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ANALYSIS OF GUNNERY TRAINING FOR THE BRADLEY INFANTRY FIGHTING VEHICLE

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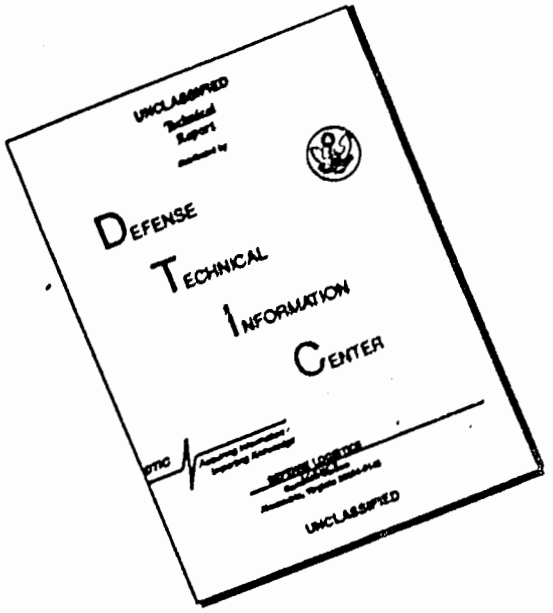

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This report examined areas of potential improvement to gunnery training evident during the initial stage of introduction of the Bradley Infantry Fighting Vehicle to U.S. Army units. The analysis consisted of a synopsis of available literature on gunnery requirements and tasks; an overview of then-current training practices, programs of instruction, and training resources; and consideration of available and projected training devices. This analysis provided a basis for selection of specific topics for further research to aid in

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the development of gunnery training programs, gunnery rules and procedures, and approaches to the evaluation and refinement of gunnery training devices.

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ANALYSIS OF GUNNERY TRAINING

FOR BRADLEY INFANTRY FIGHTING VEHICLE

Introduction

This report summarizes the results of an analysis of available data on the current Bradley Infantry Fighting Vehicle (BIFV) gunnery training system. It includes both institutional training at Fort Benning and Unit training. It also considers the recommendations for training programs development and applications presented in Department of the Army Field Manual 23-1 (Test) Bradley Fighting Vehicle Gunnery, (1983).

Requirement and Purpose

This analysis is part of a larger study to improve the understanding of and training for night fighting operations with the Bradley Infantry Fighting Vehicle. The overall study was requested by the US Army Infantry School (USAIS), Fort Benning, GA, and is co-sponsored by the Training and Doctrine Command (TRADOC), Training Technology Activity, Fort Eustis, Virginia.

The requirement for improved doctrine and training for night fighting stems from the increased emphasis on the need for continuous operations against a potential enemy which stresses 24 hour operations and night fighting. Simultaneously, the introduction of the Bradley into infantry battalions has surfaced a need for updated tactical doctrine and training to maximize the effectiveness of the Bradley-equipped Infantry. Further, more and improved night fighting devices are also becoming available in the infantry battalion including the improved capabilities for target detection and engagement provided by the Bradley's thermal Integrated Sight Unit (ISU). Thus, this study was designed to identify needed improvements in tactical doctrine and training and to provide recommendations to optimize the Bradley's fighting effectiveness in the combined arms team.

The study placed special emphasis on the requirements for fighting at night and under other limited visibility conditions; however, it has been necessary to examine all aspects of current Bradley tactical doctrine and training in order to understand the similarities and differences in the demands and requirements of the night fighting environment. Therefore, the study has examined the entire range of infantry battalion requirements and operations, day and night, as a basis for determining the special demands and requirements to be considered under night and limited visibility conditions.

This report covers only the analysis pertinent to the training of Bradley gunnery in the context of the tactical and technique related requirements for effective use of the various weapons systems of the Bradley. A companion report covers the review and analysis of current tactical doctrine for the Bradley and presents recommendations for improvement (Rollier, R. L., Salter, M. S., Perkins, M. S., Bayer, G. C., Strasel, H. C., Lockhart, D. C., Kraemer, A. J., and Hilligoss, R. E., 1984.)

The following sections present a brief overview of the Bradley Fighting Vehicle's capabilities, history, development, and missions in operation as a member of the combined arms team.

Background and History

The Bradley Infantry Fighting Vehicle (BIFV) provides unique capabilities for the infantry in operation with the combined arms team to support the doctrine developed in the Army 21 concepts. The Bradley provides weapons and mobility capabilities far in excess of the M113 armored personnel carrier (APC) it is replacing. Its uniqueness also raises questions about the tactical employment of these capabilities and the tactical doctrine which is needed to provide training developments for Bradley individuals and units. Thus, the Bradley constitutes a major improvement in potential infantry effectiveness on the battlefield. But this potential cannot be realized without adequately defining the Bradley's roles and how best to prepare commanders and soldiers to carry out these roles accurately, efficiently and effectively.

This requirement has led to unique training problems for both institutional training (Fort Benning) and unit training for transition and sustainment. This uniqueness is not only in the area of tactical doctrine, although that is of major importance. The new combination of the weapons systems on the Bradley places new requirements for training for multiple turret-mounted direct fire weapons on the infantry training system. A brief overview of the BIFV weapons capabilities is presented next, followed by a sketch of the development and evolution of infantry fighting vehicles in modern Armies.

Bradley Infantry Fighting Vehicle - Weapons Capabilities

The Bradley carries two major weapons and two relatively lesser systems in addition to the full complement of individual and crew served weapons carried by the squad members in the rear of the vehicle. The major weapons are the 25 mm chain gun, designed to defeat lightly armored vehicles and provide destructive and suppressive fire out to 3000 meters, and the TOW (the Tube-launched, Optically-tracked, Wire-guided heavy anti-armor weapon), designed to defeat main battle tanks out to 3750 meters.

The auxiliary weapons systems are the 7.62 mm machine gun mounted coaxially with the 25 mm, and the six 5.56 mm modified M16 rifles mounted as firing port weapons in the rear compartment of the vehicle and operated by the squad members. The 25 mm, the TOW, and the Coaxially mounted Machine Gun (COAX) are normally operated by the Gunner who shares the two-man turret with the Bradley Commander.

Given these weapons' capabilities, the BIFV is a potentially highly effective fighting machine capable of destroying almost anything it may meet on the fluid battlefield dictated by the doctrine of Army 21. The BIFV is also a higher priority target than the armored personnel carriers of the past. Infantry and combined arms commanders at all levels must be aware of these facts and must consider them in all aspects of Bradley employment. The doctrine and training necessary to assure this awareness needs to be developed and implemented; this overall study is directed toward providing an improved basis for such awareness.

History of the Infantry Fighting Vehicle

Necessary training can only be determined by first deciding what needs to

be trained, but that is dependent in part on the role the BIFV is to fulfill on the battlefield. The history of the Infantry Fighting Vehicle concept is necessary to determine what this role has been and what it is evolving to be.

The first Soviet Infantry Fighting Vehicle was the BMP. The BMP was designed with a cannon and missile combination so that the vehicle could itself be a tank killer at both near and far ranges. Firing ports were added so that an infantry squad could fight from the vehicle. The concept of fighting from the vehicle added protection for infantry soldiers who were supporting the tanks and retained the mobility of the squad carrying APCs. The attack would not be limited to the speed of the foot soldier, but the infantry would be able to defend and attack from under armor protection when desired and to dismount for performance of all usual infantry tasks for both defense and attack. The BMP has evolved over time to continually refine and adapt the concept of an Infantry Fighting Vehicle.

Shortly after, Germany introduced the Marder. The Germans refined the IFV concept to include a chain gun rather than a cannon and missile combination. The chain gun further defined the infantry's role to that of supporting tanks in the attack and not that of tank killers. Tank killers were being added to the battlefield with such vehicles as the Jagdpanzer Kannon, and an infantry fighting vehicle was needed to provide speed and support to the tanks in the attack. The Germans added a missile (the Milan) to their vehicle to be used mainly by the dismounted infantry squad in the defense.

With the introduction of the Bradley, the U.S. has adopted the German concept of a chain gun but included the TOW as a permanent part of the vehicle. This allows the BIFV both roles: tank killer in the defense (similar to the Soviets) and support and mobility in either the offense or the defense (similar to the Germans).

The BIFV's mission

The differences in BIFV and other IFV developments stem in part from differences between the U.S. concept of war and those of the Germans and the Soviets. The Soviet philosophy calls for an overpowering attack supported by artillery, infantry and armor. The German concept is to hold the Soviets at the German border because they lose their whole country if they give up much ground. The U.S., in contrast, believes in a highly flexible defense and attack, as dictated by the situation, using the terrain to provide cover and concealment to any unit.

The BIFV was designed to make maximum use of the terrain in providing overwatch and establishing defensive positions. The vehicle's height allows clearing many obstacles and the 25 mm or the TOW can be fired from hull defilade on the rear side of a hill. The dismount element is able to work in conjunction with the vehicle commander in the turret in providing support for the attack, while long range anti-tank and anti-IFV fires can be provided on the defense. Similarly, the dismount element is available for MOUT (Military Operations in Urbanized Terrain) and forest environments, and providing local security.

In contrast, the German vehicle includes the potential for a mounted attack but the doctrine is more defensive. Their 20mm chain gun is designed to kill other IFVs and dismounted infantry. The dismount element generally has responsibility for the Milan, although it can be mounted on the vehicle.

Thus the German approach includes two separate and loosely connected forces: a vehicle and a dismount element. By separating the two elements, the Germans double their defending forces protection.

The Soviets have added a 30 mm chain gun to some later models of the BMP. The Soviets orignally introduced their BMP with the 30mm gun in Afghanistan where they have found its greater elevation advantageous in comparison to the earlier 73mm gun. The Soviet fielding of this new BMP in Germany is an indication that they believe it may also be of use against NATO.

At this time, the Bradley is the most advanced and most powerfully armed IFV in the world. This study and the resulting data inputs to the training and doctrine development staffs at USAIS are intended to help the infantry maximize the effectiveness of the system on the battlefield of the 1980's and 1990's.

Recent Thrusts Driving This Study

In addition to the background described above, several recent US Army thrusts have given impetus to this study and generated US Army Infantry School (USAIS) interest in its results. These include:

1) Emphasis on night and limited visibility operations and training - Soviet concentration on successfully training for and carrying out of night operations as part of their philosophy of 24-hour operations has led the Department of the Army to stress the development and conduct of extensive training in night operations for the US Army. This has been translated into Divisional requirements for selected units to conduct as much as 33 to 66 percent of all training under night and limited visibility conditions. The acquisition of the thermal sight capabilities (the M1 tank, the M2/3 Bradley, TOW, Dragon, and other weapons) together with improvements in STANO devices have added to the impetus to train more under limited visibility conditions.

2) Drive to conserve/reduce training ammunition expense - Increasing constraints on budgets continue to force the conservation of available resources and the attempt to maximize the training effectiveness of all available resources. This thrust has increased the impetus to develop a sound basis for improved training developments which also meet the requirements posed by the new capabilities and the emphasis on night and limited visibility operations. This demand also drives the need to identify and verify current and projected expenses for training ammo, ranges and training devices requirements, and to assure that these scarce resources are used as effectively as possible.

3) Need to investigate further simulation / substitution / miniaturization in gunnery training - Directly related to the above are the current efforts of the Standards in Training Commission (STRAC) to augment training effectiveness and reduce costs through the increased and more effective use of simulation, substitution and miniaturization in training programs. The STRAC Program Directorate at the US Army Training Support Center (USATSC) is the DA Executive Agent for evaluation of STRAC. The commission, chartered by GEN Vessey on 9 March 1982, has the mission of prescribing "the quantities and types of munitions, by weapon system, essential for the soldier, crew, or unit to attain and sustain weapons gunnery proficiency relative to designated levels of unit readiness" (STRAC Directorate Briefing, 1984). The drive of the Commission and the interest of the STRAC Program Directorate both support this USAIS program of experimentation and development in the arena of training developments, since a

major part of the program is to examine and evaluate simulation, substitution and miniaturization possibilities for Bradley gunnery training. A major output of the study should be data to assist the USAIS and TRADOC in developing strategies for further development and utilization of both new and conventional training devices in Bradley gunnery training.

Methodology and Report Organization

This study of Bradley gunnery training has been directed toward understanding areas of potential improvement in the current training. The goals are to identify, evaluate, and implement training improvements and to promulgate them throughout the Army .

The study was initiated with an extensive review of the available literature on the BIFV, its gunnery requirements, tasks, training materials, and Programs of Instruction (POIs). These sources provided much detailed data on the actual performance requirements of the Bradley gunnery team and about the specifics of gunnery training at Fort Benning. Information from these sources was augmented by observations of training at Fort Benning in both the Gunners Course and the Master Gunners Course. Observations included both classroom training and range sessions, including subcaliber fire at Brinson Range and Ruth Range and full caliber firing at Ware Range, and Ruth range. Subsequent visits to Bradley equipped units, including the 1/15th Inf (Mech) in USAREUR, the 1/41st Inf (Mech) at Fort Hood, and the 1/29th Inf (Mech) at Fort Benning, provided observational and interview data on unit training.

This data collection effort was necessary to develop a knowledge base from which to proceed. The knowledge base was essential to the analysis of the problems and potential solutions, and the definition of the evaluation and experimental efforts necessary to demonstrate the value of identified problem solutions. These data are being used in conjunction with other data (Threat analyses, review of STANO devices capabilities and review of human performance in exceptional conditions, in particular) to derive a total picture of the requirements for gunnery training, the realities of current training, and potential training improvements.

The remainder of the report presents an analysis of Bradley gunnery training and task requirements; an overview of current POIs, practices and approaches used in Bradley gunnery training, both institutional and in units; considerations of currently available and projected training devices in relation to the training requirements; and, the current status of ammunition and range resources for Bradley training.

The next section examines the gunnery training as currently conducted in institutions and units. It begins with a review of the current doctrine and philosophy of the U.S. Army Infantry School with respect to Bradley gunnery training as prescribed in FM 23-1 (Department of the Army Field Manual FM 23-1 (Test): Bradley Fignthing Vehicle Gunnery, 1983). It continues with an analysis of BIFV gunnery task requirements for the Bradley Commander, Gunner and Driver, to identify the tasks most critical for successful gunnery performance. It then examines the approaches and practices being followed in institutional training at Fort Benning (Gunner and Master Gunner courses). Some areas are identified in which the training fully meets the requirements as well as other areas in which the requirements are not fully satisfied. The section then

reviews and examines Unit training as observed in field visits. This section also identifies strengths and weaknesses in current training in comparison with the identified critical training requirements.

The fourth section of the report reviews current and projected training devices and other aids. The device characteristics are examined in relation to the task training requirements to determine their applicability to current or future training. Devices examined are assessed as to their immediate applicability and/or their potential value in training program development. In some cases the device potentials need to be further tested to determine their greatest effect in maximizing their contributions to Bradley gunnery proficiency.

The fifth section reviews range and ammunition requirements to support Bradley gunnery training. This includes current planning and allocations based on projections for quarterly and annual live fire requirements for all Bradley teams.

The final section presents conclusions and recommendations concerning the current status and further development needs for Bradley gunnery training.

Analysis of Bradley Gunnery Training

This section reviews and analyzes current BIFV gunnery training in institutions and units to improve understanding of the training requirements and the degree to which these are currently met. It begins with a review of current recommendations for Bradley gunnery training as prepared jointly by the U.S. Army Infantry School and the U.S. Army Armor School and presented in Department of the Army Field Manual FM 23-1 (Test): Bradley Fighting Vehicle Gunnery, (1983).

Next is an analysis of the major gunnery tasks required of the Bradley Commander, Gunner and Driver to better identify the training requirements for gunnery. The results of this analysis are then used as a partial basis for evaluation of the quality and completeness of current training. The evaluation is reported as part of reviews of: 1) the USAIS institutional training in Bradley gunnery; and 2) training reported in Bradley-equipped units (including New Equipment Training). The section is completed by a brief discussion of the requirements for further training developments and/or redirections of emphasis for institutional and unit training on BIFV gunnery.

Infantry School Guidance for Bradley Gunnery Training

The current philosophy, doctrine and guidance for all training for Bradley gunnery is presented in Department of the Army Field Manual FM 23-1 (Test): Bradley Fighting Vehicle Gunnery, (1983), hereafter referred to as FM 23-1. This manual was originally prepared by the Directorate of Training and Doctrine (DOTD) of the Infantry School in conjunction with agencies at the U.S. Army Armor School. It is being revised currently to reflect changes in doctrine, techniques of engagement, etc., and the training approaches which have been evolving at the USAIS over the past years.

The FM presents "a concise and effective program for gunnery training" (FM 23-1, p. ii). As such, the manual collects materials from many other

sources and brings them together as a single source reference. Although originally intended primarily to serve Bradley-equipped units, the FM is widely used to support institutional training as well. The training recommendations are for use by leaders, staff personnel and training personnel at all levels. The manual is directed toward training for both the Infantry (BIFV) and Cavalry (BCFV) Fighting Vehicle teams and crews.

The manual contains three major parts: Introduction and Threat; Principles of Bradley Fighting Vehicle Gunnery; and, Gunnery Training. The introduction consists of a one-page discussion of the philosophy of BIFV employment and brief statements of the purpose and scope of the manual. While the current edition contains 54 pages on the Threat, much of which is duplicative of other materials available to students, USAIS indicates this is to be reduced or eliminated in the next edition of the FM.

Principles of Bradley Fighting Vehicle Gunnery

Part Two on Principles of Gunnery contains ten chapters covering the subjects gunners should practice and master to be effective. The treatment of some areas (e.g. - Weapons Systems Description and Fire Controls) is quite brief. However, these sections are extracts from the BIFV technical manuals which are readily available to trainees in USAIS courses and in the Bradley units should more detailed information be required. Of course, this duplication is intentional and necessary to make this single source reference effective for use in refresher/sustainment and transitional training of personnel in units. Chapters 3 (Weapons Systems Description and Fire Controls), 4 (Prepare to Fire), 6 (Ammunition), 7 (Target Acquisition and Identification), 8 (Range Determination) and 9 (Direct Fire) present brief summaries of these areas and are used as the basis for instruction in the Gunners and Commanders courses as well as for unit instruction.

Chapters 5 (Bradley Squad Duties), 10 (Limited Visibility Engagements), 11 (Fire Distribution and Control), and 12 (Aerial Engagement Techniques) appear to go somewhat beyond the materials taught in the School gunnery courses. Although briefly, Chapter 5 discusses the duties of the other squad members in the Bradley and relates these to the BIFV's gunnery requirements. Chapter 10 briefly discusses Limited Visibility Engagements and is unique in that it brings together in one place information that is not similarly grouped in USAIS instruction. Although the coverage is rather scanty, the chapter discusses the specific use of fire control instruments (azimuth indicator on the turret ring, gun elevation pointer on the gun rotor, and the turret position and slope indicators) in relation to construction and use of range cards and staked fire positions to aid in limited visibility engagements. This presentation should be quite helpful to the gunner trainees.

Similarly, the tactically-oriented materials on Fire Distribution and Control (Chapter 11) and Aerial Engagement Techniques (Chapter 12) are brought together in a single source for easy reference. Although much of this is paraphrased from other tactical manuals (Department of the Army Field Manual FM 7-7J: The Mechanized Infantry Platoon and Squad (Bradley), 1983, and Training Text TT7-71-1J: The Mechanized Infantry Company Team, 1982), this presentation in the context of a gunnery manual brings the information more readily to the soldiers who need it in USAIS and in units.

Overall the principles of BIFV gunnery are well presented and can provide a good basis for unit sustainment/refresher or transitional/cross training. Transitional (training M113 personnel in Bradleys) or cross training (training other squad members to perform gunner duties) would undoubtedly require additional materials and knowledgeable instructors, but this manual provides the base for such instruction.

Gunnery Training

Part Three of the manual consists of seven chapters defining a unit training program and how to carry it out. This includes a detailed presentation of the Bradley Gunnery Skills Test (the BGST--designed to evaluate squad/crew performance of 15 tasks). It also recommends an annual BIFV gunnery training program for units (Chapter 14) and describes the elements and the exercises required in the unit to fulfill this suggested program (Chapters 15 - 19).

Bradley Fighting Vehicle Gunnery Skills Test (BGST). The BGST is viewed as an important part of the training cycle; the evaluation of the success of gunnery training throughout the cycle. It is administered to all 11M members of the BIFV (M2) squad, and to all M3 crew members, on a semiannual basis. The test is the same as the evaluation used in the gunnery courses at the Infantry School including those tasks specific to the other squad members in the units. The tasks and squad members to be evaluated in the test are listed in Table 1. The chapter includes testing procedures and guidance on scoring and evaluating each task performance. Each Bradley squad or scout crew must pass the BGST prior to entry into training with either subcaliber or full caliber firing tables.

Although this test is the latest version available, USAIS has indicated that the whole chapter dealing with this test is to be revised in the near future (BFVS-TSM FM 23-1 Errata Sheet, April 1984). Information on specific revisions to be made was not available at time of reporting.

Bradley Fighting Vehicle Gunnery Program. Chapters 14 through 19 lay out a progressive gunnery training program for M2/M3 teams/crews. The overall program is addressed in Chapter 14 and the following chapters describe how to meet the specific requirements of each exercise portion of the overall program. Table 2 shows the overall training program as proposed by the Infantry School. This consists of a series of training and evaluation exercises based on a yearly training cycle. It calls for two qualification periods plus the ARTEP exercise annually.

The program is designed to train and evaluate Bradley team/crew proficiency in all recommended gunnery techniques under all field conditions, including varying weather and visibility conditions. Exercises are intended to be as realistic as possible, but actual exercise design and conduct is left in part to the individual unit, based on recognition of variations in local training conditions, time constraints, range availability and local training area (LTA) restrictions. Specific recommendations are that range firing and exercises must be continued during periods of reduced visibility caused by various weather conditions and that night training must be a part of the program. The firing exercises "are intended to qualify a Bradley-equipped platoon/section on gunnery skills against realistically depicted targets. . . . (and) . . . to maximize the Bradley weapon systems' effectiveness" (FM 23-1, p 14-1).

Table 1. Bradley Gunnery Skills Test Tasks

Skills Test Tasks	Squad Members	Bradley Cdr/Gunner
Vehicle Recognition	X	X
Load 25 mm ready boxes	X	X
Apply immediate action to 25 mm Gun		X
Load Coax machine gun		X
Apply immediate action to Coax MG		X
Load TOW system	X	X
Perform misfire procedures on TOW		X
Remove a misfired TOW missile	X	X
Load smoke grenade launchers	X	X
Perform misfire procedures on the M257 smoke grenade launcher	X	X
Boresight 25 mm automatic gun		X
Boresight Coax MG		X
Boresight TOW launcher		X
Prepare a range card		X
Acquire/track targets with turret weapons		X

Reproduced from p. 13-2 of Department of the Army Field Manual, FM 23-1 (Test): Bradley Fighting Vehicle Gunnery, December 1983.

Table 2. Sample Annual Unit Gunnery Training Program

	QUAL I				QUAL II					ARTEP		
Months:	1	2	3	4	5	6	7	8	9	10	11	12
PRELIMINARY GUNNERY TRAINING		X					X				X	
GUNNERY SKILLS TEST		X					X				X	
FIRING PORT WEAPON EXERCISE (M2)		X					X				X	
VEHICLE TEAM SUBCALIBER EXERCISE (M2/M3)		X					X				X	
FULL-CALIBER ZERO (M2/M3)		X										
VEHICLE TEAM COMBAT EXERCISE (M2/M3)		X										
PROFICIENCY FIRING EXERCISE (M2/M3)		X					X				X	
SQUAD COMBAT QUALIFICATION EXERCISE (M2)		X					X					
PLATOON EVALUATION EXERCISE (M2)		X									X	
SCOUT SQUAD QUALIFICATION EXERCISE (M3)		X					X					
SCOUT SECTION QUALIFICATION EXERCISE (M3)		X									X	

Reproduced from Table 14-1, p. 14-7, of Department of the Army Field Manual, FM 23-1 (Test): Bradley Fighting Vehicle Gunnery, December 1983.

The recommended progression of exercises is from squad/crew dry fire drills for procedures mastery, through preliminary gunnery training and subcaliber firing, to full caliber live firing. Emphasis throughout the program is placed on the 25 mm gun firing, although TOW and Coax gunnery are also addressed. Target requirements for Bradley firing are addressed for both subcaliber and full caliber firing, including both target arrays and the timing of target exposures.

Preliminary Gunnery Training. As in USAIS instruction, the program calls for training in manipulation, target acquisition, range determination, thermal sight employment, and dry fire gunnery exercises. An added training recommendation is to define and conduct squad/crew drills for all areas of preliminary training. There is verbal emphasis on target acquisition, ranging and engagement; however, much of the actual presentation is on manipulation targets (worm boards, etc.), target array designs, and scaled ranges development and usage. Of interest is the fact that although target acquisition and identification are discussed, there is no mention of available training aids (e.g.- ARI's daylight and thermal combat vehicle identification (CVI) kits (GTA 17-2-9 and -10). The chapter presents detailed tabular descriptions of five dry fire exercises which are recommended for use in squad/crew training. These involve manipulation of turret weapons, with and without turret power, vehicle movement and stabilization.

Subcaliber Gunnery Exercises. This is a series of exercises based on the use of the Brewster device with the Fiaoni adapter and either the M55 Laser or the M16 adapter (with either .22 cal or 5.56 mm ammunition). Since this manual was prepared prior to development of the Reavis-Payne refinements of the Brewster device, no mention is made of the added capabilities provided by these. Subcaliber exercises using the Brewster device (and by extension, the Reavis-Brewster device) are recommended with both the Stout board (Laser) with scaled targets and on scaled ranges (.22 cal or 5.56 mm). Target design, development and mounting for these ranges is discussed. However, no mention is made of the problems observed at Fort Benning using the ISU against scaled targets. (This concerns the inability to switch between the 4 power and the 12 power magnification and still view the scaled targets appropriately - the 12 power magnification results in inability to view the targets. This problem limits the realism of the subcaliber or Laser use of the device since normal engagement procedure is to acquire targets with the 4 power and switch to 12 power for actual engagement). Five separate subcaliber or Laser exercises are described in the tables in this chapter, including day and night exercises against both stationary and moving targets.

Bradley Gunnery - Individual, M2 and M3. Three chapters of the FM address individual, squad/crew and platoon/section gunnery training. These chapters present guidance on how to conduct and score the Vehicle Team Combat Exercise (VTCE), Squad Firing Port Weapon Exercise (SFPWE), Squad Combat Qualification Exercise (SCQE), Scout Squad Qualification Exercise (SSQE), Infantry Platoon Evaluation Exercise (IPEE), and the Scout Section Qualification Exercise (SSQE). All exercises require use of the Bradley weapons systems under both day and night conditions and under existing weather conditions. The tabular presentations of the exercises contain both directions for conduct of the exercises and scoring standards for evaluation of proficiency.

Summary of Review of Infantry School Guidance

The guidance encompassed in this field manual is entirely consistent with the current instruction at the School itself (with the exception of certain developments occurring since its publication, such as refinements to the Brewster device). The FM outlines a program for development and conduct of gunnery training with emphasis on principles of gunnery and tactical employment of the Bradley's weapons systems. There is some general discussion of both training and evaluation aspects, but little attention is given to many important aspects of Bradley gunnery. These lightly touched areas include:

1) night gunnery training—the program requires that exercises be conducted both day and night but suggests little to aid a unit trainer in how to design or conduct night exercises (apart from the structured range exercises);

2) thermal mode utilization and operation--there is essentially no information on how to train for operating with the thermal mode of the ISU, and no recommendations for thermal imagery recognition and identification training; there is also no guidance on squad use of other night vision (STANO) devices to aid the Commander and Gunner in target acquisition or identification;

3) target acquisition and identification--as for thermal mode utilization, there is little guidance and no reference to advanced vehicle recognition materials (GTA 17-2-8 Vehicle Visual Recognition is included in Appendix A, but the ARI Combat Vehicle Identification kits (GTA 17-2-9 and -10) are not);

4) range determination and estimation--documentation in the FM covers the same modes of range determination and estimation as taught in the School and suffers the same lacks; there is little detailed information that would be directly useful to unit trainers in developing a successful training program—and some information in the FM is simply wrong (e.g.- use of the choke sight as described in Para. 9-4 on pp. 9-4 and 9-5).

In summary, this manual is highly appropriate for unit use, but some information is presented in a highly abbreviated form and some desirable information is not included. Sections dealing with target acquisition and identification, range determination, and target engagement are particularly sketchy, and the resulting training information is probably insufficient for producing fully adequate unit gunnery training in these areas.

Given that the manual is under rewrite, augmentation with needed relevant additions, corrections and revisions must be incorporated into the forthcoming edition (anticipated for fielding in January of 1986). ARI should make inputs to this along the lines described in the discussion and conclusions section.

Analysis of Gunnery Task Performance Requirements

This analysis of the gunnery task performance of the Bradley team is based on a review of available descriptive material on Bradley operations, tactics and gunnery, plus POIs, and training approaches. Major inputs were the POIs for the Gunners and Master Gunners courses, the tactically-oriented training manuals (Department of the Army Field Manual FM 7-7J: The Mechanized Infantry Platoon and Squad (Bradley), 1983, Training Texts: TT 71-1J: The Mechanized Infantry Company Team, 1982, and TT 71-2J: The Mechanized Infantry Battalion, 1982), and FM 23-1, reviewed above (Department of the Army Field Manual FM

23-1 (Test): Bradley Fighting Vehicle Gunnery, 1983). Data from these sources were supplemented with observations of both institutional and unit training.

Based on the above, this section of the report defines the major gunnery related tasks required of BIFV Commanders, Gunners and Drivers. The gunnery tasks are then examined and rated with respect to several task characteristics. This analysis is to provide an improved understanding of the tasks and their relative importance for training as a basis for evaluating current Bradley gunnery training and determining what training needs remain. Subsequent sections of the report address current training and potential training devices for use in relation to these tasks.

Bradley Gunnery Tasks

Tactical employment of the BIFV and its multiple weapons systems places heavy requirements on the Commander, Gunner and Driver. The complexity of the Infantry mission and of the system itself is such that multiple tasks are often necessarily performed at once. For example, in an offensive movement, the Commander must simultaneously: 1) maintain command and control of his own vehicle (and perhaps one or more others, depending on his level); 2) be aware of, and coordinate his movements with, other vehicles in his unit; 3) maintain 360 degree observation and awareness of his advance in relation to defined objectives or phase lines; 4) maximize element security through use of terrain and other factors; 5) monitor his areas of responsibility (his sector or fields of fire) to detect and acquire potential targets; and, 6) identify enemy targets and engage as necessary. Similarly, in a defensive posture, the Commander and Gunner together must, at least: 1) select optimum primary, secondary and alternate firing positions; 2) establish cover, concealment or camouflage; 3) emplace local security; 4) define sectors and fields of fire and prepare range cards for, and mark, all firing positions; and, 5) maintain 360 degree observation and prepare for target acquisition and engagement. There are other tasks as well in each case, but these few illustrate the multiplicity of responsibilities and the complexity of the tactical and gunnery-related task requirements of the Commander and Gunner.

The Bradley gunnery tasks for the major weapons systems can be divided into those which are clearly the Commander's tasks, those which may (in some cases must) be done by both the Commander and Gunner, those tasks which are clearly the Gunner's tasks, and those tasks which the Driver must perform to assist in the total gunnery process. The Commander-only tasks include command and control, determining fields of fire, site selection, target designation and handoff and reacting to enemy fire. Tasks for both the Commander and the Gunner include observation, target acquisition, target identification, estimating target range, laying on targets, and adjusting fires. The gunner-only tasks include firing the 25 mm, TOW guidance, and Coax firing, (except, of course, that the Commander can override the Gunner in these tasks if required); the Gunner is also responsible for monitoring ammunition expenditures, reloading the 25 mm and the TOW (with assistance from other squad members), and correcting malfunctions on the major weapons. The Commander is responsible for loading and clearing malfunctions on the coaxial machine gun. This analysis excludes, for now, the tasks associated with the firing port weapons and other dismount team operations. These tasks will be treated separately below.

The following gunnery related tasks have been identified for the Bradley Commander, Gunner and Driver:

Commander Tasks:

Site selection: this involves the selection of a combat position from which to conduct the assigned mission. Although primary defensive firing positions will frequently be assigned by Company or Platoon leaders, the Squad leader must also be able to determine appropriate sites for positions which will support the platoon and higher defensive (or offensive, as in overwatch positions) plans and tactics. Many types of positions are involved in the BIFV operations: hide position, overwatch position, defilade position, turret-down position, hull-down position, dismount position, and primary, alternate and supplementary positions to meet various requirements. Commanders require training to be able to identify those characteristics of possible sites which will be appropriate to the requirements of various defensive and offensive tactics. This requirement is closely related to the next task as well.

Determine Fields of Fire: This task involves the identification of those areas or lanes which the BIFV must or can cover with fires from its main and supplementary weapons. Identification of the availability of clear fields of fire which allow broad area coverage and overlapping coverage with adjacent vehicles or units is a major aspect of the initial site selection. The fields of fire define the areas in which targets can and will be engaged. Normally, a vehicle or unit selects, or is assigned, both primary and secondary fields of fire to assure adequate fire coverage of the battlefield. The identification process includes determining the maximum ranges for engagement by each weapon system, likely engagement areas and those "deadspace" areas in which targets cannot be engaged.

Exercise of Command and Control: The major task for the Commander is the continual necessity for exercising command and control over all portions of the element he is commanding. For the Squad leader, with the responsibility for the vehicle team, the dismount team and the multiple weapons, both integral and carried on the BIFV, this may be the most demanding requirement he will face in training or in combat. For Platoon and Company Commanders, the requirement is even more complex. However, BIFV Commanders at all levels face the need to provide continuous command and control to the unit (Squad, etc.) and to provide continuous monitoring, direction and fire control for all organic weapons systems. This is especially true for the control of the 25 mm and the TOW, but applies also to the other squad weapons. The exercise of command and control (C&C) is an imporant aspect of the BIFV Commander's job which requires considerable explicit training.

Observation through 360 degrees: In both defensive and offensive operations, it is necessary to maintain awareness of friendly and enemy activity in the full 360 degree surround (as well as overhead) of the BIFV unit. The maintenance of such observation is the responsibility of the Commander and in many situations the BC (Bradley Commander) is the only person capable of providing such observation. While stationary, the observation can be accomplished with dismounted troops positioned to maintain local security. However, when mounted the Commander is the only individual who can provide the full 360 degree and overhead scanning, and then only in the open hatch mode. Overhead observation is extremely limited in either the popped hatch or closed hatch mode, but the Commander still can use the turret vision blocks to cover an approximate 280 degree field of view, excluding only the region to the left front which can be readily covered by the Driver if so directed. The Gunner is

primarily attending to his optical gun sights and can only observe the direction in which the turret is pointed. Similarly, the troops in the rear compartment can see only limited sectors from the vision blocks and cannot observe to the front at all. As discussions in both Europe and CONUS have revealed, the viewports in the rear are rarely used for observation purposes. In addition to the lack of use, there is also some doubt as to how effectively these viewing ports can be used by troops in the rear. Vibration, lack of knowledge of the mission and terrain, lack of communication and lack of vehicle identification skills all lead to difficulty in effectively using the viewports. Although identified in tactical manuals as an important aspect of command and control, this task requires emphasis in training which does not appear to exist at present except during exercises.

Reaction to Enemy Fire: This is perhaps one of the most difficult aspects of combat to train. The requirement is for near-immediate reaction with the appropriate behaviors on the part of the Commander, his entire crew and the vehicle. Appropriate action depends, of course, on the specific situation, but would normally be to attempt to engage and destroy or suppress the enemey vehicle or position. This calls for the immediate determination and execution of appropriate fire and maneuver activity. A primary response would be to issue an appropriate fire command to the Gunner to engage the enemy. In some cases, the appropriate action will include taking evasive action either prior to or simultaneously with the attempt to engage the enemy. Training for reaction to enemy fire is difficult since the stress, fear and other emotional reactions common to these situations can only rarely be simulated. However, the requirement for immediate reaction through engagement, attack or evasion remains a high priority task of the Commander and significant training is required to achieve rapid and appropriate reaction to the situational demands.

Target Acquisition: This task involves the detection and general location of potential targets. It does not include classification, recognition nor identification of the specific characteristics of the acquired potential target. The definition used in this sense is more restrictive than some definitions. Target acquisition is one of the critical problems in any defensive situation because the attacker is generally using all his skill to avoid early detection and to attempt to close within the effective range of his weapons prior to detection. This task is primarily the responsibility of the BC because of his wider field of view with the open or popped hatch; however, the Gunner shares this task and has some advantages due to the magnification (4 or 12 power) available through his optical sights. The Gunner (and the Commander) also has a considerable advantage in limited visibility conditions through the capability of the thermal sight. Target acquisition requires dedicated searching of the full field of fire, or sector, assigned to the vehicle and continual scanning over potentially long time periods. On an offensive action, the Commander must maintain this scanning behavior throughout the movement and overwatch phases. Target acquisition is an important and quite difficult task and requires considerable skill training and practice. Commanders and Gunners must be provided with adequate training in search and detection if the BIFV units are to succeed in combat.

Identification of Targets: Following detection of potential targets, the Commander must then determine whether the detection is in fact a target. This involves determination of whether it is a vehicle or other target type and more importantly whether it is friend or foe. Several steps have been defined (Smith, 1982, 1984) which can aid in this determination, such as: 1)

"classification" - the assessment of whether the detection is a non-target (a rock, foliage or other irrelevant object) or a potential target vehicle by type (e.g. - wheeled or tracked vehicle); 2) "recognition" - the determination of whether the object is friend or foe; and, 3) "identification" - the determination of what specific target or friendly vehicle is represented by the detected object. In general, the BC and Gunner must only be concerned with the classification and recognition steps of this paradigm. It is only essential that the detected object be determined to be an engageable object and whether it is friendly or enemy. However, these steps are quite difficult in the field situation, especially when targets are to be detected at ranges up to 3000 - 5000 meters. Considerable training and practice are necessary to develop and to maintain these skills, since it is important for a BIFV Gunner and Commander to know if the vehicles seen are friendly or enemy. In addition, if the object is an enemy, then the Commander needs to tell the Gunner what weapon to fire at it and at what range. This identification is the basis for the fire command to the Gunner, discussed below.

Determine Target Priority: When more than one target is acquired the Commander has the responsibility for determining which target should be engaged first, second, etc.. Targets must be ranked from first to last priority in order to insure that the BIFV engages the most serious threat first. Nearer or more dangerous targets should be engaged before farther or less dangerous targets. Considerable training in prioritization may be needed by BIFV Commanders and Gunners.

Estimate Target Range: Range estimation is an imporant and difficult task for Commanders and Gunners. The Commander must inform the Gunner of the approximate range of a target if the precision mode of gunnery is to be used. In order to come up with a range which will allow effective fire and or fire and adjust, the Commander must make a reasonably accurate judgment of the range. While range estimation is a pervasive aspect of all gunnery training which is frequently neglected in actual training, it becomes more important with the BIFV. Range estimation is difficult under the best of circumstances and is particularly difficult when one is dealing with targets beyond 1500 to 3000 meters. Even with training in range estimation being a part of every field training situation from OSUT (basic training) through the most advanced courses, range estimation skills remain a problem and are apparently subject to rapid decay with disuse. BIFV range estimation is possible using the stadia lines (Choke Sight) in the Integrated Sight Unit (ISU) optics, but this is more frequently used by the Gunner than by the Commander. The Commander and Gunner also receive training in other estimation methods (e.g. - the WORM formula and the AN/GVS-5 laser range-finder), but range estimation remains a problem in both performance and training.

Lay on First Priority Target: The Commander must determine the highest priority target of any multiple array and then lay the gun as nearly as possible on that target. The intent is to lay the gun as closely as possible to the target, but in any case to lay it so that the selected target is within the field of view of the 4 power optical sight of the Gunner. This may be performed simultaneously with the determination of target priority and/or target range. This task involves using the right hand control stick to move the gun and turret so that the optical crosshairs are as near as possible to the highest priority target. The Commander may accomplish this by directly viewing the crosshairs

through the optical sight (the Commander's extension) or by estimation of gun position using the external vane sight or other indicator of gun barrel location. These skills require training and practice with realistic targets and crew exercises with both Commander and Gunner involved.

Hand off and Fire Command: When the Commander has selected and laid the gun on the first priority target he must then hand off the target to the Gunner and direct his fire at the selected target. This is accomplished through a fixed sequence of commands which; 1) alert the Gunner to prepare to engage a target; 2) identify the weapon or ammunition to be used to engage the target; 3) identify the type of target to be engaged; 4) define the range for precision gunnery or the use of "battlesight" range as an alternative; and, 5) direct execution of the command. An example fire command to fire at a BMP at 2000 meters would take the following form:

Gunner!
SABOT!
BMP!
2000 meters!
Fire!

The actual fire commands vary dependent on the weapon selected (HE or SABOT for the 25 mm and TOW for the antitank weapon) and on the mode of fire desired: precision gunnery requires the Commander to specify a range to the target; if the Commander says "Battlesight", the Gunner uses the preselected battlesight range, normally 1200 meters. This is a somewhat complex task which involves cognitive behavior and decision making on the part of the Commander and procedural behaviors on the part of the Gunner. It should require considerable procedural training and practice to be properly performed under the variety of situations in which it will be required.

Override and Fire, if Required: If the Gunner cannot locate or identify the selected target within some short time period, or if he is unable to engage for some other reason, the Commander must override the Gunner and perform the targetting and related actions to fire the 25 mm, TOW or Coax as required. The requirement to do this is necessarily a judgment on the part of the Commander. He must have determined that the Gunner is not currently able to engage the designated target and that he, himself, must fire the weapons. This action is then accomplished using the Commander's extension of the optical/thermal sight and the controller joystick located at his right hand position. The need for this event will be rare in actual practice; however, the importance of the requirement and its result for the survival and success of the BIFV crew demands that special training be developed and implemented to assure successful performance.

Observe and Adjust Fire: Under normal engagement conditions, the Gunner conducts the actual target engagement, but the Commander will be spotting rounds and estimating aiming corrections necessary to get the initial burst point adjusted so that subsequent rounds are on target. The Commander will spot the rounds and provide adjustment instructions to the Gunner (e.g.- up 200, or right 5 mils, etc.). Again training and range practice are essential to the development of the estimation capability required to provide such correction accurately. Range practice of a Commander and Gunner acting as a crew is probably critical to the proper development of the skills inherent in this task requirement.

Load, Charge and Clear Malfunctions - Coaxial Machine Gun: The loading, charging and clearing of malfunctions of the M240C (coaxial machinegun) is a task assigned to the Commander simply because of the physical position of the gun directly in front of the Commander's position in the turret. Loading is accomplished with the assistance of the squad members in the rear of the BIFV, since the 7.62 mm ammunition is initially stored in the rear compartment. Loading and charging the machine gun are relatively simple mechanical tasks and are simply trained through demonstration and practical exercise. Clearing malfunctions of the machine gun can also be simple or it can be relatively difficult, depending on the type of malfunction and the difficulty of removing or replacing the malfunctioned round or restarting the automatic feed mechanism. This aspect of this task requires both procedural and cognitive training and should receive appropriate concentration in training courses.

Gunner Tasks:

Assist Commander in Required Tasks: A major, but unstressed, part of the Gunner's job is to support the Commander in accomplishing the overall job of the BIFV unit. While there are numerous and important tasks for which the Gunner is specifically responsible, he must continually be able and ready to operate as a team with the Commander to accomplish the total mission requirements of his vehicle/unit. This is especially true with respect to the essential tasks of surveillance, detection, recognition and identification of potential targets as well as the actual acquisition and engagement of the designated targets within the optical/thermal sights of the BIFV.

Prepare Range Cards: It is the Gunner's responsibility to prepare a range card for each selected firing position when the BIFV is halted either temporarily or in a continuing defensive posture. Range cards normally include the actual firing position, designated fields of fire, ranges to prominent landmarks or likely target areas, limits of fire (maximum effective range) for each weapon, and special features of both the terrain sector observed and the defensive plan (such as primary and secondary sectors of fire, overlapping fire areas, etc.). The Gunner is expected to construct two copies of a range card for each primary and secondary firing position in a defensive situation; one copy is forwarded to the Platoon and the second is retained in the BIFV turret for immediate reference.

Mark Firing Positions: The Gunner is also expected to mark the primary and alternate firing positions such that the BIFV can be easily repositioned after a temporary move. Accurate repositioning of the vehicle is necessary so that the range card information (target ranges and azimuths, etc.) will still be valid. This is usually accomplished by putting stakes at the front and one side of the vehicle in such a way that the Driver may readily guide the vehicle back into the same location by aligning the BIFV with the stakes. Stakes may be marked with luminous tape or other devices to provide better guidance under limited visibility conditions. This is not a very difficult task and requires little training. The important part is that the concept and the rationale behind it be internalized and that such marking of positions is actually to be performed.

Target Engagement: This is a sequence of subtasks which must be performed by the Gunner as quickly and as accurately as possible after a target is designated by the Commander, or when the Gunner himself identifies a target of opportunity. The subtasks are described below:

Acquire Designated Targets: When the Commander has designated a target via the fire command and laid the gun on (or near) the target, the gunner must quickly acquire and identify the target and begin his engagement procedure. If the Gunner fails to do this, the Commander may override with the hand controller and fire the mission himself.

Select the Weapon/Ammunition: The Gunner first selects the weapon or ammunition designated by the fire command. This is done by switch selection for 25 mm HE or SABOT ammunition or by selecting TOW. If TOW is designated, the Gunner must first elevate the TOW launcher (if not already erected) and arm the selected TOW missile in the launcher tube. If HE or SABOT is called for, the Gunner must select the appropriate ammunition on the switch panel and prepare to engage the target.

Engage the Target: The Gunner then engages the target using the designated weapon or ammunition. If TOW is being used, the Gunner simply alines the TOW reticle on the center of mass of he target and proceeds to fire the missile and track the target through the ISU until completion of the missile flight. If the 25 mm is called for, the Gunner employs either the Precision Gunnery technique or the Battlesight Gunnery technique. This choice is dictated by the Commander's fire command: if precision gunnery is desired, the Commander will specify a range to the target; if not, he will state "Battlesight" instead of a range for the target.

In precision gunnery the Gunner must index a range into the elevation quadrant of the 25 mm gun turret. He may first determine whether the range stated by the Commander is approximately correct; this may be done by his own estimation or by using the stadia lines (choke sight) in the ISU. Normally he will index the range stated by the Commander to avoid lost time in further estimation. In battlesight gunnery, the Gunner leaves the range setting at the predefined battlesight range of (normally) 1200 meters and proceeds with the fire mission.

The Gunner then uses the reticle and sighting rules to fire on the target. Both the Gunner and the Commander observe the strike of the initial round(s) and the Commander may provide adjustment directions to the Gunner. In either case, the Gunner adjusts his fire to bring the next burst onto the target and then fires a normal five-round burst. This continues until the engagement is successfully completed.

Prepare to / Engage Next Target: When multiple targets have been sighted the Gunner must then proceed to the next target designated by the Commander or observed to be a target of opportunity. Normally the Commander would direct the subsequent engagements with fire commands as indicated above.

Perform Misfire Procedures: The Gunner is responsible for performance of of those procedures necessary to correct misfires and other malfunctions of the 25 mm gun and the TOW system. TOW misfire procedures are carried out in conjunction with other squad members in the rear of the BIFV. Similarly, the Commander may assist the Gunner in addressing a 25 mm malfunction. Accurate performance of the proper procedures for correcting malfunctions is critical in terms of both time and personnel safety. Although the procedures defined for these corrections are fairly straightforward, considerable practice and drill should be required to make their performance routinized and as nearly automatic

as possible.

Ammunition Reload: Reloading the 25 mm ammunition into the ready boxes and new TOW missiles into the launcher tubes is in part the responsibility of the Gunner. He must be generally aware of ammunition expenditure and be prepared to upload fresh ammunition as time and battle conditions permit. Reloading the TOW requires the Gunner to position the turret at the appropriate azimuth and elevation to allow the squad personnel in the rear to remove the expended rounds and insert new rounds. This is a straightforward procedure but requires cognitive knowledge and turret positioning skills. Similarly, reloading of the 25 mm HE and 25 mm SABOT requires the Gunner to position the turret in two separate and specific positions to allow access to the individual boxes. When the turret is properly positioned for each box, the Gunner physically loads the box with the assistance of the squad members in the vehicle rear. Again this is a relatively simple procedural sequence which can be trained with drill and practice. In reloading, time is of the essence since the vehicle must be temporarily out of action for whatever time is taken up in this operation. Separate efforts within this study are underway to develop improved procedures and improved ready boxes to reduce the time required for reloading.

Driver's Tasks:

The gunnery related tasks of the Driver consist mainly of assisting the Commander and Gunner to perform their tasks. The Driver must quickly and accurately execute the orders of the Commander so as to support the gunnery activity. He must also assist in observation and surveillance, especially to the left front of the vehicle. To assist gunnery, he must be able to quickly move the BIFV into and out of defilade on orders and, in traveling, he must be alert to the need to maintain a more steady firing platform by following lines of least unevenness or obstruction. The Driver also assists the Commander and Gunner in target acquisition and in spotting rounds to aid in fire adjustment.

If the Commander, Gunner and Driver can effectively interact to perform these tasks in an accurate, complete and timely manner, the Bradley will adequately fulfill its requirements for major weapons system gunnery.

Analysis of Selected Task Characteristics

As the next step in the analysis, these tasks were examined with respect to several criteria related to adequate and timely performance. Five criteria were used, based on a modification of criteria and scales developed by Lenczycki and Finley (1980) for evaluation of the requirements for training for various tasks. These criteria were set against five point scales and each task was evaluated with respect to each criterion. The criteria against which tasks were rated are as follows:

1) Criticality to mission success: This scale was defined as the degree to which failure to adequately perform this task would result in mission failure and/or vehicle destruction or crew deaths. Each task was rated on a five point scale, with 1 indicating little or no effect on mission success and 5 indicating a very high effect on mission success.

2) Time Delay Acceptability: This scale assessed the degree to which the task must be performed immediately on cue in order to contribute to mission success. A scale value of 1 indicated no need for immediacy of performance. A 5 indicated the task must be performed as rapidly as possible after the cueing

event in order to assure successful mission performance.

3) Task Difficulty: The difficulty of actual performance of the task was also rated against a five point scale with 5 being most difficult and 1 being least difficult to perform.

4) Newness of the Task: Each task was also rated as to its newness to the personnel who would have to learn and perform it, based on the expected entry level for each position (E5 or 6 for Bradley Commander, E4 or 5 for the Gunner, and E2 to E4 for the Driver). Again, a 1 indicated the least newness (task had been learned or performed before) and 5 the most (entirely new task).

5) Sustainment Difficulty: This was a rating of the probable difficulty of sustaining competence in performance of the task without training - in effect the degree to which competence would be rapidly lost without sustainment training. Ratings were 1 for a slow decay in proficiency and 5 for rapid decay.

Table 3 shows the ratings for each task on each criterion. These judgments were based on an examination of the requirements of the tasks, knowledge of the training provided in institutional courses, observations of task performance (in operational testing, institutional training, and field exercises) and discussions with field trainers in Bradley-equipped units.

The data indicate that most of the tasks of the Commander and Gunner are highly critical to mission performance and also intolerant of time delay. However, they also indicate that many of these tasks are not really very difficult to perform, are not really new to the Bradley personnel (particularly for sustainment) and are not too susceptible to competence decay. These individual ratings, considered together with the summed ratings, seem to indicate that the following tasks are most critical from the viewpoint of combined performance and training need:

For the Commander:

Command and Control for Element

Acquire Potential Targets

React to Enemy Fire

Identify Targets

Determine Target Priority

Estimate Target Range

Lay on 1st Priority Target

Override Gunner when Required

Observe and Adjust Fire

These Commander tasks are all rated highly critical, intolerant of delay, relatively high in difficulty, and at least somewhat difficult to sustain competent performance without training. The two most highly rated tasks are target identification and target range estimation. This results in part because

Table 3. Characteristics of Major Bradley Gunnery Tasks

Tasks:	Task Characteristics: Criti-cality	Delay Accept	Task Diffic	New Task	Sustain Diffic	Sum:
Commander (and Gunner):						
Site Selection	3	3	2	1	1	10
Determine Fields of Fire	4	4	2	1	2	13
Command and Control	5	5	4	2	2	18
360 Degree Observation	5	4	2	1	1	13
React to Enemy Fire	5	5	3	2	1	16
Acquire Potential Targets	5	5	4	1	3	18
Identify Targets (IFF)	5	5	5	1	5	21
Determine Target Priority	5	5	4	2	3	19
Estimate Target Range	4	5	5	2	5	21
Lay on 1st Priority Target	5	5	3	3	2	18
Hand off and Fire Command	5	5	1	2	1	14
Override when required	5	5	3	3	2	18
Observe and Adjust Fire	5	5	4	3	2	19
Coax - Load, Charge, Clear malfunctions	2	3	1	3	2	11

Note: Ratings are 1 - 5, with 5 indicating the highest effect for each scale. See Text for explanations.

Table 3. Characteristics of Major Bradley Gunnery Tasks (Cont'd.)

Tasks:	Task Characteristics: Criticality	Delay Accept	Task Diffic	New Task	Sustain Diffic	Sum:
Gunner:						
Assist Commander in Target Acquisition, Identification	5	4	4	4	4	21
Prepare Range Cards	5	3	3	2	2	15
Mark Firing Positions	4	3	3	2	1	13
Acquire designated targets	5	5	3	2	2	17
Engage Target -						
Select Weapon/Ammo;	5	5	2	2	2	16
Determine/Index Range;	5	5	4	3	3	20
Fire: Lead, BOT, Adjust	5	5	4	3	2	19
Prepare/engage next target	4	4	3	2	2	15
Perform Misfire Procedures	5	5	2	2	2	16
Reload Ammunition	5	3	3	3	2	16
Driver:						
Assist Cmdr and Gunner:						
Move into/out of defilade	5	5	3	3	2	18
Steady Firing Platform	5	4	2	3	2	16
Target Acq, Spotting Rounds	4	5	4	4	2	19
Asst terrain select/manuever	4	4	4	2	2	16

Note: Ratings are 1 - 5, with 5 indicating the highest effect for each scale. See Text for explanations.

of the judged high decay rate (sustainment difficulty) for these two tasks.

For the Gunner:

Assist Commander in above tasks (Esp. Target Acquisition and Identifications - for same reasons as above)

Acquire Designated Targets

Determine/Index Range

Target Engagement (Lead, BOT, Adjust Fire)

These Gunner tasks are also rated highly critical, intolerant of time delay, and relatively difficult to perform. They are also new tasks for many infantry input personnel and require some concern with refresher training, showing some sustainment difficulty. Again, the tasks involving target identification, acquistion, and ranging are the highest rated tasks.

For the Driver:

Assist Commander and Gunner in moving into/out of defilade and Maintaining a steady firing platform

Assist in Target Acquisition and Spotting Rounds

These tasks were rated as highly critical or needing to be done immediately. They are also somewhat difficult, relatively new to the Driver input personnel pool and will require a degree of refresher training to sustain competence in the tasks.

The total set of gunnery tasks was also examined with respect to the kind of skills involved in performance of each task. This involved determining whether the skills required for the task were primarily cognitive in nature (requiring information processing) or primarily psychomotor in nature (requiring motor activity with hand-eye coordination, etc.). This analysis examined each task and rated it on a scale ranging from mainly cognitive, through three stages of mix of skill type, to mainly psychomotor. The importance of this examination is twofold: psychomotor tasks tend to be retained better (after actual learning) than do cognitive tasks (cognitive tasks tend to require more sustainment training); and, cognitive tasks usually lend themselves, better than do psychomotor tasks, to conceptual training approaches in which the actual situation may not be entirely replicated (as in a part-task trainer or simulation). Therefore this analysis has potential impact on the determination of training support requirements, including training devices.

The ratings are shown in Table 4. It can be seen that the Commander's tasks are rated as being largely cognitive in nature, with some tasks being rated as mixed, and three tasks being largely psychomotor in nature. The Gunners tasks are shown to be rated as largely psychomotor or mixed in nature as are the Driver's tasks. These ratings will be considered in relation to training devices in a later section of this report.

Table 4. Skill Components of Major Bradley Gunnery Tasks

	Skill Components		
Tasks:	Mainly Cognitive	Even Mix	Mainly Psychomotor
Commander (and Gunner):			
Site Selection	X		
Determine Fields of Fire	X		
Command and Control		X	
360 Degree Observation		X	
React to Enemy Fire		X	
Acquire Potential Targets		X	
Identify Targets (IFF)	X		
Determine Target Priority	X		
Estimate Target Range	X		
Lay on 1st Priority Target			X
Hand off and Fire Command	X		
Override when required		X	
Observe and Adjust Fire	X		
Coax - Load, Charge, Clear malfunctions		X	

Note: See Text for explanations.

Table 4. Skill Components of Major Bradley Gunnery Tasks (Cont.d)

	Skill Components		
Tasks:	Mainly Cognitive	Even Mix	Mainly Psychomotor
Gunner:			
Assist Commander in Target Acquisition, Identification		X	
Prepare Range Cards	X		
Mark Firing Positions			X
Acquire designated targets		X	
Engage Target -			
Select Weapon/Ammo;			X
Determine/Index Range;			X
Fire: Lead, BOT, Adjust			X
Prepare/engage next target			X
Perform Misfire Procedures			X
Reload Ammunition			X
Driver:			
Assist Cmdr and Gunner:			
Move into/out of defilade			X
Steady Firing Platform			X
Target Acq, Spotting Rounds	X		
Asst terrain select/manuever		X	

Note: See Text for explanations.

Squad Member Gunnery Tasks

The Bradley squad members riding in the rear of the BIFV (M2) have certain weapons-related tasks also. They must assist in observation and target acquisition, particularly to the rear and flanks of the vehicle; assist in weapons loading; and, maintain and operate their firing port weapons (FPW) as commanded by the Bradley Commander.

The specific tasks required of the squad members are listed in Table 5. Ratings for each of these tasks on the selected task characteristics listed earlier are also shown in the table. It can be seen that, while few of these tasks are rated as highly as are many of the Commander and Gunner tasks, several receive relatively high ratings. These include acquiring targets and IFF, engaging targets, reaction to fire commands, and the several tasks related to weapons reloading. These tasks were also examined with respect to the nature of the skill associated with each task - cognitive or psychomotor. The ratings for these tasks are shown in Table 6. It can be seen that the Squad member tasks are primarily psychomotor in nature with the exception of observation for targets, acquisition and reporting of targets and acquiring and sensing rounds. Again, the implications of these data will be considered in relation to the examination of training and training devices.

Effects of Night and limited visibility Conditions on Bradley Gunnery

Bradley operations at night or under conditions of limited visibility impose many unique demands on the Bradley team. While most of these mainly affect the tactical area, many are directly related to the conduct of gunnery and target engagements. The added demands on gunnery performance are not always added tasks; they frequently amount to an increased difficulty of performance, and a concurrent increase in the importance of successful performance, of the normal tasks for each squad member.

Night and limited visibility gunnery operations require that the Commander and Gunner, and other squad members as well, exercise even greater care and expertise in performing their usual tasks. A major example is the increased importance of careful identification (staking, etc.) of firing positions and the construction of range cards for each position. Position location and range cards are always of great importance in any engagement and should always be carefully accomplished by the Gunner and other squad members. However, these tasks take on a greatly increased importance under limited visibility, since the range card may provide the only means of fire distribution and control for the Bradley's weapons. Without an adequate range card, carefully prepared with azimuths of fire (based on the turret position indicator ring) to sector delimiters and likely target areas, the Bradley Commander and Gunner may totally lose their orientation and end up firing in someone else's sector, or worse, at friendly vehicles.

Similarly, the Gunner and Commander must use the thermal capability of the ISU at night and in limited visibility. This adds another dimension to the problems of identification of friend or foe and, indeed, to the total target acquisition and engagement requirement. These are not truly new tasks, however. The tasks to be performed (e.g.- acquisition, identification, ranging and engagement) are the same, but the variables affecting their performance are different as a function of the limited visibility conditions. Adequate use of the thermal sight by either the Commander or Gunner requires training on:

Table 5. Characteristics of Squad Member Gunnery Tasks

Tasks:	Task Characteristics: Criticality	Delay Accept	Task Diffic	New Task	Sustain Diffic	Sum:
Firing Port Weapon (FPW) Tasks:						
Acquire Targets, IFF, & Report to Cmdr	5	5	3	1	1	15
React to Fire Commands	5	5	2	1	1	14
Engage Targets (by walking tracers to target)	5	5	3	3	2	18
Perform Immediate Action	5	5	1	1	1	13
Maintain FPW: Assemble/ disassemble, Mount/dismount, Load/unload FPW	3	3	2	2	1	11
Other Gunnery Related Tasks:						
Provide Observation to Rear and Flanks	5	4	3	2	1	15
Acquire and Sense Rounds	4	4	3	2	1	14
Load TOW Launcher	5	5	2	2	1	15
Assist in 25 mm Loading	5	5	3	2	1	16
Assist in Coax Loading	5	5	3	2	1	16

Note: Ratings are 1 - 5, with 5 indicating the highest effect for each scale. See Text for explanations.

Table 6. Skill Components of Squad Member Gunnery Tasks

Tasks:	Skill Components: Mainly Cognitive	Even Mix	Mainly Psychomotor
Firing Port Weapon (FPW) Tasks:			
Acquire Targets, IFF, & Report to Cmdr	X		
React to Fire Commands		X	
Engage Targets (by walking tracers to target)			X
Perform Immediate Action			X
Maintain FPW: Assemble/ disassemble, Mount/dis- mount, Load/unload FPW			X
Other Gunnery Related Tasks:			
Provide Observation to Rear and Flanks	X		
Acquire and Sense Rounds	X		
Load TOW Launcher			X
Assist in 25 mm Loading			X
Assist in Coax Loading			X

Note: See Text for explanations.

Sight adjustment to optimize the display;

Scanning and sector search techniques;

The factors affecting thermal image development;

Thermal image recognition, friend or foe;

Range estimation with thermal images;

Target engagement with thermal images; and,

Fire adjustment techniques using thermal imagery.

Such training in understanding and appropriate use of the thermal ISU is necessary for both daytime and night or limited visibility operations. Given this training is required for daytime thermal ISU operation (to take advantage of its better capability for target detection), there should be few new aspects specific to training for night or limited visibility operations.

A close examination of the requirements posed by night and other limited visibility conditions indicates that the only added gunnery-related tasks for the Bradley vehicle team and other squad members would be the following:

Gunner's and Commander's use of the ISU thermal mode for target detection, acquisition, identification, and engagement. (Gunners have also been observed using the ISU thermal capability to assist the Driver and Commander in vehicle operation at night.)

Commander's use of AN/PVS-5, Night Vision Goggles, for C & C, target detection, etc. (assuming he would use the NVG as a supplement to the ISU capability).

Driver's use of the night viewer (II currently and thermal in the future) for driving, target acquisition, etc.

Other squad members' use of the squad STANO equipment for security, surveillance and target detection purposes.

As indicated above, these appear to be the only unique gunnery-related tasks. However, it must be remembered that the added tactical requirements posed by night and limited visibility operations will serve to enhance and compound the inherent difficulty of performance of the standard gunnery tasks described and analyzed above.

The results of these analyses will be considered in the discussion of individual and unit training below and in the overall discussion, conclusions and recommendations section.

Institutional Training

This section reviews the instruction and training provided by the United States Army Infantry School (USAIS) in the major weapons gunnery courses for

the BIFV. The primary emphasis of this analysis was to assess the quality and scope of institutional training on the major gunnery tasks identified earlier. The focus was on gunnery training in a tactical context as presented in the USAIS courses, with special emphasis on training for limited visibility conditions and the Soviet Threat. The analysis was initiated with a review of Programs of Instruction (POIs) and lesson plans for the three major courses. Manuals provided to support training were then examined to determine the relationship of their content to the BIFV courses. Finally, instructors in the Weapons, Gunnery and Maintenance Department (WGMD) of the Infantry School were interviewed. Interviews were directed toward identification of problems encountered in teaching gunnery using the existing references and doctrinal material.

Programs of Instruction

The major weapons gunnery training for the BIFV is presented in the BIFV Gunners Course, the BIFV Commanders Course, and the BIFV Master Gunners Course. The BIFV Gunners Course (4 weeks) provides training for junior Non-Commissioned Officers (NCOs or E-4s, E-5s, & E-6s) in technical (e.g. maintenance) aspects of the weapons systems, familiarization in firing the weapons, and tasks related to operation and maintenance of the BIFV. The Commanders Course (6 weeks) provides gunnery that is nearly identical to that of the Gunners Course, but it also gives NCOs (E-6s & E-7s) and Officers (O-2s & O-3s) instruction in command and tactical employment of the BIFV. The same instructors teach both of these courses.

The BIFV Master Gunners Course (12 weeks - taught by other instructors) includes the same basic gunnery training received in the Gunners Course. It also provides more intensive weapons maintenance training, additional gunnery training, training on how to set up ranges, and training on movement of BIFVs by rail, sea and air.

Table 7 displays the amount of time allocated to the various task cluster areas, each dealing with a set of tasks covering a particular area of instruction. Differences in emphasis of the three courses are evident from examination of the varying numbers of hours spent in each task cluster area. For example, both the Commanders and Master gunners spend more than twice as much time in Hull Operations and Maintenance than do the Gunner trainees. However, all trainees spend an equal amount of time in prefire gunnery and much more similar amounts of time in practicing target engagement (although both the Commanders and Master Gunners spend nearly an extra week in various aspects of target engagement). Table 8 shows the percentage distribution, for each course, of the instructional hours a student receives under various modes of instruction. This clearly indicates that a heavy preponderance of BIFV training is both hands-on and equipment- and performance-oriented.

As indicated, preliminary examination of POIs revealed that BIFV gunnery for the 25mm, the TOW, and the 7.62 Coaxial machinegun is taught in all three BIFV courses. Content of gunnery training such as preliminary gunnery, target engagement, and live fire aspects of gunnery is very similar for all of these courses. Differences exist in the number of hours allocated to particular training segments with the most substantial appearing in the exercises. For example, the Commanders course includes a Tactical Exercise Without Troops (TEWT) incorporated around the usual live fire and range exercises. The specific content of tactical training is not documented in the POIs.

Table 7. Time Spent in Various Task Cluster Annexes in BIFV Courses

Task Cluster Annex	Commanders Course	Gunners Course	Master Gunners Course
Vehicle Introduction	2.0	2.0	2.0
Hull Operations and Maintenance	26.0	13.0	31.0
Turret Operations and Maintenance	11.0	10.0	16.0
Weapons System Training	29.0	33.0	34.0
Prefire Gunnery	23.0	23.0	23.0
Target Engagement	135.0	91.0	128.0
Tactics (BIFV Peculiar)	39.0	0	0
Student Evaluation	20.0	22.0	51.0
Administrative Time	29.0	22.0	16.0
Master Gunner Unique	0	0	179.0
TOTAL	314.0	227.0	514.5

Data provided by WGMD, November 1984.

Table 8. Percent of Time Spent by Type of Instruction by Course

Instruction Type	Commanders Course	Gunners Course	Master Gunners Course
Conference/Lecture	9.4%	6.2%	16.2%
Demonstration	1.5%	2.3%	3.5%
Examination	6.0%	10.0%	13.3%
Practical Exercise (Hardware)	73.6%	71.4%	62.1%
Practical Exercise (Classroom)	0	0	1.4%
Administrative Time	9.4%	10.0%	3.5%

Data provided by WGMD, November 1984.

Manuals

The major training manuals to support these classes are the Department of the Army Field Manual FM 23-1 (Test): Bradley Fighting Vehicle Gunnery; Department of the Army Technical Manual 9-2350-252-10-1: Fighting Vehicle, Infantry, M2, and Fighting Vehicle, Cavalry, M3, Hull; and Department of the Army Technical Manual 9-2350-252-10-2: Fighting Vehicle, Infantry, M2, and Fighting Vehicle, Cavalry, M3, turret. Additional manuals useful for the courses include the Department of the Army Field Manual 7-11M10: Soldier's Manual (11M10 Fighting Vehicle Infantryman), Department of the Army Field Manual 7-11M20: Soldier's Manual (11M20 Fighting Vehicle Infantryman), Department of the Army Field Manual 7-11M30/40: Soldier's Manual (11M30/40 Fighting Vehicle Infantryman), and technical manuals such as Department of the Army Special Text 7-193: Tank Identification Handbook.

The "bible" for gunnery instruction is FM 23-1. The review presented earlier described this manual's major contribution to training and maintaining gunnery skills and knowledges. It is used consistently as an adjunct to daily instruction in gunnery portions of all three courses.

The technical manuals specific to the Bradley (TMs 9-2350-252-10-1 and -2) are the other "bibles" used in the courses. They present detailed operations, maintenance and troubleshooting training for all three courses. These manuals (although many errors of fact have been detected and corrected by the BIFV instructor staff), provide detailed information concerning the actual vehicle configuration, weapons and weapons control equipment and operation and maintenance of the BIFV. They were prepared under the prime contract for the Bradley and are being updated continually as errors are detected and reported.

The skill level 1 Soldier's Manual (11M10) is designed to provide information primarily on driving and basic gunnery. This manual has an emphasis on the firing port weapons and minor training (e.g.- how to load the 25 mm ready boxes) on the other weapons systems. The skill level 2 Soldier's Manual (11M20) describes and defines those skills required to achieve mastery of BIFV gunnery, with little or no information on port weapons or tactics. This manual includes all of the basic information related to use of the 25 mm gun. The skill level 3 and 4 Soldier's Manual (11M30/40) focuses entirely on tactics with little or no information on weaponry and driving. This manual supplements other tactical manuals (indicated below) as the basis for small unit tactics and techniques with the infantry's first fighting vehicle.

Taken together, these manuals provide the soldier complete familiarization with the BIFV; starting with the firing port weapons and driving, then introducing the soldier to gunnery, and finally provide information for the development of tactical skills. Precision gunnery information is provided in FM23-1 and during classroom instruction. Information on BIFV tactics is provided by available field manuals and training texts (Department of the Army Field Manual 7-7J: The Mechanized Infantry Platoon and Squad, Department of the Army Training Text 71-1J: Mechanized Infantry Company Team, Department of the Army Training Text 71-2J: The Mechanized Infantry Battalion Task Force).

Several of the manuals used to support Bradley gunnery instruction are still in draft form (as FM 23-1 (Test)) with some more recent equipment changes and training developments not being reflected. Because of the emerging nature of fighting vehicle concepts, tactics and instruction, cross referencing of

manuals can potentially result in contradictory information. However, on the surface, these manuals appear to be adequate for training support in this early stage of the BIFV's deployment. Even so, detailed analysis of these manuals' indexes, tables and cross references needs to be made to insure consistency and accuracy of information. This should be part of the extensive rewrite effort now underway.

Gunnery Instruction

Instruction in all three courses begins with one week concentrating on vehicle familiarization, safety, use of publications, and hull maintenance. Equipment training is begun in the second week with emphasis on learning the details of the hull and turret characteristics of the total weapons system. The third week generally focuses on prefire gunnery training. The majority of prefire gunnery training is dedicated to three task areas: vehicle identification; manipulation training; and boresighting. Other prefire gunnery topics include range determination, target acquisition and issuing of fire commands. Approximately fifty percent of weapons system training (part of prefire) in all courses is devoted to the 25 mm gun (M242). The remaining hours are divided, in descending priority, between the coaxial machinegun (M240C), the firing port weapons (except the Gunners course), the TOW, and the smoke grenade launchers (M257). The heavy emphasis on the 25 mm gun, in comparison to other weapons on the vehicle, corresponds to the emphasis of USAIS as reflected in FM 23-1.

After completing the prefire gunnery training, the students then move to range exercises directed toward the task skills to be tested by the BGST (Bradley Gunnery Skills Test). Although the exercises differ slightly for the three courses, all trainees are given basic training in the vehicle with both dry fire and live fire exercises, both subcaliber and full caliber. The initial firing exercise is a subcaliber exercise consisting of target engagements from first stationary positions and then moving positions using the 7.62 mm coax MG. Next is the vehicle team exercise consisting of engaging moving and stationary silhouettes from both a stationary and moving BIFV using 25mm TP-T and the coaxial machinegun. These exercises are identical for all three courses. However, the Master Gunners and Commanders courses continue with additional firing exercises after the first two basic exercises (subcal and combat vehicle) in which the Gunners participate.

The Commanders course exercises begin with a 5 hour firing port weapon exercise followed by a 130 hour FTX (field training exercise) which is designed to incoroporate the BIFV live fire gunnery exercises. This includes the basic exercises used in the Gunners and Master Gunners courses: target engagements with the M240C and the M242 from stationary positions and later advances to moving positions. In the course of the FTX, the students perform: 1) a movement to contact with a squad; 2) maneuver a dismount team; 3) direct a squad in the defense; 4) perform a movement to subsequent positions; and, 5) employ a platoon. The additional live fire exercises, including the Platoon Evaluation Exercise, are incorporated into these scenarios.

The Master Gunners begin with 4 hours of firing port weapon exercises, followed by the usual initial exercises; the 15 hour subcaliber exercise and the 15 hour vehicle team exercise, identical to the Gunners initial firing exercises. The combat squad exercise is then performed, which incudes the squad movement to contact, the direct fire and maneuver of a dismount team, the direct M2 squad fires, and the movement to subsequent positions. These operations are

performed and evaluated identically to those required in the Commanders course as part of the FTX. However, the difference in hours allotted to these exercises (Commanders course 130, and Master Gunners 45) is mainly due to the difference in emphasis of the two courses; the Commanders course FTX is largely given over to teaching and demonstration of tactical employment of the BIFV and its weapons systems.

The amount of time devoted to any single task within any of the courses is highly variable from one class to the next. These classes are dynamic and have been evolving through successive iterations over many months of trainer preparation and instructional refinement. Both training developers and instructors are still learning how best to teach which part of the material to be learned. For this reason formats for training have gone through many changes: instructor changes; training material changes; training aid changes; and, other format changes in the attempt to evolve a successful format for each course. Every aspect of the courses is continually under intense scrutiny from several sources: WGMD's command structure, civilian consultants involved in this study, the instructors themselves, and other sections in USAIS who have a vested interest in the BIFV. The hours specified above were provided by WGMD in November of 1984. Due to the constant changes in course presentation, these figures will be inconsistent with figures obtained before or after this date.

Training of Selected Tasks for the Bradley Commander and Gunner

Table 9 identifies the course periods which provide training for each of the gunnery-related tasks selected earlier as most critical for Bradley Commanders and Gunners. The training content relationship is sometimes explicit and direct but, in some cases, has been deduced from course descriptions and observations. Training that enables performance of these tasks is essential to the achievement of effective gunnery by the BIFV team. The following discusses further some of the specific training for the more critical tasks identified earlier.

The exercise of Command and Control (C^2) is an important area for the BIFV Commander. These skills are primarily taught in the Officer Basic and Advanced Courses. The major BIFV course input to this skill training occurs in the Commanders course in the FTX. Students are required to serve as either Commander, Gunner, Driver or squad member (or rotating among positions) in a BIFV operating in a (simulated) tactical environment. The required live fire exercises are incorporated into this scenario also; thus, the Commander students experience both vehicle and unit command and control as well as individual vehicle control on the firing range. Another simpler aspect of this requirement is taught in the course segment on fire commands; students in all three courses are taught how to give and receive the fire commands and subsequently receive practice in this on the range exercises or during the TEWT. Additional aspects of command and control are taught to Commanders in the tactics segment of that course.

Acquisition of potential targets is a difficult task which is probably not taught as effectively as it might be if additional scarce resources were available. Currently, target acquisition is taught as a formal block of instruction in each of the courses and is practiced in exercises on the ranges. It is one of the more difficult tasks to teach, primarily because of the lack of a wide range of potential target types and dispersed areas on which to practice target acquisition. Problems have been noted earlier in acquiring the

Table 9. Course Segments Instructing Selected Bradley Gunnery Tasks

	Course Segments												
	Range Determination	M2 Tactics	Exercises / TEWT	Issue Fire Commands	Target Acquisition	IFF/Threat/Signatures	Manipulation Training	Turret Operations	M240C	M242	TOW	Smoke Grenade	Ready Boxes
Selected Commander Tasks													
Command and Control:		X	X	X									
Acquire Potential Targets:			X		X								
React to Enemy Fire:		X	X	X									
Identify Targets:			X		X	X							
Determine Target Priority:			X		X	X							
Estimate Target Range:	X		X	X	X		X						
Lay on Priority Target:			X		X		X						
Override:			X	X			X	X					
Observe and Adjust Fire:			X										
Selected Gunner Tasks													
Identify Targets:						X							
Prepare Range Cards:	X												
Engage Targets:													
Determine/Index Range:	X		X				X						
Target Engagement - Lead, BOT, Adjust Fire			X				X						
Prepare Engage Next Target:			X	X									

Heading for Table 10

Range Determination

M2 Tactics

Exercises / TEWT

Issue Fire Commands

Target Acquisition

IFF/Threat/Signatures

Manipulation Training

Turret Operations

M240C

M242

TOW

Smoke Grenade

Ready Boxes

silhouette targets on Ware range because of the inherent difficulty in spotting the targets when they are raised in the locations. Target boards were simply very difficult to see when they came up. This has been alleviated by painting white outlines on the target boards, making them much more discriminable from the background. However, this does not pr de good training in target acquisition, it simply points out where ta ts are for target engagement purposes. This is a training area which should receive additional attention and more dedicated resources.

Reaction to enemy fire is perhaps one of the most difficult aspects of combat to train. The requirement is for quick and accurate reaction to the initial enemy fire by initiation of the appropriate procedures for engagement and destruction of the enemy. Development of the desired trained responses to enemy fire (other than the natural one of attempting to take cover) requires practice in a tactically valid environment which includes multiple engagements by enemy weapons and some indication of weapons' effects on one's own vehicle or unit. The closest approximation to this situation that is now available is the FTX for the Commanders course, in which a simulated opposing force is used and engagements are simulated using MILES (Multiple Integrated Laser Engagement System) equipment (see next section for MILES description). There is little actual training related to this necessary part of BIFV gunnery performance in the other courses. However, the emphasis on time constraints for engaging targets in range exercises is an approximation for this training. Of course, fear, confusion and other reactions, which occur in combat, cannot be truly stimulated by these approximations. The BIFV courses also provide some minimal training on reactions to enemy fire in the block on issuing fire commands. As indicated, practice on these reactions occurs during range exercises and in the Commanders Course FTX and the TEWT.

Identification of targets as friend or foe is a critically important task of the Commander, and the Gunner as his assistant. The identification of a vehicle as enemy or friend is perhaps most important, but it is also important for a BIFV Gunner and Commander to know if the vehicle can be effectively engaged by his available weapons. Engaging a vehicle at too distant a range or one that can take the hit and sustain little damage, can do little good and will only serve to give away the BIFV's position. Ideally, identification training will result in BIFV Commanders and Gunners engaging the proper targets, with the proper weapons, at the proper times. Target identification is currently taught formally in only one class on combat vehicle identification.

Target prioritization must occur when several potential or recognized targets are observed at one time. To prioritize, targets are ranked from first to last before engaging. Gunners and Commanders are currently taught to identify targets from most to least dangerous. Various elements of target prioritization are taught under the heading of target acquisition and combat vehicle identification. These skills are practiced on the ranges and during the Commanders Course TEWT. However, prioritization on the ranges generally consists primarily of shooting the target nearest the BIFV first and targets farther away second and third. This task area could well receive more emphasis in BIFV specific training, although it is discussed in tactical manuals which are readily available.

Range estimation has long been recognized as an extremely important aspect of all gunnery training and efforts to improve and provide both effective training and effective range determination aids have continued over the past

decades. Not all efforts are or have been successful but BIFV gunnery courses continue to provide detailed training with available information, techniques, and materials. Range determination training for all three BIFV courses includes a lecture and practice segment performed on the same day, plus continuing opportunities to practice ranging throughout range exercises. Training includes use of the WORM formula with binoculars and the ISU stadia lines (choke sight). Range cards are taught and practiced, although ranges are "Guestimated" on the range cards. In addition to this class, range estimation is included in a class on target acquisition and is practiced on the range exercises.

Laying on targets is taught in association with fire commands and turret operations. It is thought of as part of the process of hand off of the target to the Gunner. It involves manipulating the elevation and azimuth of the gun and the turret to bring the gun to bear on (or near) the designated highest priority target. These skills are taught in manipulation training and target acquisition. They are practiced on the range.

Override of the Gunner's actions can occur when the commander decides that the Gunner cannot identify or locate a designated target, or when he, the Commander, decides for some other reason that he can perform the engagement better or faster than the Gunner can. The Commander then takes control of the gun from the Gunner by overriding the Gunner's controls with his hand controller (joystick). After assuming control the Commander must then engage and destroy the identified target using his own controls to setup and fire the gun/weapon. The effectiveness of this override process and the return to normal team operations will be highly dependent upon the effective training and experience of the Bradley turret team as a team. Some aspects of this process are taught in the class on fire commands.

Procedures for engaging targets with the M242 (25 mm) and the coaxial machine gun are well covered in the weapons training and target engagement sections of all three courses. Training on the 25 mm represents at least half of the weapons training in all three BIFV courses. This weapon is considered the primary weapon on the BIFV and is treated as such by these courses. The concept of the BIFV as a 25 mm platform is quite evident when asking questions about the BIFV: nonspecific questions regarding prioritization, target acquisition, and laying on are commonly assumed to refer to the 25 mm. The procedures for employing the coaxial machine gun are also covered in depth in these courses. Classes on operations and maintenance, ready boxes, loading/unloading, and misfire procedures are all provided and titled as such for the M242 and similar blocks of instruction are provided for the coax. Specific blocks of instruction are dedicated to zeroing, precision gunnery, battlesight gunnery, fire commands, fire engagement, loading and unloading and misfire procedures. Range exercises, both subcaliber and full caliber, appear sufficient to provide good procedural training in both target engagement techniques and actual weapons firing.

Preparing to engage targets according to their priority is important whenever there are many available targets which need to be engaged in succession. Skills in this are taught during the class on issuing fire commands. These skills are practiced during exercises on the range. Currently the targets on the ranges cannot be distinguished except according to gross categories such as dismounted troops and tanks. According to one sergeant, target prioritization is primarily a process of engaging the nearest target first.

Summary of Institutional Training

Emphasis on Night Operations and Limited Visibility Training: Operations at night or in limited visibility increase the difficulty of successfully performing many normal daytime tasks. Given the Soviet history and doctrine of continous operations, the capability for successful employment of the firepower of the BIFV will be very important in any conflict with the Soviets. Techniques for night gunnery have become a critical component of training. Unfortunately, there appears to be little effort to integrate actual gunnery training into formal night training, most of which takes place in the FTX or other field exercise setting and does not normally involve ranges where actual gunnery can be practiced. It must be remembered that the FM 23-1 gunnery program does require that all exercises be accomplished both in daylight and nighttime conditions, but that requirement is relatively little in relation to the perceived need to combat the Soviet threat under night and all visibility conditions. Additional training in night gunnery should be incorporated into the BIFV courses and promulgated as a requirement to units, as well.

There is a reverse cycle gunnery class as part of the Master Gunners Course. This class occurs on Ware range and uses both thermal sights and artificial light to facilitate training. Both Coax and 25 mm live fire are practiced; all fire is reported to be from a moving BIFV. This is a welcome move in the right direction for BIFV training, but it should be expanded to provide additional night gunnery training to all BIFV students.

There currently is a need for increased training on the interpretation and use of thermal images in the ISU sight. Formal instruction fails to inform students of the types and sources of heat which result in thermal signatures. Many critical pieces of information are lacking because of insufficient knowledge of the required techniques to be used with thermal imagery. There is no guidance on the type of scanning pattern to be used or the sector size that can be covered at night. The field of view in the thermal mode is restricted but the nature of the image is easier to detect than with normal sights (except during limited morning and evening hours when contrast is minimal). Larger sectors can potentially be effectively scanned for the existence of an object using the thermal sights as opposed to the day sight. However, there is also an increased difficulty in detailed identification of specific vehicles and other target types at night.

Guidelines are not currently given for optimizing detection versus identification of targets by varying display adjustments. Similarly, construction of range cards to define sectors of fire and likely locations for target appearance assumes added significance during night operations. Unfortuately, formal instruction concerning the preparation and use of the range card is severely limited in the BIFV course. Currently these courses do not stress the usual methods of accurately determining ranges for construction of the cards (i.e. walking off the distance, use of the WORM formula with the range card, etc.), nor do they emphasize placement of stakes and markers for firing positions.

Uses of Simulation/Substitution/Miniaturization: The use of simulators in the BIFV specific courses is limited at best. One use of simulation is for 25 mm gunnery. This training includes the use of the coax as a subcaliber substitute. A second simultor recently introduced to BFIV gunnery training is the Reavis-Brewster device. This is a device which allows use of either the Stout Board (a chalkboard-like device to which scaled targets are pinned) and the M55 Laser device, or an M16 rifle firing either 5.56 mm rounds or .22 caliber rounds (with the rimfire adapter). Scaled targets readily available in the Army training aid inventory are used with either of these applications. The Laser/Stout Board combination can be used in garrison training, while the M16 arrangement requires a range and a short safety fan., etc.. A second use of miniature targets is in range determination where models of Soviet vehicles are used in conjunction with the WORM formula. Currently, there appears to be little perceived need for increased availability and use of additional types of training aids/devices in the courses. The reason for the lack of additional perceived need is unclear, since it appears from an observer's viewpoint that additional training aids and devices could provide considerable assistance in providing the current instruction and perhaps allow inclusion of some aspects of tactical BIFV gunnery that are not now covered.

A detailed discussion of the characteristics, capability and utility of some potentially useful training aids/devices is presented in the next section of this report. It is noted, however, that several prototype simulation devices are currently being evaluated by the USAIS. It is expected that upon completion of those evaluations, the devices ultimately selected would be integrated into the appropriate phases of training.

Positive Aspects of Institutional Training: There are many aspects of BIFV training which are of superior quality. These include all gunnery training segments which cover the procedural skills required to perform the major BIFV gunnery tasks. These segments include loading the M242, firing the M242, turret operations, and the performance of misfire procedures. Training on gunnery with the Coaxial machine gun is also superior in quality, as is that associated with turret operations and procedures. Misfire and other malfunction correction procedures training could possibly be improved with better training aids and more time. Given the alloted time and avilable training aids, the instruction is excellent.

The degree to which tactical training is incorporated with the gunnery training, primarily in the Commanders course, is an excellent innovation which should be extended to the Gunners and Master Gunners courses. Relevant tactical training in the course context would increase the meaninfulness and thus the impact of this institutional training.

The degree of instructor committment to the course preparation and presentation is quite high and should be generally commended. Many individuals involved in course development and instruction frequently spend extra time photographing parts of the BIFV to use in slide presentations as part of their lectures, actively seeking out current threat information to use in their presentations and working with researchers to suggest and or investigate potential improvements.

Improvement Areas in Training Requ' nents: Of the BIFV Gunnery Task Sets identified as most critical to the Commander and Gunner, training for the following could be improved:

1. Reactions to enemy fire

2. Acquire potential targets

3. Target identification

4. Estimate target range

5. Determine target priority

6. Hand-off and override

7. Observe and adjust fire

8. Threat target identification

10. Target Acquisition at Night

11. Range Determination at Night

Many of these tasks are not considered to be primarily within the domain of BIFV gunnery training. They are considered to be largely tactical tasks and more generally oriented than to the Bradley or BIFV gunnery. While this is somewhat true, these tasks are those which may well determine the success or failure of a single Bradley or of a Combined Arms Company Team. Training in these skills and the requisite knowledges does occur in other courses (e.g.- Officers' Basic and Advanced Courses, NCO's basic and advanced courses). However such training is needed, initially or again, in these courses as well.

One previously unmentioned aspect of the Bradley training situation that is affecting the general quality and consistency of training is the variability of the student input to the courses. Currently students are arriving for training with a wide variety of experience and prior training. Some of these students have never seen a BIFV before, others have been part of a BIFV unit for over a year. This variability forces the current classes to spend time duplicating prior training for some students to provide initial training for others. This includes introducing the BIFV to the students, essential for those who have not had any experience with the BIFV. In the future, as the BIFV becomes a standard piece of military hardware, this problem will decrease. As this happens, some of this introductory time can be used for greater detail in specific areas.

The courses provide basic training in gunnery for the Gunners, for operation, maintenance and Gunnery for the Master Gunners, and gunnery, tactical employment and command for the Commanders. The courses do not attempt to teach everything which all BIFV crewmembers will need to know to mixmally employ the BIFV and its weapons capabilities. The limited time and resources available in the School forces restricted scope and breadth of the courses; they do not attempt to do the impossible. Basic gunnery procedures and techniques are taught quite well, while much of the refinements of precision gunnery techniques are relegated to further training and experience of the soldier in the unit. Basic tactical information (i.e. site selection, determining fields of fire,

etc.) is primarily presented to the students in the Commanders Course, with little tactical training being given to the Gunners and Master Gunners. Target identification and prioritization become much more important information requirements for the Infantry with the introduction of the BIFV. Although always important to the anit-tank weapon crew, such information achieves a much higher importance for the BIFV squad and team when their vehicle is so much more observable and potentially a much higher priority target for the enemy. The requirement for this knowledge has led the Armor branch to offer classified classes in tank gunnery courses; this may become necessary for Infantry also. Such information is necessary when soldiers are expected to fight in an armored environment. These soldiers have a clear need to know penetration capabilities, armor thickness, and effective ranges of many different systems. Fighting this type of warfare adds new meaning to the term "fighting smart."

Training in target acquisition could be improved by 1) changing the structure of current ranges and 2) increasing the availability of suitable training devices. Firing fans are generally too narrow on BIFV ranges at Fort Benning. They do not provide for adequate training in acquiring targets, tracking targets, or learning lead rules for moving targets. Training devices need to be made available for test and validation studies in the BIFV courses. Until ranges, related training exercises and training aids are improved for a variety of student performance levels, these inadequacies will exist in BIFV training.

Training of range estimation/determination for target engagement in a tactical environment is limited. The following description of present training is repeated from Rollier, et. al., (1984):

> Two methods are taught: use of the stadia lines and use of the WORM formula. Use of the stadia lines is recommended during situations when time permits. The most likely situation with this consideration would be a static position in which use of information derived from a range card would be equally adequate. If the BIFV is in a static position, it is questionable how easily the stadia lines could be used to estimate range to a moving target. At night, accurate range estimation with the stadia lines is less likely. In a moving BIFV, use of the stadia lines would seem too time consuming given the time requirements to initiate return fire. Use of the stadia lines may be appropriate from an overwatch position; however, the probability of detecting a fully exposed target is low.
>
> The second range determination method, use of the WORM formula (Width of target Over the Range times Mils) with binoculars, would seem to be an even less likely technique of determining range for target engagement. It requires the Commander to estimate range with the hatch at least partially open. And given the mathematical computations involved to estimate range, combined with the stress of battle, it is questionable how well timely fire would be delivered.
>
> It would seem that greater emphasis for range estimation in a static position should be on use of range cards and sector sketches for use in both daylight and limited visibility conditions. For moving operations, more emphasis is needed in the area of map reconnaissance and estimation of distances between key features along the route.

The greater need for night training in target acquisition, identification and gunnery skills, in general, leads to an identified need for simply more and more concentrated gunnery training at night. As indicated, there is currently very little training on night gunnery, except in the reverse cycle training and BGST testing that goes on. There is also very little training in use of the thermal capability of the BIFV except in these exercises (and in the FTX setting). More emphasis needs to be placed on these areas and more resources need to be dedicated to providing such training. Some possible answers to some of the training need might be developed out of use of some of the BIFV related training devices dsicussed in the next section; however, training devices will not substitute totally for actual full caliber gunnery exercises, both day and night.

Observations on NET and Unit Training

New Equipment Training (NET)

New Equipment Training (NET) for Bradley-equipped units had been initiated much before the study team's visits to USAREUR and Fort Hood in early 1984. The NET Teams (NETT) had provided training to one Battalion in USAREUR and to two units at Fort Hood prior to our field observations. Both NET teams were formed through special selection from cadre of the School and were pre-trained by participation in an early version of the Bradley Master Gunners course and special train-the-trainer sessions. They then entered their NET training cycles. NET was accomplished somewhat differently in the two locations, but the overall training programs were essentially the same and were based directly on the materials and POIs developed at the Infantry School. In most cases, NET personnel adapted the POIs only slightly for administration to the units.

The Fort Hood Team administered the first on-site training to the 1/41st Inf Bn (Mech) in the 2nd Armored Division in early 1983. They have since trained several other battalions in the 2nd Armored Division. Their training was conducted within the normal training cycles of the Division and the battalions being trained. Training occurred within the local training areas of Fort Hood and was controlled and sequenced to some degree by the Division requirements and the Battalion Commander. An important aspect of this NET was that the BIFV squads were trained as a unit, with all members of the squads participating to some degree throughout the training. No detailed information on this training was available when the study team visited Fort Hood; however, a TCATA study reported that both maintenance and operational training was fully satisfactory to allow BIFV units to accomplish their missions throughout the period of that study (TCATA, 1984).

The USAREUR NET Team administered their first training cycle during the Fall and Winter of 1983-84 to the 1/15th Inf Bn (Mech) of the 3rd Infantry Division. Training was accomplished somewhat differently in USAREUR in that the personnel of units being trained traveled to Grafenwoehr/Vilsek for training. Both maintenance and operational training, including gunnery training, were done at the remote location. Thus, unit personnel were more under the control of the NETT than had been the case at Fort Hood. Another significant difference between the two training situations was that the USAREUR NETT trained vehicle teams (Squad Leader, Assistant Squad Leader, Gunner and Driver) separately from the other squad members. This was thought necessary due to the differences in training task requirements for the two BIFV teams rather than for any other reason. However, the study team observers were told that this caused

some difficulty in the training situation because it generated a perception of separateness (and possibly unequal valuation) between the two teams. No objective data are available which indicate any substantive difference or effect due to this difference in training, but some morale problems were attributed to the differential training treatments. Interim briefings by the TRASANA group conducting the Training Effectiveness Analysis (TEA) for BIFV indicated that the early NET training in USAREUR suffered some difficulties, especially in maintenance training (La Roque, 1984a). A major problem was reported to be the lack of adherence to the POIs for maintenance training and the resultant underutilization of training time and trainee time. Subsequent reports indicate that these NET difficulties have been largely corrected.(La Roque, 1984b).

In NET training at both locations, gunnery training was conducted according to a training schedule based on the USAIS POIs for the Gunners Course and the Commanders Course. No fixed POI was used either at Fort Hood or in USAREUR. NETT personnel worked with the basic content of the Benning POIs and modified them as needed to train unit personnel at each of the appropriate levels. Modifications to basic concepts and POI materials were consistently cleared with the Infantry School prior to implementation (MAJ J. Hinton, personal communication, January, 1984). NETT personnel also used the contents of FM 23-1 as guidance for training and for input to unit trainers. Thus, gunnery training for all personnel, including Bradley Commanders, followed the outlines and included essentially the same exercises as presented in current courses at the Infantry School. Unit trainers were also urged to follow the recommended gunnery training and evaluation programs set forth in FM 23-1 in continuing home station training in preparation for qualification training at the MTA.

Thus, NET training closely paralleled that currently provided at Fort Benning, but emphasis was on preparing unit personnel at all levels to perform their respective jobs and to work together as teams. When unit personnel were questioned about the effectiveness of NET training, responses were quite positive at both units visited.

Unit Training Observations

As indicated, the study team visited both of the initially equipped Bradley units to observe training and evaluation during ARTEP exercises. These visits were primarily to observe tactical training and operations at the squad level and have been reported in detail elsewhere (Rollier, et al., 1984). As such, observations and collecton of data on unit gunnery training and training programs was a secondary objective. The intent was to find out as much as possible about unit gunnery training in a relatively informal manner. The result was that no hard data were collected, although gunnery training was discussed on many occasions with many individuals.

Although no actual unit gunnery training was observed at either location, preparations for home station pre-MTA gunnery training were observed and discussed with unit trainers in USAREUR (3rd Inf Div, 2nd Bde, and the 1/15 Inf Bn, in Kitzengen, FRG). Trainers reported that FM 23-1 was used as the gunnery training "bible" for the Brigade and the Division. Their total gunnery training program is based on the recommended annual training program and the preliminary gunnery training and firing exercises outlined in the FM. They routinely conduct local area training on dry fire and other preliminary gunnery skills in preparation for their qualification firing which is done at Grafenwoehr. Crew gunnery and squad drills are planned for routine conduct to be based on local

and Department of the Army guidance. These are intended to prepare Bradley teams for the vehicle team, squad and platoon qualification exercises (VTCE, SCQE and IPEE).

Observations at the units included subcaliber firing with a locally fabricated adaptation of the Brewster device (using .22 cal ammo) against scaled ranges fashioned to resemble GDP positions. The use of the tank version of the B/TGMTS (Bradley/Tank Gunnery and Missile Training System, by DETRAS) was also observed. Unit trainers indicated that such devices were fundamental to successful training given their training area restrictions on full caliber or even 7.62 mm firing. Such devices allow much more and more frequent practice by Bradley teams than any other available resource.

Trainers were also using scaled ranges to train range determination with the choke sight in the ISU. This was accomplished by mounting scaled vehicle silhouettes on movable target stakes at varied distances from the vehicle line. Commanders and Gunners then practiced ranging on the targets at various simulated ranges. Trainers reported that this training had considerably improved initial ranging on full scale targets for some gunnery teams but no details were available.

Trainers questioned about training for thermal mode use of the ISU and thermal image identification indicated that no formal programs were available or used in the units. Trainers recognized that such training was needed and should be developed either locally or centrally, but no efforts were reported to be underway. Apparently, little emphasis has been placed on this aspect of gunnery, day or night.

The USAREUR unit trainers also indicated that the available Master Gunners (from Fort Benning training) were being used mainly as battalion level primary instructors for sustainment and transition training of individual Bradley gunnery teams. USAIS has defined the Master Gunner's major role was to be that of training advisor to the battalion command staff, rather than that of direct instruction. However, USAREUR's utilization of the Master Gunner skills may be more appropriate in a newly equipped battalion such as was observed there. Perhaps as the units become more highly experienced and receive more school trained personnel, the Master Gunner will be able to assume the more general level role envisioned by the Infantry School and implemented by the Armor community for tank Master Gunners.

As in USAREUR, the visit to Fort Hood was primarily to observe tactical training and evaluation during ARTEP exercises. Again, no direct gunnery training could be observed. However, discussions with Commanders and trainers were possible and some information corroborating the USAREUR data was obtained. The following similarities were found:

1) the unit also used the programs outlined in FM 23-1 as the basic building block gunnery training program. For both preliminary training and for qualification, the principles and gunnery exercises of the FM were reported to be followed closely;

2) the unit was also using team and squad drills based on the drills promulgated by the Army Training Board with local modifications (undefined) to meet their needs;

3) as in USAREUR, Master Gunners were mainly being used to train other gunners and vehicle teams (this was still true although this unit had had the Bradleys for nearly one year at the time of observation);

4) although more experienced with the Bradley and dedicated to night fighting by the 2nd Armored Division charter, this unit still had no effective training program for thermal mode ISU operation or identification of thermal targets. When asked about the Thermal Combat Vehicle Identification kit--developed at ARI Fort Hood (Smith, 1984)--the trainers questioned were unaware that it existed.

An advantage for the Fort Hood unit was their ability to practice both subcaliber and other exercises on the readily avilable ranges of the Fort Hood complex. Rather than being limited to the small local area as in USAREUR, the unit could fully utilize the major ranges and practice areas available on the post. This seemed likely to result in less interest in training devices (although the use of the Brewster device was reported) and more concern with live fire practice whenever possible. Also, this unit had taken their qualification exercises on the tank ranges (Tables VII and VIII) at Fort Hood. Currently there are no ranges designed for Bradley exercises at Fort Hood, although such ranges are planned for construction in FY 85-86.

These limited observations from Bradley units strongly indicate that gunnery training is highly dependent upon the doctrine and guidance promulgated by the Infantry School in FM 23-1. This heavy dependence makes it essential that this FM be updated, corrected and expanded in certain areas to allow units to design and conduct better, more all encompassing, gunnery training programs.

Input from the Field: BFVS-TSM Training Conference - June 1984

Additional input on Bradley gunnery training and training needs was obtained from reports of the Bradley Fighting Vehicle Systems Training Conference convened at Fort Benning by the TRADOC Systems Manager (TSM) (King, 1984). The purpose of the conference was to obtain feedback from the Bradley equipped units on the total package of BIFV doctrine and training provided by the Infantry School. Many issues were discussed at the conference with most being related to doctrine, tactics and techniques for BIFV and squad employment. However, gunnery training was also discussed and some written input was provided by several field units.

The following issues related to gunnery training were prepared by USAIS-BFVS-TSM for the meeting (however discussion of these was fairly limited due to press of other matters):

1) What changes need to be made in FM 23-1 (Test)?

2) Can the number of rounds currently allocated in FM 23-1 be reduced and still maintain crew proficiency?

3) Gunnery qualification should be at Crew? Squad? Platoon Level?

4) Should NET gunnery be revised and standardized for both USAREUR and FORSCOM? If Yes - Standards? Exercises?

5) Is the BGST a good diagnostic tool?

6) Are present crew duties adequate?

Inputs related to these issues were provided by the representatives of the 2nd Armored Division (Fort Hood) and the 3rd Infantry Division (USAREUR). The key points in the written (Vu-graph) inputs by each unit are listed below.

2nd Armored Division Major Points.

Sustainment Training Requires:

Annual Qualification for All Teams

Master Gunner Certification

Benning Validation of Master Gunner

NET Recommendations:

Provide Tactical Overview

Maintain the Squad Trainer

Increase Target Acquisition - Reduce Building Block System

Train Position Specific Personnel

Gunnery Specific:

Qualify Three Times a Year - with Equal Priority

Move Towards Vehicle and Squad Qualification

Combine Tactics with Gunnery Training

Double VTCE Requirement

Double SCQE Requirement

Integrate TOW Selection Training

Master Gunner Training:

Vehicle Technical Expertise Excellent

Increase Training for Practical Applications:
- Range Design
- Range Operations
- Targetry

Officer Training:

Include Range Design Operations and Targetry

Certification for Bradley Officers

3rd Infantry Division Major Points.

Level of Qualification

Vehicle, Squad Qualification

Platoon Qualification

Requirement for Standardization of Qualifications

Concern with ARTEP and Gunnery Standards

Gunnery Tables

Need revisions

Better Integrate Dismount Team

Range Design

Development of Local Training Ranges

Training in Range Design and Operations Required

Night Fighting

Focus on Commander and Gunner Interaction

Need for IFF and Thermal Training for Combat and Training Applications

These points were presented by the unit representatives but were not widely discussed among the conference attendees. Although there was little argument about these items, there was also little consensus as to what to do about them at this time. These listings do, however, indicate that the Bradley-equipped units are experiencing many of the same problems observed in the institutional training. They are also perceiving training problems which have been unrecognized to date.

Summary of Review of Unit Gunnery Training

It is clear from the above that a number of problem areas exist in the current doctrine for BFVS gunnery training and in its implementation in the field. The doctrine from the School, as represented by FM 23-1, tends to be sketchy in several important areas including the following:

1) target acquisition training

2) target identification training

3) thermal mode ISU operation training

4) thermal mode target identification training

5) utilization of available identification training devices

6) range determination training

7) integration of gunnery training with tactics

8) utilization of available gunnery training devices

9) gunnery in night fighting in general

In addition to these areas of light coverage, the BGST, the basic evaluation tool for squad member proficiency, is thought to be presently inadequate and is to be revised. A total revision of FM 23-1 is to be available in early 1986.

With respect to current training in units and the observed or reported problem areas, these include all of the above concerns plus others. Major concerns are reported by units about the training of both Master Gunners and Bradley Officers. Similarly, the units report concerns about the total gunnery program, its progression and the various qualification requirements for different levels. There are also reports of concern about requirements for conduct of preliminary training, dry fire gunnery and subcaliber training in home station training in local training areas.

In sum, BFVS unit gunnery training is probably being done fairly well overall, given the newness of the Bradley and its unique training requirements. But the many areas of weakness and concern on the part of unit commanders and trainers indicate that more training could be done better with improved doctrine, better training materials and devices, and improved training management. The BFVS study team must work with ARI and the USAIS to provide some of these needed improvements.

Review of Selected Training Devices

A variety of training devices has been developed, proposed or planned for potential training of Bradley Fighting Vehicle gunnery tasks described earlier. Some of these devices are designed primarily to train part of the gunnery task, others are intended to accomplish the whole gunnery training job, while other training developments are directed mainly at tactical training (to include gunnery) for the total BIFV team. However, our analysis indicates that few devices or aids can truly accomplish the whole gunnery training job, particularly when used as they most frequently are: without detailed efforts to design effective integration of the devices into the total training program.

The following reviews the variety of training devices and aids which are currently available, or are soon to come online, for potential use in training the Bradley teams. The general performance and assessment characteristics of the devices are described and their reported capabilities are compared with the requirements for Bradley gunnery task performance. Finally, the needs for

training support which are not fully met by the described devices are discussed. Potential solutions to meet these unmet needs, including the integration of selected current devices into training programs in meaningfully effective ways, are then considered for possible demonstration or test in the next phase of this study.

Characteristics of Gunnery Training Devices

The currently available training devices and aids to be discussed are listed in Table 10 in logical categories derived from device characteristics. The characteristics of each device listed in Table 10 are described in the following paragraphs.

Add-on Interactive Laser Systems

MILES, or the Multiple Integrated Laser Engagement System, is now becoming available for the Bradley. It has been demonstrated at Fort Benning and introduced to the Bradley units at Fort Hood. This Laser training system assists training of gunnery skills by using actual equipment and actual vehicles but firing a Laser beam as opposed to a projectile. The soldiers and vehicles are equipped with sensors which detect lasing from other weapons systems. Vehicles are killed only when engaged with a Laser beam coded to represent a weapon which would actually kill the target (e.g.- a TOW Laser beam would kill an M1 Tank; the beam from an M60 MG device would not). Kills are indicated by a flashing light on vehicles and a loud continuous buzzer on individual soldiers. The MILES weapons simulators for killed vehicles or soldiers are deactivated also; they will not fire again until reset by Controllers. Recent improvements in MILES now allow better simulation of indirect fire and the inclusion of Air-to-Ground and Ground-to-Air engagements (MILES-AGES). Another recent innovation is the Laser Target Identification Device (LTID) which provides Laser sensing and control of the IRETS and ARETS targets, allowing them to be killed by the MILES system elements. This innovation allows MILES to be fired at stationary or moving targets on standard ranges. Bradleys with MILES and the LTIDs on targets at Ruth Range at Fort Benning could perform the Squad Combat Exercise without firing one round of live ammo. The system assists gunners, commanders, and referees in determining who killed whom on exercises such as ARTEPS without anyone actually being fired upon and killed. The MILES system does not account for ranging to the target or the elevation required by projectile trajectory, nor does it allow for leads necessary for adequate training against moving targets. Assessment and feedback possibilities include hits, near-misses and kills for each element (soldier or Bradley), time and location where killed, identification of the opposing (or friendly) element which fired, and the effectiveness of tactical operations of the unit as a function of who was killed, when, where and why. MILES is in heavy use at the National Training Center as the major assessment tool for force on force engagements between battalions-in-training and the resident OPFOR (opposing force). Further, NETT training is now being conducted on the recently developed elements, such as the Bradley equipment and the MILES-AGES subsystem. Because of the widespread application of MILES in the Army and the wide knowledge about it, the MILES system is used as a baseline system for comparison of the other Laser-based systems described below.

The SAAB BT-41 is similar to MILES in that it is an interactive Laser engagement system and has many characteristics similar to those of MILES. It also provides in-the-optics simulation of gunfire and trajectory of rounds fired

Table 10. Current Training Devices

- Add-ons to Actual Equipment (divided into):
  - Force-on-force Interactive LASER System:
    - MILES for Bradley
    - SAAB BT-41
    - Talissi Device
    - National Training Center
  - Strap-on Gunnery Training Devices Aids:
    - BGMTS - DETRAS Device
    - Reavis/Brewster Device
      - Sub cal (5.6 or .22)
      - M55 LASER w/Stout Board
    - Telfair Device
    - Through-Sight Video
- Full- or Part-task Trainers (including):
  - Simulators / Procedures Trainers:
    - U-COFT (Conduct of Fire Trainer)
    - Perceptronics (VIGS) Trainer
    - Tanga
  - Simulations:
    - CATTS, ARTBASS, FIRST BATTLE, CAMMs
    - SIMNET (LSS - DARPA)
  - Range Modifications
    - LOMAH
    - Scaled Ranges and Targets (Sub Cal and LASER)

by a vehicle, which MILES does not do. Like MILES, the BT-41 uses Laser sensors on the targets, which can be either actual vehicles or simulated targets with detectors attached. The SAAB also accounts for the actual range to target vehicles, and considers the trajectory and elevation of rounds of different types to determine the exact location of hits and misses. Vulnerabilities of targets from 12 different aspect angles are modeled relative to different types of ammunition. The target simulator evaluates whether the shot was a hit or a miss. A hit is evaluated for effect of the round on the target based on the angle of the target as viewed from the firing element. Kills are determined by the actual probabilities of kill for the round and the locations of hits. Trajectory and sensitivity can be easily modified through programming. Documentation of all shots fired as well as received from enemy vehicles is provided on a paper print-out from the system's computer. Assessment measures include time-of-day shot was fired, round type, rounds hit, rounds to kill, and exact distances in elevation and azimuth of each round from center of mass. This information can be made available in the turret of the Bradley (or other vehicle) for relatively immediate feedback to Commander and Gunner. The SAAB Laser gunnery system is reported to have a considerable advantage in precision over the MILES system (which was never designed to be a precision gunnery trainer; only a tactical trainer). If precision gunnery can be demonstrated for the SAAB BT-41, it will be a valuable gunnery training device - one which would allow gunnery training in the most realistic way possible (short of war): in the field against a variety of friendly and unfriendly vehicles and weapons systems. This would provide good gunnery training in a tactical context.

Simfire is the British version of MILES and appears to offer most of the same capabilities with few added advantages. However, it does provide for the simulation of weapons effects in the optics - the fall of the round is simulated in the Gunner's eyepiece attachment. The system also uses a cam system to move the Laser to compensate for the elevation of the main gun, so avoiding the lack of ranging capability that exists in the MILES system. Kills and killed vehicles are simulated in about the same way as with MILES and killed vehicles are similarly disabled. Precision of the Laser beam is not specified in materials available for review. This system seems to fall somewhere between the MILES and the SAAB BT-41 in sophistication and in accuracy of portrayal of the tactical aspects of gunnery training. Simfire would probably not be a great improvement over MILES for use in Bradley training considering the large current investment in that system.

The Talissi device is a Laser device similar to MILES developed by a German company (Kurt Eichweber), and designed to be used with direct fire weapons. Muzzle flash and hits are simulated by the use of pyrotechnics. A hit which results in a kill, based on the computed probabilities, causes the automatic de-energizing of the ignition and the radio of the killed vehicle. There are three versions of Talissi: Version 1 automatically determines if line of sight is properly laid on the target; Version 2 incorporates a range finder which determines if the shot was short or long; this version will only score a hit if the range was properly adjusted; Version 3 also forces the Gunnerto consider the gun elevation in correspondence with type of ammunition and the target's range. Talissi has been used with the Marder, antitank helicopters, antitank guns, and reconnaissance vehicles. As with Simfire, the Talissi appears to be a compromise. It would add only ranging and elevation to the training capabilities of MILES. It is not clear that the Talissi can match the precision measurement and feedback of the SAAB BT-41.

The National Training Center (NTC) provides battalion-sized unit training against a threat force which uses apparent threat vehicles, threat tactical doctrine, and knowledge of the terrain. MILES is used to determine hits and kills; and all engagements (their time, location, engaging elements, and outcomes), are stored in a computer for later analysis. Immediate (end of exercise) feedback is provided to the training unit Commander and staff by the NTC controllers and Commander. The purpose of these training exercises is to provide detailed knowledge of what unit missions, procedures, tasks and techniques are weak and must be concentrated on in home-station unit training. Training at NTC is considered the ultimate tactical training experience in the U.S. Army; however, the accuracy and meaningfulness of gunnery training at NTC suffer the same limitations as those for MILES in any other training situation.

Strap-on Gunnery Training Devices/Aids

BGMTS (the Bradley Gunnery and Missile Training System made by Detras) is a gunnery simulator which requires the actual Bradley to be positioned in front of the device and uses the Bradley turret and controls as part of the simulation process. The system includes a film projector located behind a large rear projection screen and a Laser transmitter attached to the vehicle's turret and aligned with the main gun. The Commander and Gunner view the projected film display on the screen through their normal optics and perform normal target engagement procedures. Displayed on the screen are filmed field scenes of single or multiple enemy targets, with full variation in range and terrain being limited only by the availability of films. When the gun is laid on the target and the trigger is pulled, the LOS (infared line of sight transmitter) emits an eye safe Laser beam which tracks the flight trajectory of the round and simulates an explosion at the predicted point of impact. Ranging is accomodated in the projection of the flight path, so short rounds appear to burst short and long rounds appear to go over the target. Feedback and evaluation capability are limited to that provided by the simulated burst of the round and its location in relation to the target. Vibration of the round being fired, flash of the gun, smoke and dust are not simulated. The use of missiles can be simulated as can engagements of moving targets. Thermal sight films are being planned.

The Reavis/Brewster device allows the use of either an M16 or the M55 Laser as a substitute for main gun firing. The device is mounted on the barrel of the 25 mm and is boresighted and zeroed via reticle adjustment in the ISU. Used with scaled targets (M16 with either 5.56 mm or .22 cal ammo) or the Stout Board (a bulletin board like device on which to mount small scale targets for use with the M55 Laser), this device allows the Gunnerto practice the basic gunnery skills of aiming, tracking and firing. Any targets up to 1/10 scale can be used with the device except that problems are encountered with the very small (1/60) targets. Usable available scaled targets include 1/35, 1/20, and 1/10 scales. A problem with the smaller scales is related to the attempted use of the 12 power scope in the ISU. Normal usage is to acquire targets with the 4 power optics and to switch to the 12 power for engagement. Switching to 12 power causes problems in viewing both the sight reticle and the target at the same time when the scaled target is physically too close to the ISU. When used with the M16, the Reavis modification of the Brewster device compensates for both the superelevation difference between HEI-T and ADPS-T and the trajectory differences between these rounds and those of the 5.56 mm and the .22 cal rounds. When the M55 Laser and the Stout Board is used the device can also compensate for elevation and trajectory differences. Thus, the device allows

ranging to be trained with either application mode. A most recent development is an improved wiring harness (the Payne harness) for this device which is more economical, easier to install, and highly reliable. This device should provide the capability to train both Precision Gunnery and Battlesight BOT with the Bradley, with a major reduction in costs for ammo, POL and ranges. With proper instruction and suitable targets, vehicle identification, firing on moving targets, and range estimation might be taught as well.

The Telfare device is a strap-on mount which allows the .50 caliber MG, M2, to be mounted on the tank main gun tube. Fired in the single shot mode with either .50 cal ammo or a subcaliber adapter, the device will allow gunnery practice against full size, 1/2 size, or smaller scaled targets. As used with tanks, this device would obviously reduce the expense of firing live rounds. An adaptation to the Bradley has been considered but has not been produced as yet. One reason for the lack of interest is that the 7.62 mm Coax MG can be a fairly effective subcaliber training substitute for full caliber 25 mm. It is used in all three Bradley gunnery training courses. A second reason is that the Reavis/Brewster device is more appropriate than Telfair for scaled range work with the BIFV.

Through-the-Sight Video is not a gunnery specific training device. However, it can provide a unique capability for capturing the actual sight pictures seen by the Bradley Commander and Gunner. This requires installing an optical beam splitter in the visual path through the ISU and fitting the resulting optical output to a video camera. This allows direct monitoring or recording, or both, of the complete target search, acquisition and engagement process of the team (When the ISU is used). This provides the capabilities for immediate verbal feedback on behaviors by an instructor observing a monitor, delayed feedback by way of replaying the video tapes for the team, and precise measures of various variables associated with the tracking, aiming, leading, and firing practices of the Gunner/Commander through subsequent frame analysis. As with other training devices and aids, this assessment/feedback technique will provide effective training, through feedback, only to the extent that it is appropriately incorporated into a program of instruction, whether initial training or sustainment training.

Plastic ammunition can be used with either the Reavis/Brewster device (5.56 mm and perhaps .22 cal) or the coaxial machinegun. It is not yet clear whether the ranges of the small caliber plastic ammo will be satisfactory to allow scaled range usage. Plastic ammo for the 25 mm is being considered and may be made available in the future. None is currently in production. Although trajectories may be considerably altered by the use of any caliber plastic ammunition, it may prove usable in conjunction with scaled ranges and targets to train several aspects of gunnery at reduced overall costs.

Simulators / Procedures Trainers

The COFT (Conduct Of Fire Trainer) is being developed in Unit and Institutional models, with U-COFT being available in 3rd Qtr 85 and I-COFT in 1987. The U-COFT provides a high fidelity simulation of the interior of the Bradley turret and allows performance of most of the procedural functions of the BIFV Commander and gunner. It does not provide a 360 degree field of view for either the Commander or Gunner. Driver functions are not trainable in the device, but some results of the driver functions are presented to the Commander and gunner, such as the simulation of vehicle driving and stopping on orders

from the commander. Computer generated imagery (CGI) visual displays are presented to the Commander and Gunnerthrough the simulated ISU, the unity window and a single commander's periscope. Scenes presented can include day views, night views, thermal displays, fog, haze, smoke obscuration and other simulated weather conditions. The computer generated field of play is 3000 by 6000 meters and allows the insertion of multiple vehicle, aerial and troop models in the field of view. Both moving (up to six) and stationary targets can be presented and the models appear to move relatively realistically. If hostile targets are not engaged within set times, enemy fire is received. Round trajectories are depicted realistically in addition to round impact. An instructor's station allows monitoring and control of the training process and the computer automatically keeps records and scoring. The instructor can choose to use a computer-selected sequence of sessions (each about ten minutes long and presenting about ten targets), based on the performance of the crew in prior sessions, or he can at any time select specific training sessions for the crew. Sessions vary in difficulty based on target number (single or multiple), own vehicle motion or target motion, and other parameters (as weather and malfunction conditions). The training sequence can be frozen by the instructor at any point in time for critique of individual task performance. An entire exercise can also be played back for instructional purposes. Performance criteria are built into the system and scoring on individual sessions is used to determine what sessions will be presented next to any given team. Scoring and performance measurement are precise, consistent and recorded by team and by unit (when fielded). Various formats of printout summaries are available to the instructor or the Unit Commander for training management purposes. The system does train turret procedures quite well and teams trained in the U-COFT performed live fire as well as teams trained on the actual equipment during the OT-I for the U-COFT. (Moon, J. and Strasel, H. C., 1982). Some major tasks, such as 360 degree observation and vehicle identification, are not trainable in the U-COFT. Training for range determination may be questionable also, due to imagery differences. There is no attempt to simulate or to train for gun malfunctions. On the other hand, the capability for training many normal and emergency procedures (including turret power failures) in a wide variety of limited visibility conditions is a major training plus.

The Perceptonics MK-2/3, the Bradley version of the videodisc-based Part Task Gunnery Trainer (PTGT), also called the VIGS (Videodisc Interactive Gunnery Simulator), can be used in a classroom or in the field (on ranges) to simulate the Gunner's firing tasks. The trainer is a single station (Gunner only) device which presents videodisc-stored film images of actual vehicles on a TV monitor viewed through a simulated Gunner's ISU. Gunner's handles are placed in a reasonably accurate simulation of the original turret and their manipulation causes the "scope" field of view and reticles to move across the visual scene displayed on the monitor. Targets can be tracked, ranges can be determined using stadia lines, and firing can be simulated, including selection of weapons and ammunition options. Firing commands are presented to the Gunner aurally. Currently these do not accurately simulate real commands, but they could be modified to be faithful replications of the actual commands being trained now. Automated scoring of hits, misses and rounds fired is built into the trainer along with certain other performance characteristics. Certain deficiencies in this trainer have been identified by USAIS SMEs (Subject Matter Experts) and communicated to Perceptronics, but not all of the fixes have yet been made. As it is now, this trainer should be useful for initial or sustainment training of some of the basic gunnery procedures. With the deficiencies fixed, it could

also be useful for refresher training in ranging, IFF, and night gunnery if appropriate imagery could be made available.

Tanga is an Israeli-developed single station trainer similar to the Perceptonics. It uses film representation of target imagery and presents this to the simulated Gunner's position through simulated optics. The only known configuration is designed to provide general gunnery training for a variety of tanks employed by the Israeli Army. Gunner's handles are provided and the targets can be tracked, ranged and engaged by the Gunner. The device is designed to improve the Gunner's skill at target location, aiming and tracking, rapid firing, and burst on target firing. It allows for insertion of errors for advanced gunners. It simulates flash, recoil, smoke obscuration, sounds of firing, and round locations, including hits on targets. A printed output of Gunnerperformance is provided for exercise critique.

Tactical Simulations

Sophisticated tactical simulations (or wargames) are now available in many forms and varieties. The CATTS (Combined Arms Tactical Training Simulation) is the forerunner of ARTBASS and both provide major simulation capabilities for Command Group (Bde and Bn Staffs). CAMMS and First Battle are simulations/games which provide tactical training for Commanders from Platoon through Battalion level. None of these simulations can provide detailed training in specific gunnery tasks. However, the training in tactical manuever, use of terrain, cover and concealment, etc., inherent in the tactical scenarios and game rules would have obvious beneficial effects on the Bradley Commander's ability to perform his gunnery related functions.

SIMNET (or LSS for Large Scale Simulation) is a DARPA sponsored development which may soon provide tactical training for multiple squad or platoon level elements (up to multiple Battalions eventually) in simulated force-on-force situations. This large scale simulation is to interconnect up to 1000 player elements operating at modified computer terminals and performing as individual Bradleys, selected dismount elements (Dragon team), M1s, and other elements. The simulation scenarios should provide excellent training in tactical play if appropriate effects are simulated and presented at the level appropriate to the trained individuals or teams. There is not likely to be the capability for precision gunnery training in this system, since the actual gunnery equipment will probably not be simulated in the element stations. As with the wargames, tactical training gained here should enhance the Commander's ability to perform his gunnery related tasks in the Bradley.

Range Modifications

LOMAH (Location of Misses and Hits) is a projectile locating system which theoretically can be mounted on any existing or projected target systems. It detects the location of a projectile passing the plane of the target and provides direct feedback to the firing line through a video display of the exact location of the projectile. Multiple sensors, located on the target base, detect the shock waves of projectile passage and translate the wave arrival times into location coordinates. Detection range (around the target) is dependent on the number and nature of the sensors located at the specific target. The projectile's passage coordinates are displayed in relation to an image of the target and hit position and errors of elevation or azimuth are displayed. There is a replay capability for the last set of shots. This

feedback is more useful than mere hit or miss information because the Gunner can use the location information to correct his next aim point, or in some cases to rezero his weapon. This information is particularly useful to any person new to the particular gun being used. LOMAH should be investigated for use in precision gunnery training, particularly for use in zeroing the 25 mm and Coax, and for use with the 7.62 Coax as a subcaliber trainer for the 25 mm. Use with other subcaliber training approaches should also be investigated It may also prove to be useful in firing port weapon training for the Bradley squad.

Scaled ranges and targets can be used with either live subcaliber fire (5.56 mm or .22 cal) or Laser simulations of fire. This adaptation can be done with the Reavis-Brewster device discussed above or with the MILES and SAAB type systems. Currently, the Army has standard targets scaled at 1/60, 1/35, 1/20, and 1/10 which could be used on a range complex or, with Lasers, in local training areas (LTA), maintenance or motor pool areas.

Training Devices and Gunnery Tasks to be Trained

The devices described above comprise most of those available or contemplated for potential use in Bradley gunnery training. This section presents an analysis of these devices and their capabilities in relation to the identified gunnery tasks requiring training. The folowing considers the device characteristics and their suitability for training each task.

Table 11 summarizes the general characteristics of the individual training devices described above and listed on the horizontal axis of the matrix. The devices are grouped by logical categories and remarks apply to all in each category. Where significant diffferences exist among items in a category, these will be discussed below. This summary is a consolidation of ratings of each device against the characteristics shown on the vertical axis of the matrix.

Table 12 summarizes ratings of the suitability of each device type with respect to training the identified tasks. Each task is listed at the left, followed by the sum of the ratings assigned in the previous analysis of task "criticality" (from Table 3). That value is followed by a rating based on the judgment of skill type (cognitive or psychomotor) from Table 4. This rating simply assigns a 1 for a "mainly cognitive" rating in Table 4 and ascending numbers to 5 for "mainly psychomotor". Finally, the devices were rated, by category, as to their likely suitability for training each task. Again a five point scale of suitability was applied to each device in relation to training each task. The values 1 - 5 were assigned to represent the following general statements about each device for a task:

1 - Device is judged unsuitable for training this task;

2 - It is doubtful that the device will be suitable for training this task;

3 - Device is suitable - with major additions, modifications or preparation - for training this task;

4 - Device is suitable - with minor additions, modifications or preparation - for training this task; and,

Table 11. Summary of Characteristics of Current Training Devices

Characteristics:	CURRENT TRAINING DEVICES	Training Devices: Actual Equipment	Force-on-force LASERS	Nat'l Training Center	Strap-on devices: BGMTS; Reavis/Brewster; Telfair; TSV	Simulators/Procedures Trainers: U-COFT; VIGS; Tanga	Simulations: CATTS; ARTBASS; CAMMs; SIMNET	Range Modifications: LOMAH; Scaled ranges and targets
Display Format:		AE	AE	AE	AE-Sights	See Text Varies	Boards CRT	CRT & Various
Number of Stations:		All	All	All	2(+)	2-UCOFT 1-Others	Not Specif. Bradley	Varies
Which Crew Members:		All	All	All	Gunner, Cdr	BC & G or G Only	Leaders ?	BC &
Tasks trained:		All Poss.	All ?	All Poss.	All Possible- But problem w/ Ranging & ID	All Specif. Gunner Tasks	Leader Tactical Tasks	Direc. Gunner Tasks
Targets Displayed: Sing or Mult:		Dep. on Range	Dep. on Range	Yes Mult	Mult Poss.	Mult	Mult	Varies Mult Poss.
Stat & Moving Tgts? - Veh.?:		Dep. on Range	Dep. on Range	Yes Mult	Dep. on Range or Display Film	Stat & Moving-COFT	No Exc. LSS	Movers Poss.
Identification Possible?:		Dep. on Range	Yes	Yes	Yes?	COFT-No Others ?	?	Yes
Ranging Possible?:		Yes		Yes	Yes	Yes	?	Yes
Performance Measures?:		See Text---------->						
Collection/Scoring:		Man	Auto	Auto	Varies	Auto	Auto & Man	Varies
Location for Use:		Range	Range FTX	NTC	Garrison, LTA	Garrison	Garrison	Range, LTA, MTA
Physical Size:		AE	AE	--	BGMTS Reqs. Hanger	COFT-Trailer Oths.- Desk	Trailers?	--
Overall Judged Value:		Good	Good	Exec.	Varies By Device	COFT-Exec. for Proceds.	High for Tactics	Good for Basics
Limitations to Use:		See Text---------->						

Table 12. Suitability of Training Devices for Selected BIFV Gunnery Tasks

Tasks:	Crit Sum	Cognit/ Psycmtr	Training Devices: Actual Equipment	Force-on-force LASERs	Nat'l Training Center	BGMTS	Reavis/Brewster	Telfair Device	Through-Sight Video	U-COFT	VIGS	Tanga	CATTS, ARTBASS, CAMMs	SIMNET (LSS - DARPA)	LOMAH	Scaled ranges and targets
Selected Commander Tasks																
Command and Control	18	2	3	4	5	1	1	1		2	1	1	4		1	1
Acquire Potential Targets	18	3	3	4	5	4	3	3		5	1	1	1		3	3
React to Enemy Fire	16	3	3	4	4	2	1	1		5	1	1	1		1	1
Identify Targets (IFF)	21	1	3	3	5	4	3	3		2	1	1	1		3	3
Determine Target Priority	19	1	3	5	5	5	3	3		5	1	1	1		5	5
Estimate Target Range	21	1	3	3	3	3	3	3		4	1	1	1		4	4
Lay on 1st Priority Target	18	5	5	5	5	5	5	5		5	1	1	1		5	5
Override when required	18	4	5	5	5	5	5	5		5	1	1	1		5	5
Observe and Adjust Fire	19	1	3	3	3	3	3	3		5	1	1	1		5	3
Selected Gunner Tasks																
Assist Commander in above	21	3	3	4	5	3	2	2		5	1	1	1		1	1
Acquire Designated Targets	17	3	4	4	4	4	4	4		5	4	4	1		4	4
Target Engagement:																
Determine/index range	20	4	4	4	4	4	4	1		5	4	4	1		4	4
Fire: Lead, BOT, Adjust	19	5	3	3	3	3	2	2		5	3	3	1		4	4

Note: Criticality Sum is the sum of ratings from Table 1. For Cognitive/Psychomotor - Ratings are 1 - 5, with 1 being mainly Cognitive and 5 being mainly Psychomotor. For Training Device Suitability - Ratings are 1 - 5, with 1 implying no suitability for training and 5 implying a high suitability for training the given task. See text.

5 - Device is fully suitable for training this task.

The following discussion considers both the summarized characteristics of the devices and their suitability for task training.

The first device column of both Tables 11 and 12 show a summary of the characteristics of the actual equipment (the Bradley itself) used as training equipment for gunnery. This shows that the Bradley obviously can be used to train all required tasks for all crew members. However, as a trainer, the Bradley requires ammunition, ranges, POL and other resource support to be effective. It also requires that the instruction be conducted essentially one-on-one and that the instructor personnel closely monitor and evaluate performance manually and with no automatic support (except as provided by range scoring, etc.). These limitations, including the costs of operation, make the Bradley less than optimum as a trainer.

The next two columns describe the training characteristics of the force-on-force interactive Laser systems and the National Training Center, which uses MILES for assessment of gunnery and other weapons effects. All systems of this type use the actual equipment and require full equipment, POL, and other support, except for ammunition, that is required for the actual Bradley used as a trainer. Also, the effectiveness of these devices for gunnery training has not yet been fully demonstrated. MILES was not designed as a gunnery trainer and does not allow several important items of gunnery performance (e.g.- ranging and BOT). It also does not provide adequate feedback on round firing, obscuration, trajectory, or location of the strike of the round. Other systems, especially the SAAB-Scania BT-41 and Simfire, do provide for performance of these critical gunnery tasks and are reported to provide sufficient precision of Laser strike to adequately evaluate gunnery performance. These systems appear to be excellent for tactical training and should be effective for many of the BIFV gunnery-related tasks, particularly at the National Training Center. However, for some Gunner's tasks and the required interactions with the Commander, the current system (MILES) is not fully adequate because the Gunner is not required to perform all tasks (e.g. no ranging).

The "strap-on" gunnery training devices are treated in the next major column, including BGMTS, the Reavis-Brewster Device, The Telfair device and the Through-the-Sight Video (TSV) capability. Taking the last first, the Video device is not a stand alone training device; it simply allows an instructor to view or record the sight picture from the ISU and provides the instructor with the basis for feedback to the Commander or Gunner. This provides a highly desirable adjunct to training with or without any of the other strap on devices (or with the Laser systems). The TSV can also be used with full caliber fire on actual ranges.

The BGMTS (DETRAS) device also straps on to the actual equipment and can be used to train Commander-Gunner interactions and actual firing procedures for the Gunner. It can be used in Garrison or in an LTA and does not require full POL, range, or ammunition support. The device does require a large hangar-type area in which to be setup. It must be protected from weather, etc., and requires space to move the Bradley up to the projection screen area. It is questionable whether the device can be used to fully train either Commander or Gunner in either target identification or ranging; this capability depends heavily on the availability of appropriate film images, the quality of the film, and the available documentation of targets and ranges presented in the images. As yet,

there have been no demonstrations of any capability for thermal viewing training with the device although thermal imagery could probably be developed for this purpose. Scoring is essentially by visual inspection of the image of the rounds on the projected targets and this is the only real feedback provided to the Bradley team. This device should be a reasonably good trainer for gunnery procedures and aiming and tracking with the 25 mm and the TOW. It lacks some capabilities desirable for training some of the selected major tasks, as indicated above.

The Reavis-Brewster device provides good training on Commander-Gunner interactions and the basic Gunner acquisition, aiming and firing tasks. With either the M55 Laser and the Stout Board or the M16 and live (subcal) ammunition, this device will allow preliminary gunnery training and familiarization for either initial or cross training of Gunners. A problem with this device, viewed as serious by some trainers, is that the close range required for engaging scaled targets precludes the use of the 12 power capability of the ISU. Near targets must be engaged with the 4 power optics. This makes training sequences unrealistic in that the Gunner cannot acquire targets with the 4 power and then switch to the 12 power as he normally would do. This limitation should not rule out the use of the device for preliminary, transition and refresher training.

The Telfair device has never been adapted to the Bradley; however, its advantages and limitations would be nearly identical to those of the Brewster Device without the Reavis modification - it would not allow proper ranging and with scaled targets, would preclude use of the 12 power scope. It is also too heavy for the 25 mm gun. Similarly, training would be appropriate to the basic Gunner tasks for both preliminary and transition training. The duplication of capability is one good reason it has not been adapted.

The Simulators and Procedures trainers are considered next in Table 11 and the characteristics and capabilities of these vary greatly. The Perceptronics and Tanga devices are highly similar in what they can train and in that they train only the Gunner. The Perceptronics, using videodisc stored images, has more flexibility of target presentation (if the expensive and extensive filming and disc development is done well) than the Tanga, using a film strip projector. Both devices train the basic Gunner's tasks and can present multiple moving targets as desired, given the imagery availability. Neither device incorporates thermal imagery, although this should be possible. The capability for either ranging or identification of vehicles is questionable with both devices. However, the ranging stadia are included in the Perceptronics device and effective training of ranging procedures may be possible. Similarly, vehicle identification may prove to be possible with either device.

The Conduct of Fire Trainer (COFT) provides adequate procedures training for both Commander and Gunner under a variety of conditions. These can be programmed to include normal conditions, limited visibility or smoke, bad weather, equipment malfunctions and several combinations of these. The automated target engagement presentation, scoring and data recording capability of the COFT makes it unique among these devices. Although the computer generated imagery can simulate multiple moving targets, both friendly and enemy, the imagery does not facilitate actual vehicle identification. The simulated vehicles can be distinguished, but they are not realistic enough for true vehicle identification training.

Simulations are considered next and these are directed largely at tactical training of Commanders and Staff Officers. There is little to be gained for Bradley gunnery training from the examination of current simulations. As the DARPA Simnet (LSS) is further developed, it may demonstrate some value for gunnery.

The potential for range modifications to contribute to Bradley gunnery training is high, both for the LOMAH technology and the current and future developments and uses of scaled targets. These approaches can be used on miniature ranges (or full size with LOMAH) and can be combined with subcaliber firing devices (e.g. Reavis-Brewster device) to provide gunnery training with ammunition cost savings. LOMAH technology also offers new capabilities for assessing not only individual performance but the differential effectiveness of different gunnery training approaches. It can be used to evaluate all basic gunnery tasks for the turret Gunner and potentially for the FPW operators, as well.

Summary of Training Devices and Bradley Requirements

A review of the data of Tables 11 and 12 indicates that certain devices or training approaches are more likely to be suitable for training certain task clusters than other devices. Some discussion of these differences and their implications for Bradley training are presented below.

As the tables show, the actual equipment, the Bradley itself, can provide training in all task clusters, given enough resource support and high quality instruction capability. This is basically the major approach that has been taken up till now in both institutional and unit training. However, the data also indicate that some other devices can probably provide better training in many task cluster areas than the actual equipment, with fewer continuing resource requirements and lesser costs of operation.

The review indicates clearly that the force-on-force Laser systems can provide high quality training of tactically-related gunnery tasks, especially those of the Commander and those on which the Commander and Gunner must interact. The ultimate now available in this regard is the National Training Center, which provides not only full interaction with a Threat-like OPFOR (Opposing Force) but also an automated scoring and repetitive evaluation and feedback capability. These systems appear to be highly suitable for training the following selected (based on the earlier task requirements analysis) Commander (and Gunner-assisted) tasks:

Command and Control

Acquire Potential Targets

Determine Target Priority

Lay on Target

Override when Required

The Laser systems do not provide quite as good training capability for the following selected Commander tasks:

React to Enemy Fire

Identification of Targets

Estimate Target Range

Observe and Adjust Fire

These systems appear fairly suitable for training all selected Gunner tasks with the exceptions of Identification of Targets, Range Card Preparation, Adjustment of Fire and Reloading Ammunition.

It must be remembered that many capabilities for precision gunnery training are claimed for the SAAB BT-41. If this promise is borne out in on-going testing, this Laser system may be even more suitable for the above tasks and may allow better training on the specific Commander and Gunner tasks mentioned above as not trainable with these systems.

The strap-on devices and procedural trainers do not appear as suitable for training the tactically-related gunnery tasks as the interactive systems. Rather these devices are seen to be quite suitable for training on the procedural tasks associated with actual target engagement and gun firing. In this category, BGMTS and the Reavis-Brewster Device can provide good training for both the Commander and Gunner in the procedural tasks. This is also true for the U-COFT, which is of course designed specifically to be such a trainer for the Commander and Gunner positions. Similarly, the Perceptronics VIGS or Tanga devices are seen to be potentially usefull for part-task training for the Gunner but not the Commander, except when acting as Gunner. The VIGS is reported to have some shortcomings in design fidelity; however, it still should prove useful as a purely gunnery procedural trainer. There is also some indication that these devices, particularly BGMTS and VIGS, might be useful in range determination training if appropriate imagery could be developed for the devices and combined with appropriate training techniques. These devices and approaches are primarily useful for training the following selected Gunner tasks:

Acquire Designated Targets

Engage Targets:
- Select Weapon/Ammunition
- Determine/Index Range
- Fire: Lead, BOT, Adjust Fire

The range modification approaches, LOMAH and scaled ranges and targets, appear to be highly suitable for training basic Gunner skills. When used with the actual equipment or with some of the other devices (e.g. the Reavis-Brewster Device), these approaches should be quite effective. They are likely to be most useful in training the same set of selected Gunner tasks named above. LOMAH especially has potential for developing improved zeroing and gunnery skills on either full size or scaled ranges.

Through-the-Sight Video (TSV) can be used in conjunction with any or all of the above devices which utilize the actual equipment (the ISU). It is not a training device, but should be a useful adjunct to any training program developed using any of the above approaches.

As discussed earlier, the currently available simulation capabilities (e.g. CATTS, ARTBASS, SIMNET) do not appear to be suitable for gunnery-related training. The level of simulation in these situations is at so high a level that no individual or Commander-Gunner team training in gunnery skills is likely to result.

Review of Ammunition and Ranges

The foregoing has reviewed the requirements for Bradley Gunnery Training, the current institutional and unit training for Bradley gunnery and some available and developing training devices which may assist in improving the current training. This section examines the ammunition and range resources which are currently available or under development for use in Bradley training.

It must be remembered that no matter how good a training program is made available, the quality of the actual training will always be dependent on the quality and quantity of resources to support that training program. Just as the quality and quantity of the available instructors affect the quality of the training program, so do the availability and ease of access to other resources impact on the quality of training. If Bradley units are supposed to go to ranges to train but have no fuel to get there, not much training takes place. Similarly, if the ranges are inadequate to meet the training objectives of the exercises, or if ammunition is in short supply and cannot support the training, then little effective training can take place.

Because of the importance of ammunition and ranges to conduct of effective training, the study team reviewed the current status of these resources and their potential for providing either facilitation or constraint to current and programmed training. There was no intent to "reinvent the wheel" by doing a new requirements study, rather this was to be a straightforward review of what is available, what is planned and how that might impact on current and future gunnery training. The review was conducted by interviewing knowledgeable personnel at Fort Benning (DOTD, STRAC, BFVS-TSM, WGMD, 197th Inf Bde (Sep), and others), at the Directorate for Army Ammunition, Ranges and Targets (DAART) at Fort Eustis, VA and at the Directorate for Standards in Training Commission (STRAC) also at Fort Eustis, VA.

This section presents the findings from our review. It describes the currently projected needs for ammunition to support the current institutional and unit training plans based on USAIS doctrine and FM 23-1. It also reports current and developing range availability in relation to the projected requirements to maintain Bradley team, squad/crew and platoon/section proficiency. Both the M2 and M3 requirements are considered due to the high degree of commonality and the need to examine both sets of requirements.

Ammunition Requirements for M2/M3 Training

Department of the Army Field Manual FM 23-1(Test), (1983), recommends a Sample Annual Unit Gunnery Training Program for the M2 and M3. This unit gunnery training program was presented earlier as Table 2 and is also reproduced as Exhibit A in Appendix A to this report. Ammunition requirements for specific M2 and M3 exercises are discussed in the same FM, chapters 17 through 19. These two sections provide a basis for the present ammunition requirements as estimated by the BFVS TRADOC System Manager (BFVS-TSM) and separately by the

BFVS New Equipment Training Team (NETT) from WGMD. Exhibits B - O in Appendix A summarize different estimates of these projected ammunition requirements for different units and under different levels of firing. These estimates are explained and discussed below.

Of the BIFV's multiple weapons systems, the individual TOW rounds are the single most expensive ammunition required. However, training on the TOW consists mainly of elevating the launcher, boresighting the weapon through the Integrated Sight Unit (ISU), misfire procedures, ammunition loading and unloading, and other non-firing aspects. The TOW is seldom fired in training. On the other hand, the 25 mm gun, as the primary weapon, is fired heavily in all gunnery training. This makes the 25 mm gun ammunition the most expensive training requirement. This is true for both the M2 and M3 training.

Although the 25 mm firing does not represent the most rounds fired in training (the 7.62 mm COAX and the 5.56 mm Firing Port Weapons fire many more rounds), the high cost per round makes it the most expensive of the M2/M3 weapons in gunnery training.

BFVS-TSM Estimates of Unit Training Ammunition Requirements

The BFVS-TSM has prepared a set of projected ammunition requirements based in part on the gunnery training program of FM 23-1. Reproductions of these Summary Sheets are shown as Exhibits B - E in Appendix A. The BFVS-TSM summary sheet for the Infantry Battalion Annual Unit Gunnery Program-M2 is shown in Exhibit B. This ammunition requirement is based on the rounds needed for six of the eleven training events in the Annual Gunnery Training Program: Vehicle Team Combat Exercise (VTCE), Squad Combat Qualification Exercise (SCQE), Scout Squad Qualification Exercise (SSQE), Scout Section Qualification Exercise (SSQE), Platoon Life Fire Exercise, Proficiency Firing Exercise and Scout Crew Combat Exercise. All of these exercises are for one day and one limited visibility run across Qualification I, Qualification II and/or ARTEP exercises as listed in Table 2 and Exhibit A. Table 13 summarizes the rounds required and the costs shown in Exhibit B. Cost information on 25 mm rounds was provided by DAART, Fort Eustis, VA, in September 1984.

Exhibits C through E present the BFVS-TSM's summaries of the same information for the Armor Battalion Scout Platoon Gunnery Program M3, the Divisional Cavalry Squadron M3, and the Regimental Cavalry Squadron Program M3, respectively.

Exhibit F, Tables 1 through 3, gives a breakdown of the Infantry Battalion requirements for ADPS, TPT and TOTAL rounds (and costs) by vehicle type (Command (M2), Squad (M2), and Scout (M3) vehicles). Totals shown for each round type and total rounds correspond to those shown in Exhibit B.

New Equipment Training Team (NETT) Estimates

The New Equipment Training Team (NETT) of WGMD was tasked by the 1st Cavalry Division, Fort Hood, Texas to forecast a minimum amount of M2/M3 ammunition per exercise (NETT training plus one run) consistent with the training philosphy of FM 23-1. The ammunition requirements estimated by the NETT are based on:

Table 13. BFVS-TSM Estimates of Annual Ammunition Costs for a Mechanized Infantry Battalion

(Rounds) Costs		
ADPS	TPT	TOTAL
44,700 ($1,653,900)	24,960 ($549,120)	69,660 ($2,023,020)

1) the Mechanized Infantry Battalion E/W (BFVS) TO&E J410, April 1984 (This TO&E is shown in Exhibit G); and,

2) four exercises from the suggested annual gunnery training program: Vehicle Team Combat Exercise (VTCE), Squad Combat Qualification Exercise (SCQE), Scout Squad Qualification Exercise (SSQE), and Vehicle Team Subcaliber Exercise (VTSE) for Firing Port Weapon (FPW) all for one Qualification run in both day and limited visibility modes (FPW day mode only).

The normal composition of a J-Series Mechanized Infantry Division is listed as five Mechanized Infantry Battalions, five tank Battalions and 1 Cavalry Squadron. Similarly, a J-Series Armored Division should have four Mechanized Infantry Battalions, six Tank Battalions and 1 Cavalry Squadron (Department of the Army Field Manual FM 71-100, 1983). In contrast, the 1st Cavalry Division (Fort Hood) is composed of two Mechanized Infantry Battalions, one Cavalry Squadron, and four Tank Battalions.

Appropriately the NETT personnel used the actual compositon of the 1st Cavalry Division to prepare their ammunition estimates which are shown in exhibits H through L in Appendix A. The NETT estimated ammunition requirements for a Mechanized Infantry Battalion are shown in Exhibit H (25 mm Ammunition Requirements) and I (Small Arms Ammunition Requirements - including 7.62 mm and 5.56 mm, smoke grenades and 40 mm TPT). Exhibit J gives the ammunition requirements for the one Cavalry Squadron (ADPS, TPT, 7.62 mm and smoke grenades). Exhibit K gives the ammunition requirements for the four tank battalions (ADPS, TPT, 7.62 mm and smoke grenades). A summary of the total estimated requirements for the 1st Cavalry Division is given in Exhibit L.

Comparison of Unit Ammunition Estimates

For comparison purposes, Exhibit H, the NETT estimated 25 mm ammunition requirements, is summarized in Table 14. Comparison with Table 13 shows the number of rounds and costs of ADPS is reduced 61.4%, TPT 48.9%, and Total by 56.9% by the NETT proposal. While neither WGMD nor the NETT group advocates this reduction to the absolute minimum, they believe that such a reduction would still meet the basic requirements of FM 23-1.

It is significant to note that DAART and the STRAC Directorate have requested ammunition funding for FY 85 to support 66,000 APDS/TPT rounds per Mechanized Infantry Battalion, an amount close to the BFVS-TSM estimates for the current program (Exhibit B).

Estimated Fort Benning Ammunition Requirements

The M2 ammunition requirements for FY 85 for Fort Benning are defined in the following exhibits:

1) Exhibit M shows the ammunition requirements to support the Commanders, Gunners and Master Gunners Courses of WGMD; this includes 25 mm and all other ammunition and pyrotechnics required for each course;

2) Exhibit N shows the requirements of D Co, ITG, to support the three week add-on to One Station Unit Training to provide initial Skill level one training for MOS 11M; and,

Table 14. NETT Estimates of Annual Ammunition Costs for a Mechanized Infantry Battalion

(Rounds) Cost		
APDS	TPT	TOTAL
17,240 ($637,880)	12,760 ($280,720)	30,000 ($918,600)

3) Exhibit O presents the ammunition requirements defined by D Co, 1/29 INF, 197th Infantry Brigade (Sep), to support normal unit training of BIFV squads and teams.

Summary of Review of Ammunition Requirements

This section has reviewed the best estimates of current unit training ammunition requirements as of Summer 1984. It has presented requirements for a Mechanized Infantry Battalion (M2/M3), the BFVS-TSM estimates of the ammunition funding required to sustain ADPS/TPT training for FY 85 as listed in FM 23-1 (Test), the NETT estimates of the minimum amount of ammunition necessary to conduct training in the 1st Cavalry Division and the local estimates of Fort Benning FY 85 M2 training ammunition requirements.

This review has indicated that the requirements for Bradley ammunition are very heavy and the costs are very high. Even though costs have been decreasing over the last five years (from about $52 in FY 79 to about $20 in FY 84-85 for TPT), the increasing number of battalions being equipped with Bradleys will continue to push overall costs upward quickly. While DAART and STRAC have requested funding for 66,000 rounds per battalion, and the USAIS DOTD STRAC Group has requested 68,460 rounds per battalion, Department of the Army (DA) has turned down these high figures. The overall STRAC (The DA Commission) headed by MG Johnson will be deciding the final allowable ammunition per battalion shortly.

Another question regarding ammunition has been that of actual supply. A few years ago it was predicted that there would be huge shortfalls in production to meet full requirements when the Bradley was fielded. So far no shortfalls have occurred; however, it is anticipated that such shortfalls may occur in FY 86-89, due to the increased unit demand. One other aspect of this is that some units and installations that have requested large amounts of APDS cannot currently fire APDS because of range restrictions (as, for example, there is no range at Fort Benning on which APDS can be fired). USAIS has requested a 1 to 1 exchange of TPT for requested APDS for those installations where the latter cannot be used; but again DA wants to provide only a 70% exchange rate. This means that the projected requirements may not fully materialize until the range construction projects discussed later have been completed. Currently installations and units must adjust their actual training schedules, exercises and ammunition usage to the limits of the range support available.

For the present, it appears that neither ammunition costs nor supply will be direct constraints to training Bradley units. However, the total costs escalation resulting from increasing Bradley unit numbers will continue to drive the Army toward dollar and resource saving training alternatives to live fire. With more units there will be more competition for the limited ammunition dollars and fewer rounds per battalion will likely be the result. This situation makes the development of more cost effective training programs all the more important. Identification and implementation of BIFV training improvements, whether device-based or not, will become a more crucial aspect of the USAIS requirements as this trend continues.

Range Developments

Ranges for training are obviously an essential part of the Army's training processes and capabilities. Without adequate ranges on which to live fire

(either full or subcaliber), soldiers cannot be expected to become fully proficient with their weapons systems. Live fire ranges provide not only the realistic training demanded by the individual soldiers and their leaders, they also provide the basic criterion measures to assess individual and unit readiness. While training devices, whether full or part task trainers, can provide effective procedural training and practice in many skills essential to gunner proficiency, both individual soldiers and their commanders want to see "steel-on-target" to demonstrate the level of proficiency achieved. Not only are ranges necessary to satisfy the "gut-felt need" for steel-on-target, they are also necessary to confirm that training, provided by whatever means available, has in fact been effective.

Training Ranges (Department of the Army Training Circular TC 25-2, 1980) lists eight resource requirements necessary to effective training: Land; Manpower; Money; Fuel; Ammunition; Facilities; Equipment; and, Software (How to). The TC points out that nearly all of these resources must be considered in design, development or modernization of ranges suitable to the needs posed by the increased lethality and ranges of our modern weapons systems. The design and development of ranges and target systems to meet the needs of the Army users (Infantry, Armor, etc.) is the responsibility of the Directorate of Army Ammunition, Ranges and Targets (DAART) located at Fort Eustis, VA. This agency is responsible for all new range design and development as well as for consultation and advice to installations planning an upgrade of current ranges. Thus, DAART is intimately involved in the process of range development and redevelopment to meet the Bradley Gunnery training needs world-wide.

With the introduction of the M2 and M3 Bradley Fighting Vehicles, together with the M1 Abrams tank, into Mechanized Infantry and Armor Units world-wide, Army live firing ranges must be able to provide individual, squad/crew and platoon/section gunnery training in both day and limited visibility modes. Ranges to be developed or redeveloped must, in particular, be able to support the gunnery training and evaluation programs defined in FM 23-1. The programs outlined therein are the current guiding requirements for BIFV and CFV gunnery training.

In some installations such as Grafenwoehr and Wildflecken, existing ranges have been upgraded to accommodate the BIFV firing requirements, while at other installations, entirely new ranges must be constructed. Some current developments in this effort are described below.

Multi-Purpose Range Complex Development

To meet the evolving needs for better and more useful ranges to support Infantry and Armor systems training, DAART has been working with representatives of the Infantry, Armor and Aviation Schools, and of FORSCOM to develop a generic range facility to meet current and projected needs. This planned generic range is known as the Multi-Purpose Range Complex (MPRC) and is intended to support heavy weapons training for the foreseeable future. Concepts for the range have been been approved and designs have been completed by the Army Corps of Engineers for two versions of the MPRC. Construction has already begun or construction contracts have been let at Forts Bliss, Hood and Riley.

The two versions of the MPRC are the Heavy MPRC and the Light MPRC. The Heavy range (three lanes) is designated for installations with Mechanized Infantry and Armor Battalions. The Heavy MPRC is designed to accommodate all

BIFV gunnery exercises, with platoon or section exercises using the entire range. The MPRC Light range (one lane) is designated for installations with predominately light infantry units. It is necessary that the Light range be able to handle at least one heavy vehicle because of National Guard and Reserve Components requirements. The Light MPRC can handle all BIFV anti-tank and aerial gunnery including squad/crew gunnery exercises.

The MPRC will use the Infantry (IRETS) and Armor (ARETS) remoted target system. This system provides stationary and moving target devices (standard NATO individual frontal plywood silhouettes) and simulation equipment which are computer operated and controlled. The MPRC will provide collective training facilities for the IFV/CFV and M1 tank systems. The range will accommodate platoon level collective training exercises as prescribed in FM 23-1 as well as individual crew qualification training.

For the Heavy MPRC, the downrange area will consist of three 4500 meter by 300 meter lanes separated by a 50 meter buffer zone. Each lane will contain 45 stationary and 22 moving Infantry targets and 20 stationary and 4 moving Armor targets. The Light MPRC will contain almost as many targets as the Heavy, with the former having fewer Armor moving targets. Like targets are to be built at approximately equal distances from the firing line (base line) across all three lanes for the heavy range.

Technical aspects of MPRC design, including the Target Engagement Sequence Table which specifies the target layout, are contained in "Design Information for: MULTI-PURPOSE RANGE COMPLEX," Huntsville Division, Corps of Engineers, HNDM 1110-1-6, October 1982. A copy of the final generic MPRC design as been received by Systems Branch, Unit Training Division, DOTD, USAIS.

The construction schedule for the MPRC is:

CONUS HEAVY MPRC:

FY	TRAINING AREA	NOTES
83	Fort Bliss	3rd Armored Cavalry Regiment
83	Fort Hood	2nd Armored Div, 1st Cav Div
83	Fort Riley	1st Inf Div
84	Fort Irwin	NTC; 1st BN 73 Armor; 6Bn 31st INF
85	Fort Knox	194th Armored Bde, Army Armor Center
85	Fort Stewart	24th Inf Div
86	Fort Carson	4th Inf Div (Mech)
86	Yakima Firing Range	Services Fort Lewis (9th ID)

CONUS LIGHT MPRC:

FY	TRAINING AREA	NOTES
85	Fort Bragg	82nd Abn Div, XVIII Abn Corps
85	Hunter Liggett	Services Fort Ord (7th ID), CDC
86	Fort Campbell	101st Abn Div (Air Assault)
87	Fort Polk	Heavy/Light not decided, 5th ID (Mech)

OTHER FY	TRAINING AREA	NOTES
85	Camp Casey (Japan)	Heavy MPRC
87	Schofield Bcks (Hawaii)	Light MPRC, 25th ID
83-85	Grafenwoehr/Wildflecken	Ranges modified for BIFV/BCFV
83-84	Fort Benning	Army Inf Tng Ctr, 197th Inf Bde

In the Fort Benning institutional training for the BIFVs the two firing ranges specifically constructed for the BIFV training (Ruth and Ware ranges) meet the training requirements in general. Some limitations of these ranges will be discussed below. While the 197th Infantry Brigade could utilize a MPRC, the training requirements of this single brigade do not justify the construction costs of a MPRC.

Modifications to Existing Ranges - Grafenwoehr

With the emphasis on combat readiness that has always existed in USAREUR, there has been a consistent and continuing range improvement program over the past several years. The Grafenwoehr complex has been the focus of this program with some improvements taking place at Wildflecken as well. From FY 82 through FY 84 many improvements have been made to Grafenwoehr range capabilities. These include upgrading of the tank range capabilities as well as development of ranges suitable to the BFVS training requirements. For Mechanized Infantry operations, the range developments have included modifications to support battalion training and firing tables for up to a company team sized force. Improvements have been in installation and upgrading of moving targets, installation of thermal targets, improved program scenarios, improved automated scoring procedures, development of better course roads and static stands, and improvements to control towers and other support facilities. Some specifics on range capabilities to support BIFV gunnery training are listed below by range and capability:

Range	Training Capability	Max Range	Vehic Tgts	Inf Posns	Moving Tgts
24	Mech Inf Squad Qual	2500 M	19	112	4
34	Mech Inf Veh Team	1500 M	15	42	3
39	Mech Inf Veh Team	1400 M	15	42	3
42	Mech Inf Plat Qual	3500 M	50	152	4
45	Mech Inf Squad Qual	2700 M	20	120	3
79	Company Team	3500 M	120	100	10
26	Mech Inf Squad Qual	2500 M	13	32	2

As indicated above, these ranges car handle most of the basic requirements for Bradley gunnery as outlined in FM 23-1. It should also be noted that range 42 listed above, capable to support the Mechanized Infantry Platoon Qualification, has been developed/modified to closely parallel the MPRC Heavy range configuration. Thus, it can provide for both mounted and dismounted operations for a Platoon sized Bradley unit with full evaluation of activities at that level.

Summary of Review of Range Developments

This section has provided an overview of the current status of range developments which can support the Bradley gunnery training programs described earlier. The Multi-Purpose Range Complex installations being put into multiple facilities throughout the Army are intended to solve the Bradley and M1 gunnery training problems for those units at those installations. It is not totally clear that these range complexes can in fact solve those problems. Questions which arise incude whether the single range complex would in fact allow all units to fulfill their training and qualification requirements within the training year. This is, of course, a question of how many units require use of the range and detailed scheduling. These are the basic requirements of the installation range control and training manager personnel and were addressed in the feasibility and design studies conducted by DAART and the Corps of Engineers together with the user personnel at the installations.

Equally pertinent questions arise as to the suitability of the range design for BIFV and M1 training. The problems observed on Ruth and Ware ranges need not be repeated in the MPRC designs. Two major problems have been observed at these ranges: one involves Ruth Range and the other involves Ware. The moveout distances at Ruth Range are so short that the Bradley cannot go fast enough to overcome the vehicle vibration which causes gunners to have difficulty engaging both stationary and moving targets; when the Bradley speeds are increased, the engagement times become too short for effective training to occur. On Ware Range, until recently, the targets were extremely difficult for the gunners to detect. This reduced the effectiveness of initial training unless the instructor pointed out the targets; if the instructor points out the targets the trainee receives little practice in aspects of gunnery such as target acquisition and rapid engagement. This condition has now been alleviated by providing white outlines on all targets; which has the same effect as having the instructor point out each target.

Recent improvements in Grafenwoehr and Wildflecken ranges should provide increased effectiveness of the training regimens within the USAREUR community. No data as to the actual effectiveness of the gunnery training programs in USAREUR are yet available. However, anecdotal reports from observers indicate that the range improvement programs have been effective in increasing the overall effectiveness for gunnery training.

Discussion, Conclusions and Recommendations

The foregoing sections have presented an analysis of Bradley gunnery training requirements, a review of current training in the Infantry School and in units, an overview of the capabilities and characteristics of available gunnery training devices, and an overview of current ammunition and range availabilities and requirements. This review has been conducted to identify training gaps or needs--requirements for additional training and/or training revisions which could result in improved Bradley performance in units. Several areas of such training needs have been identified and these are discussed below.

First and foremost, Bradley gunnery training should be intimately intertwined with the training of overall Bradley doctrine, tactics and techniques--as part of a total systems' training package. That is not currently happening either in the School or in units. Training is being done piecemeal, in insular portions, and there is little interrelation of the parts to form the whole of Bradley training that should exist. In our review of the School courses above and in the companion document (Rollier, et al., 1984) it has been shown that there is little true integration of tactics and doctrine with the fundamentals of Bradley gunnery. This does happen to some extent in the Commanders Course, but only to a small degree. Otherwise, gunnery training is basically isolated from tactical training and is taught as an end in itself.

This piecemeal approach seems to stem in part from a lack of an integrated Infantry School position on the role and functions of the BIFV. Because the Bradley is unique for the Infantry, there has developed a fascination with the BIFV as the BIFV--as an end system in itself. This perception and fascination seems to be more widespread among School personnel than in units, although it exists there also. If the Infantry mission remains what it has traditionally been--to support armor in the offense and to take and hold ground, it needs to be clearly stated that the Bradley is only a new tool with which to perform that Infantry mission. Much current training presents the BIFV as a new and different system, requiring new and different applications. This frequently ignores the relationship of BIFV capabilities to basic infantry mission requirements. While providing the capability to do some things that could not be done the same way with the M113, the BIFV is still only an improved and more powerful tool to support Infantry Squad, Platoon, Company and higher unit activities. There is a need to provide an integrated doctrinal basis for all Bradley training, for its implementation, and for effective employment of its weapons capabilities, in the context of the Infantry mission as required by Army 21. Such an approach should be developed and its basic concepts should be presented as an introduction to each BIFV course provided by the School. The conceptual approach should also be integrated into the new version of FM 23-1. This would lead to better integrated and more tactically meaningful gunnery training as well as better Infantryman training at all levels.

On a somewhat more basic level, the current gunnery training provided in the School and in units does not fully prepare Gunners or Commanders to fight the Bradley effectively in many situations. While procedural skills and tasks appear to be adequately trained, training in the overall tactical aspects of gunnery and in several of the most significant and highly critical Commander and Gunner tasks appears to be slighted. These inadequately trained tasks include:

1) site selection

2) determine fields of fire

3) 360 degree observation

4) reaction to enemy fire

5) acquire potential targets

6) target identification

7) estimate target range

8) determine target priority

9) observe and adjust fire

In particular, training in target acquisition, in Threat knowledge, in target identification, in range determination and in use of the thermal mode of the ISU are lacking in depth and bredth of coverage. This appears to be true in both School and unit training, based on the POIs and materials examined and the observations conducted in this review. The gunnery training programs of the Gunners, Master Gunners, and Commanders Courses are essentially identical and none appears to provide adequate training in the above tactically related aspects of gunnery. Training time previously provided for the ISU thermal mode has been eliminated from these courses. Similarly, target identification training consists of a few hours in which trainees are shown photographs of vehicles with little systematic feedback on success or failure of identifications. This training includes use of the somewhat outdated Department of the Army Special Text 7-193, (1981), which presents no information on effectiveness of weapons and does not include some newer weapons systems (e.g.- T-64, BMP/M-1981). Other available materials for combat vehicle identification (both day and thermal) are not used nor even mentioned. General training on the Threat and specific capabilities of Threat vehicles is also nearly nonexistent. Additionally, the course training for many specific gunnery techniques is poor and could be improved; this results from either lack of specific rules for how to perform (e.g.- lack of adequate lead and lag rules for 25 mm firing at moving targets, or from a moving vehicle) or lack of adequate training materials as well as training content (e.g.- inadequate zeroing targets and procedures for the 25 mm).

Some of these training deficiencies could be improved by simple changes in POI content. For instance, the addition of the two available Combat Vehicle Identification Kits (day and thermal - GTA 17-2-9 and -10, respectively) to the training would provide better training in target identification and acquisition than is now provided. Similarly, development and implementation of a sequence of instruction on the adjustment, use and interpretation of the thermal mode of the ISU, to include causes and effects of thermal images and of the variations in these images, would greatly improve the thermal training.

Correcting other deficiencies in training may require development of training programs and materials which effectively integrate some of the developing training devices into the training programs. For example, the current deficits in range determination and estimation training might be dealt

with in this way. Some of the current devices examined above show promise for providing range estimation training if appropriate materials and training sequences could be developed. These include at least the Bradley Gunnery and Missile Training System (BGMTS), the Videodisc Interactive Gunnery Simulator (VIGS) and some adaptations of scaled ranges as possibilities. There is a distinct potential, also, for using the precision gunnery capability of the SAAB BT-41 to improve range estimation based on appropriate training and feedback provided within tactical exercises, or in range exercises when combined with the Laser Target Indicator Devices (LTIDs) for range targets.

The Reavis-Brewster device is now being used in gunnery training at Fort Benning and will shortly be distributed to Bradley equipped units in USAREUR and CONUS. This device, an improved version of the Brewster device already in the training inventory, is an effective target engagement trainer when used with appropriate scaled ranges and targets available from TASCs world-wide. The device allows effective training of the Commander and Gunner interactions necessary to hand-off and engage targets and, to a more limited degree, for the team to adjust fire. This adaptation provides effective engagement practice drills and should be integrated with range determination training on the same scaled ranges using the ISU choke sight.

The other most likely device candidate for inclusion in gunnery training both at the School and in units is the LOMAH technology. The capability for obtaining precise feedback on the location of misses and hits for fired rounds would be invaluable in initial zeroing, in sub caliber firing and in full round exercises. Current round scoring capabilities on most ranges do not provide effective knowledge of round hit location and the developing IRETS and ARETS ranges will still only provide hit or miss feedback to gunners and instructors. LOMAH technology could substantially improve both training effectiveness and evaluation capabilities for any BIFV range complex.

A major emphasis of this overall study was to examine training for night and limited visibility operations and fighting. In both the School training and unit training for gunnery, night operations training was found to be nearly non-existent. Each of the formal evaluation exercises within the gunnery courses and in the unit taining program do include the requirement to perform the basic range exercise at night as well as in daytime. However, this is essentially the extent of night gunnery training that occurs. No other night gunnery training was observed in the School nor reported by unit personnel interviewed. Night tactical exercises were in fact observed in both USAREUR and Fort Hood, and in both cases Gunners and Commanders were using the ISU for both manuever and surveillance. However, nothing which could be called gunnery training, or even practice drills, was observed in either exercise. Simulated gunnery engagements with "enemy" vehicles did occur in these exercises, but the training value of such activity, without control or feedback, must be suspect.

As described earlier, the current edition of FM 23-1 is serving as the "bible" for gunnery training. However, it is clearly recognized by the School and by unit trainers that much of the information in this manual must be revised and updated. It is essential that the upcoming revision should incorporate considerable new material on integrated gunnery and tactics as well as updated and improved techniques for gunnery. Material dealing with the ISU thermal mode is also sorely needed--although such material must be developed, it is not now available anywhere. Similarly, the identified need for improved lead and lag rules for 25 mm gunnery should be satisfied to the extent possible when

the FM is revised. Further, the limited material dealing with night gunnery, which concentrates mainly on preparation of range cards and staking firing positions--both important topics, should also be augmented with gunnery drills, target acquisition and identification drills and similar materials. Many of these improved materials would also have to be developed since little appropriate material exists.

In summary, the following describe the status of institutional and unit training as observed and described by institutional and unit trainers:

1) Gunners Course:

* Provides Basic Familiarization with Bradley Gunnery

* Concentrates on Procedural and Pre-Gunnery Skills

* Procedures Basically Well Trained and Learned

* Limited Firing Restricts Expertise

* Problems:

  Inadequate Training in:

  Range Determination

  Target Acquisition

  Target Identification (IFF)

  Target Engagement - Live Fire (or Adequate Substitute with Live Targets)

  Night Gunnery

* Produces Gunners who Need Much More Training to "Qualify"

2) Master Gunners Course:

* Gunnery Training is Essentially Identical to Basic Course

* Mechanical Procedures, Maintenance and Training are Stressed and Generally Well Done

* Problems:

  Gunnery Problems are Identical to Basic Course

3) Unit Training:

* Master Gunners in Units are Trained In Master Gunner Course: They Share the Limitations of All Course Graduates.

* Master Gunners Are Attempting To Train New Gunners and Upgrade Basic Course Graduates.

* Unit Gunnery Trainers Are Trying to Develop local Training

* Devices and Aids to Training Are Being Fabricated locally - 3rd ID is Example

* Problems:

  FM 23-1 is Weak in Many Necessary Training Areas

  Training In Units Suffers all Usual Restrictions:

    Incompletely Trained Instructors

    Lack of Training Time In Adequate Facilities

    Inadequate Training Devices, Aids, and Materials

    Overall Lack of Time for Training

    Turnover in Personnel (Although less than Normal)

  Results in Continued Inadequate Training in:

    Range Determination

    Target Acquisition

    Target Identification (IFF)

    Target Engagement - Live Fire (or Adequate Substitute with Live Targets)

    Night Gunnery

Recommendations

Based on the above summary of findings, the following recommendations for gunnery training developments and/or training program improvements are provided.

1) Current friend or foe identification training is inadequate in both institutional and unit settings. Not all available materials for vehicle identification are used in instruction. Current presentations are done in a relatively unstructured fashion with no systematic feedback of results of identifications. Recommend that ARI assist the USAIS to obtain and integrate all currently available materials into the institutional training and assure that units are made aware of available materials. (Specific materials have been referenced earlier).

2) Since training in target acquisition and foe recognition, especially with thermal imagery, is desperately needed, recommend further the development of an improved POI for target identification and thermal target training. This POI should be based on the above referenced materials and other developments (to include identification of the causes and effects of thermal energy in relation to vehicular and other target images). POI development should be based on a study of the suitability of current training devices (e.g.- VIGS, BGMTS, etc.)

for aiding target acquisition and identification training. The study should also investigate the incorporation of some possible modifications of the Thermal Sight Trainer (NTEC) and/or the Thermal Training Viewer (NVEOL) (These two potentially useful training devices were reviewed in Appendix G to Rollier, et al., 1984). The improved POI should also be turned into an exportable package for unit use.

3) Recommend also that inexpensive alternative approaches to identification of friendly units and troops should be studied in the field environment to determine what sorts of quick fixes can be provided to the field. Some alternative approaches which might be considered include markers, cold lights, BetaLights, inexpensive transponders, etc..

4) Too little instruction is dedicated to range determination training as currently presented in FM 23-1 and in both institutional and unit training. Recommend that the USAIS develop better materials and aids to improve current instruction and increase the degree of emphasis on range determination by both Commanders and Gunners in current instruction.

5) To further develop range determination training capabilities, recommend that an ARI research effort be designed to determine the feasibility of use of scaled ranges and/or training devices to better train. Preliminary evidence developed by the USAIS and ARI (Personal communication, Dr. J. Morey and Sgts Reavis and Roberson, July - August 1984) from field trials of the Reavis-Brewster device and reported training experience in units indicate that scaled targets may be quite useful in range estimation training with the BIFV. Also the examination of current devices indicates that the VIGS, BGMTS, and SAAB BT41 are logical candidate devices to include in such a study. It is believed that these devices have enough potential for range determination training, along with training other aspects of gunnery, to make a study effort potentially fruitful.

6) Recommend that appropriate data and materials be assembled or developed to provide adequate instruction of how to adjust and most effectively use the ISU in both day and thermal modes. This should include both physical adjustments and techniques of use of the sight in both modes--to include scanning techniques, scanning duty cycle (time on/off the sight), and similar approaches to ma effectiveness of use. This package of materials should then be incorporated into both School training and materials to be provided to the field.

7) Current instruction in specific target engagement techniques (zero, lead, multiple & moving targets, etc.) is insufficient to achieve high proficiency in these techniques. Recommend that ARI and and USAIS initiate a study to develop a realistically based, standardized, instructional approach to these problems. The suggested study should include: development of lead and lag rules that are both more precise and easier to apply than those currently in use; determine how best to teach lead, lag, and other engagement techniques in dry fire and tactical engagements; and, examine the potential of using LOMAH for development of better zero training techniques. This study should also examine the feasibility of use of additional training devices (e.g. - SAAB BT-41, BGMTS, VIGS, and possibly others) for use for this type of training.

8) There is currently too little emphasis on night gunnery training. Such training as is given provides inadequate coverage of techniques for thermal or other STANO device target acquisition and not enough instruction on range cards,

direction of fires at night, etc. Recommend the study of the feasibility of assembling an improved systematic program for night gunnery training for use in the School and for export to units. Such a program must consider inclusion of improved thermal acquisition and identification training (as indicated above); increased instruction and emphasis on range card development, and should provide for the conduct of more night gunnery training. Such training must also require proper procedures and techniques be applied by Bradley teams.

9) Although not specific to gunnery training, training for night operations (as opposed to training at night) is almost non-existent. Recommend that the USAIS and ARI collaborate on the development of POIs and training packages or materials, for potential use in both institution and unit training programs, which are aimed at preparing the soldier to train and operate at night in the unfamiliar and basically threatening night environment. Initial training for night operations would include daytime learning and rehearsals of those tasks which are more difficult to perform at night and those tasks which may only be required in night operations (these include all night surveillance tasks, OP/LP tasks, etc.). One approach to this is to reexamine the use of special goggles (Light Attenuation Devices - LADs) for daytime training for night operations (although it is possible that this approach may not work for training the STANO related tasks).

10) Simultaneously, current night training is unrealistic with respect to the activities of an Infantry squad. This results partially from the tactical scenarios followed in observed ARTEP exercises and partially from the lack of available time (and, sometimes, available NCO expertise) for Platoon and squad level training in basic infantry skills and tasks. Recommend that Infantry units be encouraged to conduct more night training, more realistically, through USAIS provision of unit drills for night operations training. Drills must: be realistic; meaningful to the individual soldier; and, emphasize proper use of STANO equipment. They should be designed to require exercise of sleep discipline, dismount operations (Patrols, OP / LPs), and the full use of STANO devices.

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APPENDIX A

TO

ANALYSIS OF GUNNERY TRAINING

FOR BRADLEY FIGHTING VEHICLE SYSTEMS

Contents:

Exhibit A

Sample Annual Unit Gunnery Training Program

	QUAL I				QUAL II					ARTEP		
Months:	1	2	3	4	5	6	7	8	9	10	11	12
PRELIMINARY GUNNERY TRAINING		X					X				X	
GUNNERY SKILLS TEST		X					X				X	
FIRING PORT WEAPON EXERCISE (M2)		X					X				X	
VEHICLE TEAM SUBCALIBER EXERCISE (M2/M3)		X					X				X	
FULL-CALIBER ZERO (M2/M3)		X										
VEHICLE TEAM COMBAT EXERCISE (M2/M3)		X										
PROFICIENCY FIRING EXERCISE (M2/M3)		X					X				X	
SQUAD COMBAT QUALIFICATION EXERCISE (M2)		X					X					
PLATOON EVALUATION EXERCISE (M2)		X									X	
SCOUT SQUAD QUALIFICATION EXERCISE (M3)		X					X					
SCOUT SECTION QUALIFICATION EXERCISE (M3)		X									X	

Reproduced from Table 14-1, p. 14-7, of Department of the Army Field Manual, FM 23-1 (Test), December 1983.

Exhibit B

The following schedules are reproduced from the TRADOC System Manager's Summary Sheets, BFVS TSM, Fort Benning, GA.

I. Current annual unit gunnery program - M2

EXERCISE	QUAL I	QUAL II	ARTEP
VEH TM CBT EX	X		
SCT CREW CBT EX	X		
SQD CBT QUAL EX	X	X	
SCT SQD CBT QUAL EX	X	X	
PLT LIVE FIRE EVAL	X		X
SCT SECTION QUAL EX	X		X
PROF FIRING EX	X	X	X

II. Total number of 25 mm engagements (APDS/TPT) per year/vehicle

TYPE VEHICLE	PRIMARY CREW	PROF FIRING
1. Command Vehicle	14/10	18/0
2. Scout Vehicle	56/46	18/0
3. Squad Vehicle	60/42	18/0

III. Total number 25 mm rounds (APDS/TPT) fired per year/vehicle

TYPE VEHICLE	PRIMARY CREW	PROF FIRING	TOTAL
1. Command Vehicle (6) zero 1x1	155/115	180/0	335/115
2. Scout Vehicle (6)	575/445	180/0	755/485
3. Squad Vehicle (48)	615/445	180/0	795/445

IV. Total 25 mm ammunition cost per vehicle per year

TYPE VEHICLE	NO RDS APDS/TPT	COST PER RD APDS/TPT	APDS COST	TPT COST	VEHICLE TOTAL COST
1. Command Vehicle (6)	335/115	$37/22	$12,395	$2,530	$14,925
2. Scout Vehicle (6)	755/485	37/22	27,935	10,670	38,605
3. Squad Vehicle (48)	795/445	37/22	29,415	9,790	39,205

V. Total number 25 mm rounds per Bn/year (APDS/TPT) = 44,700/24,960 (69,660)

VI. Total cost of 25 mm per Bn/year = 2,203,020

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1. Zero one time only

Exhibit C

The following schedules are reproduced from the TRADOC System Manager's Summary Sheets, BFVS TSM, Fort Benning, GA.

I. Armor Battalion Scout Platoon Annual Gunnery Program M3

Table		Level I	Level II
V	Moving/Stationary CFV against Moving/Stationary Targets	X	X
VI	Stationary CFV against Moving/ Stationary Targets	X	
VII	Practice Combat Course for Moving Stationary CFV	X	
VIII	Record Combat Course for Moving/Stationary CFV	X	X
IX	Practice Combat Course for a Scout Section (two CFVs)	X	
X	Record Combat Course for a Scout Section (two CFVs)	X	

Note: Level I is the Primary (Record) Gunnery.
Level II is the Sustainment Gunnery.

II. Total Number of 25 mm Target Engagements (APDS/TPT) per year/vehicle

TYPE VEHICLE	TOTAL ENGAGEMENTS
Scout Plt CFV (7)	69/34

III. Total Number of 25 mm Rounds APDS/TPT fired per year/vehicle

TYPE VEHICLE	TOTAL ROUNDS
SCOUT PLT CFV (7)	690/340

IV. Total 25 mm Ammunition cost per vehicle per year

TYPE VEHICLE	NO RDS APDS/TPT	COST PER RD APDS/TPT	APDS COST	TPT COST	VEHICLE TOTAL COST
Scout Plt CFV	690/340	$37/22	$25,530	$7,480	$33,010

V. Total Number Rounds per ARBN/YEAR (APDS/TPT) = 4,830/2,380 = 7,210

VI. Total Cost of 25 mm per ARBN/YEAR = $231,070

Exhibit D

The following schedules are reproduced from the TRADOC System Manager's Summary Sheets, BFVS TSM, Fort Benning, GA.

I. Divisional Cavalry Squadron Annual Gunnery Program M3

Table		Level I	Level 2
V	Moving/Stationary CFV against Moving/Stationary Targets	X	X
VI	Stationary CFV against Moving/ Stationary Targets	X	
VII	Practice Combat Course for Moving/Stationary CFV	X	
VIII	Record Combat Course for Moving/Stationary CFV	X	X
IX	Practice Combat Course for a Scout Section (two CFVs)	X	
X	Record Combat Course for a Scout Section (two CFVs)	X	

Note: Level 1 is the Primary (Record) Gunnery.
Level II is the Sustainment Gunnery.

II. Total Number of 25 mm Target Engagements (APDS/TPT) per year/vehicle

Type Vehicle	Total Targets
All CFVs (40)	69/34

III. Total Number of 25 mm Rounds APDS/TPT fired per year/vehicle

Type Vehicle	Total Rounds
All CFVs (40)	690/340

IV. Total 25 mm Ammunition cost per vehicle per year

TYPE VEHICLE	NO RDS APDS/TPT	COST PER RD APDS/TPT	APDS COST	TPT COST	VEHICLE TOTAL COST
ALL CFVS	690/340	$37/22	$25,530	$7,480	$33,010

V. Total Number 25 mm Rounds per Div Cav Sqdn/Year (APDS/TPT) = 27,600/13,600 = 41,200

VI. Total Cost of 25 mm per Div Cav Sqdn/year = $1,320,400

Exhibit E

The following schedules are reproduced from the TRADOC System Manager's Summary Sheets, BFVS TSM, Fort Benning, GA.

I. Regimental Cavalry Squadron Annual Gunnery Program M3

Table		Level I	Level II
V	Moving/Stationary CFV against Moving/Stationary Targets	X	X
VI	Stationary CCFV against Moving/ Stationary Targets	X	
VII	Practice Combat Course for Moving/Stationary CFV	X	
VIII	Record Combat Course for Moving/ Stationary CFV	X	X
IX	Practice Combat Course for a Scout Section (two CFVs)	X	
X	Record Combat Course for a Scout Section (two CFVs)	X	

Note: Level I is the Primary (Record) Gunnery
Level II is the Sustainment Gunnery

II. Total Number of 25 mm Target Engagements (APDS/TPT) per year vehicle

Type Vehicle	Total Engagements
All CFVs (38)	69/34

III. Total Number of 25 mm APDS/TPT fired per year/vehicle

Type Vehicle	Total Rounds
All CFVs (38)	690/340

IV. Total 25 mm Ammunition Cost per vehicle per year

TYPE VEHICLE	NO RDS APDS/TPT	COST PER RD APDS/TPT	APDS COST	TPT COST	VEHICLE TOTAL COST
All CFVs	690/340	$37/22	$25,530	$7,480	$33,010

V. Total Number 25 mm Rounds per Reg Cav Sqdn/Year (APDS/TPT) = 26,220/12,920 = 39,140

VI. Total Cost of 25 mm per Reg Cav Sqdn/Year = $1,254,380

Exhibit F

The following schedules are reproduced from the TRADOC System Manager's Summary Sheets, BFVS TSM, Fort Benning, GA.

Table 1

APDS Rounds (Cost) Per Mechanized Infantry Battalion By Vehicles

	Primary Crew	Proficiency Firing	Total
6 Command Vehicles	930($ 34,410)	1080($ 39960)	2010($ 74370)
6 Scout Vehicles	3450($127,650)	1080($ 39960)	4530($167,610)
48 Squad Vehicles	29520($1,092,240)	8640($319,680)	38160($1,411,920)
	33900($1,254,300)	10800($399,600)	44700($1,653,900)

Table 2

TPT Rounds (Cost) Per Mechanized Infantry Battalion By Vehicles

	Primary Crew	Proficiency Firing	Total
6 Command Vehicles	690($15180)	0	690($15180)
6 Scout Vehicles	2910($64,020)	0	2910($64020)
48 Squad Vehicles	21360($469,920)	0	21360($469,920)
	24960($549,120)	0	24960($549,160)

Table 3

APDS and TPT Rounds (Cost) Per Mechanized Infantry Battalion By Vehicles

	Primary Crew	Proficiency Firing	Total
6 Command Vehicles	1620($49,590)	1080($39960)	2700($89,550)
6 Scout Vehicles	6360($191,670)	1080($39960)	7440($231,630)
48 Squad Vehicles	50880($1,562,160)	8640($319,680)	59520($1,881,840)
	58860($1,803,420)	10800($399,600)	69660($2,203,020)

Exhibit G

Mechanized Infantry Battalion E/W (BFVS)
TOE J410 April 1984

This TOE is the basis for the development of data in Exhibits H - L below.

Headquarters and Headquarters Company (HHC)

Commanding Officer	1 M2 (Command)	
S 3 (Bn Motor Officer)	1 M2 (Command)	
Scout Platoon Hq		2 M3
Section		2 M3
Section		2 M3
	2 M2 (Command)	6 M3

Rifle Company

Headquarters Section	
Commanding Officer	1 M2 (Command)
Platoon Hq	1 M2
Rifle Squad	1 M2
Rifle Squad	1 M2
Rifle Squad	1 M2
	4 M2
Platoon	4 M2
Platoon	4 M2
Company Total	13 M2

Rifle Company	1 M2 (Command)
	12 M2
	13 M2

Rifle Company	1 M2 (Command)
	12 M2
	13 M2

Rifle Company	1 M2 (Command)
	12 M2
	13 M2

RECAP: HHC	2 M2 (Command)	6 M3(Scout)
4 Rifle Companies	4 M2 (Command)	
	48 M2 Squad	
	54 M2	6 M3

Exhibit H

Infantry Battalion - 25 mm Ammunition Requirements

Exercise	Ammo Type	Rounds Per Run	# Runs	Zero Rqts	Total Rounds Per Vehicle	BIFVs/ Exercise	Total Rifle Co Requirements	HHC BFVs	HHC Rqts	Total Bn Rqts	1st Cav Div Requirements
VTCE	25 mm APDS	70	2*	10	70(2)+10=150	13	13(150)=1950	8	8(150) 1200=1200	4(1950)+ 2(9000) =9000	2(9000) =18000
SCQE	"	70	2	0	70(2)+0=140	13	13(140)=1820	0	-	4(1820) =7280	2(7280) =14560
SSQE	"	60	2	0	60(2)+0=120	0	-	8	8(120) =960	960	2(960)=1920
	Total 25 APDS								2160	17240	2(17240)=34480
VTCE	25 mm TPT	50	2	10	50(2)+10=110	13	13(110)=1430	8	8(110)=880	4(1430)+ 880=6600	2(6600) =13200
SCQE	"	50	2	0	50(2)+0=100	13	13(100)=1300	0	-	4(1300) =5200	2(5200)=10400
SSQE	"	60	2	0	60(2)+0=120	0	-	8	8(120)=960	960	2(960)=1920
	Total 25 TPT								1840	12760	2(12760) = 25520

* 1 Day and 1 Limited Visibility run

Exhibit I

Infantry Battalion - Small Arms Ammunition

Exercise	Ammo Type	Rounds Per Run	# Runs	Zero Rqts	Total Rounds Per Vehicle	BIFVs/ Exercise	Total Rifle Co Requirements	HHC BFVs	HHC Rqts	Total Bn Rqts	1st Cav Div Requirements
VTCE	7.62 mm (4+1) Coax	200	2	50	200(2)+50=450	13	13(450)=5850	8	8(450)=3600	4(5850)+ 3600 = 27000	2(27000)=54000
SCQE	"	400	2	0	400(2)+0=800	13	13(800)=10400	-	-	4(10400) =41600	2(41600)=83200
SSQE	"	500	2	0	500(2)+0=1000	0	-	8	8(1000) =8000	8000	2(8000) =16000
SCQE	7.62 mm (4+1) M60	300	2	0	300(2)+0=600	9	9(600)=5400			4(5400) =21600	2(21600) =43200
	Total 7.62 (4+1)								11,600	98,200	194,400
VTSE	7.62 (T) Sub-cal Zero	0	0	50	50	13	13(50)=650	8	8(50)=400	4(650)+ 400= 3000	2(3000)=6000
VTSE	7.62 (T) Exercise	140	6	-	140(6)=840	13	13(840)=10920	0	-	4(10920) =43680	2(43680)=87360
VTSE	7.62 (T) HHC Exer	140	10	-	140(10)=1400	0	-	8	8(1400)	11200	2(11200)=22400
	Total 7.62 (T)								11,200	57,880	115,700

Exhibit I (Cont'd)

Infantry Battalion - Small Arms Ammunition (Cont'd)

Exercise	Ammo Type	Rounds Per Run	# Runs	Zero Rqts	Total Rounds Per Vehicle	BIFVs/ Exercise	Total Rifle Co Requirements	HHC BFVs	HHC Rqts	Total Bn Rqts	1st Cav Div Requirements
SCQE	5.56 mm Ball (M16)	240	2	480	240(2)+480=960	9	9(960)=8640			4(8640) =34560	2(34560) =69120
FPW	5.56 mm (T)	720	1		1(720)=720	12	12(720)=8640			4(8640) =34560	2(34560) =69120
SCQE	5.56 mm Ball (M16)	720	2		2(720)=1440	9	9(1440)=12960			4(12960) =51840	2(51840) =103680
	Total 5.56 (B + T)						21,600			86,400	172,800
SCQE	Smoke						208		-	4(208) =832	2(832)=1664
SSQE	Grenades						-		96		2(96) = 192
											1856
SCQE	40 mm TPT						156			4(156) =624	2(624)=1248

Exhibit J

Cavalry Squadron - Ammunition Requirements

Exercise	Ammo Type	Rounds Per Run	# Runs	Zero Rqts	Total Rounds Per Vehicle	BIFVs/ Exercise	Total Rifle Co Requirements	HHC BFVs	HHC Rqts	Total Bn Rqts	1st Cav Div Requirements
VTCE	25 mm APDS	70	2	10	70(2)+10=150	21		-	-	2(150) 3150	3150
SSQE	"	60	2	0	60(2)+0=120	21		-	-	21(120) =2520	2520
	Total 25 APDS										5670
VTCE	25 mm TPT	50	2	10	50(2)+10=110	21				2310	2310
SSQE	"	60	2	0	60(2)+0=120	21				2520	2520
	Total 25 TPT										4830
VTCE	7.62 mm (4+1) Coax	200	2	50	200(2)+50=450	21				21(450)= 9450	9450
SSQE	"	500	2	0	500(2)+0=1000	21				21(1000) =21000	21000
VTSE	7.62 mm(T) Sub-cal Exercise	140	10	50	140(10)+50=1450	21				21(1450) =30450	30450
	Total 7.62										60900
SSQE	Smoke Grenades									336	336

Exhibit K

Tank Battalion - Ammunition Requirements

Exercise	Ammo Type	Rounds Per Run	# Runs	Zero Rqts	Total Rounds Per Vehicle	BIFVs/ Exercise	Total Rifle Co Requirements	HHC BFVs	HHC Rqts	Total Bn Rqts	1st Cav Div Requirements
VTCE	25 mm APDS	70	2	10	70(2)+10=150	6				6(150) =900	4(900)=3600
SSQE	"	60	2	0	60(2)+0=120	6				6(120) =720	4(720)=2880
	Total 25 APDS										6480
VTCE	25 mm TPT	50	2	10	50(2)+10=110	6				6(110) =660	4(660)=2640
SSQE	"	50	2	0	60(2)+0=120	6				6(120) =720	4(720)=2880
	Total 25 TPT										5520
VTCE	7.62 mm (4+1) Coax	200	2	50	200(2)+50=450	6				6(450) =2700	4(2700)=10800
SSQE	"	500	2	0	500(2)+0=1000	6				6(1000) =6000	4(6000)=24000
VTSE	7.62 (T) Sub-cal Exercise	140	10	50	140(10)+50 =1450	6				6(1450) =8700	4(8700)=34800
	Total 7.62										58800
SSQE SQ	Smoke Grenades									96	4(96)=384

Exhibit L

1st Cavalry Division Ammunition Requirements less NETT Firing Rounds*

Type Ammunition	2 Inf Bn Requirements	1 Cav Sqd Requirements	4 Tnk Bn Requirements	Total
25 mm TPT	25520	4830	5520	35,870
25 mm APDS	34480	5670	6480	46,630
7.62 mm (4+1)(Coax)	153200	30450	34800	218,450
7.62 mm (4+1)(M60)	43200	0	0	43,200
7.62 mm (T)	115760	30450	34800	181,010
5.56 mm (BALL)	69120	0	0	69,120
5.56 mm (T)	172800	0	0	172,800
40 mm TPT	1248	0	0	1,248
Smoke Grenades	1856	336	384	2,576

Exhibit M

USAIS Bradley Ammo Requirements for FY 85
as submitted to TRADOC February 1984

Nomenclature	DODAC	Courses		
		Commander	Gunner	Master Gunner
25 mm TPT2	A976	138000	86400	15060
25 mm HEI-T3	A975	750	750	450
25 mm dummy	A967	2000	2000	1000
7.62 mm coax	A131	207000	97000	142420
7.62 mm ball	A146	140000	146000	5790
7.62 mm dummy	A159	8000	8000	4000
5.56 mm FPW	A072	28600	-	21420
5.56 mm ball	A071	16440		13680
5.56 mm dummy	A060	500	-	200
22 cal. long rifle ball	A086	16440	-	13680
Grenade, smoke screen	G815	2040	1960	480
Grenade, HC hand smoked	G930	50		
Grenade hand smoked green	G940	25		
Smoke pots	K866	10		
Signal ground alum white	L312	100		
Signal ground alum green	L314	50		
Simulator projector airb	L366	200		
Simulator projector SS	L367	1840	960	304
Simulator projector	L594	100	-	-
Simulator flash ARTY (Hoffman Dervice)	L602	23000	12000	4275
TOW HE	PB 25	5	5	3
	Classes:	6	5	3
	Students:	274	240	38

Notes:
DODAC = Department of Defense Ammunition Code
TPT = Target Practice-Tracer
HEI-T = High Explosive Incindiary-Tracer

Class number and size have already changed from the projections on which these numbers are based. However, the number of students remains about the same. For class projections and size refer to the appropriate Course Monitor in Bldg 4. Mr. Miller (USAIS, Bldg 4, Room 511) has ammo projections through 1992 in his office.

Exhibit N

Consolidated Ammunition List for D Co, ITG
(OSUT 3 weeks add-on for MOS 11M)

Ammunition	DODAC	# per Student	# of Students	Total	#/Class Demo/PE	Number Classes	Total	Grand Total
7.62 mm (T)	A 146				800	33	26400	26400
7.62 mm (blank)	A 111	134	1295	175,530				175530
5.56 mm (T)	A 072	270	1295	349,650	540	33	17820	367470
5.56 mm (Blank)	A 080	313	1295	405,335	72	33	2376	407711
Ctg,Gren Screening	G 815				8	33	264	264
Simulator, Flash	L 596				30	33	990	990

Notes: Approximately 3 classes per month for 11 months. Schedule calls for 1295 students for FY 85. Source: S3, D Co, ITG, SFC Sarla.

Exhibit O

Bradley Ammunition Requirements for FY 85 for D CO,
1/29 INF 197th Inf Bde, Fort Benning, Georgia

Ammunition	DODAC	Number of Rounds	
25 mm TP-T	A 976	43,580	
25 mm HEI-T	A 975	6.800	
7.62 mm Ball	A 146	142,400	
5.56 mm (T)	A 068	14,680	(Individual rounds)
5.56 mm (T)	A 072	14,680	(Bradley,boxed,speed-load)
ATWESS Simulator	L 367	33,800	
TOW, Practice	PB 18	10	
TOW, HE	PB 25	1	

Source: S3, 1/29th INF, SFC Colson.