthen berm is the most effective low cost, low maintenance solution for them.

For other applications, however, specific bullet traps are needed. The traps currently in use are the result of several years of experimentation and evolution. The current trap uses 2X4s for the sides. The legs are 8 ft. 2X4s and the top and bottom are 4 ft. cross pieces . The back is a 1/4 inch armor plate. The front is 7/16 plywood on top of Linatex. The purpose of the Linatex is to prevent bullet fragments from coming back out the front of the trap. Earlier versions used old phone books as fillers instead of the Linatex, but that caused a cleanup problem and drastically increased the weight. In the current version, the plywood is used primarily for cosmetics and a piece of cardboard could work instead. The bullet passes through the target and the front covering, either plywood or cardboard. When the bullet hits the Linatex, it stretches the Linatex, but does not penetrate until it hits the armor plate at the back. The Linatex snaps back and is self sealing, being similar to the material used in aircraft and helicopter fuel tanks. The bullet splatters on the armor plate. According to calculations and experiments done by Terry, it appears the fragments from the bullet ricochet from the armor plate in a 360 degree pattern at an angle of 20.5 degrees, regardless of the angle of impact of the bullet. The entire interior perimeter is lined with angle iron to prevent fragments from escaping the trap. Thunder Ranch uses 2X4s because of the limited manpower they have to move the traps around. Terry recommended 2X6s for the Army because, even though the traps will be heavier, there is sufficient manpower to move them and the

Linatex will last nearly twice as long with the larger air space (5.5 inches vs. 3.5 inches). The Linatex will stretch farther before penetration occurs, resulting in a smaller hole to seal. Linatex is the highest cost component of the trap.

Thunder Ranch believes the Linatex will last at least 3 years at their usage rates with the 2X4 arrangement. That is, by my calculation, about 10,000 rounds. The current traps have more than a year's usage and show almost no wear, so it is possible they will last much longer, especially if 2X6s are used instead. Thunder Ranch, replaces materials much more frequently than the Army would in order to maintain the image of everything being nearly new that is vital to their commercial success. For instance, plywood is used for the front of the traps, as mentioned earlier, because it can be painted to match the color scheme and is a little "classier" than cardboard. These plywood fronts are replaced every 600 to 1000 rounds even though they could last 5 or 6 times longer. The Army could use cardboard fronts for target mounting in the interests of economy with no degradation in performance.

.223 (5.56mm) ammunition is of 2 types at the ranch. Close range firing (100 yards or less) is done with frangible ammunition, which can be used with the traps. Longer range firing is done into earthen berms, for the most part, using ball ammunition. Ball ammunition has a tendency to dimple the armor plating, but is far less expensive than the frangible ammunition.

The two adjunct instructors for the class are both from the Albuquerque area. Jim Welch is an instructor at the C.T.A., which is located on base at Kirtland. Jay Johnston is a former instructor at the C.T.A. and is currently with the Bernalillo County Sheriff's Dept. Both men have offered to answer any questions we might have that fall within their expertise.

Subject:	**Date:**	**From:**
Trip to Ft. Knox, 7/18/95	July 20, 1995	D.D. Evans

To:	**cc:**	**Location/Phone:**
Gene Fabian	Owen Hoskins	AV10/202
	Mike Murphey	(703) 413-3132
	Bonnie Packer	

Bob Thompson, CW5 Mock of the Army Safety Office, and I visited Ft. Knox to talk to Andy Andrews, the Range Control Officer. Andy runs what is generally considered to be one of the best range operations in the Army. He is very inventive in his approach and is constantly looking for ways to improve performance and cut costs. Mr. Mock is looking at our program as a way to try to reduce ricochets, which have caused some incidents when they hit aircraft that had entered the restricted zone over several ranges.

Andy is in the process of modeling the bullet strike pattern at each range. To be comprehensive, it will need to be done for each firing point at each range, but this is currently a proof of concept test. Given the bullet strike pattern for each point, it is believed that bullet traps can be set up behind targets where the rounds would normally strike, thereby reducing the probability of giving away the location of the target. The ranges at Ft. Knox are terraced in a gradual slope so that from the firing point, it looks like one flat field with none of the "anthills" that give away target location , such as we saw at Ft. Jackson. It is believed that traps can be placed in front of the target to catch low rounds, but camouflaged so as not to reveal the target location. Additional fake traps could be scattered around the range for the same reason. At the terminus of the range, a full width trap would replace the berm. Andy believes with proper engineering, he can trap up to 80 percent of the rounds.

The Combat Pistol Qualification Course (CPQC) is a slightly different story. Target locations are known because they are at close range (10 - 35 meters). A trap in front is needed because the layout of targets causes rounds penetrating closer targets to impact the front berm of farther targets. Andy proposed traps in front of each target and a full length trap at the back edge of the range. Again, he believes this will catch up to 80 percent of the rounds fired. The discussion centered on the design of the traps needed. There was some question as to whether a flat, angled plate, or a curved plate would work better.

The upshot is that it is believed that bullet traps could work on more places than we first thought after our visit to Ft. Jackson. Key to this, however, will be accurate and comprehensive modeling of the bullet strike pattern at each firing point. This pattern will be influenced by the elevation of the firing point relative to each target, the distance to the target, and the experience of the shooter. It is probably safe to assume that most basic trainees will not shoot as well as more experienced troops. I would like offer the following for consideration, based upon my discussions with Andy Andrews:

I would like to conduct several live fire trials at a couple of representative sites, say Ft. Jackson or Benning to get basic trainees, Ft. Knox to get non-infantry combat troops, and perhaps at one of the infantry or airborne divisions. I would like to place a covering of paper or cardboard marked off in 1 inch squares in front of and behind targets at three firing points and have the troops fire their normal courses of fire. Between each relay, we could count the hits in the coverings and record their locations relative to the targets and firing points. We would also probably need to measure the elevation difference between the firing points and the targets. These data would then be used to corroborate the results of the model when that was developed. All we would need as input to the model would be the distance and elevation difference between firing points and targets. The model would tell us where to put the traps and how big to make them. In the interests of economy, we would probably have to standardize trap design and size it to capture some nominal percentage of rounds. I don't propose developing the model or doing the calculations under this task, but would like to take the impact measurements as I believe those data will have a direct bearing on what traps are feasible on which ranges.

Subject:	**Date:**	**From:**
Trip to Ft. Benning	July 26, 1995	D.D. Evans

To:	**cc:**	**Location/Phone:**
Gene Fabian	Owen Hoskins	AV10/202
	Mike Murphey	(703) 413-3132
	Bonnie Packer	

Bob Thompson and I visited Ft. Benning to talk to Frank Harris, the Range Control Officer. Ft. Benning hosts basic trainees, National Guard and Reserves, the Infantry School, the Infantry Officer Candidate School, the Ranger School, ROTC summer camp, 75th Rangers, and 3rd Bn, 24th Infantry. They have one of the largest range complexes in the Army as far as sheer numbers go. They have 57 small arms or multi-use ranges. Ft. Benning shares many of the same climatological problems that Ft. Jackson and Ft. Rucker share, high rainfall and sandy soil. To compound this problem, the funding levels for range maintenance have been so dramatically reduced that they cannot employ enough staff to adequately maintain the ranges. Range maintenance has become the responsibility of the units who use them, with Range Control providing oversight. The result is that ranges are not as well maintained as we have seen at other locations, but are in no worse condition than the average range we have visited. This is probably attributable to the previously mentioned lack of funding.

We looked at most of the different types of ranges, but there was one difference from any we had seen to date. Ft. Benning has moving targets on their field fire and record fire (IRETS) ranges. The moving targets are at ranges up to 200 m. They pop up, run 10 meters, and drop, making them more difficult to hit and, from our point of view, more difficult to capture bullets. It would not be impossible, simply more difficult than stationary targets. We saw cases where the bullet impact areas have dug tunnels back into the hillside or where there was not a backstop, had leveled trees and other growth for a significant distance. Like Ft. Jackson, Ft. Benning uses skid plates in front of many of the targets, with the attendant ricochet potential. On the primary IRETS range, there were several homemade bullet traps, but we did not have an opportunity to examine them. All of the metal plating we saw on other ranges, however, was standard steel plating, not armor plate. Consequently, there was a lot of damage and/or dimpling on the plates. The beaten zones were quite distinct, lending weight to the thought that perhaps bullet traps would work. The problem is to determine what design.

Subject:	**Date:**	**From:**
Trip report to Fort Drum, NY, 8/8/95	August 11, 1995	R.A. Thompson

To:	**cc:**	**Location/Phone:**
Gene Fabian	Owen Hoskins Mike Murphey Dave Evans Bonnie Packer	AV10/202 (703) 413-3123

On 8 August Mr. Gene Fabian, Mr. Richard Condon and I visited the Ft. Drum (10th Mountain Division) and met with Mr. Al Schwark, Range Division Chief. Also present at the meeting were Mr. Jim Haines, Fort Drum Environmental Officer, and Mr. Jeff Nelson of the Caswell Corporation. Mr. Fabian and I briefed these individuals on the purpose of our visit. Mr. Schwark gave us a through briefing on the operation and maintenance of his ranges at Fort Drum. After Mr. Schwark's briefing, Mr. Nelson briefed us on the capabilities of the Caswell Lamella Bullet Trap and gave us a set of plans for the bullet trap that had been installed on Range 8 (Multipurpose Small Arms Range) at Fort Drum.

At the conclusion of the briefings, we were transported to Range 8 to witness the firing of several individual small arms into the Caswell Bullet Trap. The Lamella trap was constructed of wood timbers bolted together to form a frame from which the rubber strips was hung in alternating chevron patterns. The rubber strips were approximately 10 feet long, 3 feet wide, and 1/2 inch in thickness. In front of the trap was a secondary trap approximately 5 feet wide, 3 feet high, and 1 foot thick, also constructed of rubber material 1/2 inch in thickness. Standard U.S. Army small arms targets were used for the demo.

100 rounds each of 5.56mm ball, 9mm ball, and 7.62mm belted ball ammunition was used for the demo. The 5.56mm was fired from the standard issue M-16 Rifle, 9mm from the M9 Pistol, and the 7.62mm was fired from a machine gun. When the 5.56 and 7.62 ammo was fired into the trap, the projectiles disintegrated on impact because of their high velocities. The 9mm stayed intact. Upon completion of firing, approximately 10% of the 9mm bullets were found in the bottom of the trap. Only fragments of the 5.56 and 7.62 projectiles were found in the bottom of the trap. The remainder of the projectiles were imbedded in the trap. No projectiles exited the rear of the trap.

Upon completion of the demo, an inspection was made of the trap. Numerous holes were made in the rubber strips with little or no noticeable damage to the trap. Several small fragments of the 5.56 and 7.62 ball ammunition were found imbedded in the Lamella strips. Caswell Corporation stated that this type of trap would easily withstand impact of 50,000 rounds before any maintenance would have to be performed.

Maintenance of this type of trap would be easily accomplished with only simple hand tools. When the strips are worn or damaged, they will be replaced with new strips or exchanged with strips from the rear of the trap.

This trap is the first of three traps to be installed at Fort Drum. Estimated cost of the trap is roughly $1,000 per linear foot. Mr. Schwark will be recording the number of rounds fired by type of weapon into this trap.

Subject:	**Date:**	**From:**
Trip to Ft. Pickett, VA, 8/10/95	August 11, 1995	D.D. Evans

To:	**cc:**	**Location/Phone:**
Gene Fabian	Owen Hoskins	AV10/202
	Mike Murphey	(703) 413-3132

On 10 August, Bob Thompson, Owen Hoskins, and David Evans visited Ft. Pickett at the invitation of Range Control to observe the 504th Airborne, 82nd Airborne Division conduct live fire training in the Ft. Pickett Military Assault Course (MAC). The MAC is designed to provide live fire training in assaulting and seizing urban areas. The MOUT (Military Operations on Urbanized Terrain) is designed for blanks only, but is also for urban warfare training. Operations were scheduled to start at 0900, but transportation problems forced a delay in the arrival of the troops until 1100. Training was expected to begin after a break for lunch, but scheduling problems forced postponement of that until 1445.

The MAC is a mockup of several building fronts with RETS type targets installed in some doorways and windows. Fired rounds impact either in a hill behind the target on, in the case of those structures on the left of the MAC, into an impact area. From what we were able to observe, it appears the MAC would be an excellent candidate for bullet traps. In addition, the block houses on the course might be usable for pistol training and rifle training with frangible ammunition if the Thunder Ranch traps were employed.

Subject:	**Date:**	**From:**
Trip to Bullet Trap manufacturers, 8/15 - 16/95	August 18, 1995	D.D. Evans

To:	**cc:**	**Location/Phone:**
Gene Fabian	Owen Hoskins	AV10/202
	Mike Murphey	(703) 413-3132

On 15 August, Gene Fabian, Owen Hoskins, and David Evans visited Caswell International in Minneapolis, MN to discuss their bullet traps and see a demonstration. The trap most discussed is the GranTrap, a trap that used granulated rubber inside to capture bullets. The lamella trap installed at Ft. Drum is considered an older technology and is licensed from a German company. Following a briefing and question and answer session, we witnessed a firing demonstration. An ordinary copier paper box was filled with the granular material and a 5.56mm round was fired into it from a range of 5 feet. The trap stopped the bullet within the first 12 inches. Subsequent shots were similarly captured. After that demonstration, we went to the Minnetonka Police Dept. to see one of the GranTraps installed on their indoor range. The trap evidenced some wear and the standard patch had been placed on the area of most frequent bullet impact, but it appeared to perform flawlessly during the tests. Roughly 200 rounds of handgun ammunition were fired into the trap.

On 16 August, we visited Range Masters, Inc. (RMI) in Le Center, MN, about 50 miles from Minneapolis. RMI makes a bullet trap out of blocks of rubber material that are a mixture of shredded, recycled tires and a bonding compound with a Kevlar additive. The mixture is placed in a mold and pressure formed. The formed block is then set aside to cure for several days. The blocks resemble very large cinder blocks in that they have openings, called recovery channels, for the spent rounds to fall through. The design of the blocks can be quickly tailored to the specific type of ammunition being fired to facilitate the round running out of energy as it hits the recovery channel opening. Multiple blocks are banded together to form the bullet trap.

Both manufacturers expressed a willingness to provide traps for the demonstration.

Subject:	**Date:**	**From:**
Trip report to Fort Sill, OK, 8/23/95	August 28, 1995	R.A. Thompson

To:	**cc:**	**Location/Phone:**
Gene Fabian	Owen Hoskins Mike Murphey Dave Evans	AV10/202 (703) 413-3123

On 23 August I visited Fort Sill, Oklahoma and met with Mr. Sam Gerace, Range Division Chief and Mr. Don Aston, Assistant Range Division Supervisor. I briefed these individuals on the U.S. Army Environmental Center Bullet Trap Feasibility Assessment and the purpose of my visit. Mr. Gerace briefed me on the operations and maintenance of his small arms ranges and on some of his concerns for several of his ranges. Mr. Gerace has several problems with his pistol range and off-duty marksmanship range. The first problem is that the face of the berm on the pistol ranges is covered with rock and poses a ricochet problem. His second area of concern is the erosion of berms on his 25 Meter range. Mr. Gerace would like us to come up with a viable solution to his erosion problem. After meeting with Mr. Gerace, I was escorted to all of Fort Sill's small arms ranges by Mr. Aston.

There are only three ranges at Fort Sill that use berms as a backstop. All other ranges fire into the impact area. The first stop on the range tour was a multi-weapon range that is used very little and shows no wear and tear of the bullet impact area. We then visited several Field Fire, Record Fire, Automated Record Fire, and 1000-Inch (25 meter) ranges. The field fire ranges are standard Army ranges, the berm in front of the target uses a two piece metal skid plate covered with pea gravel. Numerous targets coffin berms were in need of maintenance and several of the skid plates were exposed causing ricochets when hit. The 1000-Inch range is less than two years old and is already showing signs of high volume firing. The machine-gun range is used for orientation and familiarization and has 20 elevated firing points. Only hard targets are used on this range. These hard targets are old tracked vehicle shells that have been placed in the impact area. They are also used as M79 or M203 grenade targets.

Fort Sill's Range Control has oversight and controls all firing scheduled by units. However, maintenance and repair of most ranges is performed by units that have been assigned to specified ranges. This is the same practice as at Ft. Benning, with the same results.

Subject:	**Date:**	**From:**
Trip report to Fort Leonard Wood, MO, 8/24/95	August 28, 1995	R.A. Thompson
To:	**cc:**	**Location/Phone:**
Gene Fabian	Owen Hoskins Mike Murphey Dave Evans	AV10/202 (703) 413-3123

On 24 August I visited Fort Leonard Wood, Missouri and met with Mr. Andy Mostajo, Range Division Chief and SFC Jordan, NCOIC for Range Operations. I briefed these individuals on the U.S. Army Environmental Center Bullet Trap Feasibility Assessment and the purpose of my visit. Mr. Mostajo briefed me on the operations and maintenance of Fort Leonard Wood's ranges. Mr. Mostajo has a unique operational set up at Range Control; his range operations is located adjacent to all of his small arms ranges. His staff consists of three Department of the Army Civilians and fifty three military personnel. Mr. Mostajo has good support from the Post Commander as well as support from the Engineer Battalion there at Leonard Wood. I was escorted to all of Fort Leonard Wood's small arms ranges by Mr. Mostajo.

We visited several ranges that were in operation but were not able to go downrange to look at the target areas or impact areas. There are two qualification ranges that are used almost constantly, Mr. Mostajo stated that he tries to rotate usage of these ranges to prevent wear out of the berms, impact areas, and target mechanisms. He also performs maintenance during range down time. Metal skid plates are not used on any of his ranges. Wood timbers are imbedded into the ground in front of the target coffins to prevent erosion and also acts as a "Bullet Trap". The only range that shows any significant signs of wear is the pistol range and that is mainly due to berm erosion. Mr. Mostajo said that this repair was on his priority repair list. The soil there is mostly clay and does not allow much leaching of lead into the ground. Also, the water table there is over 500 feet deep. Over the past year, there have been three environmental studies and inspections conducted with no significant findings. The qualification and practice record fire ranges were well maintained with good vegetation and cover and the trees were left in natural position when the ranges were built.

Training is conducted 251 days a year at Leonard Wood with an expenditure of 2500 rounds of 5.56mm ammo every three days.

Subject:	**Date:**	**From:**
Trip report to DELTA Defense, Inc.	September 11, 1995	R.S. Young

To:	**cc:**	**Location/Phone:**
Gene Fabian	Owen Hoskins Mike Murphey Dave Evans Bonnie Packer	AV10/202 (703) 413-3123

On 7 September I visited the DELTA Defense, Inc. manufacturing facilities and test firing range near Stafford, Virginia with Bob Thompson. This trip was the result of a previous meeting between Mr. Thompson and Dr. Roy Kelly, VP for Technology of DELTA Defense. The objective of the trip was to obtain information on a soft bullet trap marketed by a British company, the Nitor Group, and to identify the effects of frangible bullets on a variety of bullet trap materials.

We met with John Bainer, their Director of Test and Evaluation at their manufacturing plant. Mr. Thompson gave Mr. Bainer a brief overview of the Bullet Trap task and the reason for our interest in their products. Mr. Bainer briefed us on the product line of their ammunition by caliber, their customer list, and some of the specialized applications for indoor range use made possible by frangible bullets. He also briefed us on the results of testing conducted at the Sandia Terminal Ballistics Lab using their Ultra-High Speed Photometrics cameras to record the effects of impact of their 5.56mm round into armor plate (see attachment). We were then joined by Dr. Kelly, who accompanied us to the range for demonstration firing after a tour of their manufacturing facilities.

DELTA Defense occupies a small steel framed structure approximately 50' by 100' that has both milling and ammunition loading facilities. They are capable of simultaneously producing medium sized runs of two different calibers. They have a leased range facility nearby consisting of a four point, 100 yard range, concrete firing pad and range house equipped with test firing benches, chronographs, and diagnostic equipment.

Dr. Kelly showed the DELTA/NITOR rubber bullet trap blocks and demonstrated the ability of the compressed rubber to absorb bullets of both frangible and conventional material. Mr. Bainer fired a 15 round magazine of 9mm frangible ball-type ammunition into a cardboard covered wooden box placed between his feet. The box was reinforced with a mild steel plate in the bottom. None of the frangible bullet material escaped the box and there was no appreciable damage to the box. He then fired a submachine gun walking forward to a distance of six feet from another mild steel target, yet creating no back splatter. His final demonstration involved firing against the plate from a very shallow angle to demonstrate how the rounds fragment even on glancing impact with no solid bullet ricochet.

Mr. Thompson then conducted several tests consisting of firing against concrete and cinder block back stops. This resulted in varying degrees of degradation to the backstops, with the cinder block showing the most damage. We then evaluated the similarity in live firing performance between the frangible and standard ammunition.

An M-16 magazine was loaded with 20 rounds of 5.56mm alternating between M-16 A2 rounds and the DELTA ammunition. The firing at both semi- and full automatic rates revealed that recoil and ballistic performance out to 100 yards were very similar to that of conventional service ammunition.

Although the purpose of the trip was to evaluate the effects of frangible bullets on a variety of backstop materials, it became obvious that there needs to be a systems approach to evaluation of small arms ranges. This must involve new thinking about range design, bullet traps and the ammunition fired for an overall solution.

Subject:	**Date:**	**From:**
Minutes of Bullet Trap Workshop, 10/16/95	October 24, 1995	R.S. Young

To:	**cc:**	**Location/Phone:**
Owen Hoskins	Gene Fabian	AV10/202
	Dave Evans	(703) 413-3123

A workshop to discuss evaluation criteria for bullet traps was conducted at Fort Eustis, VA at the Army Training Support Center on October 16, 1995. The objective of the workshop was to establish the parameters that bullet traps must meet to be effective on Army ranges. The following people attended the workshop:

Name	Organization	Name	Organization
Joan VanDervort	ATSC	Gene Fabian	AEC
Jim Walk	ATSC-CTSD	Dave Evans	TRW
Andy Andrews	Ft. Knox Range Mgr.	Russ Hunley	ATSC-CTS
James Pope	Ft. Knox Range Control	SFC Ronnie Ward	Ft. Knox Range Ctrl
Al Schwark	Ft. Drum Range Division	Randy Young	QUADELTA
Capt. Mike VanValkenberg	USAF Ctr. for Env. Excellence		

Joan VanDervort opened the workshop and welcomed the participants. She said she wanted the focus of the effort to be on the evaluation criteria. Gene Fabian of the Army Environmental Center gave an overview of the bullet trap study as a whole. He said the focus was to be proactive, to keep the lead from migrating off the ranges, and to cope with impending environmental regulations. Mr. Fabian also revealed that the study would be in two phases, with Phase II involving a six month live-fire test of several types of bullet traps. If traps appear feasible then a follow on task will be initiated to write a range manual for bullet traps.

Dave Evans then began an exploration of the discussion topics included in the agenda. He began by summarizing work on the subtask to date including a review of traditional and new technologies, range visits, problems identified, ideal bullet trap criteria, and a summary of the NRA headquarters range trap that may be modified as an outdoor system. Mr. Evans mentioned that the Waterways Experiment Station was proposing Shock Attenuating Concrete (SACON) as a bullet trap medium, and several people recognized the danger posed by ricochets that might be caused by bullet buildup in the SACON. Mr. Andrews stated that the appearance of a bullet trap behind zero type targets should not be a problem but on qualification ranges it might prove distracting to soldiers.

Installation: Mr. Schwark advocated minimal site preparation. Reasonable site work should involve only level grading of the site, and then a gravel layer for stabilization. Mr. Andrews opined that a plastic sheet or filter fabric should be laid down then the gravel placed over it as a

barrier to vertical migration of lead. Personnel requirements should be kept to a minimum because their hours were an unrecoverable resource for the post. Personnel should be restricted to one or two men for no more than three weeks. If possible a turnkey installation should be contracted for.

Performance: Ballistic requirements were generally agreed upon. The trap should be able to easily trap ammunition with the energy of the 7.62mm round and less. Calibers that should be considered in this category were 7.62mm, 5.56mm, .45 cal., 10mm, .40 cal., 9mm, cal. 38, and 12 ga. shotgun. Mr. Fabian divided load-up of the traps into two categories: periodic - requiring unloading of the trap and light maintenance, and ultimate - where the trap reaches failure. There was much discussion about how to translate these units of measure into a practice that will allow planning and scheduling (i.e. How many rounds equal periodic and ultimate load-up?). No definitive conclusion was reached because different traps might load-up at very different rates. This led the discussion to acceptable maintenance rates. Most ranges perform some light maintenance every six weeks or so, and heavy maintenance and repair every six months. The traps should not require more support. Although Ms. VanDervort desired a capture rate "as high as possible", there was consensus that an 80% capture rate would be the lowest rate that would justify using a bullet trap. On the 25m ranges the rate should approach 100%. All agreed that there should be no impact on training.

Operational/Maintenance: Although the participants stipulated that less downtime is better, rates that equal present practice is acceptable. That would be 2-3 hours for monthly maintenance, and 2-3 days for the six month maintenance periods. One suggestion was to require some kind of indicator that would alert operators before failure of the trap. No requirement for additional personnel will be acceptable because range staffs have already been cut back seriously.

The workshop ended before occupational exposure could be addressed in the general session. However, Captain Van Valkenberg stated later that troops handling lead would be protected by wearing rubber gloves. He felt that respiratory hazards were not serious in an outdoor range. Of the catchment media, the best would catch the lead whole, and the worst would use water. Ms. VanDervort was asked by participants to talk to the Directorate of Resources Management Office to begin work on a procedure whereby ranges could receive at least partial proceeds from recycled lead to help defray the cost of range maintenance. Issues involving the testing protocol were not addressed by the workshop.

Trip Report - Brief Bullet Trap Selection Criteria, Nov.7-8, 1995	11/10/95	R.S. Young
Gene Fabian	Owen Hoskins Mike Murphey Dave Evans Bonnie Packer	AV10/202 (703)413-3123

On 7 November I traveled with Dave Evans to Hampton, Virginia to brief the draft of the bullet trap evaluation criteria to Joan VanDervort, Army Training Support Center, Fort Eustis, Virginia. Also present from ATSC was Russ Hunley.

Previous to this briefing, a workshop was conducted on October 16th, 1995 with range managers from installations throughout the Army to gather their input about acceptable parameters for bullet traps. Guidance from the Project Officer, results of our research, and input from the workshop were combined to develop the draft Bullet Trap Selection Criteria.

After general discussion of the status of the task overall, attention was turned to paragraph 3.1 - Functional Evaluation Criteria. Criteria were grouped by topics; installation, performance, maintenance, exposure, and environmental issues were all reviewed. In addition, operational evaluation criteria were addressed.

Some form of installation site preparation was recognized as essential, and it was determined that a requirement for a concrete pad would not necessarily eliminate a bullet trap (BT) from consideration. Performance standards will have to be high. Every round that strikes the trap must be retained without either ejection or ricochet. On the 25 meter ranges 98% of all rounds must be captured. For any BT to be justifiable, at least 80% of the rounds should be trapped. There should be no escape of toxic metals into the environment.

Maintenance is recognized as a cost of doing business. Traps should not increase the number of maintenance hours for periodic (regular) maintenance, and the range should not be shut down more than 2-3 days for semi annual maintenance of the traps. Maintenance can require specialized tools and equipment, but maintenance should not require expensive or complicated and specialized equipment.

Exposure of range personnel to lead should be within normal safety guidelines. They should only require rubber gloves and standard respirators found on the GSA schedule and readily available in the supply system. Environmental concerns mandate that all heavy metals remain within the trap, not overflow the trap even when full, and should not cause ricochets when full to designed capacity. There can be no water runoff from the trap and should not generate excessive disposal or reclamation requirements. The lead and any filler material (i.e. GRAN TEX) should be recyclable.

Operational evaluation criteria are much more open for interpretation. For example, a bullet trap could be visible on a 25 meter zero-fire range and not distract the shooter or affect training realism. However, the same trap on a record fire range could give away the target location in advance and eliminate the target identification and location value of the training. In no way could a trap mask the target behind it, as in the case of the Combat Pistol Qualification Range.

There was also some discussion of the need to validate the criteria. This will require full scale live-fire test of six months duration over a full climactic range of temperature and precipitation. Otherwise these criteria would only be subjective opinion. It will be necessary to determine the cone of fire pattern for targets of various distances from the firing line at the qualification trainfire ranges. When this information is known, it can be determined which targets would meet the 80% capture criteria.

It was recognized that no single bullet trap will meet the Army's total requirement on every range. In fact there may be situations on some ranges that will require four types of solutions such as target coffins of SACON, rubber blocks in front of that to inhibit the creation of tell-tale "ant hills" in front of the target, an in-ground trap behind the target, and a Gran Trap at the rear of the range to prevent erosion. At the conclusion of the briefing, Mr. Evans said these comments would be briefed to the Project Officer for his review on November 13th, and would be incorporated in the final evaluation criteria.

Subject:	**Date:**	**From:**
Visits to bullet trap manufacturers	February 12, 1996	D.D. Evans

To:	**cc:**	**Location/Phone:**
Gene Fabian	Randy Young	AV10/202 (703) 413-3132

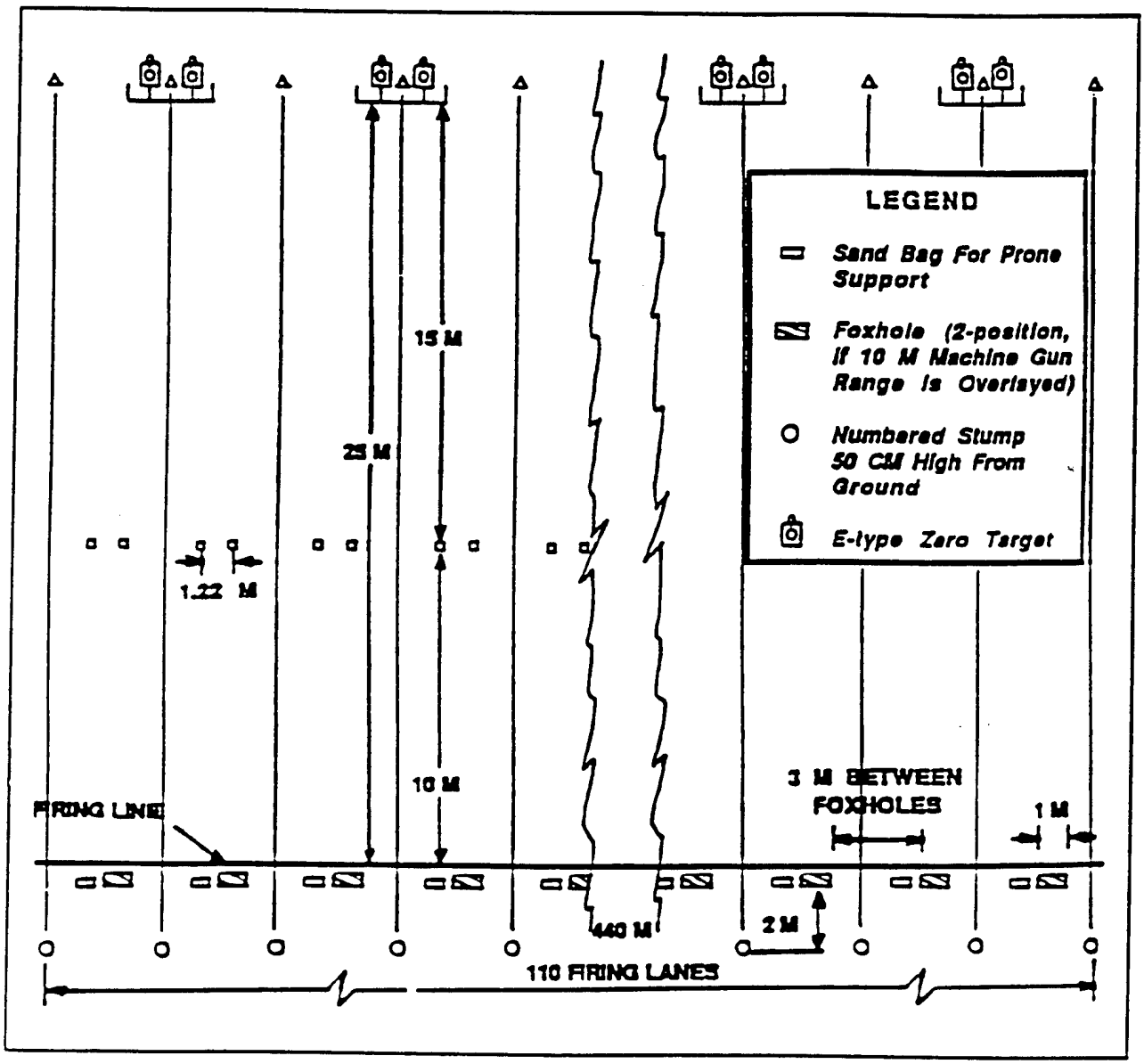
On February 7, Randy Young and David Evans visited Shooting Ranges International in Las Vegas, NV. SRI has developed a helical bullet trap that is somewhat different from conventional traps. The deflector plates are on the sides as opposed to top and bottom on most other traps. The trap does have plates top and bottom, but they are not intended to be the primary deflection plates. The deflector plates direct the bullet into a vertical helical chamber where it spins around horizontally until it runs out of velocity. At that time, it drops through an opening in the bottom of the chamber into a container. The helical chamber can be ordered in one of two sized, small for handgun ammunition only, or large, for rifle and handgun. The deflector plates are modular and can be readily replaced. The trap uses no lubricants or other additives and has a provision for attaching a vacuum filter system to control lead dust.

On February 8, Randy Young and David Evans visited Action Target in Provo, UT. Action Target makes a horizontal helical trap with deflection plates more conventionally placed on the top and bottom. Unlike the SRI trap, the bullet enters the Action Trap from the deflection plates and is guided by a helical chamber to an impact plate. The bullet hits the impact plate and fall through an opening in the bottom of the trap into a container. The trap is available in a variety of widths, from 3 to 8 feet. A vacuum filter system is also available to control lead dust and smoke.

On February 9, Gene Fabian, Randy Young, and David Evans visited Tinker AFB near Oklahoma City, OK to talk to Range Manager Larry Dike and visit the range where an Action Target bullet trap system was recently installed. Tinker AFB fires both rifle and handgun ammunition on the range. Mr. Dike stated the trap installation was driven by environmental considerations primarily. He was quite pleased with the trap system and explained in detail how it worked, including the operation of the filter system. Tinker AFB is keeping detailed records on the performance of the system and offered to share that information with the Army.

SECTION 6

ILLUSTRATIONS



Use – This range permits shot grouping, battle sight zeroing, 25 m scaled target practice, proficiency C course firing (Fig B-17)

Characteristics:

Number of firing positions – 110 lanes

Firing line width – 440 m (4 m. lane).

Target area width – 440 m at furthest target (25 m)

Firing point configuration – foxholes, stumps, sandbags.

Target configuration – E-type silhouettes in fixed frames (Fig B-10) with 25 m zero targets (Fig B-1 thru B-7, B-9, B-17) or 25 m automatic rifle targets (Fig B-15)

Associated facilities – standard facilities.

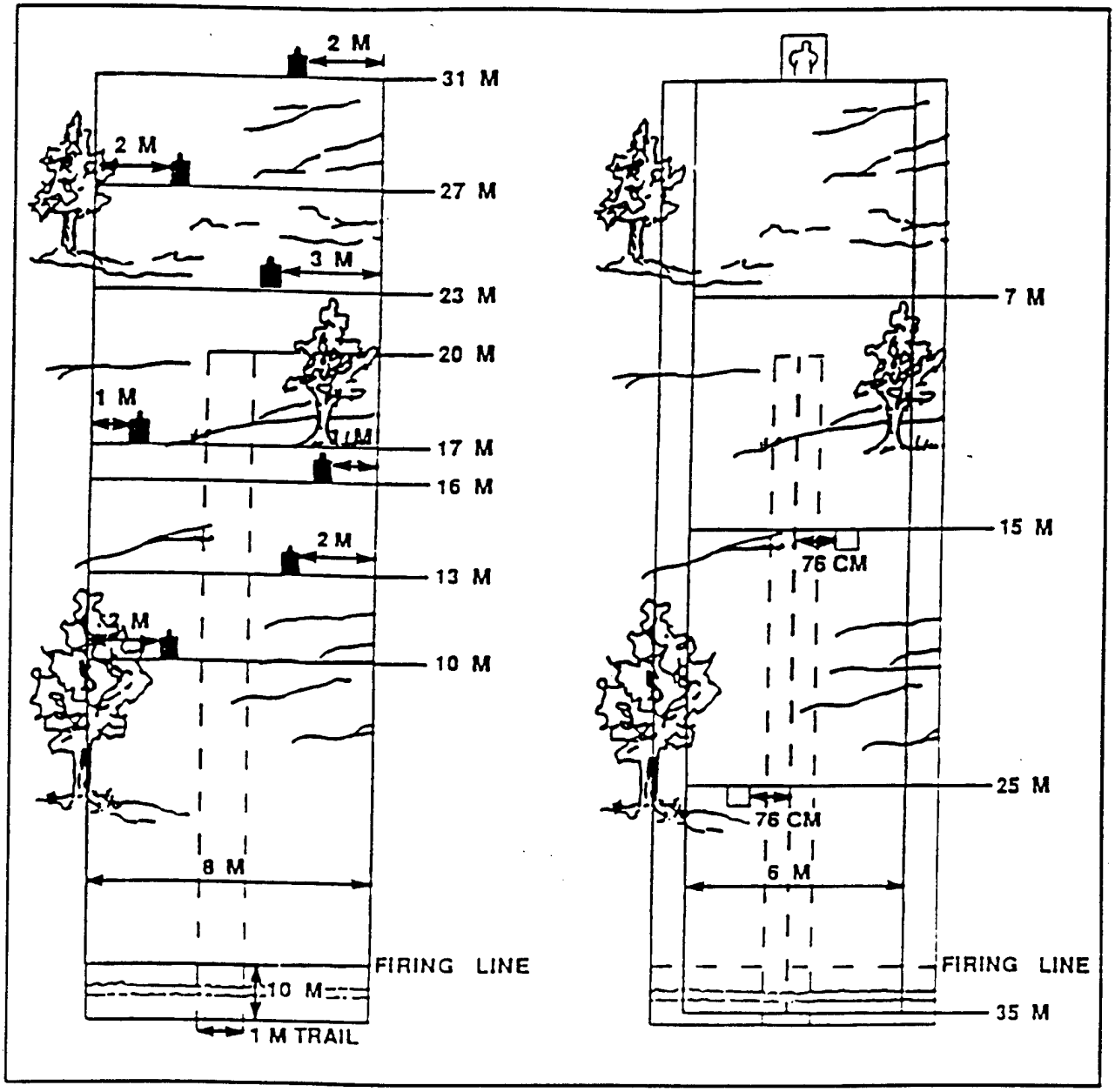
References – FM 23-8, FM 23-11, FM 23-65, FM 23-67.

Additional Information: 25 m recoilless rifle targets (Fig B-32, B-33) used when range is for subcaliber firing. Rather than construct a new machine gun 10 m range, the first 20 lanes of this range may have stands for target boots installed at 10 m if the range meets appropriate safety standards. Add MG 10 m range only if land is available to provide the required safety fan.

This range can be used for night fire (Fig 6-8, option 3).

Basic 25-meter firing range (zero)

Figure 6-1.



Use: The CPQC (on the left) is used for instructional firing and combat pistol qualification. The MPFQC may be overlaid on this range (shown on the right)

Characteristics:

Number of firing positions – 15 lanes.

Firing line width – 120 m (8 m per lane)

Target area width – 120 m at furthest target (CPQC 31 m; MPFQC. 35m).

Firing point configuration – CPQC. slightly raised area; MPFQC. 2 portable barriers, one 24" wide X 28" high at 25 m from the target; one 24" wide X 30" high at 15 m from the target.

Target configuration – CPQC: 7 E-type silhouettes (Fig B-11) with electrically activated, target-elevating mechanisms on each line. Targets located at 10, 13, 16, 17, 23, 27, 31 m. MPFQC: standing silhouette pasteboard target.

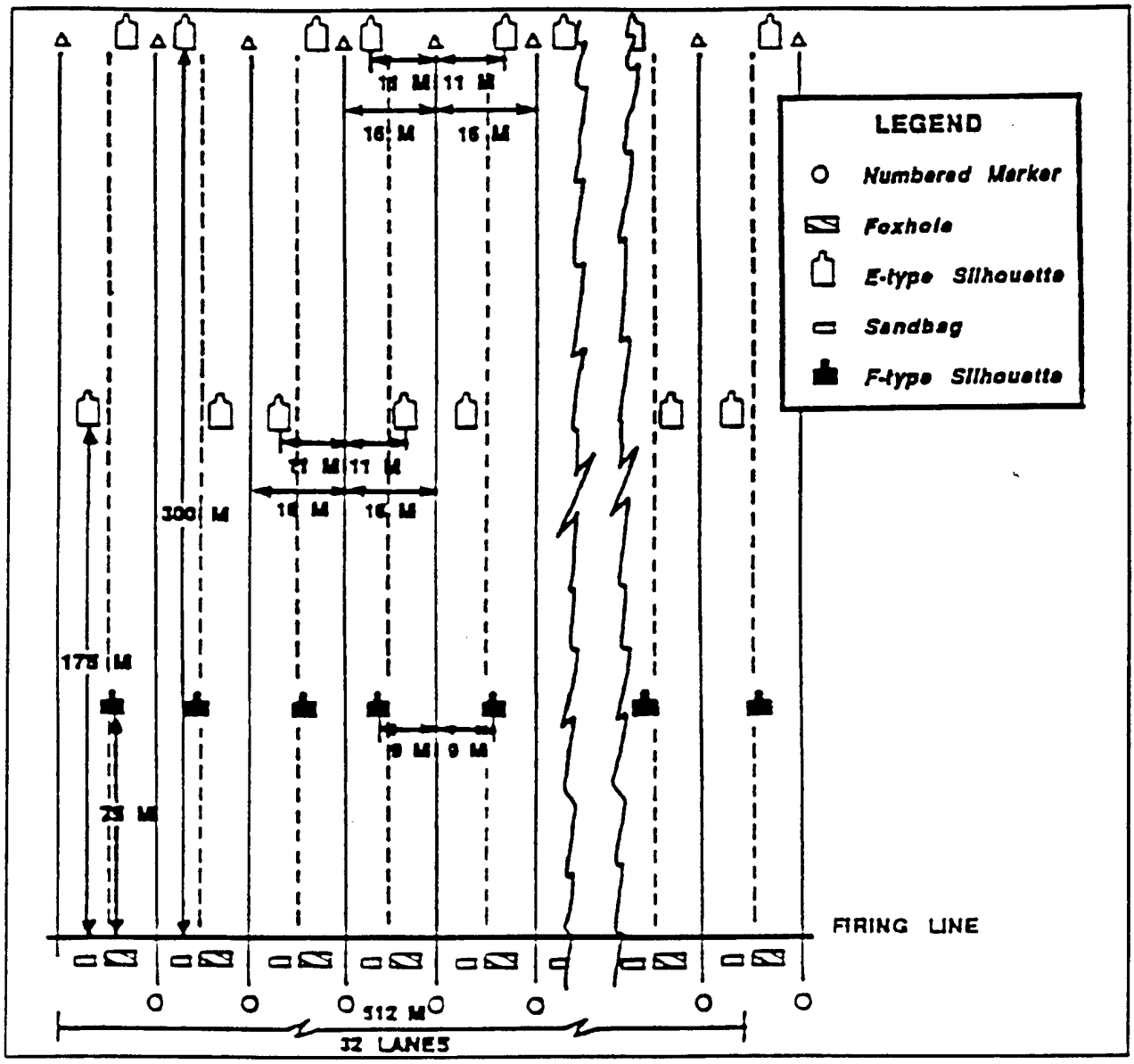
Associated facilities – standard facilities.

References – CPQC: FM 23-35, STP 7-11B1-SM, STP 7-11B24-SM, CEHND 1110-1-15; MPFQC: FM 19-10, CEHND 1110-1-15.

Additional Information: CPQC. each lane is a minimum of 31 m long; all lanes are exactly alike. MPFQC. each lane is 35 m long; all lanes are exactly alike.

Combat pistol qualification course (CPQC)/military police firearms qualification course (MPFQC)

Figure 6-2.



Use: Soldiers fire at targets at distances comparable to those on battlefield, develop speed in target engagements, develop confidence in individual ability. The range may be adapted for night firing.

Characteristics:

Number of firing positions – 32 lanes

Firing line width – 512 m (16 m per lane)

Target area width – 512 m at furthest target (300 m)

Firing point configuration – foxholes, stumps, sandbags

Target configuration – 3 banks of targets having elevating mechanisms parallel to firing line: F-type silhouettes (Fig B-12) at 75 m, E-type silhouettes (Fig B-11) at 175 and 300 m.

Associated facilities – standard facilities.

References – FM 23-9, HNDM 1110-1-5.

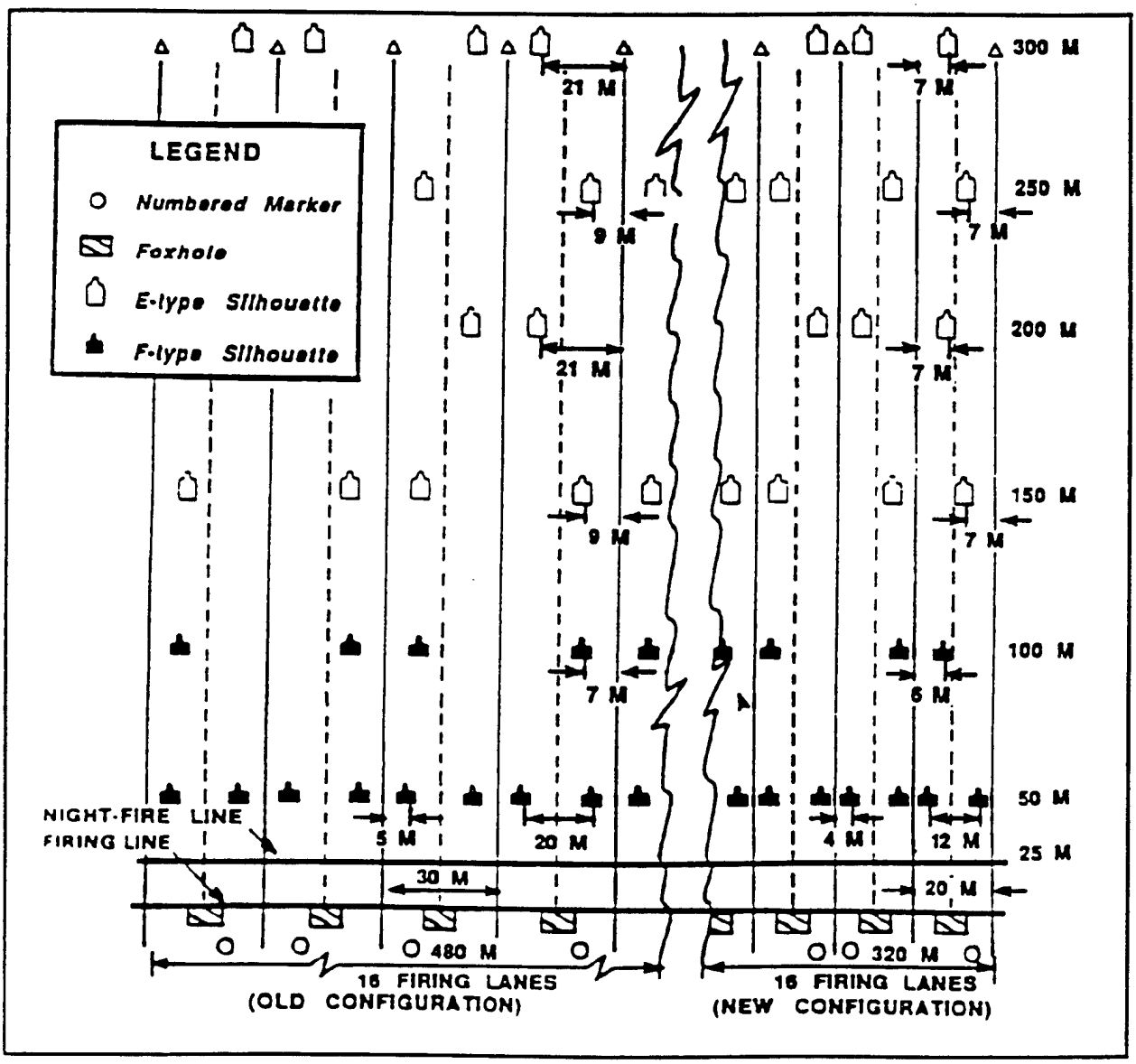
Additional Information: For downrange feedback field firing, 75 m (Fig B-6) and 175 m (Fig B-7) feedback targets should be used at those indicated distances as well as loudspeakers located downrange.

This range may be used for automatic rifle practice.

Except for initial field firing exercises, targets are exposed for prescribed periods of time.

Automated field-fire (AFF) range

Figure 6-3.



Use: Soldiers practice engaging personnel targets in a simulated combat environment. Soldiers can also receive a qualification rating.

Characteristics:

Number of firing positions – 16 lanes.

Firing line width – 480 m (30 m/lane maximum); new ranges may use 20 m lanes.

Target area width – 480 m at furthest target (300 m).

Firing point configuration – foxholes, numbered markers.

Target configuration – 7 silhouettes with elevating mechanisms in each lane: 2 F-type silhouettes (Fig B-12) at 50 m (2 m apart); 1 F-type silhouette at 100 m; 1 E-type silhouette (Fig B-11) at 150, 200, 250, 300 m.

Associated facilities – standard facilities, ready area (waiting station where gunners cannot see targets), retired area (weapon-cleaning, personnel-holding station).

References – FM 23-9, HNDM 1110-1-5.

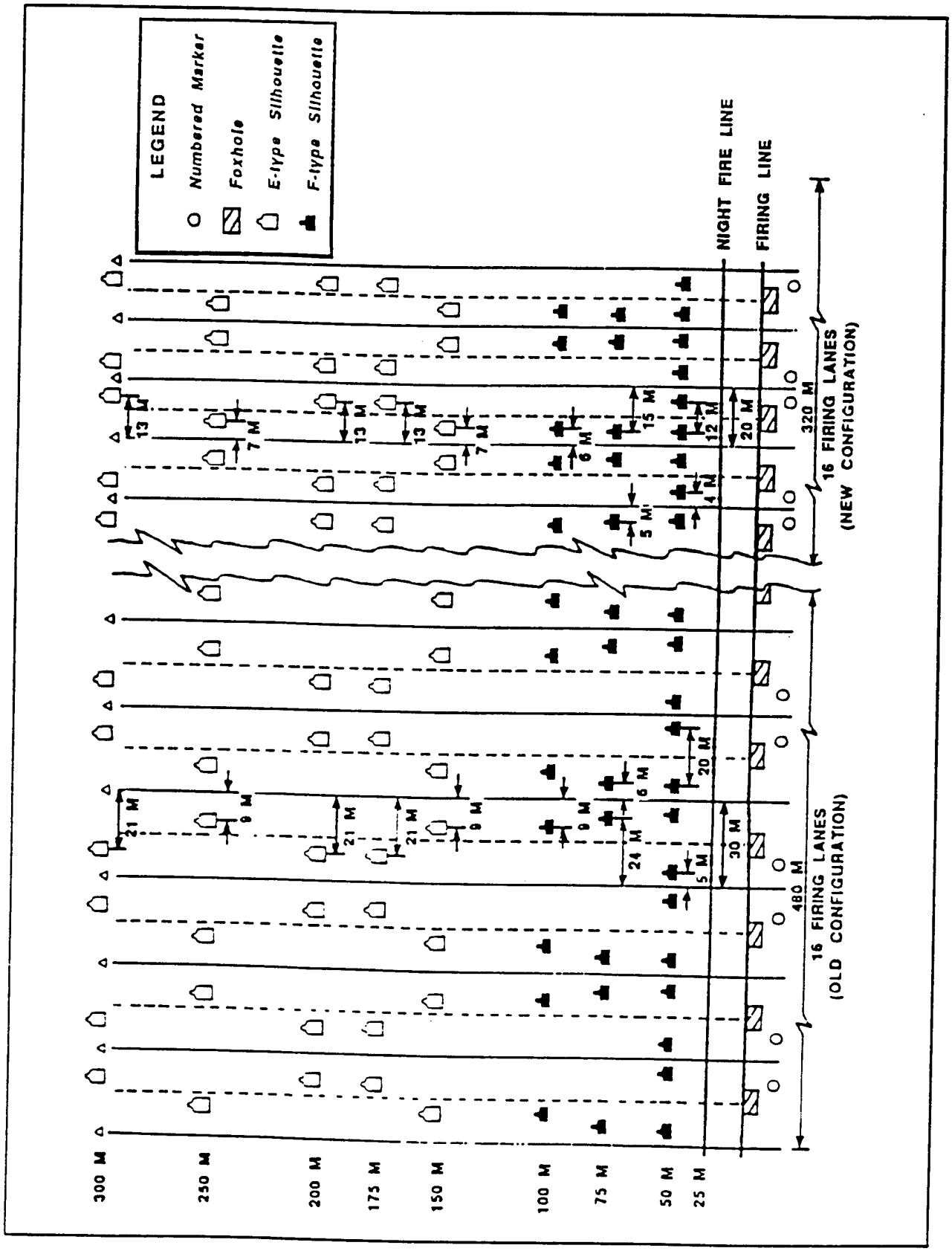
Additional Information: Terrain in target area slopes downward gradually approx 200 m, then upward gradually approx 110 m.

Target-elevating mechanisms are centrally and individually controlled. Computers connected to target sensors record performance.

Night firing is accomplished from the night-fire line, using 50 m, single E-type silhouettes at 25 m.

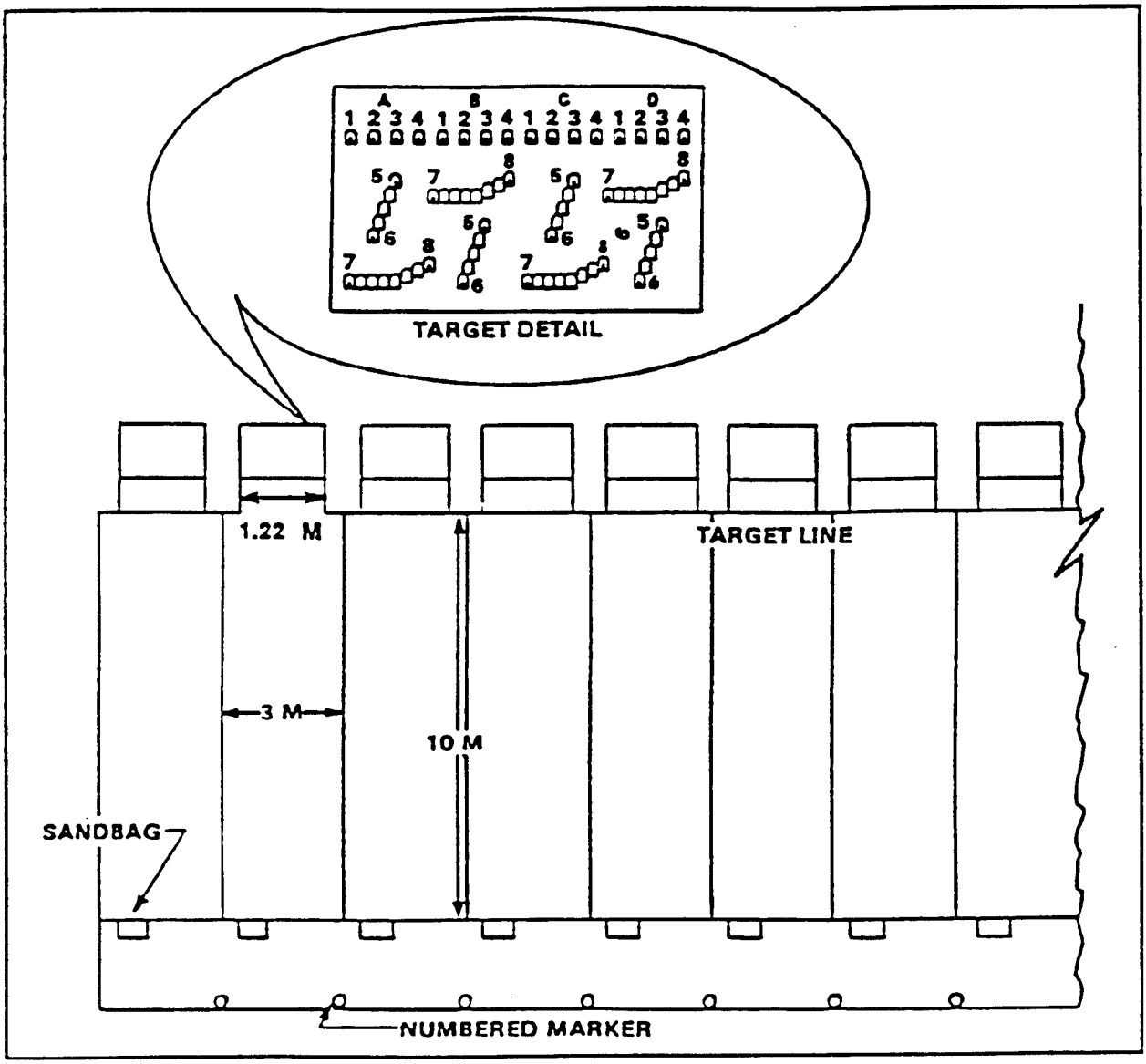
Automated record-fire (ARF) range

Figure 6-4.



Modified record-fire (MRF) range

Figure 6-5.



Use: Soldiers use this range to zero M60 and M2 machine guns and squad automatic weapon (SAW), to fire the 10 m portion of record fire, and to become familiar with weapon characteristics, noise, and recoil. They use this range to practice machine gun traversing and searching, to develop speed during operation, and to obtain an accurate burst. They can also zero M60 and M2 machine gun night vision devices.

Characteristics:

Number of firing positions – 20 lanes (if overlaid on 25 m zero range, use only 20 of 110 lanes).

Firing line width – at least 3 m/lane.

Target area width – (a) m at furthest target (10 m)

Firing point configuration – numbered markers on slightly elevated, sodded ground; brass deflectors between lanes.

Target configuration – machine gun, 10 m marksmanship targets (Fig B-30) stretched over a wood frame, one on each lane.

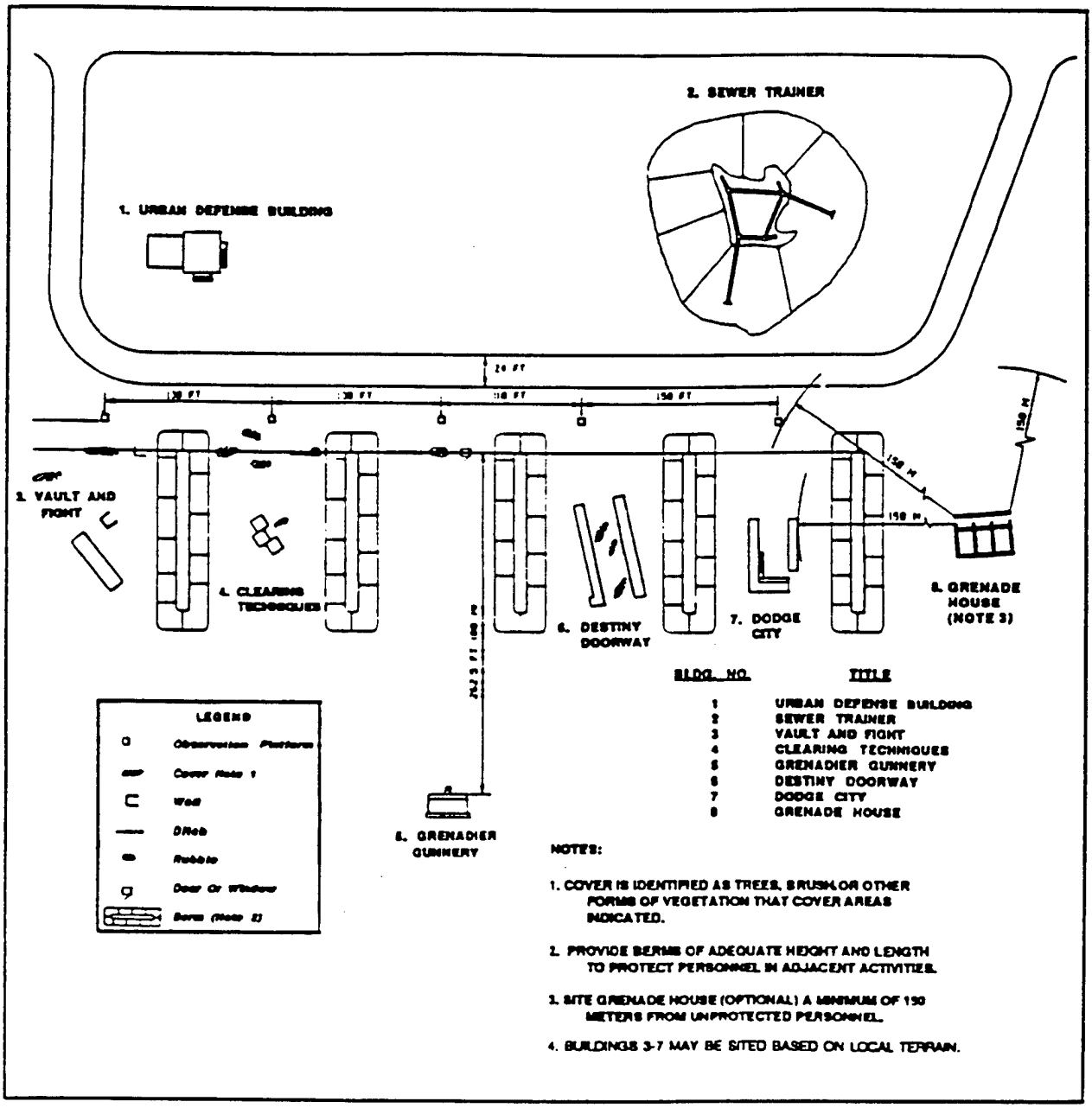
Associated facilities – standard facilities, public address system, bleachers.

References – FM 23-14, FM 23-65, FM 23-67.

Additional Information: Before building a new MG 10 m range, make every attempt to modify a 25 m rifle range for this use. Action will depend on the number of MG and the installation's other needs for range time. If range limits permit, this range may be used for 10 m firing of the M2. If using a 25 m range, lane width will be 4 m.

Machine gun 10-meter range

Figure 6-6.



Use: This range facility is used for individual and low-level collective training using live-fire or MILES.

Characteristics:

Number of firing positions – 8 training structures.

Firing line width – 20 m between training structures

Target configuration – course should be site-adapted

Associated facilities – standard facilities

References – FM 90-10(HTF), FM 90-10-1(HTF), ARTEP 7-20-MTP, CEHND 1110-1-7

Additional Information: Each training structure supports one or more individual/low-level collective tasks.

Vegetation should be left natural. Course preferably is located adjacent to an impact area or surface danger zone.

Site the grenade house a minimum of 150 m from unprotected personnel (see AR 385-63).

Low-level collective skill proficiency is attained in this range facility before advancing to the MOUT collective training facility

Military operations on urbanized terrain (MOUT) assault course (MAC)

Figure 6-7.

SECTION 7

REFERENCES

SECTION 7

REFERENCES

1. U.S. Army, February 1992. *Training Ranges*, Department of the Army Training Circular 25-8.

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3. Army Infantry Center and Fort Benning, March 1989. *Catalogue of Live Fire Ranges and Artillery/ Mortar Firing Points*, USAIC Pamphlet 210-21.

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5. U. S. Army Training Center and Fort Jackson, June 1994. *Range Operations*, Fort Jackson Regulation 350-14.