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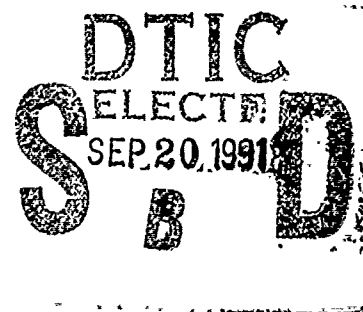
U.S. Army Research Institute  
for the Behavioral and Social Sciences

Research Report 1587

# A Device/Aid-Based Strategy for Training M1 Tank Gunnery in the Army National Guard

John E. Morrison, David A. Campshure,  
and Earl L. Doyle

Human Resources Research Organization



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April 1991

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |                                                | * Training devices,<br>Training aids,<br>Training strategy,                                                          |                                                      |                                  |
| 19. ABSTRACT (Continue on reverse if necessary and identify by block number)<br>→ Training devices and aids can help overcome constraints to on-tank gunnery training in the Army National Guard. This report describes a strategy for using devices and aids to train gunnery. The training strategy is divided into five components, each of which refers to a general problem in training:<br><br>→ 1. Identification/organization of training objectives. Training objectives for the device/aid-based training strategy were derived from on-tank exercises described by the Tank Combat Tables, FM 17-12-1 (Department of the Army, 1988b). The objectives were organized into a four-level learning hierarchy of gunnery training: preliminary, basic, intermediate, and advanced.<br><br>→ 2. Assignment of training devices/aids to the objectives. Training devices and aids were assigned to the four phases of training by matching performance requirements of the<br>(Continued) |       |                                                |                                                                                                                      |                                                      |                                  |
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## 19. ABSTRACT (Continued)

combat tables to the capabilities of the training devices/aids. The results of this matching process indicated that the devices and aids overlapped in function, and each can be used in more than one phase of training.

3. Allocation of training time to the devices/aids. Training time was allocated on the basis of data obtained from two sources. For the officially fielded devices, the suggested training times were obtained from the Armor Training Strategy, ST 17-12-7 (U.S. Army Armor School, 1990a). For TopGun and the Hand-Held Tutor, estimated training times were derived from the results of empirical evaluations of these research technologies.

4. Specification of instructional content. For each of the four training phases, the instructional content of training was determined by specifying (a) training goals, which were defined as sets of exercises that soldiers, crews, or platoons should strive to complete, or level of proficiency that they should attain; and (b) diagnostic exercises, which were device/aid-based performance evaluations for assessing the proficiency of soldiers/crews/platoons on devices and their readiness for on-tank training.

5. Overall management of training on devices and aids. Several issues related to training management were discussed. One training management issue was the proposed sequence of training, which differed as a function of initial and sustainment training. Another set of issues related to the key features of the instructional strategy and their effects on skill acquisition, sustainment, and transfer. The final issue concerned implementation problems introduced by the strategy. Also, some potential solutions to the problems were discussed.

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Office, Deputy Chief of Staff for Personnel  
Department of the Army

**April 1991**

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Army Project Number  
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Training Simulation

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## FOREWORD

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The Army National Guard (ARNG) is emphasizing training devices/aids to enhance the home-station training of M1 tank gunnery. To this end, a four-phased research project has been initiated to identify (a) devices/aids available for use, (b) tasks to be trained on each device/aid, (c) environmental constraints affecting device/aid usage, and based on this information, to (d) develop a practicable ARNG device/aid-based M1 tank gunnery training strategy for use at home station. This report describes the results of the final phase of the project, wherein the information derived from the previous reports is integrated to develop a strategy for using devices and aids to support and enhance on-tank gunnery training in the ARNG.

The research was conducted by the Training Technology Field Activity, Gowen Field (TTFA-GF), whose mission is to improve the effectiveness and efficiency of Reserve Component (RC) training by using the latest in training technology. The research task supporting this mission, "Application of Technology to Meet RC Training Needs," is organized under the "Training for Combat Effectiveness" program area.

The National Guard Bureau (NGB) sponsored this research under a Memorandum of Understanding, signed 12 June 1985, establishing the TTFA-GF. Results have been presented to Chief, Organization and Training Division, Training Support and Management Branch, NGB; Chief, Training Division, Office of the Chief, Army Reserve (OCAR); Director, Training Development and Analysis Directorate (TDAD), TRADOC; and Deputy Director, Training and Doctrine, U.S. Army Armor School (USAARMS).



EDGAR M. JOHNSON  
Technical Director

# A DEVICE/AID-BASED STRATEGY FOR TRAINING M1 TANK GUNNERY IN THE ARMY NATIONAL GUARD

## EXECUTIVE SUMMARY

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### Requirement:

Gunnery training devices and aids can help to overcome constraints to on-tank gunnery training in the Army National Guard (ARNG). To obtain the maximum benefit from these training devices and aids, a detailed training strategy is needed to describe how they should be used to train gunnery in the ARNG.

### Procedure:

Training strategies were defined as methods for addressing general problems in training design, development, and implementation. With respect to gunnery training in the ARNG, five problem areas were identified: (a) the identification and organization of gunnery training objectives, (b) the assignment of training devices and aids to those objectives, (c) the allocation of training time to the devices and aids, (d) the identification of appropriate exercises or lessons on the devices and aids, and (e) the overall management of training on devices and aids. The methods, and results from applying the methods, were organized according to these five problem areas.

### Findings:

The findings related to each of the five problem areas are summarized as follows:

1. To ensure that training on devices and aids were fully integrated with training on the tank, the training objectives for device/aid-based training were derived from on-tank exercises as described by the Tank Combat Tables, FM 17-12-1 (Department of the Army, 1988b). The objectives were organized into a four-level learning hierarchy corresponding to the preliminary, basic, intermediate, and advanced phases of gunnery training. Each of the four phases was described in terms of its performance requirements according to the domain of activities described in a previous report in this series (Campshure, 1990).

2. The selection of training devices and aids was based on a systematic match of the performance requirements of the combat tables (identified in the previous problem area) to the capabilities of the devices (described by Campshure, 1990). The results of this matching process indicated that most of the devices can be used in more than one phase, or (from the other perspective) that there are multiple training devices and aids appropriate to each phase of training.

3. Training time was allocated on the basis of data obtained from two sources: (a) for the officially fielded devices, the suggested times were obtained from the Armor Training Strategy, ST 17-12-7 (U.S. Army Armor School,

1990a); and (b) for TopGun and the Hand-Held Tutor, estimates were derived from the results of evaluations of these research technologies. The time allocations for each training device and aid were then distributed to each of the four phases of training.

4. The instructional content of the training was determined by specifying training goals and diagnostic exercises appropriate to each of the four phases of training. The training goals were defined as either (a) the set of interrelated exercises that soldiers, crews, or platoons should strive to complete during a particular phase of training; or (b) the level of proficiency that soldiers, crews, or platoons should attain by the end of a training phase. The diagnostic exercises were device/aid-based performance evaluations for determining whether soldiers/crews/platoons were acceptably proficient at some given level of device/aid training or were ready to participate in initial on-tank training.

5. Training management issues were discussed to describe how the separate components of the training strategy should be integrated. One such issue was the sequence of training. For the present strategy, there were important differences between the sequencing of initial and sustainment training. Another set of issues concerned the key features of the instructional strategy and their effects on skill acquisition, sustainment, and transfer. These key features must be borne in mind when implementing the strategy. Similarly, some implementation problems introduced by the strategy were discussed along with some potential solutions to the problems. To provide a concrete example of how the training strategy might be implemented, a sample training schedule is included as an appendix.

#### Utilization of Findings:

This report provides an integrated approach to training with devices and aids that should be immediately applicable to ARNG training. Although specifically tailored to the needs of the ARNG, the discussion of methods should also be useful to the design, development, and implementation of tank gunnery training in the Active Component and the U.S. Army Reserve.

# A DEVICE/AID-BASED STRATEGY FOR TRAINING M1 TANK GUNNERY IN THE ARMY NATIONAL GUARD

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# A DEVICE/AID-BASED STRATEGY FOR TRAINING M1 TANK GUNNERY IN THE ARMY NATIONAL GUARD

## Introduction and Background

The extent of gunnery training that armor units can conduct on their tanks is severely constrained both by reductions in training ammunition and by restrictions in operating tempo (OPTEMPO). On-tank gunnery training in the Army National Guard (ARNG) is especially restricted by some problems that are specific to the Reserve Component (RC). One overriding problem for all RC training is the lack of time available for training: Compared to Active Component (AC) units, RC units have fewer than 20% of the days available for training. Other RC problems that impact on-tank gunnery training include limited access to training areas and shortage of mission-essential equipment (Eisley & Viner, 1988). Given these constraints, gunnery training in the ARNG must rely increasingly on advanced training technology (i.e., computer-based training devices and aids) to train and sustain gunnery skills. To obtain the most benefits from these technologies in the limited time available for training in the RC, guidance is needed to specify how training devices and aids should be used to promote the efficient acquisition, retention, and transfer of gunnery skills. In the present report, this "how to" guidance is defined as a *training strategy*. The purpose of the research described in the present report is to develop a gunnery training strategy for the ARNG that relies, to the greatest extent possible, on devices and aids.

The role of training devices and aids in gunnery training is somewhat ambiguous. That gunnery training should increasingly rely on training devices and aids is generally accepted in the armor training literature. For instance, the authors of Armor Training Strategy, ST 17-12-7 (U.S. Army Armor School [USAARMS], 1990a) suggest that advanced training technology be used as leverage against dwindling training resources. Similarly, the authors of a National Guard Bureau (NGB) White Paper entitled An Integrated Training System (NGB, 1990) view the reliance on training devices and aids as crucial to their philosophy of enhancing home station training. At the same time, however, there is general acceptance of the contention that training devices and aids cannot completely replace the demanding, realistic, and motivating aspects of training on the tank itself. In recognition of the importance of on-tank training, the authors of ST 17-12-7 also assert that, for the foreseeable future, gunnery training in the RC "...will continue to be vehicle based and require expenditures of fuel, ammunition, and spare parts" (p. 4-1). An appropriate rapprochement of these conflicting views is that device/aid-based gunnery training should supplement, but not supplant on-tank training.

One approach to integrating device-based and on-tank training of gunnery is outlined in Standards in Weapons Training, Pamphlet 350-38, (Department of the Army [DA], 1988a). The approach to ARNG gunnery training is described as a "three-phase interlocking" strategy. The first phase calls for training of basic skills at the armory using training devices. Intermediate gunnery skills are trained at the local training area (LTA) using appropriate on-tank exercises called combat tables. Gunnery (crew) qualification is determined at the major training area (MTA) using more advanced combat table evaluations. In this scheme, the combat tables provide, in essence, the intermediate and

terminal performance objectives for gunnery training. Viewed in this light, the purpose of gunnery training devices and aids, then, is to prepare individuals, crews, and platoons to be trained and evaluated on the combat tables. Although DA Pamphlet 350-38 suggests how device/aid-based and vehicle-based training should be integrated, the document explicitly states that this training strategy is *notional* to allow commanders flexibility in achieving their training goals. Although flexibility is a desirable characteristic in a gunnery training strategy, more detailed guidance is needed to derive the maximum benefit of training technology in the constrained ARNG environment. As a first step in developing an integrated technology-based training strategy that is specific to the ARNG, it is useful to first review two previous strategies that provide procedural information about how devices and aids should be used to train gunnery skills.

#### Previous Device/Aid-Based Gunnery Training Strategies

Hoffman and Morrison (1988) described a device-based gunnery training strategy that focused on four computer-based devices for training M1 gunnery and tactical skills: the Videodisc Interactive Gunnery Simulator (VIGS), the arcade-like TopGun device, the Unit Conduct-of-Fire Trainer (U-COFT), and the Simulation Networking (SIMNET) battle simulation system. Their approach to development of this strategy was to first determine the domain of gunnery performance in terms of specific conditions and actions. They then performed a rational evaluation of devices to determine the extent to which the features of the devices could be used to simulate the conditions and to support practice on the actions. Using heuristic guidelines derived from instructional theory and from the practical constraints of gunnery training, Hoffman and Morrison derived a hierarchy of instructional units from which an appropriate sequence of instruction on the devices could be derived. According to their hierarchy, training would start with the most basic prerequisite skills and progressively add more advanced skills until proficiency of the entire domain would be attained. Thus, the strategy focused on the initial acquisition of gunnery skills with no specific provision for skill sustainment.

Hoffman and Morrison's (1988) strategy was designed to serve as a model for any gunnery training program; therefore, it was not tied to any particular course of instruction or any tank gunnery evaluation event such as Table VIII. In contrast, the Armor Training Strategy, ST 17-12-7 (USAARMS, 1990a) described a program that was designed specifically for actual armor training in units and in the institution. The explicit purpose of this document was "...to provide unit commanders, training officers, and master gunners a single-source document that integrates the various individual devices into the overall Armor device-based training strategy" (p. iii). The focus of this document was to describe how both computer-based and tank-appended devices should be used to support an established gunnery and maneuver training program. For the ARNG, this document recommended the frequency with which devices should be used and the suggested length of individual device training sessions. This strategy was laid out for the initial year (FY 1990) then modified for the near term (FY 1991-92), the mid term (FY 1993-96), and the far term (FY 1997-2005) as new devices were expected to be fielded.

The two strategies are similar in that they provide only general advice about how devices should be used. In that regard, the Armor School document at several different points characterized its own guidance as a "macrostrategy" implying that more detailed information (a "microstrategy") would be forthcoming. Such a microstrategy would include information such as specific exercises to practice on individual devices/aids; appropriate performance criteria to ensure sufficient learning, retention, and transfer; and alternate approaches when devices are not available or training time is limited. Some of this information is provided for one ARNG device in a recently published document entitled the Mobile Conduct-of-Fire Trainer Microstrategy, ST 17-12-7-2 (USAARMS, 1990b). To develop comprehensive guidance for device/aid-based gunnery training in the ARNG, however, a detailed and integrated strategy should be developed that includes all computer-based training devices and aids. Some of the groundwork for such a detailed strategy has already been laid out by research in the present series, which is briefly summarized in the following section.

### Research in the Present Series

The present report is the last in a series whose purpose is to describe the development of a detailed strategy for training gunnery skills in the ARNG. In the first report from this project, Morrison, Drucker, and Campshure (1990) identified training aids and devices that would be applicable to ARNG armor training either now or within the next five years. They distinguished between tank-appended training devices that are primarily used to execute the combat tables, and stand-alone devices and aids that are used to prepare crews for the tables. They argued that the training strategy should concentrate on the use of the stand-alone training devices and aids because they do not require an operational tank or a maneuver area and can be used in the armory during inactive duty training (IDT) weekends. This emphasis on armory-based training is consistent with the NGB's (1990) explicit guidance to take training to soldiers. In other words, as much training as possible should be conducted at the armory to avoid wasting valuable time transporting soldiers to distant training sites.

Morrison et al. (1990) identified six computer-based technologies as appropriate for training M1 tank gunnery skills and knowledges at the armory: (a) the M1 TopGun device; (b) the M1 VIGS; (c) the M1 Mobile Conduct-of-Fire Trainer (M-COFT); (d) Guard Unit Armory Device Full-Crew Interactive Simulation Trainer, Armor (GUARD FIST I); (e) SIMNET; and (f) the Hand-Held Tutor (HHT). Morrison et al. reviewed the extant military literature on these devices finding that they overlap somewhat in terms of training many of the same skills. They concluded that this overlap should be exploited to promote skill retention and transfer. Morrison et al. also examined the research literature with respect to the topics of skill acquisition, skill retention, prediction of performance, and transfer of training. The results of the review revealed substantial evidence that gunnery skills are acquired on the devices and aids. In contrast, relatively little is known about the retention of those skills, the relationship between device/aid performance and performance on the tank, or the transfer of skills learned on training devices and aids to performance on the tank.

The second report in this series (Campshire, 1990) presented a detailed rational evaluation of the capabilities of the training devices and aids identified by Morrison et al. (1990) to be appropriate for training M1 tank gunnery. This analysis was accomplished by determining the degree to which the training devices simulated the tank components and the environmental conditions, and the extent to which gunnery behaviors could be performed on the devices. Also, the HHT was analyzed to determine its potential to impart gunnery-related knowledges. These analyses further specified the roles of the devices and aids in the gunnery training strategy: (a) the two low-cost training devices (TopGun and VIGS) support training on prerequisite gunner skills related to precision gunnery; (b) GUARD FIST I simulates most tank components and allows performance of most gunnery behaviors by virtue of the fact that it is attached to an actual M1 tank; (c) M-COFT allows training on the widest array of gunnery engagements including gunnery-related activities that are not trainable on the other devices, such as, secondary gunnery activities, machine gun engagements, and degraded mode gunnery; (d) SIMNET is useful in simulating many of the mission-oriented conditions that are not simulated by the other devices, but it provides less support of gunnery activities compared to GUARD FIST I and M-COFT; and (e) the HHT is beneficial in training a small, but important, subset of basic gunnery knowledges.

In the third report in this series, Drucker (1990) described the gunnery training programs that are currently implemented in the Idaho ARNG (IDARNG), paying particular attention to the conditions that constrain that training. His description was based on responses to interviews and questionnaires administered to battalion and company level personnel, and on written training guidance and schedules provided by the brigade, battalion, and individual companies. Drucker identified five types of conditions that constrain gunnery training in the IDARNG: (a) the limited availability of computer-based training devices and aids, (b) the limited access to the LTAs, (c) the environmental constraints at the MTA, (d) the limited access to tanks for training, and (e) other (i.e., nongunnery) training requirements. Some of the problems (e.g., no tank storage facilities at LTAs) were specific to the IDARNG and were currently being addressed by local leadership. Other problems (e.g., nongunnery training requirements) had more application to RC training in general, and seemed more intractable. The proposed gunnery training strategy should compensate for these more general conditions. For instance, the strategy must allow for the fact that less than 75% of IDT training time can be allotted to gunnery training.

#### Purpose and Organization of the Present Research

Using information derived from the previous reports as groundwork, the purpose of the present research was to describe the development of a strategy for using training devices and aids to support and enhance on-tank gunnery training in the ARNG. A training strategy can be broken down into multiple components, each addressing an important problem in training design, development, and implementation (Morrison & Holding, 1990). With respect to gunnery training in the ARNG, these problems were identified to be (a) the identification and organization of gunnery training objectives, (b) the assignment of training devices/aids to those objectives, (c) the allocation of training time among the devices and aids assigned to training, (d) the determination of appropriate exercises or lessons on the devices and aids, and

(e) the overall management of training on devices and aids. The first four topics relate to individual components of the training strategy, whereas the final topic pertains to how the components should be put together. These five problems provide the topics around which the remaining major sections of the present report are organized.

### Identify and Organize Gunnery Training Objectives

The training designer is initially faced with two related problems: to derive the objectives for training and to organize those objectives into an appropriate structure and sequence for learning. To ensure that training on devices and aids is fully integrated with training on the tank, it is assumed that the on-tank exercises described in Tank Combat Tables, FM 17-12-1 (DA, 1988b) provide appropriate objectives for training on devices and aids as well as for training on the tank. The combat tables consist of two different types of exercises termed gunnery and tactical tables. In addition to providing the objectives for training, the gunnery and tactical tables serve to structure and sequence gunnery training as well. For this aspect of the training strategy, then, the problem is not to derive new objectives for training gunnery and to create a novel organization for them; rather, the problem is to understand the existing objectives that are provided by the combat tables, and to describe the structural and sequential dependencies that pertain to these on-tank gunnery exercises.

### Organization of the Objectives

According to guidance provided by the Standards in Training Commission (STRAC) as published in Standards in Weapons Training, Pamphlet 350-38 (DA, 1988a), armor units in the ARNG are required to train on basic and intermediate gunnery tables (I - VIII)<sup>1</sup> and basic, intermediate, and advanced tactical tables (A-I). Note that, in contrast to AC units, ARNG units do not train on the advanced gunnery tables (IX-XII). Figure 1 provides a conception of the overall organization of the combat tables for tank gunnery training in the ARNG. As can be seen in the figure, the structural and sequential relationships among these combat tables are described as a four-level learning hierarchy. As in any learning hierarchy, instruction starts at the bottom of the structure that corresponds to the more basic skills, and proceeds upward by progressively and systematically adding more and more advanced skills.

Preliminary training is shown as the bottom level of Figure 1 indicating that this phase of training must be accomplished prior to beginning the other phases. The focus of this level is on the prerequisite individual skills that are initially trained in Basic Armor Training (BAT) and reinforced through the Skills Qualification Testing (SQT) program.<sup>2</sup> On the basis of the commander's

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<sup>1</sup>STRAC guidelines hold that, for units that have the M-COFT, training on that device substitutes for Gunnery Tables I-III.

<sup>2</sup>The SQT is currently under revision to be replaced by the Skill Development Test (SDT). At the present time, however, the SQT program remains in effect.

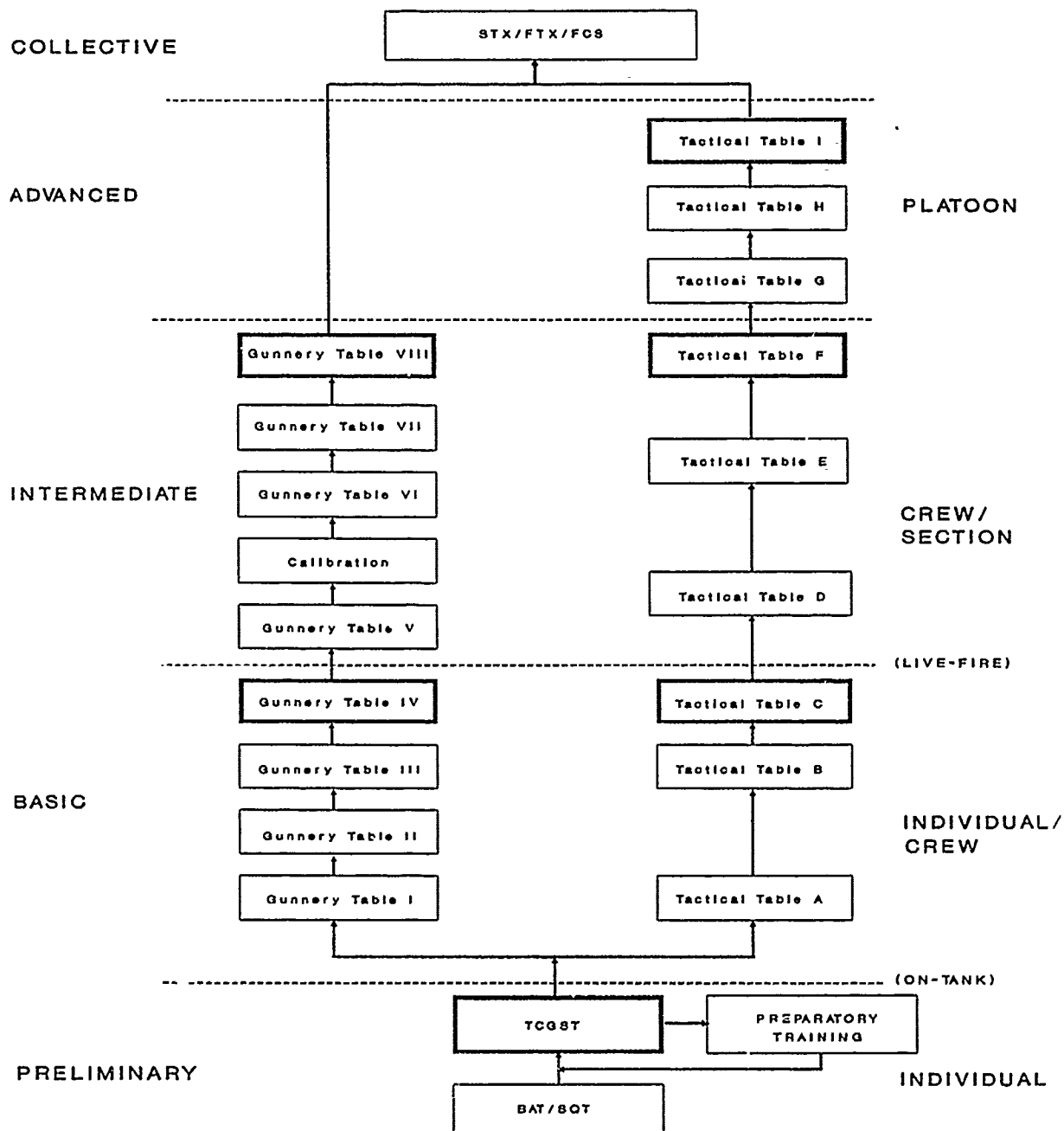


Figure 1. Overall organization of tank combat tables depicted as a learning hierarchy.

subjective assessment of his unit's proficiency and/or on the basis of results from the Tank Crew Gunnery Skills Test (TCGST), the commander may elect to provide preparatory training. This training should include all or some of the following knowledges and skills: (a) crew duties, (b) boresighting procedures, (c) gun manipulation skills, (d) tracking, (e) target acquisition, (f) range estimation, (g) use of the M1 thermal imaging system, and (h) smoke employment. Regardless of the extent of preparatory training, all armor crewmen must demonstrate their proficiency on these skills by passing the TCGST prior to training on the combat tables. Thus, while not actually a combat table exercise per se, the TCGST provides the starting point for gunnery training on the tank.

After passing the TCGST, training proceeds along two separate strands corresponding to the gunnery and tactical tables. Although the gunnery tables and tactical tables appear sequentially independent, they are in fact somewhat correlated in time by virtue of the differentiation among the levels of gunnery training. In other words, at each level, training on the corresponding gunnery tables and tactical tables should be conducted concurrently. As can be seen in Figure 1, both gunnery and tactical tables are sorted into basic, intermediate, and advanced exercises. This progression corresponds to advancement in the echelon of training: The basic combat tables contain both individual and crew exercises, the intermediate tables pertain to both crew- and section-level exercises, and the advanced tables include only platoon-level exercises. Beyond the advanced level, the gunnery and tactics strands converge in field exercises (e.g., the Situational Training Exercise [STX], Field Training Exercise [FTX], and Fire Coordination Exercise [FCX]) to be conducted at the platoon, company, and battalion levels. These collective training exercises provide a fifth level to the learning hierarchy, but are traditionally considered beyond the scope of gunnery training. In other words, the four hierarchical levels of gunnery training prior to collective training (preliminary, basic, intermediate, and advanced) define the domain of unit gunnery training in the ARNG.

One apparent contradiction in the combat tables is that, whereas intermediate tactical tables (D-F) are defined as section-level exercises, intermediate gunnery tables (V-VIII) are defined as crew-level exercises. In the intermediate gunnery tables, however, the unit commander has the option of employing a wingman tank with each firing tank to assist in target acquisition and observation of target effects. In doing so, the intermediate gunnery tables provide some initial practice in section-level gunnery. For this reason, FM 17-12-1 (DA, 1988b) suggests that intermediate tactical tables (D F) be trained after the intermediate gunnery tables (V-VIII). However, range scheduling may override this suggestion. For instance, live-fire ranges that are required for Gunnery Table VIII may be available to ARNG units only at their MTA. The MTA, in turn, may be available only at specific times during the training year, such as during Annual Training. In contrast, the tactical tables are typically executed with the Multiple Integrated Laser Engagement Simulation (MILES) system or as a dry-fire exercise, and can therefore be trained at the LTAs which are much more accessible. As a consequence, scheduling concerns may dictate that the intermediate tactical tables be trained prior to the corresponding gunnery tables.

Figure 1 highlights the last tables within each level of the hierarchy. These exercises are particularly significant because they are designed to be the most difficult and comprehensive training exercises within basic, intermediate, and advanced levels. As such, the final tables in both strands serve as "qualification" exercises for demonstrating either proficiency in crew-level gunnery (Gunnery Table VIII) or platoon-level tactics (Tactical Table I). Prior to the qualification exercises, the last table within each level serves both as the intermediate objective for confirming proficiency at the present level of training and as the prerequisite for training at the next level. Thus, these tables are referred to as "gate" exercises. The use of gates is central to training in the ARNG to ensure that soldiers and/or crews are "... proficient through previous experience to benefit from the training rather than squander valuable time" (NGB, 1990, p. 6). In the present context, the TCGST represents the culmination of preliminary training and serves as a gate for gunnery and tactical training on the tank. Similarly, Gunnery Table IV, which is executed with either MILES or a subcaliber device, is a gate for the intermediate gunnery tables, which are live-fire, full-caliber exercises. On the tactical side of the figure, Table C is the gate table for section-level training, and Table F is the gate table for platoon-level training.

### Content of the Objectives

To understand the content of the training objectives in more detail, the following subsections provide a description of the performance requirements of the TCGST, the gunnery tables, and the tactical tables respectively. The performance requirements of these training and evaluation events are described in terms of the domain of gunnery behaviors as summarized in the second report in the present series (Campshure, 1990). This report described the capabilities of gunnery training devices to support training on the behaviors required in crew, section, and platoon-level gunnery. Following the terminology developed by Hoffman and Morrison (1988), Campshure organized gunnery behaviors into meaningful units called "activities." Appendix A presents an analysis indicating which activities are required to perform the tasks on each of the combat tables. These behavioral analyses serve two purposes: (a) to describe the performance requirements of each of the tables, and (b) to match the requirements of the tables to the capabilities of the training devices as documented by Campshure. The former purpose relates to the present training problem (Identify/Organize Gunnery Training Objectives), whereas the latter relates to the next problem discussed in the subsequent major section (Assign Training Devices and Aids).

TCGST. The TCGST consists of individual tasks that relate to prerequisite knowledges and skills, which are only indirectly related to the gunnery activities. As shown in Appendix Figure A-1, 27 of the 37 gunnery activities in the crew-level domain are not tested in the TCGST (e.g., Activity 7: Engage multiple targets with the main gun), and 9 of the 17 TCGST tasks do not relate to any crew-level gunnery activity (e.g., Task 3: Clear, disassemble, assemble, perform a functions, and load the M240 coaxial machine gun). In terms of the domain of crew-level activities, the unique aspect of the TCGST is that it provides an evaluation of secondary (pre-combat) skills including "Boresight the Main Gun" (Station 6), and "Prepare Gunner's Station for Operation" (Station 10).

Gunnery tables. The gunnery tables provide on-tank practice, within rigidly defined conditions, of most of the behaviors that constitute the domain of tank gunnery. According to Tank Combat Tables, FM 17-12-1 (DA, 1988b), the overall objectives of the gunnery tables, as applied to the ARNG, are to develop skills progressively, to sustain crew-level gunnery proficiency, and to provide a method for evaluating a crew's ability to use the fire control system and appropriate engagement techniques. The gunnery tables are organized according to two principles. First, Gunnery Tables I-VIII are divided into two groups of four tables (basic and intermediate) based on the level of skills required to execute the engagements. Second, within each of the two groups of tables, the first three tables are designed to provide a wide variety of exercises by maximizing coverage of the domain of the 64 basic types of engagements.<sup>3</sup> The fourth and final table in each group is a gate table that is designed to evaluate a crew's ability to execute the engagements learned in the preceding tables. These gate tables must be passed before crews are allowed to advance to the next level of gunnery.

Analysis of test conditions and the analysis of required behaviors (presented in Appendix A (Figures A-2 and A-3) indicate that the intermediate gunnery tables are more difficult than the basic gunnery tables in at least four respects. First, the intermediate gunnery tables are full-caliber, live-fire exercises whereas the basic tables are executed with subcaliber devices, with MILES, or as dry-fire exercises. Second, the intermediate tables entail both main gun and machine gun engagements, whereas the basic tables consist of main gun engagements only. Third, targets for intermediate tables engagements are generally emplaced at greater ranges than those in the basic tables. Fourth, the intermediate tables require more multiple target engagements than do the basic tables. In other ways, however, the main gun engagements of the intermediate tables are much like those in the basic tables, and therefore overlap in terms of their performance requirements. In fact, the intermediate tables actually require firing fewer engagements in degraded modes (i.e., with simulations of failures to the tank's fire control systems) than do the basic tables. In sum, the progression in skill development from the basic to the intermediate tables is clear in some respects, but not in others.

Tactical tables. Although both the gunnery tables and the tactical tables provide on-tank practice of gunnery-related tasks, they emphasize qualitatively different skills. For instance, whereas the gunnery tables stress practice on the full array of gunnery procedures under somewhat constrained situations, the tactical tables emphasize practice of selected tactical skills under less predictable conditions (DA, 1988b). In particular, the targets used for tactical tables are more realistic--that is, they can

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<sup>3</sup>According to Tank Combat Tables, FM 17-12-1 (DA, 1988), gunnery engagements can be distinguished by five basic conditions: (a) own tank movement (stationary or moving), (b) target type (moving or stationary and single, multiple, or simultaneous), (c) gunner's sight used (primary or auxiliary), (d) main gun engagement technique (precision or battlesight), and (e) visibility (day, night, or obscuration). According to this analysis, there are 64 different types of engagements that are defined by all possible combinations of those five conditions.

appear at any heading, have shoot-back capabilities, and perform evasive maneuvers. As a consequence, the crews, sections, or platoons being trained must fully use the tank's mobility and agility as well as their own tactical skills and knowledges to defeat the simulated targets. One of the explicit training objectives of the tactical tables is to train crews to fire while moving; consequently, most of the scenarios are within the context of offensive missions. In addition, unlike the gunnery tables, the tactical tables are all conducted under daylight conditions.

In contrast to the gunnery tables where the distinction between hierarchical levels is somewhat ambiguous, the nine tactical tables (designated A-I) are organized according to two explicit sequencing principles. The first principle is that training exercises within the tactical tables are sequenced according to echelon--that is, training starts at the crew level (Tables A-C), proceeds to the section level (Tables D-F), and ends at the platoon level (Tables G-I). Because of these changes in echelon, the performance requirements in Appendix A shift from crew-level activities (Figure A-4) to section/platoon individual leadership and collective activities (Figures A-5 and A-6). The second principle, which concerns the sequence of tables within the three groups, is that tactical tables are arranged to provide increasingly realistic practice experiences: The initial table in each group provides training on basic coordination skills, the second table provides a structured drill of those skills, and the third table is a reaction exercise. The reaction exercises support training of the coordination skills in a realistic tactical scenario to allow the crewmen to practice real-time decision making. As shown in Appendix A, the reaction exercises cover proportionally more of the performance domain than either of the two preceding exercises within the group. The reaction exercises for the first two groups of tasks (Tactical Tables C and F) serve as gates to determine whether training can proceed to the next higher level, whereas the final reaction exercise (Tactical Table I) is the qualification table for individual platoons.

### Summary of Training Objectives

Training objectives for the device/aid-based training strategy were derived from on-tank exercises described by the combat tables. The purpose of using the combat tables as training objectives was to ensure that training with devices and aids would be fully integrated and compatible with training on the tank. The objectives were organized into a four-level learning hierarchy with each level corresponding to a different phase of gunnery training. Each phase was then described in terms of its performance requirements. Although this scheme presented some ambiguity in instructional sequencing, the combat tables provided reasonable training objectives for the device/aid-based training strategy.

### Assign Training Devices and Aids

In his previous analysis of device/aid capabilities, Campshure (1990) concluded that the five training devices (TopGun, VIGS, M-COFT, GUARD FIST I, and SIMNET) and the training aid (HHT) all have value for training TC and gunner skills. Whereas GUARD FIST I and SIMNET offer full-crew simulations providing some training for loaders and drivers, Campshure's analysis

indicated that only a small portion of the actions required by loaders and drivers can be performed in a realistic manner. Thus, although GUARD FIST I and SIMNET can train the loader and driver to interact with the tank commander and gunner in gunnery engagements, training on basic loading and driving skills should continue to be trained on the tank. However, the device/aid-based training program can deliver some of the cross training in gunner skills that loaders and drivers are required to receive.

The problem addressed in this section is to assign the training devices and aids to the appropriate phase(s) of gunnery training. The present section discusses the methods used for assigning training devices and training aids for training each phase, and presents the results from applying those methods.

### Training Devices

The assignment of training devices was based on the performance requirements of the combat tables. The preceding section described the gunnery and tactical tables in terms of the crew-level, platoon leadership, and platoon collective activities that constitute the domain of tactical gunnery, as described in the second report in this series (Campshure, 1990). The purpose of defining this domain was to assess the capabilities of the devices by determining the extent to which each of the gunnery activities could be trained on each device. Assignment of the devices to be used during the four phases of training was accomplished by relating the performance requirements of the combat tables (as presented in Appendix A) to the device capabilities (as described by Campshure). The decision rule for assigning devices can be stated as follows: A device was chosen to train the skills associated with a gunnery activity if Campshure rated it as either partially or highly supporting the activity. Devices were not assigned when they were shown to only marginally support the training of an activity, because these devices were not considered capable of adequately or realistically training the skills represented by the activity. The results of the analyses of the devices to be used to train the activities associated with each of the four phases of training are presented in detail in Appendix B and are summarized in Table 1.

The data in Table 1 should not be overinterpreted. One evident limitation is that the aggregated data in Table 1 do not identify which specific activities are or are not supported. For instance, Table 1 fails to show that none of the devices trains the following activities from the basic phase: (a) searching in open-hatch mode; (b) engaging targets given crosswind sensor, lead angle sensor, or GPS failures; (c) employing vehicle exhaust smoke; and (d) engaging targets using the loader's M240 machine gun. (However, these details can be determined from examination of Appendix B.) Another limitation of these data is that the calculation of device coverage as a percentage of supported activities implicitly assumes that the activities are equally important--a questionable assumption at best. Thus, these data should not be interpreted as providing a definitive index of the utility of the devices for gunnery training at each level. Despite the shortcomings of these data, however, this analysis does provide three unambiguous findings that are useful in assigning devices:

Table 1

Number of Required Activities and Percentages of Crew- and Platoon-Level Activities Supported by Training Devices

| Training Phases                       | Number of Activities | Training Devices |      |        |              |        |
|---------------------------------------|----------------------|------------------|------|--------|--------------|--------|
|                                       |                      | Top Gun          | VIGS | M-COFT | GUARD FIST I | SIMNET |
| Crew-Level Activities                 |                      |                  |      |        |              |        |
| Preliminary                           | 10                   | 20%              | 30%  | 80%    | 50%          | 30%    |
| Basic                                 | 30                   | 23%              | 27%  | 77%    | 70%          | 47%    |
| Intermediate                          | 23                   | 30%              | 30%  | 96%    | 78%          | 52%    |
| Platoon-Level Activities <sup>a</sup> |                      |                  |      |        |              |        |
| Intermediate                          | 13                   | --               | --   | --     | --           | 100%   |
| Advanced                              | 17                   | --               | --   | --     | --           | 94%    |

Notes. The missing entries under platoon-level gunnery activities (--) indicate that, except for SIMNET, devices are not able to simulate the interaction of tanks required to train platoon-level activities.

<sup>a</sup>Platoon-level activities include both platoon leadership and platoon collective activities as specified by Campshure (1990).

1. Both M-COFT and GUARD FIST I support training on most of the requirements for the preliminary, basic, and intermediate phases of gunnery training.

2. Although TopGun and VIGS support fewer activities than do M-COFT and GUARD FIST I, they can still potentially train a substantial portion of the requirements for preliminary, basic, and intermediate phases of training.

3. SIMNET supports training on some of the crew-level activities, but its benefits are primarily realized through its support of platoon-level gunnery activities.

To maximize the use of the training devices, other factors, in addition to whether the devices train the required skills, must be taken into consideration when assigning the devices to the different phases of training. One such factor is that some skills can be trained on only one device. In such cases, efforts must be made to ensure that the key device is allocated to train those skills during the appropriate phase. For example, only M-COFT supports engagements involving the tank commander's (TC's) caliber .50 machine gun; thus, time on the device should be reserved during the intermediate phase

to train those engagements. The device also simulates fire system control failures not simulated by any of the other devices. Likewise, only SIMNET is designed to train section- and platoon-level exercises; therefore, time should be allotted to the device to train the associated skills during the intermediate and advanced phases.

Another factor that should be considered is the availability of each of the training devices. For instance, devices fielded at the company-level (i.e., VIGS and GUARD FIST I) should be available on an almost unlimited basis and should therefore be used during all of the appropriate phases of training. In contrast, devices fielded at the battalion-level or higher (i.e., M-COFT and SIMNET<sup>4</sup>) should be available on a limited basis and hence should be used during the phases of training that best take advantage of the device's capabilities. The limited availability of these two devices has two implications for their use in the training strategy:

1. Based on the analysis of behaviors trained, M-COFT can be used during the preliminary, basic, and intermediate phases of gunnery training. However, because time on the device is limited, crews should concentrate M-COFT training on the skills trained during the basic and intermediate phases as opposed to the preliminary phase. The rationale underlying this strategy is that training for the preliminary phase can be accomplished more cheaply and efficiently on the tank by itself or on the tank augmented with GUARD FIST I. This conclusion is in accord with the suggestion in the Mobile Conduct-of-Fire Trainer Microstrategy, ST 17-12-7-2 (USAARMS, 1990b) that M-COFT not be used to train the prerequisite skills related to target acquisition, target identification, fire commands, reticle lay, tracking, lasing, and switch positioning. Instead, the M-COFT should be saved "...for intense engagement practice which melds a wide range of combat skills and attitudes" (p. 2-7).

2. Units should use SIMNET to acquire and to sustain skills trained during the intermediate and advanced phases, even though some of the crew-level skills trained during the preliminary and basic phases can be trained on the device. Specifically, the time available for SIMNET training should focus on its unique capability--that is, training section- and platoon-level exercises during the intermediate and advanced phases.

### Training Aid

Only one automated training aid (the HHT) was identified as being relevant to M1 gunnery training. Because training aids address gunnery knowledge rather than skill, Campshure (1990) did not evaluate the HHT with

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<sup>4</sup>Although there are plans to field a few mobile versions of SIMNET in RC units, it will remain primarily a research and development device. The follow-on device to SIMNET, the Mobile Close Combat Tactical Trainer (M-CCTT), is scheduled to be fielded in ARNG units in FY 1993-96 (DA, 1988b). Although the exact capabilities of M-CCTT are not known at this time, it has been described as an "enhanced SIMNET" (U.S. Army Armor School, 1990). For the present report, the M-CCTT is considered to be identical to SIMNET.

respect to the crew-level, platoon leadership, or platoon collective activities. Instead, he assessed the degree to which the HHT provided instruction on the knowledges identified by Morrison and Hoffman (1988) as prerequisites to gunnery performance. His analysis indicated that the HHT is beneficial for training on a small, but important subset of knowledges related to (a) TC fire commands, (b) crew verbal announcements, (c) precision gunnery techniques, (d) machine gun engagement techniques, and (e) degraded mode gunnery techniques.

Because the knowledges imparted by the HHT are prerequisite to the performance of their corresponding gunnery tasks, those knowledges must be acquired before those tasks can be practiced on the tank or the devices. Although armor crewmen should have received instruction on those knowledges prior to using the HHT, the HHT provides a means for ensuring that those knowledges have been acquired before actual skill training takes place. Consequently, use of the HHT is emphasized during preliminary level training to reinforce previously learned knowledges and impart new ones. On the other hand, knowledges covered by the HHT are associated with crew-level activities trained in the basic and intermediate phases as well. Thus, the training aid should also be used during the basic and intermediate phases of training to provide crewmen with additional instruction on the topics they failed to retain from self-study during the preliminary phase.

#### Summary of Device/Aid Assignments

Table 2 displays a summary of the training devices and aids that are appropriate to each of the four phases of gunnery training. The summary is based on the analyses of the devices to be used to train the activities associated with each of the four phases of training, the fact that some activities are supported by only a single device, and the anticipated availability of the devices. Note that most of the devices can be used in more than one phase, or (from the other perspective) that there are multiple training devices and aids appropriate to each phase of training. There are two reasons for this redundancy. One is that gunnery training devices and aids overlap in their training function (Morrison et al., 1990)--that is, they train many of the same skills. The other reason is that the performance requirements do not greatly differ from phase to phase, especially between those at the basic and intermediate phases (see the previous section, Identify/Organize Gunnery Training Objectives).

#### Allocate Training Time

The next problem in the design of a training strategy is to allocate time for using each of the devices and aids assigned for training. The most empirically valid approach to estimating device training time requirements is that pioneered by Roscoe and colleagues (e.g., Roscoe & Williges, 1980); their approach is based on the results from a transfer-of-training experiment. Because of the extreme data collection requirements of transfer experiments, training developers sometimes use expert opinion as a substitute for transfer data (e.g., Pfeiffer & Horey, 1988). In an attempt to make the collection of expert opinion more systematic and explicit, Fotouhi (1990) used a modified Delphi technique (Dalkey, 1969) to obtain consensus from a panel of eight experts who had significant experience with training devices and with training

Table 2

Summary of Applicability of Training Devices and Aids to the Phases of Gunnery Training

| Training Phase | Training Devices and Aids |      |        |                 |        |     |
|----------------|---------------------------|------|--------|-----------------|--------|-----|
|                | TopGun                    | VIGS | M-COFT | GUARD<br>FIST I | SIMNET | HHT |
| Preliminary    | X                         | X    |        | X               |        | X   |
| Basic          | X                         | X    | X      | X               |        | X   |
| Intermediate   | X                         | X    | X      | X               | X      | X   |
| Advanced       |                           |      |        |                 | X      |     |

Note. An "X" indicates a training device or aid is appropriate for training gunnery at the cross-referenced phase.

in the ARNG. The experts were asked to estimate the amount of time on training devices that soldiers would need to prepare for each of the gates in the gunnery training hierarchy. Despite high levels of interrater reliability across device/gate combinations ( $r = .88$ ), the experts showed substantial disagreement on individual allocations even at the end of the session. One source of disagreement was that experts were allowed to respond "not applicable" whenever they judged a device as not suitable for preparing soldiers for a particular gate. The result was that time estimates for some device/gate combinations were based on very few judgements. Furthermore, the averages of those estimates were unreasonably large, viewed in light of the constraints to training time in the ARNG.

#### Time Allocations from ST 17-12-7 and Research Literature

Because of the problems with the data presented by Fotouhi (1990), the present strategy views the allocations of training time provided in the Armor Training Strategy, ST 17-12-7 (USAARMS, 1990a) as the best estimates of these times until better data can be obtained. These estimates are summarized in Table 3. Note that Table 3 does not include time allocations for either TopGun or the HHT because neither are officially fielded training devices/aids. For these experimental technologies, the research literature reviewed by Morrison et al. (1990) can provide some guidelines for allocating training time.

For TopGun, the evidence reviewed by Morrison et al. (1990) suggested that skill acquisition and transfer occur relatively quickly: Bliss (1989) showed that acquisition of skill on homogeneous sets of TopGun engagements stabilizes quickly; Hart, Hagman, and Bowne (1990) presented findings suggesting that transfer from TopGun to M-COFT of skills related to stationary target engagements is virtually complete after a single 20-min session. However, Hart et al. failed to detect transfer of training for moving target

Table 3

Recommended Annual Usage of Training Devices and Aids as Provided by Armor Training Strategy, ST 17-12-7 (USAARMS, 1990a)

| Training Devices | Number of Sessions | Length of Sessions (in hrs) | Total Time (in hrs) |
|------------------|--------------------|-----------------------------|---------------------|
| VIGS             | 18                 | 1                           | 18                  |
| M-COFT           | 13                 | 2                           | 26                  |
| GUARD FIST I     | 13                 | 1                           | 13                  |
| SIMNET           | 4                  | 4                           | 16                  |

engagements within the 60 trials presented in their experiment. To estimate the training time required for moving engagements, they categorized TopGun engagements by target size (small, large), distance (close, far), speed (slow, fast), and direction (45, 90, and 180 degrees). This taxonomy yields 24 (2 X 2 X 2 X 3) different types of engagements, and assuming no transfer among engagement types, each should be trained for at least 10 trials, or about 20 mins apiece. According to the analysis by Hart et al., then, TopGun training time should total 240 trials or about 480 mins (8 hrs).

It should be noted, however, that the experiments by Bliss (1989) and Hart et al. (1990) employed the TopGun's formal mode of training wherein the engagements are prespecified and stored on diskette. Unfortunately, few of these formal training diskettes exist, and units are not likely to produce their own. Units would therefore be more apt to use TopGun only in the recreational mode wherein target engagement conditions are determined on a probabilistic basis. The present strategy assumes that only the recreational mode would be used by units. The extent to which the estimate of training time requirements provided by Hart et al. applies to the recreational mode is not clear. In lieu of more research, however, their estimates provide the best estimates of training time for TopGun.

Bridgeman and Fertner (1986) suggested that the "optimal" HHT training strategy is to have soldiers work 30-60 mins/day distributed over a 1- or 2-week period. Thus, the total training time recommended by the HHT developers could total as few as 2.5 hrs and as much as 10 hrs. Empirical data from the two experimental evaluations of the armor HHT can help to better pinpoint this requirement. Participants in the first session of Bridgeman and Fertner's evaluation were given approximately 5.5 hrs to finish the 27 instructional units on conduct of fire. In the second session, another group of soldiers were given less time (less than 3 hrs) to finish the same number of units. Performance gains in the second session were less than those in the first session suggesting that 3 hrs was not a sufficient allocation of time. In the second evaluation of the armor HHT (Shlechter 1990), soldiers took

approximately 2 hrs to finish the 13 units on multiple returns and degraded mode gunnery. Thus, an allocation of 8 hrs appears sufficient time to complete the initial study of all 40 HHT units. Morison et al. (1990) suggested that soldiers are likely to forget some of the material learned on the HHT, and would therefore benefit from reviewing the HHT after initial learning. Wells and Hagman's (1989) guidance for ARNG training is that relearning should require less than half the time that original learning takes--or, in the present case, about 4 hrs.

Given the total training time per device/aid and the applicability of the devices/aids to the training phases (Table 2), the next step is to distribute training time on each device/aid to each phase of training. The results of this process are presented in Table 4. The previous analysis shown in Table 1 indicated that the TopGun, VIGS, and SIMNET devices supported approximately the same percentage of activities among the training phases to which they were applicable. Accordingly, total time on these devices was distributed equally among these phases. On the other hand, this analysis showed that M-COFT was somewhat more applicable to the intermediate phase than to the basic phase; therefore, more time was allocated to the intermediate phase. Likewise, the analysis indicated that GUARD FIST I supports a smaller percentage of activities in the preliminary phase than in the basic or intermediate phases, therefore, less time was allocated to the preliminary phase. Finally, initial training on the HHT was allocated to the preliminary phase of training with less time allocated for review of the material in subsequent phases.

Table 4

Allocation of Device/Aid Training Time to Phase of Training

| Training Phase | Training Devices and Aids |        |        |              |        |        |
|----------------|---------------------------|--------|--------|--------------|--------|--------|
|                | TopGun                    | VIGS   | M-COFT | GUARD FIST I | SIMNET | HHT    |
| Preliminary    | 2.67 hrs                  | 6 hrs  | ---    | 3 hrs        | ---    | 8 hrs  |
| Basic          | 2.67 hrs                  | 6 hrs  | 12 hrs | 5 hrs        | ---    | 4 hrs  |
| Intermediate   | 2.67 hrs                  | 6 hrs  | 14 hrs | 5 hrs        | 8 hrs  | 4 hrs  |
| Advanced       | ---                       | ---    | ---    | ---          | 8 hrs  | ---    |
| Total          | 8 hrs                     | 18 hrs | 26 hrs | 13 hrs       | 16 hrs | 16 hrs |

#### Summary of Time Allocations

Table 4 concisely summarizes the training time that should be allocated to each of the devices. These allocations were based on estimates provided by gunnery training documents and on findings from the research literature. It should be noted that these allocations assume that individual soldiers, crews, and platoons are undergoing initial training on the devices. Considerably

less time should be needed to sustain the skills once they have been initially learned. The topic of sustainment training is discussed in the last section (Manage Training).

An alternative approach to allocating training time might have been to first specify appropriate lessons and exercises to be trained on the devices/aids, and then allocate time according to estimates of how long it would take to complete those lessons. However, as is discussed above, suggested training times already exist, and the proposed strategy ought to be consistent with them. Consequently, the approach taken was to start with these estimates, and then select exercises that would fit within the time allocations. The selection of training exercises is discussed in the next section.

### Specify Instructional Content

The next step in the development of the training strategy is to specify the instruction that should occur during the time allocated for each device/aid. In the present section, the content of this instructional strategy is defined by two types of exercises: those related primarily to training, and those related primarily to evaluation. The methods and results related to selecting these two types of exercises are discussed in the next two subsections.

#### Training Exercises

Training exercises were defined as sets of interrelated exercises that train skills appropriate to one of the four phases of training. The sets were specified by determining the initial level at which inexperienced crews should begin training, and the level of training that they should strive to attain by the end of training in that phase. The purpose of establishing goals for the level of training on a device was to provide trainers with a means for assessing the progress of individuals/crews prior to the end of a training phase. Two types of goals were established as appropriate: achievement and proficiency. According to Morrison et al. (1990), achievement refers to the progress that an individual or crew has made on a device, such as the highest exercise completed in the M-COFT or GUARD FIST I training matrices. In contrast, proficiency refers to performance on a test or exercise; it is often reported in the form of a score or rating.

The method for selecting training exercises was a heuristic process in that it was based on some general considerations rather than precise procedures. These considerations, presented in descending order of importance, are summarized as follows:

1. The behaviors trained in each phase. The exercises for a particular phase of training had to provide a reasonable match to the activities trained during that phase.

2. Time allocated for training on devices/aids. The training goals were set to be attainable within the time allocated for the device as specified in the previous section.

3. Intrinsic training strategies. The selected exercises were consistent with training strategies that are intrinsic parts of the devices/aid software or courseware. Examples of intrinsic training strategies are the training matrices followed in M-COFT and GUARD FIST I. These strategies were discussed in detail by Morrison et al. (1990).

4. Extrinsic training strategies. The selections were also consistent with the extrinsic gunnery training strategies that have been developed to integrate the use of training devices and aids. These strategies, described in the Introduction and Background, include the Armor Training Strategy, ST 17-12-7 (USAARMS, 1990a), the Mobile Conduct-of-Fire Trainer Microstrategy, ST 17-12-7-2 (USAARMS, 1990b), and the model strategy developed by Hoffman and Morrison (1988).

5. Progression in difficulty. Exercises chosen for later phases were more difficult than those chosen for earlier phases. Morrison and Holding (1990) cautioned against sequencing from easy to difficult without consideration of the inclusion principle wherein the difficult task includes all parts of the easier task. On the other hand, learning the easier task first permits the trainee to acquire appropriate methods of performance, or smaller error tolerances, that would be impossible to acquire by learning the more difficult task first. Consistent with educational practice, Morrison and Holding recommended the easy-to-difficult progression be followed provided the potential for direct inclusion is absent.

Not all of the these considerations were pertinent for each device/aid. The paragraphs that follow describe how the four factors influenced the choice of the initial level and the goals for training on the devices/aids for each of the four phases of training. As a general note to the method, the use of device-specific terminology could not be avoided in referring to the specific exercises that are recommended by the strategy. To the extent possible, the terminology is explained in the text. The results of this process are summarized in the first three rows of Figures 2-5.

Preliminary. Depending upon the proficiency of the crews in his unit, the company commander may mandate that his men take the TCGST without special preparation, or with one preliminary dry run through the stations. If the individuals perform satisfactorily on the TCGST, training should begin at the next (basic) phase. If the crews do not perform satisfactorily or if the commander feels that his men are not ready to take the TCGST, training begins at the present (preliminary) phase.

Because the preliminary phase defines the beginning of unit gunnery training, determining the starting point for training on the devices/aid for inexperienced individuals/crew was obvious--the initial exercise or level on each device/aid. This was not true for TopGun, which does not allow the user to choose specific exercises in recreation mode. However, the player can choose his level of play (Novice, Qualified, or Expert Skill Levels), which in turn determines the difficulty of target engagements. There are three stages in each game; upon completion of each stage, the player is given a performance rating of either Qualified or Unqualified. He can also alter the difficulty of the engagements by controlling two aspects of game play that can be

| Preliminary Training Phase   | Training Device/Aid                                  |                                                                                                                                                               |        |                                    |        |                                                                                                                               |
|------------------------------|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------------------------|--------|-------------------------------------------------------------------------------------------------------------------------------|
|                              | TopGun                                               | VIGS                                                                                                                                                          | M-COFT | GUARD FIST I                       | SIMNET | HHT                                                                                                                           |
| Frequency of use             | 8 20-min sessions.                                   | 6 1-hr sessions.                                                                                                                                              |        | 3 1-hr sessions.                   |        | Approximately 8 hrs of self-study.                                                                                            |
| Level of initial training    | Novice level in TC override mode, immortal own tank. | Lesson on engaging single, stationary main gun targets from a stationary tank.                                                                                |        | Exercise 1-1 in matrix.            |        | Unit 1 of the first booklet: <u>Conduct of Fire for the M1 Tank.</u>                                                          |
| Achievement/Proficiency goal | Qualifie status in Stage 3 of Novice Level.          | Rating of Superior or Distin guished on exercises for engaging single, stationary and moving main gun targets from a stationary tank using GPS, TIS, and GAS. |        | Complete the exercises in Group 2. |        | Complete all units of both the first and the second booklet: <u>M1 Degraded Mode Gun-nery and Multiple Return Strategies.</u> |
| Diagnostic                   | None.                                                | None.                                                                                                                                                         |        | None.                              |        | HHT post-test developed by Bridgeman & Fertner (1986).                                                                        |

Figure 2. Summary of strategy for using training devices/aids during the preliminary phase of training.

| Basic Training Phase         | Training Device/Aid                                  |                                                                                                                                         |                                                                              |                                                                                         |        |                                                                |
|------------------------------|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|--------|----------------------------------------------------------------|
|                              | TopGun                                               | VIGS                                                                                                                                    | M-COFT                                                                       | GUARD FIST I                                                                            | SIMNET | HHT                                                            |
| Frequency of use             | 8 20-min sessions.                                   | 6 1-hr sessions.                                                                                                                        | 6 2-hr sessions.                                                             | 5 1-hr sessions.                                                                        |        | Approximately 4 hrs.                                           |
| Level of initial training    | Qualified Level in TC command mode, mortal own tank. | Lesson on engaging single, moving main gun targets from a stationary tank using the GPS, TIS, & GAS.                                    | Exercise 32211 (Reticle Aim Level 8) in the TC/Gunner matrix.                | Exercise 3-1 in matrix, or continue from matrix position attained in Preliminary phase. |        | Start reviewing materials by taking HHT pre-tests.             |
| Achievement/Proficiency goal | Qualified status in Stage 3 of Qualified Level.      | Rating of Superior or Distinguished on exercises for engaging multiple, moving main gun targets from a moving tank using the TIS & GAS. | Complete Reticle Aim Group 3 (Reticle Aim Level 21) in the TC/Gunner matrix. | Complete the exercises in Group 4.                                                      |        | Complete review of required units.                             |
| Diagnostic                   | Same as proficiency goal.                            | Same as proficiency goal.                                                                                                               | Exercises 32233, 31421, 32323, & 34361.                                      | Exercises 3-1, 3-4, 3-6, & 4-2.                                                         |        | Paper-and-pencil test developed by Bridgeman & Fertner (1986). |

Figure 3. Summary of strategy for using training devices/aids during the basic phase of training.

| Intermediate Training Phase  | Training Device/Aid                               |                                                                                                                                                                            |                                                                                                                          |                                                                                   |                                                                              |                                                                |
|------------------------------|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------|----------------------------------------------------------------|
|                              | TopGun                                            | VIGS                                                                                                                                                                       | M-COFT                                                                                                                   | GUARD FIST I                                                                      | SIMNET                                                                       | HHT                                                            |
| Frequency of use             | 8 20-min sessions.                                | 6 1-hr sessions.                                                                                                                                                           | 7 2-hr sessions.                                                                                                         | 5 1-hr sessions.                                                                  | 2 4-hr sessions.                                                             | Approximately 4 hrs.                                           |
| Level of initial training    | Expert Level in TC command mode, mortar own tank. | Lesson on engaging multiple, moving main gun targets from a stationary & moving tank using the GPS.                                                                        | Exercise 32411 (Reticle Aim Level 22) in the TC/gunner matrix, or continue from matrix position attained in Basic phase. | Exercise 5-1 in matrix, or continue from matrix position attained in Basic phase. | Practice section movement, formations, and drills.                           | Start reviewing materials by taking HHT pre-tests.             |
| Achievement/Proficiency goal | Qualified status in Stage 3 of Expert Level.      | Rating of Superior or Distinguished on a exercises for engaging multiple, moving & stationary main gun & machine gun targets from a moving tank using the GPS, TIS, & GAS. | Complete Reticle Aim Group 5 (Reticle Aim Level 35) in the TC/gunner matrix.                                             | Complete the exercises in Group 6.                                                | Conduct a section-level reaction exercise to standards for Tactical Table F. | Complete review of required units.                             |
| Diagnostic                   | Same as proficiency goal.                         | Same as proficiency goal.                                                                                                                                                  | Test developed by Hoffman & Witmer (1989) which includes COFT exercises 34633, 34611, 34622, & 31563.                    | GUARD FIST I Exercises 5-2, 5-6, 6-3, 6-5, & 6-6.                                 | Same as proficiency goal.                                                    | Paper-and-pencil test developed by Bridgeman & Fertner (1986). |

Figure 4. Summary of strategy for using training devices/aids during the intermediate phase of training.

| Advanced Training Phase      | Training Device/Aid |      |                                                                               |                                                              |                                                                                                                     |     |
|------------------------------|---------------------|------|-------------------------------------------------------------------------------|--------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|-----|
|                              | TopGun              | VIGS | M-COFT                                                                        | GUARD FIST I                                                 | SIMNET                                                                                                              | HHT |
| Frequency of use             |                     |      | As needed, given device availability.                                         | As needed, given device availability.                        | 2 4-hr sessions.                                                                                                    |     |
| Level of initial training    |                     |      | Last position attained in the TC/Gunner matrix during the Intermediate phase. | Last matrix position attained during the Intermediate phase. | Practice wingman concept and platoon formations and drills.                                                         |     |
| Achievement/Proficiency goal |                     |      | Complete the TC/Gunner matrix and Certification.                              | Complete evaluation exercises for Group 6.                   | Conduct a platoon-level maneuver, which incorporates platoon reaction exercises, to standards for Tactical Table I. |     |
| Diagnostic                   |                     |      | None.                                                                         | None.                                                        | Same as proficiency goal.                                                                                           |     |

Figure 5. Summary of strategy for using training devices/aids during the advanced phase of training.

manipulated through the use of a field modifiable initiation parameter (FMIP). The first aspect is the TC mode, which can be set either to slew the player onto targets (TC override mode), to guide the player verbally onto targets (TC command mode), or to provide no guidance from the simulated TC (no TC mode). The second aspect is the mortality of the player's tank, which can be set to be either immortal (cannot be killed) or mortal (vulnerable to enemy fire). In the preliminary phase, the recommendation is to have the gunner start TopGun training at the Novice Skill Level with these aspects set to make gunnery easy: TC mode set to override and mortality of tank set to immortal.

The literature review by Morrison et al. (1990) uncovered no research on the prediction of live-fire performance from TopGun. Consequently, an acceptable criterion for performance on TopGun cannot be empirically derived. The only reasonable alternative is to use the TopGun system standards: Soldiers should attain a performance rating of "Qualified" in Stage 3 of the Novice skill level. This proficiency goal should easily be achieved within the 2.67 hrs (160 mins) allocated to TopGun training in this phase. It should be emphasized that the training time allocation is only a rough estimate of the time required to reach the training goal. If a soldier reaches the proficiency goal before 2.67 hrs, he should not continue training; rather, TopGun training should be reallocated to another soldier awaiting training. In their review, Morrison et al. (1990) also noted evidence for the adverse fatigue effects from massing training together in long sessions on Battlesight, a precursor to TopGun (Abel, 1986). To avoid these negative effects on training, it is recommended that TopGun training in this phase be divided into eight 20-min sessions.

Preliminary training on VIGS should begin with a lesson composed of the most basic gunnery conditions--single, stationary main gun targets engaged from a stationary tank during unlimited daylight. A specific VIGS exercise was not chosen as the starting point for VIGS training, because no complete list of all exercises stored on the VIGS videodiscs was available to us. On the other hand, trainers do not have to choose VIGS engagements by individual exercises. By following the directions provided in M1/M1A1, Tank Gunnery Videodisc Gunnery Simulator (VIGS), Device 17-142 (ECC International, 1988), trainers can generate lessons composed of specific types of exercises by stipulating the conditions desired. It is therefore recommended that the lesson-generating feature be used by trainers to create lessons that serve as the preliminary training on VIGS. The exercises selected for the final lesson (i.e., the goal) should match the key conditions for engagements in the TCGST--that is, single, stationary and moving main gun targets engaged from a stationary tank using the gunner's primary sight (GPS), the gunner's auxiliary sight (GAS), and the thermal imagery system (TIS). As was true with TopGun, there is no research on deriving an empirically based performance standard. Consequently, the VIGS system standard for proficiency is used: Gunners should earn a performance rating of "Superior" or "Distinguished" on the goal lesson to be considered proficient. This level of proficiency should be attainable in the six 1-hr sessions allocated to the VIGS.

Preliminary crew training on GUARD FIST I should begin with the first exercise in the GUARD FIST I matrix (Exercise 1-1). During this phase, crews should try to complete the exercises in Groups 1 and 2 of the GUARD FIST I matrix, whose engagements are similar to those conducted on the TCGST. The total run time of all GUARD FIST I training scenarios in these two groups is just over 20 mins. As described by Morrison et al. (1990), however, the GUARD

FIST I instructor/operator may present only a subset of those scenarios, and instead have the crew demonstrate proficiency on the appropriate evaluation exercises. Thus, given 3 hrs allocated to GUARD FIST I in this phase, the achievement goal of successfully completing Groups 1 and 2 should easily be attained.

Training with the HHT should be conducted on a self-study basis with individuals checking out and studying the training aid between weekend drills. Training should start with the first booklet entitled Conduct of Fire for the M1 Tank. The achievement goal for this training aid is to successfully complete the first booklet and a second booklet entitled M1 Degraded Mode Gunnery and Multiple Return Strategies within approximately 8 hrs. As described by Morrison et al. (1990), the HHT courseware presents pretests at the beginnings of each instructional unit. If the learner makes no errors on the unit pretest, the courseware sequences him to the next unit. If the learner makes at least one error, the HHT displays the correct response and sequences him to the explanation portion of the unit. Thus, if the soldier knows this material, he should complete the courseware in much less than the allocated time.

Basic. The array of skills trained on TopGun is limited by the fact that only a small number gunnery conditions are represented by the device. This means that the same skills are trained at each of the three phases of training supported by the device. As discussed earlier, one variable that can be altered is the level of play, which affects the difficulty for performance of those skills. Training during the basic phase on TopGun should begin at the Qualified Skill Level. To further increase the difficulty level of the engagements, the FMIPs should be changed to operate TopGun in the TC command mode and from a mortal tank. Using the TopGun system standard again, the proficiency goal for the device is the achievement of Qualified status in Stage 3 of the Qualified Skill Level. As in the previous phase, it is estimated that this can easily be achieved within eight 20-min sessions.

Gunners should start basic training on VIGS where they left off in the previous phase--with a lesson that features engaging single, moving main gun targets from a stationary tank using the GPS, TIS, and GAS. Note that the basic phase of training includes stationary as well as moving target engagements. However, research reviewed by Morrison et al. (1990) suggests that moving targets, although more difficult, include all the skills required to hit stationary targets (Hart et al., 1990; Graham & Smith, 1990). Therefore, according to the principle of inclusion (Morrison et al., 1990; Morrison & Holding, 1990), greater transfer should be obtained from moving to stationary targets than vice versa. Thus, VIGS training time would be better invested in training for moving targets. Basic lessons are more difficult than preliminary lessons in that they introduce multiple engagements, engagements from a moving tank, and the use of the GAS and TIS. Accordingly, the proficiency goal is for gunners to attain a rating of Superior or Distinguished on a lesson consisting of exercises that require the gunners to engage multiple, moving main gun targets from a moving tank using the GAS and TIS.

Basic training on M-COFT should begin with exercise 32211 (Reticle Aim Level 8) of the TC/gunner matrix, the initial exercise for TC/gunner pairs entering sustainment training on the device. From this starting point, they should progress through the TC/gunner matrix according to the instructional

strategy built into the device software. According to Morrison et al. (1990), the training goal for new or beginning TC/gunner pairs is to complete Reticle Group 2 (Reticle Aim Level 14). However, given the allocation of 12 hrs to M-COFT in this phase, TC/gunner pairs should be able to get beyond this level to complete Group 3 (Reticle Aim Level 21). That this more ambitious goal can be achieved is supported by guidance in the M1 Unit Conduct-of-Fire Trainer (U-COFT) Training Device Support Package, FC 17-12-7-1 (U.S. Army Armor Center, 1985). This document suggests that it should take TC/gunner pairs 30-40 hrs of U-COFT training to complete the 39 reticle aim levels in the TC/gunner matrix; in other words, they should progress at an average rate of one level per hr of training. Empirical support of this rate is provided by Campshure, Witmer, and Drucker (1989) who found that crews conducting transition training on U-COFT progressed through the TC/gunner matrix at approximately this rate. Ultimately, however, whether TC/gunner pairs can complete the 13 levels assigned to this phase (from Reticle Aim Level 8 to 21) in the 12 hrs allocated to M-COFT is a question for future research.

The starting point for GUARD FIST I training in the basic phase is Exercise 3-1 of the matrix, or the exercise following the last one completed during preliminary training. The achievement goal is to successfully complete the exercises in Group 4 of the matrix. The principle reason for selecting these particular exercises is their consistency with the intrinsic training strategy of GUARD FIST I (i.e., its training matrix). Although the total run time of all scenarios in Groups 3 and 4 is greater than the time in Groups 1 and 2 (approximately 40 mins vs. 20 mins), the training time allocated in this phase is also greater (5 hrs vs. 3 hrs). Consequently, it is anticipated that crews should be able to attain the training goal within the time allocated for GUARD FIST I.

In their previous literature review, Morrison et al. (1990) suggested that retention of the gunnery knowledges trained by the HHT would be increased by repeatedly reviewing the material. On the basis of this suggestion, all soldiers should review all HHT lessons originally learned in the preliminary phase. As described in the preliminary phase, instruction on the HHT is self-paced. Given the fact that they have previously learned the materials, the review of the HHT should be accomplished much faster than original learning. The estimated relearning time is approximately 4 hrs, but this allocation should be verified through systematic observation of ARNG soldier's actually using the training aid. Also, research should address whether or not repeated reviews of the material provide retention benefits that justify the additional time allocated to HHT training in the basic and intermediate phases.

Intermediate. To increase the difficulty of the engagements on TopGun, intermediate level training should start at the Expert Skill Level in the TC command mode with a mortal tank. The device goal for training at this level is for gunners to attain Qualified status in Stage 3 at the Expert Skill Level. As in the previous two phases, TopGun training in this phase is allocated eight 20-min training sessions. The proficiency goal may be difficult to achieve within the allotted time; however, only systematic observation can confirm whether or not this allocation needs to be increased.

VIGS training during the intermediate phase should begin with a lesson that features engaging multiple, moving main gun targets from a stationary and moving tank using the GPS. Again, this lesson duplicates many of the skills trained during the preceding phase. From this point, however, machine gun

engagements are added to the lessons to incorporate the activities corresponding to the intermediate phase. The VIGS goal for this phase is for gunners to attain a rating of Superior or Distinguished on lessons that require the gunners to engage multiple stationary and moving targets with the main gun and machine gun from a moving tank using the GPS, GAS, and TIS.

TC/gunner pairs should begin intermediate training on M-COFT with Exercise 32411 (Reticle Aim Level 22), or with the M-COFT exercise following the last one completed during basic training. The training goal for this phase is to complete Reticle Aim Group 5 (Reticle Aim Level 35). This goal is based on the device's instructional strategy and the 14 hrs allocated for M-COFT training during this phase.

On GUARD FIST I, intermediate training should start with Exercise 5-1, or with the exercise following the last one completed during the basic phase of training. During this phase, the goal for crews is to complete the exercises in Group 6 of the matrix. This progression is consistent with the GUARD FIST I matrix and the types of engagements represented in the intermediate combat tables. The total running time of all scenarios in Groups 5 and 6 is greater than that in Groups 3 and 4 (50 mins vs. 40 mins). Nevertheless, training on these two groups should easily be accomplished within the 5 hrs allocated to GUARD FIST I training in this phase.

Training on SIMNET starts at the intermediate phase. Crews should begin SIMNET training by practicing simple movement (e.g., move using wingman concept) as well as section formations and drills. As described by Morrison et al. (1990), SIMNET is unlike VIGS, M-COFT, and GUARD FIST I in that it does not contain structured exercises. Rather, trainers structure training on the device in the same manner they plan and structure on-tank training. This flexibility allows sections and platoons to conduct exercises on SIMNET much as they would on the range. Following the progression of section-level skills found in the intermediate tactical tables, crews should start by practicing section movement formations and techniques, then work toward conducting a section-level maneuver that incorporates the different section reaction exercises. The goal for intermediate level SIMNET training should be to conduct such a section-level maneuver to the standards published in Tank Combat Tables, FM 17-12-1 (DA, 1988b) for Tactical Table F.

Advanced. No formal training time is allocated for M-COFT and GUARD FIST I during the advanced phase. If crews have access to the devices, however, those that have not completed training on either device should work toward that goal.

Advanced training on SIMNET begins with crews rehearsing platoon formations and drills. Training from this point should follow the same progression as the platoon-level exercises in the advanced tactical tables. That is, training should start with exercises on platoon movement formations and techniques, progress to platoon drills, and finish with a platoon-level reaction exercise. The SIMNET goal for training at this phase is to conduct a platoon-level maneuver that incorporates the platoon reaction exercises, to the standards published in Tank Combat Tables, FM 17-12-1 (DA, 1988b) for Tactical Table I.

## Diagnostic Exercises

In addition to training exercises for the four phases of gunnery training, the content of training consists of diagnostic exercises for the appropriate devices/aids. There are two purposes for the diagnostic exercises: (a) to test the readiness of inexperienced individuals and crews to participate in initial on-tank training, and (b) to confirm the proficiency level of experienced individuals and crews in sustainment training. Thus, the diagnostic exercises serve a similar purpose as the gate tables for the on-tank exercises.

For the devices, the diagnostics took the form of exercises that were chosen to give the closest possible match to the gate table for each of the four training phases. Rather than selecting exercises that directly mirror the tasks in the gate tables, the strategy used in the present research was that described by Hoffman and Witmer (1989) wherein key conditions were matched. During the development of a U-COFT test of M1 gunnery proficiency, Hoffman and Witmer found that some of the tasks conducted during Gunnery Table VIII were not directly replicated by the U-COFT exercises. As an alternative method of selecting test items, they identified the key conditions (e.g., target arrays, ranges, visibility conditions, target and own tank movement) that define the tasks in Gunnery Table VIII and selected U-COFT exercises that matched these conditions. Using the list of gunnery conditions identified by Hoffman and Morrison (1988) and used by Campshure (1990) during the second phase of this research, that same procedure was followed to match device exercises and the gate tables for the four phases of training.

The purpose of matching the diagnostics to the gate tables was to identify exercises that have the potential to predict performance on the gate tables. Although the speculation that such exercises should correlate positively with actual on-tank performance is a reasonable hypothesis, it should be stressed that the predictive validity of these tests has not been empirically verified. In fact, Morrison et al.'s (1990) review of research on training devices indicated that device-based tests such as the ones proposed herein are typically not highly correlated with on-tank performance. There may be psychometric reasons for the lack of significant test-performance correlations--most notably unreliability of the device-based test or of the measures of actual performance. Alternatively, the problems may be due to subtle differences in the way certain behaviors are performed on a device and how they are performed on the tank. Regardless of whether the diagnostic exercises accurately predict on-tank performance, they nevertheless provide a means for assessing the device proficiency of an individual or crew on the conditions that compose the gate tables. Such information is important to the present strategy because it can be used to reallocate time on the device from those who are demonstrably proficient on the device or aid to those most in need of further device/aid training.

For TopGun, VIGS and SIMNET, the proficiency goals for the preliminary, basic, and intermediate phases of training serve as the diagnostic test. The gunnery proficiency test designed by Hoffman and Witmer (1989) based on Table VIII conditions was chosen as the M-COFT diagnostic for the intermediate phase. In three other cases, diagnostic exercises were selected from the M-COFT and GUARD FIST I training matrixes: (a) the GUARD FIST I diagnostic for the basic phase, based on Table IV conditions; (b) the M-COFT diagnostic for the basic phase, based on Table IV conditions; and (c) the GUARD FIST

diagnostic for the intermediate phase, based on Table VIII conditions. For these three missing cases, Hoffman and Witmer's (1989) method for selecting exercises was employed. Appendix C provides a description of the resulting matches between conditions in the gate tables and in the device exercises for those three cases. In some cases, conditions found in a gate exercise were not represented in the device exercise. To correct this, the test conditions of some of the device exercises were modified or augmented. For instance, to cover firing under nuclear, biological, and chemical (NBC) conditions as specified in Gunnery Tables IV and VIII, crews should be required to fire portions of some exercises wearing protective masks. These modifications to the device exercises are detailed in Appendix C. It should be noted however that, except for Hoffman and Witmer's work and the GUARD FIST I evaluation exercises, detailed test procedures for the diagnostics have not been specified; the development of test procedures was deemed outside of the scope of the present research. To actually use these tests in the training strategy, the test procedures should be specified in appropriate detail.

The diagnostic test for the HHT is a paper-and-pencil knowledge test developed by Bridgeman and Fertner (1986) for evaluating the effectiveness of the training aid. Like the device-based diagnostic exercises, this paper-and-pencil test serves two purposes: (a) to determine whether soldiers have acquired the knowledges covered by the HHT prior to conducting training on the devices or the tank, and (b) to confirm that soldiers in sustainment training have retained those knowledges. Because the HHT trains only a limited array of gunnery knowledges and not skills, the diagnostic tests are not matched to the gate tables. Rather, the items that compose the tests are meant to be a representative sample of the knowledges covered by the HHT's units of instruction.

The diagnostic exercises selected for use are summarized in bottom rows of Figures 2-5. Each is also described below according to the phase of training during which it is to be administered.

Preliminary. The tasks conducted during the TCGST are not resource intensive and are designed to be trained and tested on the tank. In addition, relatively few of the TCGST tasks are supported by the devices. As a result, no device-based diagnostics are recommended. For the HHT, the paper-and-pencil knowledge test developed by Bridgeman and Fertner (1986) should serve as the diagnostic.

Basic. On TopGun and VIGS, the goals for gunners during the basic phase of training are in essence tests of proficiency. As such, the proficiency goal for TopGun (i.e., Qualified status in Stage 3 of the Qualified skill level) and VIGS (i.e., a Superior or Distinguished rating on a lesson representative of the skills trained during the phase) should be used as diagnostic tests.

For M-COFT and GUARD FIST I, Hoffman and Witmer's (1989) procedure was used to select exercises on each device that matched the conditions found in the tasks conducted during Gunnery Table IV. The resulting exercises selected for M-COFT were 32233, 31421, 32323, and 34351. On GUARD FIST I Exercises 3-1, 3-4, 3-6, and 4-2 were chosen to comprise the diagnostic test.

The paper-and-pencil test on the HHT should be used to determine if knowledges not previously learned have been acquired and to confirm that those knowledges acquired earlier have been retained.

Intermediate. As in the basic phase, the goals for gunners on TopGun (i.e., Qualified status in Stage 3 of the Expert skill level) and VIGS (i.e., a Superior or Distinguished rating on a lesson representative of the skills trained during the phase) at the intermediate phase of training are in themselves tests of proficiency and should be used as diagnostic tests. Likewise, the goal on SIMNET (i.e., conduct a section-level maneuver to standards) is a measure of proficiency and should be used as the diagnostic for the device at the intermediate phase.

The U-COFT test of gunnery proficiency developed by Hoffman and Witmer (1989) was selected as the M-COFT diagnostic exercise for this phase of training because it matches the conditions found in Gunnery Table VIII.<sup>5</sup> The exercises chosen by Hoffman and Witmer for their test were 34633, 34611, 34622, and 31563. Using the same procedure, GUARD FIST I Exercises 5-2, 5-6, 6-3, 6-5, and 6-6 were selected for their match of Gunnery Table VIII conditions.

A parallel version of the HHT diagnostic test should be used to determine if knowledges not previously learned have been acquired and to confirm that those knowledges acquired earlier have been retained.

Advanced. SIMNET is the only device or aid recommended for use during the advanced phase. Consequently, no diagnostic tests were selected for TopGun, VIGS, M-COFT, GUARD FIST I, or the HHT. As during the intermediate phase, the SIMNET goal for this phase of training (i.e., conduct a platoon-level exercise to standards) serves as proficiency goal on the device and should also be used as the device diagnostic.

### Summary of Instructional Content

The instructional content of the training was determined by specifying training goals and describing diagnostic exercises. The training goals were defined by sets of interrelated exercises that individuals or crews should strive to complete during a particular phase of training. The purposes of the device-based diagnostic exercises were to determine (a) whether individuals, crews, or platoons were ready to participate in initial on-tank training or (b) whether they were acceptably proficient at some given level of training. This content, which is summarized in Figures 2-5, provides the "blueprint" for the strategy for training tank gunnery in the ARNG. The procedures for implementing the strategy within an ARNG unit are discussed in the next section.

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<sup>5</sup>Special COFT exercises have been designed specifically to mimic Gunnery Tables VII and VIII that are called UT-7 and UT-8, respectively. These exercises are used exclusively by the U.S. Army Armor School, and there are no plans to make them available to either AC or RC units.

## Manage Training

For an ARNG unit, a complete cycle of gunnery training is accomplished in about 1 year. However, the particular combat tables that are fired and the frequency with which they are fired varies as a function of whether the ARNG unit is training in a gunnery year or maneuver year, which alternate annually. As shown in Table 5, there are two major differences between a gunnery and a maneuver year as prescribed by the STRAC guidelines (DA, 1988a). The first difference is that the basic gunnery and tactical tables are executed twice during the gunnery year, whereas these same tables are fired only once during the maneuver year. The second difference is that Tables VI and VIII are not fired at all during the maneuver year; instead units fire a Telfare (subcaliber) version of Table VII in preparation for the live-fire version of Table VII. Despite these differences in the details of on-tank training during gunnery and maneuver years, the overall structure and sequence of gunnery training does not significantly differ between the two types of training years. Training in both gunnery and maneuver years comprise basic, intermediate and advanced combat tables; consequently, the corresponding device/aid-based training would not change.

Table 5

Frequency that ARNG Units Are Required to Perform Combat Tables  
According to Standards in Weapons Training, Pamphlet 350-38 (DA, 1988)

| Combat Tables          | Training Year |          |
|------------------------|---------------|----------|
|                        | Gunnery       | Maneuver |
| <b>Gunnery Tables</b>  |               |          |
| III                    | 2             | 1        |
| IV                     | 2             | 1        |
| V                      | 2             | 1        |
| VI                     | 1             | -        |
| VII (Telfare)          | -             | 1        |
| VII (Live-fire)        | 1             | 1        |
| VIII                   | 1             | -        |
| <b>Tactical Tables</b> |               |          |
| A-C                    | 2             | 1        |
| D-F                    | 1             | 1        |
| G-I                    | 1             | 1        |

Drucker's (1990) review of gunnery training in the IDARNG revealed that gunnery training competes with requirements for training skills unrelated to gunnery (e.g., training on individual weapons) and nontraining events (e.g., command inspections) for the limited duty time available to ARNG soldiers. Given the importance of gunnery training to ARNG armor units, Drucker concluded that gunnery training must be efficient so that training devices and aids are used effectively and time is not wasted. To make gunnery training efficient, an overall approach to training management must be developed to integrate the individual components of the training strategy. In the present

section, management concerns are discussed with respect to three issues: (a) the sequence of initial and sustainment training events, (b) important features of the training strategy that must be understood by training managers, and (c) potential problems in implementing the strategy and solutions to those problems.

### Sequence of Training Events

The appropriate sequence for gunnery training varies as a function of whether soldiers/crews are undergoing initial training or sustainment training. We define initial training as training that is appropriate for crews that have not been together for a complete gunnery cycle. Crews of this type would include those crews that have one or two crewmen who recently qualified for their job positions, experienced crews that have recently transitioned to a newer tank, or new crews that have been reconstituted from old ones.<sup>6</sup> In contrast, we define sustainment training as that which is appropriate for crews that have trained together for at least one gunnery training cycle culminating in crew qualification on Gunnery Table VIII and platoon qualification on Tactical Table I. Thus, device/aid-based training for crews in sustainment training is essentially the relearning of gunnery skills and knowledges. The general sequence of training for initial and sustainment training are described in the following sections.

Initial training. As shown in Figure 6, the strategy for initial training should follow the recommended sequence for starting at either the preliminary or basic phase, progressing through the intermediate phase, and finishing at the advanced phase of gunnery training. Note that for each of the four phases, the proposed strategy calls for soldiers/crews to be trained on devices and aids prior to training on the tank. No diagnostics were recommended for the preliminary phase of training. For the other phases, however, the strategy calls for each soldier/crew/platoon to take the diagnostic after completing its training goal on the devices/aids, but before on-tank training. If it fails the diagnostic test, the proposed strategy calls for remedial training on the devices/aids that is tailored to its weaknesses. As discussed in the previous section (Determine Instructional Content), the predictive relationship between the diagnostic test and on-tank performance is less than perfect; therefore, there exists the possibility of incorrectly deciding, on the basis of the diagnostic, that a soldier, crew, or platoon is ready for on-tank training. To reduce the probability of making such an error, trainers may require soldiers/crews/platoons to pass either

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<sup>6</sup>The reconstituted crews present somewhat of a problem in that, although the crew members have no experience together, they may have had substantial gunnery training in their previous crews. The Mobile Conduct-of-Fire Trainer Microstrategy, ST 17-12-7-2 (USAARMS, 1990b) provides some guidance for the situation where reconstituted crews have had previous experience with the M-COFT. This document provides different matrix entry points for the situations where (a) the TC has M-COFT experience, but the gunner does not; (b) the gunner has M-COFT experience, but the TC does not; and (c) both TC and gunner have M-COFT experience, but not together. Unfortunately, the other devices have no such strategy; therefore, the present strategy recommends that, for all other training devices, reconstituted crews be treated as those undergoing initial training.

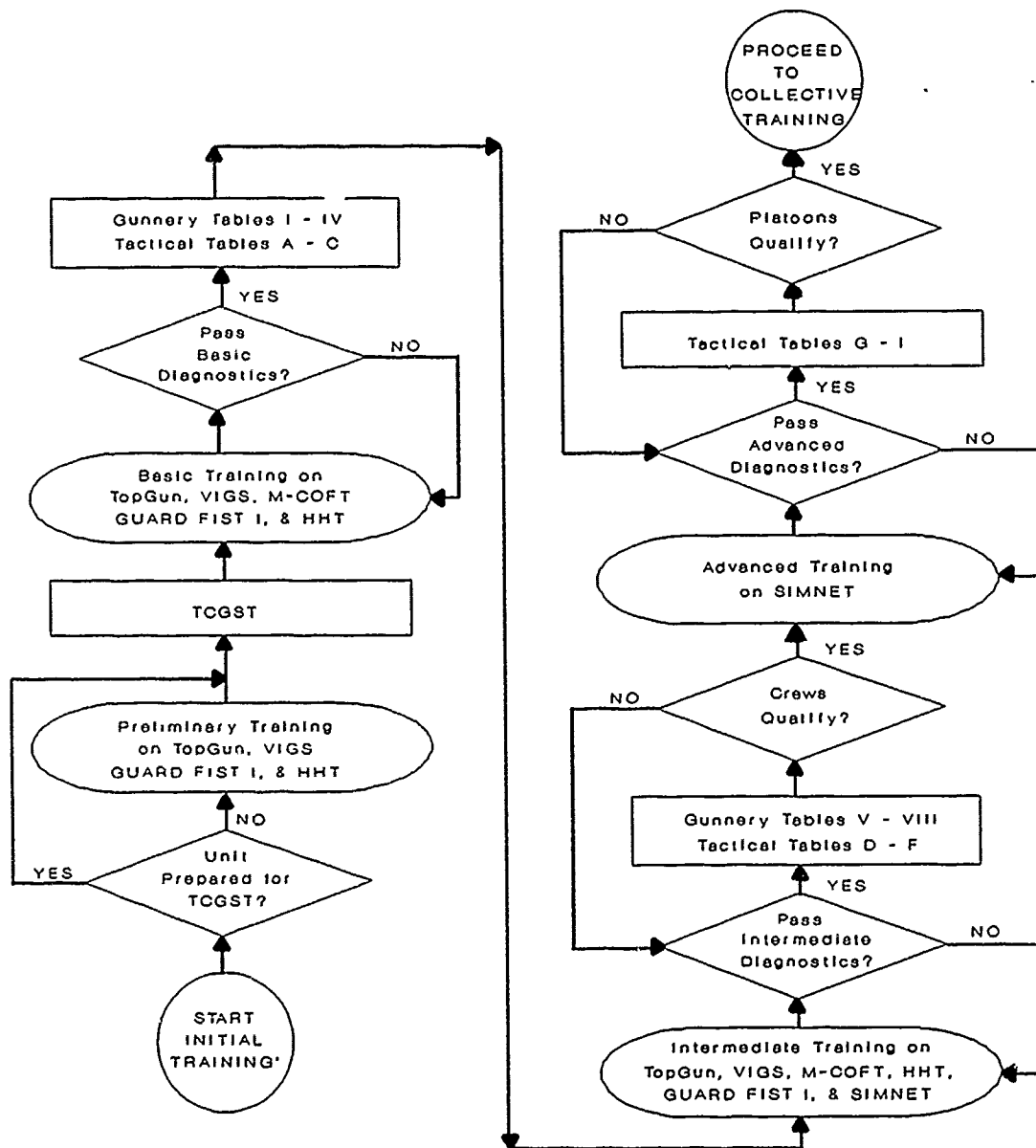


Figure 6. Sequence of initial training events. (Rectangles represent on-tank training events, ovals depict training on devices and aids, and diamonds refer to outcomes of evaluations.)

multiple diagnostic tests on a single device/aid, or (if a unit has multiple devices) to pass one diagnostic test for each of the training devices and aids. Requiring soldiers/crews to pass multiple tests would make the diagnostics more difficult in that they would be less likely to pass all tests than to pass just one test. Increasing test difficulty in this manner also increases the probability of the other type of error--that is, denying on-tank training to soldiers/crews/platoons that are truly ready for that training. Nevertheless, the consequences of the former error (i.e., excessive training on devices and aids) seems less costly than the consequences of the latter (i.e., ineffective or even unsafe training on the tank).

Following the sequence shown in Figure 6, the first decision point is the commander's subjective evaluation of the unit's level of preparedness for the TCGST. As discussed earlier, if he deems the unit to be ready, it may bypass training at the preliminary level and start gunnery training by taking the TCGST immediately. In accordance with standard practice, training on the TCGST continues until all soldiers have passed the evaluation. After the TCGST, the basic phase starts with training on four of the devices: TopGun, VIGS, M-COFT, and GUARD FIST I. Given that soldiers/crews pass appropriate diagnostics, they proceed to the basic tables (Gunnery Tables I-IV and Tactical Tables A-C). As in the TCGST, on-tank training continues until all soldiers/crews pass the gate tables (Gunnery Table IV and Tactical Table C). For the intermediate and advanced combat tables that employ live-fire ranges, crews and/or platoons may be allowed only one or two attempts to qualify at the gate tables (Gunnery Table VIII and Tactical Table I) because of constrained schedules of MTA ranges. As a result, not all crews and/or platoons would necessarily qualify in a single IDT weekend or AT period, and appropriate retesting must be scheduled for a subsequent IDT weekend. For the crews/platoons that fail to qualify, the strategy recommends that they retake the diagnostics to determine whether or not further device/aid-based training is needed before retesting on the qualification tables. If it fails the diagnostic(s), the crew/platoon should receive remedial training that is appropriate to its weaknesses. If, on the other hand, it passes the diagnostic(s), its performance would suggest that the crew/platoon is deficient on skills that are peculiar to on-tank performance. In the latter case, remedial training should be conducted on the tank.

Sustainment training. As discussed in the context of allocating training time, relearning should take roughly half the time of initial training. The exact time requirements for sustainment training depend upon many factors, the principle ones being the level of learning reached during initial training and how long it has been since the last training session (e.g., Hagman & Rose, 1983). Such factors contribute to large individual differences in sustainment training needs. As a result, the sustainment strategy should be tailored to the proficiency level of the soldiers, crews, or platoons. The trainer should use the time saved from not having to train those who are highly proficient to concentrate training on those needing more time.

In contrast to the initial training strategy which starts at the bottom and proceeds up the learning hierarchy, the sustainment strategy (Figure 7) starts with a diagnostic test at the intermediate level and proceeds down to determine whether to start retraining at the intermediate or basic phase. If the crew passes the intermediate diagnostic, it is confirmed proficient on the devices and aid at the crew level. If the crew fails the intermediate

diagnostic, it then takes the basic diagnostic. If it fails the basic diagnostic, training begins at the basic level; if it passes the basic diagnostic, training starts at the intermediate level. From either point, the soldiers/crews work up the hierarchy until they are confirmed proficient at the crew level.

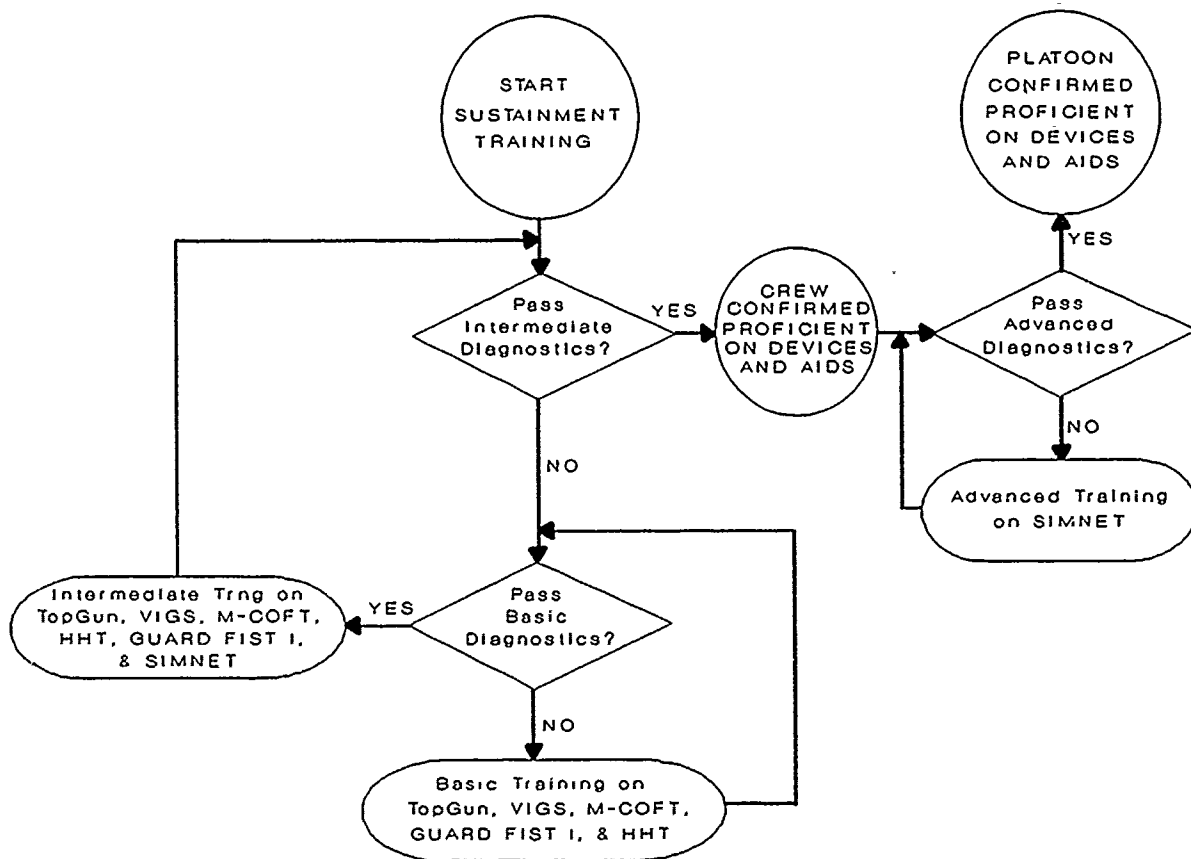


Figure 7. Sequence of sustainment training events. (Rectangles, represent on-tank training events, ovals depict training on devices and aids, and diamonds refer to outcomes of evaluations.)

Strictly speaking, the strategy does not begin at the top of the hierarchy--that is, sustainment training does not begin with the diagnostic for the advanced level. The reasoning is that, as shown in the previous analyses in Appendix A, the behaviors trained in the advanced phase (platoon leadership and collective activities) are qualitatively different than those trained in the intermediate and basic phases (crew activities). As shown in Figure 7, crews must complete training at the intermediate level prior to conducting the advanced platoon-level diagnostic. In other words, proficiency must be confirmed at both the crew and platoon levels. For crews/platoons that are confirmed proficient at both the intermediate and advanced phases, no further sustainment training is required. To provide a check on the possible degradation in gunnery skills, however, crews should confirm their proficiency at least twice yearly.

#### Important Features of the Training Strategy

As presented in the present report, the proposed gunnery training strategy consists of multiple components. Unfortunately, there are many

factors that may outdate or invalidate certain components of the strategy. For instance, training doctrine is in a constant state of flux, possibly resulting in changes to the on-tank training objectives or to their organization. Another factor is the evolution of training technology, realized as new aids and devices or as upgrades of existing technologies. Finally, training research and development methods that provide the basis for the training strategy are subject to constant revision and refinement. As a consequence, acceptance or rejection of the strategy should not be made on an all-or-nothing basis; rather, the user should examine each component separately to evaluate its relevance to his training situation. One reason for describing the rationale for each component in detail is to allow the user to understand and modify the component as required. However, in changing the details of the strategy, it is important to retain certain important features of the strategy that are central to its logic. These features and their effects on skill acquisition, retention, and transfer are summarized below.

Primacy of on-tank training. Much time is lost taking soldiers to and from appropriate training sites for training on the tank, whereas training with devices and aids permits the training to be brought to the soldier (NGB, 1990). On the other hand, most armor trainers feel that the demanding, realistic practice experiences that can only be obtained on the tank are essential to gunnery training. As a result, training managers spend much time and effort planning for and scheduling on-tank training. Because of the constraints to on-tank training as well as its perceived training value, the present strategy assumes that managers will first plan for on-tank training and then derive appropriate device/aid-based training that supports the planned on-tank training. This approach introduces a lock-step aspect to device/aid-based training in that device/aid-based training is selected to support on-tank exercises that must be scheduled on a unit-wide basis. This lock-step aspect to the strategy somewhat limits the capability of devices and aids to permit soldiers to learn at their own pace, an oft-cited benefit of computer-based technologies. However, the disadvantages of lock-step training are more than offset by the advantage of ensuring that training on devices and aids is consistent with and supportive of training on the tank. This congruence is necessary for obtaining transfer of skills and knowledges from devices and aids to performance on the tank.

Use of diagnostic testing. The use of diagnostic tests promotes efficiencies in both initial and sustainment training. In initial training, the diagnostics ensure that soldiers are sufficiently prepared on skills and knowledges learned on devices so that training time on the tank is not wasted. In this sense, then, the diagnostics function as device/aid-based gates in training. In sustainment training, diagnostic testing is used to identify the appropriate level for training. This approach avoids inefficiencies caused by having soldiers train above or below their current level of proficiency. By avoiding such inefficiencies in training, the diagnostic tests directly affect the rate of skill acquisition and indirectly affect skill transfer and retention.

Exploitation of multiple devices. In the previous device-based gunnery training strategy devised by Hoffman and Morrison (1988), the researchers contended that the overlap in the functions of gunnery training devices should be exploited to provide multiple experiences on gunnery training objectives in increasingly realistic contexts. Later, Morrison and Holding (1990) speculated that alternating between devices whose fidelity to the actual

equipment is less than perfect can potentially increase transfer effects. Morrison and Holding argued that, if the departures from fidelity in the devices are somewhat complementary, the process of alternating between devices should permit the armor crewman to build a better cognitive model of the target skill. The use of multiple devices is consistent with empirical findings that transfer is enhanced when tasks are practiced under a variety of conditions (e.g., Wells & Hagman, 1989). This notion is also consistent with Schmidt's (1975) theoretical argument that one of the essential conditions for the development of schemata, his hypothetical mechanism underlying transfer, is variability in the conditions of training.

Although the use of multiple devices may theoretically enhance transfer, this aspect of the gunnery training strategy conflicts with the Armor School's goals for their device-based training strategy. The Mobile Conduct-of-Fire Trainer Microstrategy, ST 17-12-7-2 (USAARMS, 1990b) explicitly states that one goal of its strategy is to reduce the number of devices (p. A-2). The primary benefit of reducing the number of devices is to decrease the support required to operate and maintain technologies that are functionally similar. To resolve this conflict, research is needed to measure the transfer benefits of training on multiple devices. Only then can training managers determine whether the transfer advantages of multiple devices outweigh the increased logistical costs.

Alternation of device/aid-based and on-tank training. In their discussion of gunnery training, Morrison and Holding (1990) argued that the training designer should not assume the traditional approach of completing all training on a device prior to transferring to actual equipment. Rather, they hypothesized that training with the actual equipment first may provide the armor crewman a better model of terminal performance, which in turn results in enhanced subsequent learning on the device. Thus, enhanced transfer may be obtained by alternating between training on devices/aids and training on the tank. Such alternation occurs between the phases of the present strategy. Perhaps this is most clearly illustrated for the basic and intermediate phases of gunnery training. Soldiers/crews start with basic training on the devices and aids and then proceed to on-tank training on Gunnery Tables I-IV and Tactical Tables A-C. They then go back to training on devices and aids for intermediate training, and then proceed to on-tank training for Gunnery Tables V-VIII and Tactical Tables D-F. This sort of alternation should enhance the transfer between devices/aids and on-tank performance. For the full transfer potential of alternation to be realized, however, training on devices and aids must address the same objectives as those being trained on the tank.

Repeated practice experiences. Two aspects of the strategy ensure that soldiers receive repeated practice experiences on objectives. This repetition should enhance the retention of gunnery skills and knowledges. First, training on the HHT is programmed to provide repeated practice on the material contained in the training aid. Second, many of the same or similar gunnery engagements are repeated in the basic and intermediate phases of training. The repetition of gunnery engagements results from the similarity between the basic and intermediate gunnery objectives rather than from systematic design. Regardless of the reason for the repetition, the repeated practice should have a positive effect on retention of gunnery skills.

## Problems in Implementing the Strategy

As described above, the training strategy was designed to have positive effects on skill acquisition, retention, and transfer. The training strategy also raises some problems related to its implementation. Some of these problems are discussed below along with some proposed solutions.

Lack of access to devices. The strategy assumes that units have access to all devices, a condition not likely to be met in most ARNG armor units. Access to SIMNET continues to be limited to ARNG units near the permanent SIMNET sites, and the contract for the follow-on system that will be fielded to the ARNG (the M-CCTT) has not been let. Limited numbers of the other two research devices/aids, TopGun and HHT, restrict the availability of those technologies for ARNG training. Even with regard to "official" devices, GUARD FIST I is still in prototype form, and the fielding for M-COFT has only started. Fortunately, the built-in overlap of devices and aids should allow the trainer to substitute for those devices to which they may not have access. For instance, Campshure (1990) described VIGS capabilities as being similar to TopGun, allowing VIGS to substitute for the less available TopGun. Similarly, GUARD FIST I's capabilities are similar to M-COFT, allowing them to be substituted for one another.

Allocation of training time. There are two problems in the allocation of training time. The first is whether the proposed strategy allocates too much or too little time to attain the training goals of the strategy. This is an empirical question that should be answered by systematic observation of ARNG gunnery training. Even if the allocations were reasonable in terms of training goals, there remains the pragmatic question of whether the allocated times can be fit into tight ARNG training schedules. For instance, Drucker (1990) discussed a problem in the allocation of training time on M-COFT: It is impossible to provide the recommended 2 hrs of training to all 14 crews in a company during a single IDT weekend. As discussed above, effective use of diagnostics may reduce the time required to train on devices and aids given that units are undergoing sustainment training. There are other possible methods for reducing or alleviating the training time requirements of the devices and aids:

1. Split assemblies. For key resources where access is limited, such as the M-COFT, units may need to use split assemblies to ensure that all soldiers get trained. Split assemblies allow the trainer to divide unit personnel into two or more groups for training on separate weekends. This solution, however, presents some of its own problems. Drucker (1990) noted that spreading M-COFT training over different weekends in one company may limit the availability of M-COFT for other units. Split assemblies also demand that full-time unit trainers be present at additional times. Finally, split assemblies cause scheduling problems in that the split assemblies must be scheduled to be completed *before* the scheduled IDT weekend.

2. Concurrent training. With some forethought by unit training managers, device/aid training can be scheduled to run concurrently. For instance, while TC/gunner pairs are being trained on M-COFT, the drivers and loaders can be crosstrained on gunner skills using either the TopGun or the VIGS.

3. Cooperative learning. If the number of HHTs is limited, training can be structured in small groups. As reviewed in Morrison et al. (1990), Shlechter's (1990) results suggest that cooperative learning on the HHT for groups of up to 3 soldiers is "instructionally efficient": soldiers complete units more quickly with no apparent losses in knowledge. However, cooperative learning environments can sometimes have a negative impact on individual performance. Wells and Hagman (1989) identified two conditions that they put forth as being necessary for effective cooperative learning: (a) that each group member be accountable for his own performance, and (b) that rewards be apportioned on the basis of group performance.

Sequencing among devices. There appears to be a "natural" sequence to the gunnery training devices: start with individual gunner training on either TopGun or VIGS, incorporate the tank commander with M-COFT, and then go to full-crew training on GUARD FIST I. Although intuitively appealing, there is no empirical evidence that certain device sequences lead to better transfer of training. Furthermore, strict sequential rules among the devices would lead to self-defeating restrictions in scheduling. For instance, if TopGun, VIGS, and M-COFT were available for training, the best use of time would be to have two crewmembers train on the gunner trainers and the other two train on M-COFT as a TC/gunner pair. To use training time efficiently, the crewmembers should simply switch devices at the end of the training session without regard to which was used first. To avoid restricting the training manager's scheduling, the present strategy does not prescribe required sequencing among the devices.

Differences in rates of learning. Perhaps the most important feature of the proposed strategy is that training on devices is designed to be congruent with field training. This implies that all soldiers and crews train to approximately the same level of proficiency on the devices and aids. Clearly, crews will differ with respect to the rate with which they progress in training on the devices and aids. The faster individuals and crews should be encouraged to train beyond the immediate training goals of the unit if possible. However, the greatest priority in allocating device/aids training time should be given to soldiers/crews who lag behind the unit's current phase of training. To the extent possible, they should try to catch up using the training strategy that is inherent to the device, but at an accelerated rate.

#### Summary of Training Management

Training management issues were discussed to describe how the individual components of the training strategy are integrated. One such issue was the sequence of training. For the present strategy, there were important differences between the sequencing of initial and sustainment training. Another set of issues concerned the key features of the instructional strategy, and their effects on skill acquisition, sustainment, and transfer. These key features must be borne in mind when implementing the strategy. Similarly, some implementation problems introduced by the strategy were discussed along with some potential solutions to the problems. To provide a concrete example of how the training strategy might be implemented, Appendix D provides an example of a year-long training schedule for an ARNG company. This schedule shows how device training might be sequenced in relation to field training and to the gate tables. The sample schedule also shows how the major features of the strategy might be implemented including (a) the use of diagnostic testing, (b) the assignment of devices to different phases of

gunnery training, (c) the allocation of training time to the devices, and  
(d) the management of crews at different levels of proficiency.

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Appendix A

Performance Requirements of Tank Combat Tables

| Crew-level Activity/Option           | Tank Crew Gunnery Skills Test (TCGST) |
|--------------------------------------|---------------------------------------|
| 1. Prepare stations for operations   | 10                                    |
| 2. Perform prepare-to-fire checks    | 6                                     |
| 3. Acquire targets                   |                                       |
| 3.1.1. Search open hatch - day       |                                       |
| 3.1.2. Search closed hatch - day     |                                       |
| 3.1.3. Search at night               | 11                                    |
| 3.2. Detect/Locate/Identify targets  | 1                                     |
| 3.3. Evaluate situation              | 14                                    |
| 4. Engage single target w/ main gun  |                                       |
| 4.1. Offense - precision gunnery     |                                       |
| 4.2. Defense - precision gunnery     | 12                                    |
| 4.3. GNR cannot ID announced target  |                                       |
| 4.4. Engage target using TIS         |                                       |
| 5. Adjust fire                       |                                       |
| 5.1. Reengage technique              |                                       |
| 5.2. GNRs standard adjustment        |                                       |
| 5.3. TCs standard adjustment         |                                       |
| 6. Engage single target w/ coax      |                                       |
| 7. Engage multiple tgts w/ main gun  |                                       |
| 8. Engage targets w/ the cal .50     |                                       |
| 8.1. Simultaneous targets            |                                       |
| 8.2. Cal .50 targets                 |                                       |
| 9. Engage target - degraded modes    |                                       |
| 9.1. Using battlesight gunnery       | 12                                    |
| 9.2. Given LRF failure               |                                       |
| 9.3. Given multiple LRF returns      |                                       |
| 9.4. Given loss of symbology         |                                       |
| 9.5. Given crosswind sensor failure  |                                       |
| 9.6. Given cant sensor failure       |                                       |
| 9.7. Given lead angle sensor failure |                                       |
| 9.8. Given GPS failure               |                                       |
| 9.9. Given GPS/TIS failure           |                                       |
| 9.10. Using GAS                      | 12                                    |
| 9.11. In emergency mode              |                                       |
| 9.12. In manual mode                 |                                       |
| 10. Engage targets from TC position  | 15                                    |
| 11. Assess results of engagement     |                                       |
| 12. Engage target using LDRs M240    |                                       |
| 13. Immediate action misfire         | 9                                     |
| 14. Employ smoke                     |                                       |
| 14.1. Using smoke grenade launcher   |                                       |
| 14.2. Using vehicle exhaust smoke    |                                       |
| 15. Submit reports                   |                                       |

Figure A-1. Relationship of the Tank Gunnery Skills Test (TCGST) to crew-level activities. The numbers in the body of the matrix refer to specific stations (tasks) within the test.

| Crew-level Activity/Option           | Table I                        | Table II           | Table III                          | Table IV       |
|--------------------------------------|--------------------------------|--------------------|------------------------------------|----------------|
| 1. Prepare stations for operations   |                                |                    |                                    |                |
| 2. Perform prepare-to-fire checks    |                                |                    |                                    |                |
| 3. Acquire targets                   |                                |                    |                                    |                |
| 3.1.1 Search open hatch - day        | A1-5                           | A1-7, A9, A10      | A1-3, A5-10                        | A2, A3, A4, A5 |
| 3.1.2. Search closed hatch - day     |                                | A8                 | A4                                 | A1             |
| 3.1.3. Search at night               | B1, B2, B3                     | B1-8               | B1-10                              | B1-5           |
| 3.2. Detect/Locate/Identify targets  | A1-6, B1-3                     | A1-10, B1-8        | A1-10, B1-10                       | A1-5, B1-5     |
| 3.3. Evaluate situation              |                                | A1-10, B1-10       | A1-10, B1-10                       | A1-5, B1-5     |
| 4. Engage single target w/ main gun  |                                |                    |                                    |                |
| 4.1. Offense - precision gunnery     | A7**, A8**                     |                    | A3, A5                             | A4, B2         |
| 4.2. Defense - precision gunnery     | A5, A6, A7**, A8**             | A2, A3, B4         | A1                                 |                |
| 4.3 GNR cannot ID announced target   |                                | A11*               | A11*                               | A11*           |
| 4.4. Engage target using TIS         |                                | B1, B3, B5, B7, B8 | B3, B4                             | B1, B3, B4, B5 |
| 5. Adjust fire                       |                                |                    |                                    |                |
| 5.1. Reengage technique              |                                | A11*               | A11*                               | A11*           |
| 5.2. GNRs standard adjustment        | A6                             | A11*               | A11*                               | A11*           |
| 5.3. TCs standard adjustment         |                                | A11*               | A11*                               | A11*           |
| 6. Engage single target w/ coax      |                                |                    |                                    |                |
| 7. Engage multiple tgts w/ main gun  | A3, A4, A7**, A8**             | A5, A7, A8         | A7, B6, B7, B8                     | A1, A3         |
| 8. Engage targets w/ the cal .50     |                                |                    |                                    |                |
| 8.1. Simultaneous targets            |                                |                    |                                    |                |
| 8.2. Cal .50 targets                 |                                |                    |                                    |                |
| 9 Engage target - degraded modes     |                                |                    |                                    |                |
| 9.1 Using battlesight gunnery        | A5b, A5e                       | A1, A10            |                                    |                |
| 9.2. Given LRF failure               | A5c                            | A1, A4             | A4                                 | A2             |
| 9.3. Given multiple LRF returns      |                                |                    |                                    |                |
| 9.4. Given loss of symbology         |                                |                    | A8, B10                            |                |
| 9.5. Given crosswind sensor failure  |                                |                    | A6                                 |                |
| 9.6. Given cant sensor failure       |                                |                    |                                    |                |
| 9.7. Given lead angle sensor failure |                                |                    | A6, B5                             |                |
| 9.8. Given GPS failure               | A6                             |                    |                                    |                |
| 9.9. Given GPS/TIS failure           |                                | B2, B4, B6         | B1, B2, B9                         |                |
| 9.10. Using GAS                      | A3b, A3d, A5d, A5e, A6c<br>A6d | A4, A6, A9, B2     | A2, A4, A8, A9, A10,<br>B1, B2, B9 | A2             |
| 9.11. In emergency mode              | A5d                            |                    |                                    |                |
| 9.12. In manual mode                 | A3c, A3d                       | A9                 |                                    |                |
| 10. Engage targets from TC position  | A4, A7**, A8**                 |                    |                                    | A5             |
| 11. Assess results of engagement     |                                | A1-10, B1-8        | A1-10, B1-10                       | A1-5, B1-10    |
| 12. Engage target using LDRs M240    |                                |                    |                                    |                |
| 13. Immediate action misfire         |                                |                    |                                    |                |
| 14 Employ smoke                      |                                |                    |                                    |                |
| 14.1. Using smoke grenade launcher   |                                |                    |                                    |                |
| 14.2. Using vehicle exhaust smoke    |                                |                    |                                    |                |
| 15. Submit reports                   |                                |                    |                                    |                |

\*Option may be performed under any of the table tasks given certain circumstances. \*\*Only the tracking components of this activity is relevant to these tracking board tasks.

Figure A-2. Relationship of basic gunnery tables (I-IV) to crew-level tasks. The letter-number combinations in the body of the matrix refer to specific tasks within the gunnery tables.

| Crew-level Activity/Option           | Table V        | Table VI   | Table VII      | Table VIII            |
|--------------------------------------|----------------|------------|----------------|-----------------------|
| 1. Prepare stations for operations   |                |            |                |                       |
| 2. Perform prepare-to-fire checks    | A1,A2          |            |                |                       |
| 3. Acquire targets                   |                |            |                |                       |
| 3.1.1. Search open hatch - day       | A1-6           | A1-4       | A2,A3,A5       | A1-3,A5,A5a           |
| 3.1.2. Search closed hatch - day     | A7             |            | A1,A4,A6       | A4                    |
| 3.1.3. Search at night               | B1-5           | B1-3       | B1-3           | B1-5a                 |
| 3.2. Detect/Locate/Identify targets  | A1-7,B1-5      | A1-4,B1-3  | A1-6,B1-3      | A1-5a,B1-5a           |
| 3.3. Evaluate situation              | A1-7,B1-5      | A1-4,B1-3  | A1-6,B1-3      | A1-5a,B1-5a           |
| 4. Engage single target w/ main gun  |                |            |                |                       |
| 4.1. Offense - precision gunnery     |                |            |                |                       |
| 4.2. Defense - precision gunnery     |                |            | A5             | B5a                   |
| 4.3. GNR cannot ID announced target  | *              | *          | *              | *                     |
| 4.4. Engage target using TIS         | B2,B3          | B2,B3      | B1             | B2,B3,B4,B5a          |
| 5. Adjust fire                       |                |            |                |                       |
| 5.1. Reengage technique              | *              | *          | *              | *                     |
| 5.2. GNRs standard adjustment        | *              | *          | *              | *                     |
| 5.3. TCs standard adjustment         | *              | *          | *              | *                     |
| 6. Engage single target w/ coax      | A3,A4,B1,B2,B3 |            |                |                       |
| 7. Engage multiple tgts w/ main gun  |                | A1-3,B2,B3 | A2,A3,A4,A6,B1 | A3,A4,A5,A5a,B2,B3,B4 |
| 8. Engage targets w/ the cal .50     |                |            |                |                       |
| 8.1. Simultaneous targets            | A7             | A4         | A1,B2          | A2                    |
| 8.2. Cal .50 targets                 | A6,B5          |            |                |                       |
| 9. Engage target - degraded modes    |                |            |                |                       |
| 9.1. Using battlesight gunnery       |                | A3,A4      | A3             | A1                    |
| 9.2. Given LRF failure               |                | A4         |                | A1                    |
| 9.3. Given multiple LRF returns      |                |            |                |                       |
| 9.4. Given loss of symbology         |                |            |                |                       |
| 9.5. Given crosswind sensor failure  |                |            |                |                       |
| 9.6. Given cant sensor failure       |                |            |                |                       |
| 9.7. Given lead angle sensor failure |                |            |                |                       |
| 9.8. Given GPS failure               |                |            |                |                       |
| 9.9. Given GPS/TIS failure           | B1             |            | B2             | B5                    |
| 9.10. Using GAS                      |                | A4         | A1             | A1,B1                 |
| 9.11. In emergency mode              |                | A3         | A1             | A1                    |
| 9.12. In manual mode                 |                |            |                |                       |
| 10. Engage targets from TC position  |                | B1         | B3             | B1                    |
| 11. Assess results of engagement     | A1-7,B1-5      | A1-4,B1-3  | A1-6,B1-3      | A1-5a,B1-5a           |
| 12. Engage target using LDRs M240    | A5,B4          |            | B2             |                       |
| 13. Immediate action misfire         |                |            |                |                       |
| 14. Employ smoke                     |                |            |                |                       |
| 14.1. Using smoke grenade launcher   |                |            |                |                       |
| 14.2. Using vehicle exhaust smoke    |                |            |                |                       |
| 15. Submit reports                   |                |            |                |                       |

\*Option may be performed under any of the table tasks given certain circumstances.

Figure A-3. Relationship of intermediate gunnery tables (V-VIII) to crew-level tasks. The letter-number combinations in the body of the matrix refer to specific tasks within the gunnery tables.

| Crew-level Activity/Option           | Tactical Table A        | Tactical Table B | Tactical Table C             |
|--------------------------------------|-------------------------|------------------|------------------------------|
| 1. Prepare stations for operations   |                         |                  |                              |
| 2. Perform prepare-to-fire checks    |                         |                  |                              |
| 3. Acquire targets                   |                         |                  |                              |
| 3.1 1. Search open hatch - day       |                         |                  | C-1, C-2, C-3, C-4, C-5, C-6 |
| 3.1 2. Search closed hatch - day     |                         |                  |                              |
| 3.1 3. Search at night               |                         |                  |                              |
| 3.2. Detect/Locate/Identify targets  | G-2, G-3, L-5, L-8, D-9 |                  | C-1, C-2, C-3, C-4, C-5, C-6 |
| 3.3. Evaluate situation              |                         |                  | C-1, C-2, C-3, C-4, C-5, C-6 |
| 4 Engage single target w/ main gun   |                         |                  |                              |
| 4.1. Offense - precision gunnery     | L-7                     |                  |                              |
| 4.2. Defense - precision gunnery     | L-7, T-5, D-8           |                  |                              |
| 4.3. GNR cannot ID announced target  |                         |                  |                              |
| 4.4. Engage target using TIS         | G-1                     |                  | C-2*, C-3*, C-5*             |
| 5 Adjust fire                        |                         |                  |                              |
| 5.1. Reengage technique              |                         |                  |                              |
| 5.2. GNRs standard adjustment        |                         |                  |                              |
| 5.3. TCs standard adjustment         |                         |                  |                              |
| 6. Engage single target w/ coax      |                         |                  | C-1, C-5                     |
| 7. Engage multiple tgts w/ main gun  |                         |                  | C-3, C-4                     |
| 8 Engage targets w/ the cal 50       |                         |                  |                              |
| 8.1. Simultaneous targets            |                         |                  | C-1                          |
| 8.2. Cal .50 targets                 |                         |                  | C-6                          |
| 9 Engage target - degraded modes     |                         |                  |                              |
| 9.1. Using battlesight gunnery       |                         |                  |                              |
| 9.2. Given LRF failure               |                         |                  |                              |
| 9.3. Given multiple LRF returns      |                         |                  |                              |
| 9.4. Given loss of symbology         |                         |                  |                              |
| 9.5. Given crosswind sensor failure  |                         |                  |                              |
| 9.6. Given can sensor failure        |                         |                  |                              |
| 9.7. Given lead angle sensor failure |                         |                  |                              |
| 9.8. Given GPS failure               |                         |                  |                              |
| 9.9. Given GPS/TIS failure           |                         |                  |                              |
| 9.10. Using GAS                      |                         |                  |                              |
| 9.11. In emergency mode              |                         |                  |                              |
| 9.12. In manual mode                 |                         |                  |                              |
| 10. Engage targets from TC position  |                         |                  |                              |
| 11. Assess results of engagement     |                         |                  | C-1, C-2, C-3, C-4, C-5, C-6 |
| 12. Engage target using LDRs M240    |                         |                  | C-1                          |
| 13. Immediate action misfire         |                         |                  |                              |
| 14 Employ smoke                      |                         |                  |                              |
| 14.1. Using smoke grenade launcher   |                         |                  | C-2*, C-3*, C-5*             |
| 14.2. Using vehicle exhaust smoke    |                         |                  | C-2*, C-3*, C-5*             |
| 15. Submit reports                   | L-6, T-7                |                  |                              |

\*Smoke is an optional condition for Tasks C-2, C-3, and C-5; if used, the TIS is the appropriate sight.

Figure A-4. Relationship of crew-level Tactical Tables (A-C) to crew-level tasks. The letter-number combinations in the body of the table refer to specific tasks within the tactical tables. The letters in Tactical Table A indicate the task is performed by TC (T), gunner (G), loader (L), and driver (D).

| Platoon Leadership Activities                      | Tactical Table D | Tactical Table E | Tactical Table F             |
|----------------------------------------------------|------------------|------------------|------------------------------|
| 16. Issue tactical reports                         |                  |                  | F-1, F-2, F-5, F-6           |
| 17. Issue platoon/section fire command             |                  |                  | F-1, F-2, F-4, F-5           |
| 18. Request indirect fire                          |                  |                  |                              |
| 18.1. Request initial indirect fire                |                  |                  |                              |
| 18.2. Shift/lift fire                              |                  |                  |                              |
| 19. Specify movement                               |                  |                  |                              |
| 19.1. Specify movement formation                   |                  |                  | F-3                          |
| 19.2. Specify movement technique                   |                  |                  |                              |
| 19.3. Specify direction                            |                  |                  |                              |
| Collective Activities                              | Tactical Table D | Tactical Table E | Tactical Table F             |
| 20. Travel in platoon formation                    |                  |                  |                              |
| 20.1. Move tactically using wingman concept        | D-1              | E-1, E-2, E-3    | F-1, F-2, F-3, F-4, F-5, F-6 |
| 20.2. Execute a herringbone (stop) formation       | D-2              |                  | F-3, F-5                     |
| 20.3. Execute a coil (stop) formation <sup>a</sup> |                  |                  |                              |
| 20.4. Execute a wedge formation                    |                  |                  |                              |
| 20.5. Execute an echelon formation                 |                  |                  |                              |
| 20.6. Execute a line formation                     |                  |                  |                              |
| 20.7. Execute a vee formation                      |                  |                  |                              |
| 20.8. Execute a column formation                   | D-2              |                  |                              |
| 21. Execute battle drills                          |                  |                  |                              |
| 21.1. Execute action drill                         |                  | E-1              | F-4                          |
| 22.2. Execute contact drill                        |                  | E-2              | F-4                          |
| 22.3. React to air attack                          |                  |                  | F-6                          |
| 22.4. React to indirect fire                       |                  | E-3              |                              |
| 22. Bound by section                               |                  |                  |                              |
| 23. Overwatch a bounding platoon                   |                  |                  |                              |
| 24. Occupy a battle position                       |                  |                  |                              |
| 24.1. Occupy initial battle position               |                  |                  |                              |
| 24.2. Occupy subsequent battle position            |                  |                  |                              |
| 25. Maneuver within a battle position              |                  |                  |                              |
| 26. Employ fire patterns                           |                  |                  |                              |
| 26.1. Employ frontal fire                          |                  |                  | F-1, F-2, F-4                |
| 26.2. Employ cross fire                            |                  |                  |                              |
| 26.3. Employ depth fire                            |                  |                  |                              |
| 27. Employ firing techniques                       |                  |                  |                              |
| 27.1. Employ observed fire                         |                  |                  | F-5, F-6                     |
| 27.2. Employ alternating fires                     |                  |                  |                              |
| 27.3. Employ simultaneous fires                    |                  |                  | F-1, F-2, F-4*, F-6          |

\*Task F-4 specifies only that firing technique be in accordance with platoon SOP, however, frontal pattern appears most appropriate to situation.

Figure A-5. Relationship of section-level Tactical Tables (D-F) to platoon leadership and collective gunnery tasks. The letter-number combinations in the body of the table refer to specific tasks within the tactical tables.

| Platoon Leadership Activities                | Tactical Table G | Tactical Table H   | Tactical Table I                  |
|----------------------------------------------|------------------|--------------------|-----------------------------------|
| 16. Issue tactical reports                   |                  |                    | I-1, I-2, I-3, I-4, I-5, I-6, I-7 |
| 17. Issue platoon/section fire command       |                  |                    | I-1, I-2, I-3, I-4, I-5, I-6, I-7 |
| 18. Request indirect fire                    |                  |                    |                                   |
| 18.1. Request initial indirect fire          |                  |                    |                                   |
| 18.2. Shift/lift fire                        |                  |                    |                                   |
| 19. Specify movement                         |                  |                    |                                   |
| 19.1. Specify movement formation             |                  |                    | I-1, I-2, I-3, I-4, I-5, I-6, I-7 |
| 19.2. Specify movement technique             |                  |                    |                                   |
| 19.3. Specify direction                      |                  |                    |                                   |
| Platoon Collective Activities                | Tactical Table G | Tactical Table H   | Tactical Table I                  |
| 20. Travel in platoon formation              |                  |                    |                                   |
| 20.1. Move tactically using wingman concept  |                  |                    |                                   |
| 20.2. Execute a herringbone (stop) formation | G-3              |                    |                                   |
| 20.3. Execute a coil (stop) formation        | G-2              |                    |                                   |
| 20.4. Execute a wedge formation              | G-4              | H-1, H-2, H-3, H-4 | I-1, I-2, I-3, I-4, I-6.          |
| 20.5. Execute an echelon formation           |                  |                    |                                   |
| 20.6. Execute a line formation               | G-4              |                    |                                   |
| 20.7. Execute a vee formation                |                  |                    |                                   |
| 20.8. Execute a column or staggered column   | G-1              |                    | I-5                               |
| 21. Execute battle drills                    |                  |                    |                                   |
| 21.1. Execute action drill                   |                  | H-1                | I-2*, I-4*, I-5*, I-6*            |
| 22.2. Execute contact drill                  |                  | H-2                | I-2*, I-4*, I-5*, I-6*            |
| 22.3. React to air attack                    |                  | H-3                | I-3                               |
| 22.4. React to indirect fire                 |                  | H-4                |                                   |
| 22. Bound by section                         | G-6              |                    |                                   |
| 23. Overwatch a bounding platoon             |                  |                    |                                   |
| 24. Occupy a battle position                 |                  |                    |                                   |
| 24.1. Occupy initial battle position         |                  |                    | I-7                               |
| 24.2. Occupy subsequent battle position      |                  |                    |                                   |
| 25. Maneuver within a battle position        |                  |                    |                                   |
| 26. Employ fire patterns                     |                  |                    |                                   |
| 26.1. Employ frontal fire                    |                  |                    | I-2**, I-4***, I-7                |
| 26.2. Employ cross fire                      |                  |                    | I-4***                            |
| 26.3. Employ depth fire                      |                  |                    | I-2**, I-6                        |
| 27. Employ firing techniques                 |                  |                    |                                   |
| 27.1. Employ observed fire                   |                  |                    |                                   |
| 27.2. Employ alternating fires               |                  |                    |                                   |
| 27.3. Employ simultaneous fires              |                  |                    |                                   |

\*Task I-2 call for "actions on contact" which may entail either an action or a contact drill. \*\*Task I-2 calls for either frontal or depth pattern. \*\*\*Task I-4 calls for either frontal or cross pattern.

Figure A-5. Relationship of platoon-level Tactical Tables (G-I) to platoon leadership and collective gunnery tasks. The letter-number combinations in the body of the table refer to specific tasks within the tactical tables.

## Appendix B

### Relationship of Activities and Phases of Training to Training Device Capabilities

| Crew-level Activities                | Unit Gunnery Training Phase |               |               |          |
|--------------------------------------|-----------------------------|---------------|---------------|----------|
|                                      | Preliminary                 | Basic         | Intermediate  | Advanced |
| 1 Prepare stations for operations    | H                           |               |               |          |
| 2. Perform prepare-to-fire checks    | H                           |               | H             |          |
| 3 Acquire targets                    |                             |               |               |          |
| 3.1.1 Search open hatch - day        |                             | None          | None          |          |
| 3.1.2 Search closed hatch - day      |                             | T, M, G, S    | T, M, G, S    |          |
| 3.1.3. Search at night               | H, G                        | M, G          | H, G          |          |
| 3.2 Detect/Locate/Identify targets   | V                           | H, G, S       | H, G, S       |          |
| 3.3. Evaluate situation              | H                           | H             | H             |          |
| 4 Engage single target w/ main gun   |                             |               |               |          |
| 4.1. Offense - precision gunnery     |                             | V, M, G, S    |               |          |
| 4.2 Defense - precision gunnery      | T, V, M, G, S               | T, V, G, H, S | T, V, M, G, S |          |
| 4.3 GNR cannot ID announced target   |                             | M, G, S       | H, G, S       |          |
| 4.4 Engage target using TIS          |                             | T, V, H, G    | T, V, H, G    |          |
| 5 Adjust fire                        |                             |               |               |          |
| 5.1 Reengage technique               |                             | T, V, M, G, S | T, V, M, G, S |          |
| 5.2. GNRs standard adjustment        |                             | T, H, G, S    | T, H, G, S    |          |
| 5.3. TCs standard adjustment         |                             | H, G, S       | H, G, S       |          |
| 6. Engage single target w/ coax      |                             | V, H, G       | V, H, G       |          |
| 7 Engage multiple tgts w/ main gun   |                             | T, V, H, G, S | T, V, H, G, S |          |
| 8 Engage targets w/ the cal .50      |                             |               |               |          |
| 8.1 Simultaneous targets             |                             |               | H             |          |
| 8.2 Cal .50 targets                  |                             |               | H             |          |
| 9 Engage target - degraded modes     |                             |               |               |          |
| 9.1. Using battlesight gunnery       | H, G, S                     | H, G, S       | H, G, S       |          |
| 9.2 Given LRF failure                |                             | H, G, S       | H, G, S       |          |
| 9.3. Given multiple LRF returns      |                             |               |               |          |
| 9.4 Given loss of symbology          |                             | G             |               |          |
| 9.5 Given crosswind sensor failure   |                             | None          |               |          |
| 9.6. Given cant sensor failure       |                             |               |               |          |
| 9.7. Given lead angle sensor failure |                             | None          |               |          |
| 9.8. Given GPS failure               |                             | None          |               |          |
| 9.9. Given GPS/TIS failure           |                             | H, G          | H, G          |          |
| 9.10 Using GAS                       | T, V, H, G                  | T, V, H, G    | T, V, H, G    |          |
| 9.11. In emergency mode              |                             | M, G          | H, G          |          |
| 9.12. In manual mode                 |                             | H             |               |          |
| 10. Engage targets from TC position  | H, G, S                     | H, G, S       | H, G, S       |          |
| 11. Assess results of engagement     |                             | V, H, G, S    | V, H, G, S    |          |
| 12. Engage target using LDRs M240    |                             | None          |               |          |
| 13. Immediate action misfire         | None                        |               |               |          |
| 14 Employ smoke                      |                             |               |               |          |
| 14.1 Using smoke grenade launcher    |                             | H             |               |          |
| 14.2. Using vehicle exhaust smoke    |                             | None          |               |          |
| 15. Subalt reports                   |                             | H, G, S       |               |          |

Figure B-1. Relationship of crew-level activities, unit gunnery training phases, and training devices. (T = TopGun; V = VIGS; M = M-COFT; G = GUARD FIST I; S = SIMNET; None = the activity is trained during that phase, but is not adequately supported by any of the devices; blank cells beneath a phase indicate that the combat tables for that phase do not cover the corresponding activity.)

| Platoon Leadership Activities                      | Unit Gunnery Training Phase |       |              |          |
|----------------------------------------------------|-----------------------------|-------|--------------|----------|
|                                                    | Preliminary                 | Basic | Intermediate | Advanced |
| 16. Issue tactical reports                         |                             |       | S            | S        |
| 17. Issue platoon/section fire command             |                             |       | S            | S        |
| 18. Request indirect fire                          |                             |       |              |          |
| 18.1. Request initial indirect fire                |                             |       |              |          |
| 18.2. Shift/lift fire                              |                             |       |              |          |
| 19. Specify movement                               |                             |       |              |          |
| 19.1. Specify movement formation                   |                             |       | S            | S        |
| 19.2. Specify movement technique                   |                             |       |              |          |
| 19.3. Specify direction                            |                             |       |              |          |
| Collective Activities                              |                             |       |              |          |
| 20. Travel in platoon formation                    |                             |       |              |          |
| 20.1. Move tactically using wingman concept        |                             |       | S            |          |
| 20.2. Execute a herringbone (stop) formation       |                             |       | S            | S        |
| 20.3. Execute a coil (stop) formation <sup>a</sup> |                             |       |              | S        |
| 20.4. Execute a wedge formation                    |                             |       |              | S        |
| 20.5. Execute an echelon formation                 |                             |       |              |          |
| 20.6. Execute a line formation                     |                             |       |              | S        |
| 20.7. Execute a vee formation                      |                             |       |              |          |
| 20.8. Execute a column formation                   |                             |       | S            | S        |
| 21. Execute battle drills                          |                             |       |              |          |
| 21.1. Execute action drill                         |                             |       | S            | S        |
| 22.2. Execute contact drill                        |                             |       | S            | S        |
| 22.3. React to air attack                          |                             |       | S            | S        |
| 22.4. React to indirect fire                       |                             |       | S            | S        |
| 22. Bound by section                               |                             |       |              | S        |
| 23. Overwatch a bounding platoon                   |                             |       |              |          |
| 24. Occupy a battle position                       |                             |       |              |          |
| 24.1. Occupy initial battle position               |                             |       |              |          |
| 24.2. Occupy subsequent battle position            |                             |       |              |          |
| 25. Maneuver within a battle position              |                             |       |              |          |
| 26. Employ fire patterns                           |                             |       |              |          |
| 26.1. Employ frontal fire                          |                             |       | S            | S        |
| 26.2. Employ cross fire                            |                             |       |              | S        |
| 26.3. Employ depth fire                            |                             |       |              | S        |
| 27. Employ firing techniques                       |                             |       |              |          |
| 27.1. Employ observed fire                         |                             |       | S            |          |
| 27.2. Employ alternating fires                     |                             |       |              |          |
| 27.3. Employ simultaneous                          |                             |       | S            |          |

Figure B-2. Relationship of platoon leadership and collective activities, unit gunnery training phases, and training devices. (T = TopGun; V = VIGS; M = M-COFT; G = GUARD FIST I; S = SIMNET; blank cells beneath a phase indicate that the combat tables for that phase do not cover the corresponding activity.)

## Appendix C

### Selection of M-COFT and GUARD FIST I Diagnostic Exercises

Table C-1

## Coverage of Gunnery Table IV Conditions by GUARD FIST I Diagnostic Exercises

| Parameter                       | Conditions         | Gunnery<br>Table IV | Exercise |                |     |     |
|---------------------------------|--------------------|---------------------|----------|----------------|-----|-----|
|                                 |                    |                     | 3-1      | 3-4            | 3-6 | 4-2 |
| 1. Target Type                  | a. tank            | X                   | /        | /              | /   | /   |
|                                 | b. pers. carrier   | X                   | /        | -              | /   | /   |
|                                 | c. helicopter      | -                   | -        | -              | -   | -   |
|                                 | d. bunkers         | -                   | -        | -              | -   | -   |
|                                 | e. antitank        | -                   | -        | -              | -   | -   |
|                                 | f. truck           | -                   | -        | -              | -   | -   |
|                                 | g. troops          | -                   | -        | -              | -   | -   |
|                                 | h. aircraft        | -                   | -        | -              | -   | -   |
| 2. Target Movement              | a. sta. front      | X                   | /        | /              | /   | /   |
|                                 | b. sta. flank      | X                   | /        | /              | /   | /   |
|                                 | c. sta. oblique    | -                   | -        | -              | -   | -   |
|                                 | d. mov. flank      | X                   | /        | /              | /   | /   |
|                                 | e. mov. oblique    | X                   | -        | /              | -   | -   |
|                                 | f. mov. zig-zag    | -                   | -        | -              | -   | -   |
|                                 | g. mov. approach   | -                   | -        | -              | /   | /   |
|                                 | h. mov. retreating | -                   | -        | -              | -   | -   |
| 3. Target Cover/<br>Concealment | a. fully exposed   | X                   | /        | /              | /   | /   |
|                                 | b. hull defilade   | -                   | -        | -              | -   | -   |
|                                 | c. turret defilade | -                   | -        | -              | -   | -   |
|                                 | d. fully hidden    | -                   | -        | -              | -   | -   |
| 4. Target Array                 | a. single targets  | X                   | -        | /              | /   | /   |
|                                 | b. mult. targets   | X                   | /        | /              | /   | /   |
|                                 | c. both sgl & mult | -                   | -        | -              | -   | -   |
| 5. Target<br>Orientation        | a. owntank         | X                   | /        | /              | /   | /   |
|                                 | b. elsewhere       | X                   | /        | /              | /   | /   |
| 6. Target Range                 | a. < 900 meters    | X                   | /        | -              | /   | -   |
|                                 | b. 900-1800 meters | X                   | /        | /              | /   | /   |
|                                 | c. > 1800 meters   | -                   | -        | -              | -   | /   |
| 7. Target Sector                | a. forward         | X                   | /        | /              | /   | /   |
|                                 | b. flanks          | -                   | -        | -              | -   | -   |
|                                 | c. rear            | -                   | -        | -              | -   | -   |
| 3. IFFN                         | a. all threat      | X                   | /        | /              | /   | /   |
|                                 | b. all friendly    | -                   | -        | -              | -   | -   |
|                                 | c. mix             | X <sup>a</sup>      | -        | -              | -   | -   |
| 9. Enemy Activity               | a. no return fire  | X                   | /        | /              | /   | /   |
|                                 | b. direct fire     | -                   | -        | -              | -   | -   |
|                                 | c. indirect fire   | -                   | -        | -              | -   | -   |
|                                 | d. obstacles       | -                   | -        | -              | -   | -   |
|                                 | e. minefields      | -                   | -        | -              | -   | -   |
|                                 | f. elec c-meas     | -                   | -        | -              | -   | -   |
| 10. NBC Conditions              | a. free of hazards | X                   | /        | /              | /   | /   |
|                                 | b. contaminated    | X                   | -        | / <sup>b</sup> | -   | -   |

(table continues)

| Parameter                           | Conditions          | Gunnery<br>Table IV | Exercise |     |     |     |
|-------------------------------------|---------------------|---------------------|----------|-----|-----|-----|
|                                     |                     |                     | 3-1      | 3-4 | 3-6 | 4-2 |
| 11. Equipment Status                | a. fully oper'l     | X                   | -        | ✓   | ✓   | ✓   |
|                                     | b. ineffective LRF  | X                   | ✓        | ✓   | ✓   | ✓   |
|                                     | c. mult rtns        | -                   | -        | -   | -   | -   |
|                                     | d. no symbols       | -                   | -        | -   | -   | -   |
|                                     | e. crswnd snr fail  | -                   | -        | -   | -   | -   |
|                                     | f. cant snr fail    | -                   | -        | -   | -   | -   |
|                                     | g. lead snr fail    | -                   | -        | -   | -   | -   |
|                                     | h. GPS fail         | -                   | -        | -   | -   | -   |
|                                     | i. GPS/TIS fail     | -                   | -        | -   | -   | -   |
|                                     | j. stab fail        | -                   | -        | -   | -   | -   |
|                                     | k. turret pwr fail  | -                   | -        | -   | -   | -   |
| 12. Number of Crewmen               | a. four             | X                   | ✓        | ✓   | ✓   | ✓   |
|                                     | b. three            | X                   | -        | ✓   | -   | -   |
| 13. Supply Shortages                | a. none             | X                   | ✓        | ✓   | ✓   | ✓   |
|                                     | b. ammo             | -                   | -        | -   | -   | -   |
|                                     | c. fuel             | -                   | -        | -   | -   | -   |
| 14. Mission                         | a. offense (moving) | X                   | -        | ✓   | ✓   | ✓   |
|                                     | b. defense (st'ry)  | X                   | ✓        | -   | -   | -   |
| 15. Fire Control                    | a. single tank      | X                   | ✓        | ✓   | ✓   | ✓   |
|                                     | b. frontal (sc'n)   | -                   | -        | -   | -   | -   |
|                                     | c. cross (sc'n)     | -                   | -        | -   | -   | -   |
|                                     | d. depth (sc'n)     | -                   | -        | -   | -   | -   |
|                                     | e. frontal (pltn)   | -                   | -        | -   | -   | -   |
|                                     | f. cross (pltn)     | -                   | -        | -   | -   | -   |
|                                     | g. depth (sc'n)     | -                   | -        | -   | -   | -   |
| 16. Movement Formation              | a. column           | -                   | -        | -   | -   | -   |
|                                     | b. echelon lft/rt   | -                   | -        | -   | -   | -   |
|                                     | c. stgr'd column    | -                   | -        | -   | -   | -   |
|                                     | d. line             | -                   | -        | -   | -   | -   |
|                                     | e. wedge            | -                   | -        | -   | -   | -   |
|                                     | f. herringbone      | -                   | -        | -   | -   | -   |
|                                     | g. vee              | -                   | -        | -   | -   | -   |
|                                     | h. coil             | -                   | -        | -   | -   | -   |
| 17. Special Engagement Requirements | a. surprise tgts    | -                   | -        | -   | -   | -   |
|                                     | b. assault fire     | -                   | -        | -   | -   | -   |
|                                     | c. support by fire  | -                   | -        | -   | -   | -   |
| 18. Space                           | a. spt-by-fire int  | -                   | -        | -   | -   | -   |
|                                     | b. fire & man int   | -                   | -        | -   | -   | -   |
|                                     | c. assault int      | -                   | -        | -   | -   | -   |
|                                     | d. fire pos int     | -                   | -        | -   | -   | -   |
| 19. Visibility                      | a. unlimited-day    | X                   | ✓        | ✓   | -   | ✓   |
|                                     | b. limited-day      | -                   | -        | -   | -   | -   |
|                                     | c. w/o ill-nite     | X                   | -        | -   | ✓   | -   |
|                                     | d. w/ill-nite       | -                   | -        | -   | -   | -   |

(table continues)

| Parameter              | Conditions | Gunnery<br>Table IV | Exercise |     |     |     |
|------------------------|------------|---------------------|----------|-----|-----|-----|
|                        |            |                     | 3-1      | 3-4 | 3-6 | 4-2 |
| 20. Terrain Grade      | a. flat    | X°                  | /        | /   | /   | /   |
|                        | b. hilly   | X°                  | /        | /   | /   | /   |
| 21. Terrain Vegetation | a. none    | X°                  | /        | /   | /   | /   |
|                        | b. brush   | X°                  | -        | -   | -   | -   |
|                        | c. trees   | X°                  | /        | /   | /   | /   |

Notes. X = condition is used to define Gunnery Table IV. / = condition is covered by exercise.  
 - = condition is not used to define Gunnery Table IV, or not covered by exercise.

<sup>a</sup>Friendly vehicles may be added to the target array at the commander's discretion. <sup>b</sup>Simulate NBC engagement by requiring that Tasks 3 and 4 be fired with crew wearing protective masks. <sup>c</sup>Simulate Laser Range Finder failure by requiring crew to use Gunner's Auxiliary Sight. <sup>d</sup>Simulate three-man crew by requiring TC to engage targets in Tasks 3 and 4 without gunner's assistance. <sup>e</sup>Terrain features are range dependent.

Table C-2

## Coverage of Gunnery Table IV Conditions by M-COFT Diagnostic Exercises

| Parameter                       | Conditions         | Gunnery<br>Table IV | Exercise |       |       |       |
|---------------------------------|--------------------|---------------------|----------|-------|-------|-------|
|                                 |                    |                     | 32225    | 31421 | 32323 | 34361 |
| 1. Target Type                  | a. tank            | X                   | /        | /     | /     | /     |
|                                 | b. pers. carrier   | X                   | /        | /     | /     | /     |
|                                 | c. helicopter      | -                   | /        | /     | /     | /     |
|                                 | d. bunkers         | -                   | -        | -     | -     | -     |
|                                 | e. antitank        | -                   | -        | -     | -     | -     |
|                                 | f. truck           | -                   | /        | /     | -     | -     |
|                                 | g. troops          | -                   | /        | -     | -     | /     |
|                                 | h. aircraft        | -                   | -        | -     | -     | -     |
| 2. Target Movement              | a. sta. front      | X                   | -        | -     | /     | /     |
|                                 | b. sta. flank      | X                   | /        | -     | /     | /     |
|                                 | c. sta. oblique    | X                   | /        | -     | /     | /     |
|                                 | d. mov. flank      | X                   | -        | /     | -     | -     |
|                                 | e. mov. oblique    | X                   | -        | /     | -     | -     |
|                                 | f. mov. zig-zag    | -                   | -        | -     | -     | -     |
|                                 | g. mov. approach   | -                   | -        | /     | -     | -     |
|                                 | h. mov. retreating | -                   | -        | -     | -     | -     |
| 3. Target Cover/<br>Concealment | a. fully exposed   | X                   | /        | /     | /     | /     |
|                                 | b. hull defilade   | -                   | /        | /     | /     | /     |
|                                 | c. turret defilade | -                   | /        | /     | /     | /     |
|                                 | d. fully hidden    | -                   | /        | /     | /     | /     |
| 4. Target Array                 | a. single targets  | X                   | /        | /     | /     | -     |
|                                 | b. mult. targets   | X                   | -        | -     | -     | /     |
|                                 | c. both sgl & mult | -                   | -        | -     | -     | -     |
| 5. Target<br>Orientation        | a. own tank        | X                   | /        | /     | /     | /     |
|                                 | b. elsewhere       | X                   | /        | /     | /     | /     |
| 6. Target Range                 | a. < 900 meters    | X                   | /        | /     | -     | /     |
|                                 | b. 900-1800 meters | X                   | /        | /     | /     | /     |
|                                 | c. > 1800 meters   | -                   | /        | -     | /     | -     |
| 7. Target Sector                | a. forward         | X                   | /        | /     | /     | /     |
|                                 | b. flanks          | -                   | -        | -     | -     | -     |
|                                 | c. rear            | -                   | -        | -     | -     | -     |
| 8. IFFN                         | a. all threat      | X                   | -        | /     | -     | /     |
|                                 | b. all friendly    | -                   | -        | -     | -     | -     |
|                                 | c. mix             | X <sup>a</sup>      | /        | -     | /     | -     |
| 9. Enemy Activity               | a. no return fire  | X                   | /        | /     | /     | /     |
|                                 | b. direct fire     | -                   | -        | -     | -     | -     |
|                                 | c. indirect fire   | -                   | -        | -     | -     | -     |
|                                 | d. obstacles       | -                   | -        | -     | -     | -     |
|                                 | e. minefields      | -                   | -        | -     | -     | -     |
|                                 | f. elec c-meas     | -                   | -        | -     | -     | -     |
| 10. NBC Conditions              | a. free of hazards | X                   | -        | /     | /     | /     |
|                                 | b. contaminated    | X                   | /        | -     | -     | -     |

(table continues)

| Parameter                           | Conditions          | Gunnery<br>Table IV | Exercise       |       |       |       |
|-------------------------------------|---------------------|---------------------|----------------|-------|-------|-------|
|                                     |                     |                     | 32233          | 31421 | 32323 | 34361 |
| 11. Equipment Status                | a. fully oper'l     | X                   | ✓              | ✓     | ✓     | -     |
|                                     | b. ineffective LRF  | X                   | -              | -     | -     | ✓     |
|                                     | c. mult rtns        | -                   | -              | -     | -     | -     |
|                                     | d. no symbols       | -                   | -              | -     | -     | -     |
|                                     | e. crswnd snr fail  | -                   | -              | -     | -     | -     |
|                                     | f. cant snr fail    | -                   | -              | -     | -     | -     |
|                                     | g. lead snr fail    | -                   | -              | -     | -     | -     |
|                                     | h. GPS fail         | -                   | -              | -     | -     | ✓     |
|                                     | i. GPS/TIS fail     | -                   | -              | -     | -     | -     |
|                                     | j. stab fail        | -                   | -              | -     | -     | -     |
|                                     | k. turret pwr fail  | -                   | -              | -     | -     | -     |
| 12. Number of Crewmen               | a. four             | X                   | ✓ <sup>b</sup> | ✓     | ✓     | ✓     |
|                                     | b. three            | X                   | ✓ <sup>b</sup> | -     | -     | -     |
| 13. Supply Shortages                | a. none             | X                   | ✓              | ✓     | ✓     | ✓     |
|                                     | b. ammo             | -                   | -              | -     | -     | -     |
|                                     | c. fuel             | -                   | -              | -     | -     | -     |
| 14. Mission                         | a. offense (moving) | X                   | -              | -     | ✓     | ✓     |
|                                     | b. defense (st'ry)  | X                   | ✓              | ✓     | -     | -     |
| 15. Fire Control                    | a. single tank      | X                   | ✓              | ✓     | ✓     | ✓     |
|                                     | b. frontal (sc'n)   | -                   | -              | -     | -     | -     |
|                                     | c. cross (sc'n)     | -                   | -              | -     | -     | -     |
|                                     | d. depth (sc'n)     | -                   | -              | -     | -     | -     |
|                                     | e. frontal (pltn)   | -                   | -              | -     | -     | -     |
|                                     | f. cross (pltn)     | -                   | -              | -     | -     | -     |
|                                     | g. depth (sc'n)     | -                   | -              | -     | -     | -     |
| 16. Movement Formation              | a. column           | -                   | -              | -     | -     | -     |
|                                     | b. echelon lft/rt   | -                   | -              | -     | -     | -     |
|                                     | c. stgr'd column    | -                   | -              | -     | -     | -     |
|                                     | d. line             | -                   | -              | -     | -     | -     |
|                                     | e. wedge            | -                   | -              | -     | -     | -     |
|                                     | f. herringbone      | -                   | -              | -     | -     | -     |
|                                     | g. vee              | -                   | -              | -     | -     | -     |
|                                     | h. coil             | -                   | -              | -     | -     | -     |
| 17. Special Engagement Requirements | a. surprise tgts    | -                   | -              | -     | -     | -     |
|                                     | b. assault fire     | -                   | -              | -     | -     | -     |
|                                     | c. support by fire  | -                   | -              | -     | -     | -     |
| 18. Space                           | a. spt-by-fire int  | -                   | -              | -     | -     | -     |
|                                     | b. fire & man int   | -                   | -              | -     | -     | -     |
|                                     | c. assault int      | -                   | -              | -     | -     | -     |
|                                     | d. fire pos int     | -                   | -              | -     | -     | -     |
| 19. Visibility                      | a. unlimited-day    | X                   | ✓              | -     | -     | ✓     |
|                                     | b. limited-day      | -                   | -              | -     | -     | -     |
|                                     | c. w/o ill-nite     | X                   | -              | ✓     | ✓     | -     |
|                                     | d. w/ill-nite       | -                   | -              | -     | -     | -     |

(table continues)

| Parameter              | Conditions | Gunnery<br>Table IV | Exercise |       |       |       |
|------------------------|------------|---------------------|----------|-------|-------|-------|
|                        |            |                     | 32233    | 31421 | 32323 | 34361 |
| 20. Terrain Grade      | a. flat    | X <sup>c</sup>      | /        | /     | /     | /     |
|                        | b. hilly   | X <sup>c</sup>      | /        | /     | /     | /     |
| 21. Terrain Vegetation | a. none    | X <sup>c</sup>      | /        | /     | /     | /     |
|                        | b. brush   | X <sup>c</sup>      | /        | /     | /     | /     |
|                        | c. trees   | X <sup>c</sup>      | /        | /     | /     | /     |

Notes. X = condition is used to define Gunnery Table IV. / = condition is covered by exercise.  
 - = condition is not used to define Gunnery Table IV, or not covered by exercise.

<sup>a</sup>Friendly vehicles may be added to the target array at the commander's discretion. <sup>b</sup>Simulate three-man crew by requiring TC to engage targets in Tasks 9 and 10 without gunner's assistance. <sup>c</sup>Terrain features are range dependent.

Table C-3

## Coverage of Gunnery Table VIII Conditions by GUARD FIST I Diagnostic Exercises

| Parameter                       | Conditions         | Gunnery<br>Table VIII | Exercise |                |     |     |     |
|---------------------------------|--------------------|-----------------------|----------|----------------|-----|-----|-----|
|                                 |                    |                       | 5-6      | 5-2            | 6-3 | 6-5 | 6-6 |
| 1. Target Type                  | a. tank            | X                     | ✓        | ✓              | ✓   | ✓   | ✓   |
|                                 | b. pers. carrier   | X                     | ✓        | ✓              | ✓   | ✓   | ✓   |
|                                 | c. helicopter      | -                     | -        | -              | -   | -   | -   |
|                                 | d. bunkers         | -                     | -        | -              | -   | -   | -   |
|                                 | e. antitank        | -                     | -        | -              | -   | -   | -   |
|                                 | f. truck           | -                     | -        | -              | -   | -   | -   |
|                                 | g. troops          | X                     | -        | -              | ✓   | ✓   | -   |
|                                 | h. aircraft        | -                     | -        | -              | -   | -   | -   |
| 2. Target Movement              | a. sta. front      | X                     | ✓        | ✓              | ✓   | ✓   | -   |
|                                 | b. sta. flank      | X                     | ✓        | ✓              | ✓   | ✓   | ✓   |
|                                 | c. sta. oblique    | -                     | -        | -              | -   | -   | -   |
|                                 | d. mov. flank      | X                     | ✓        | ✓              | ✓   | ✓   | ✓   |
|                                 | e. mov. oblique    | X                     | -        | -              | ✓   | -   | -   |
|                                 | f. mov. zig-zag    | -                     | -        | -              | -   | -   | -   |
|                                 | g. mov. approach   | -                     | ✓        | -              | ✓   | ✓   | ✓   |
|                                 | h. mov. retreating | -                     | -        | -              | -   | -   | -   |
| 3. Target Cover/<br>Concealment | a. fully exposed   | X                     | ✓        | ✓              | ✓   | ✓   | ✓   |
|                                 | b. hull defilade   | -                     | ✓        | ✓              | ✓   | ✓   | ✓   |
|                                 | c. turret defilade | -                     | ✓        | ✓              | ✓   | ✓   | ✓   |
|                                 | d. fully hidden    | -                     | ✓        | ✓              | ✓   | ✓   | ✓   |
| 4. Target Array                 | a. single targets  | X                     | ✓        | ✓              | -   | -   | -   |
|                                 | b. mult. targets   | X                     | ✓        | ✓              | ✓   | ✓   | ✓   |
|                                 | c. both sgl & mult | -                     | -        | -              | -   | -   | -   |
| 5. Target<br>Orientation        | a. owntank         | X                     | ✓        | ✓              | ✓   | ✓   | ✓   |
|                                 | b. elsewhere       | X                     | ✓        | ✓              | ✓   | ✓   | ✓   |
| 6. Target Range                 | a. < 900 meters    | X                     | -        | -              | ✓   | ✓   | ✓   |
|                                 | b. 900-1800 meters | X                     | ✓        | ✓              | ✓   | ✓   | ✓   |
|                                 | c. > 1800 meters   | X                     | ✓        | -              | -   | -   | ✓   |
| 7. Target Sector                | a. forward         | X                     | ✓        | ✓              | ✓   | ✓   | ✓   |
|                                 | b. flanks          | -                     | -        | -              | -   | -   | -   |
|                                 | c. rear            | -                     | -        | -              | -   | -   | -   |
| 8. IFFN                         | a. all threat      | X                     | ✓        | ✓              | ✓   | ✓   | ✓   |
|                                 | b. all friendly    | -                     | -        | -              | -   | -   | -   |
|                                 | c. mix             | X <sup>a</sup>        | -        | -              | -   | -   | -   |
| 9. Enemy Activity               | a. no return fire  | X                     | ✓        | ✓              | ✓   | ✓   | ✓   |
|                                 | b. direct fire     | -                     | -        | -              | -   | -   | -   |
|                                 | c. indirect fire   | -                     | -        | -              | -   | -   | -   |
|                                 | d. obstacles       | -                     | -        | -              | -   | -   | -   |
|                                 | e. minefields      | -                     | -        | -              | -   | -   | -   |
|                                 | f. elec c-meas     | -                     | -        | -              | -   | -   | -   |
| 10. NBC Conditions              | a. free of hazards | X                     | ✓        | ✓              | ✓   | ✓   | ✓   |
|                                 | b. contaminated    | X                     | -        | ✓ <sup>b</sup> | -   | -   | -   |

(table continues)

| Parameter                           | Conditions          | Gunnery<br>Table VIII | Exercise |     |     |     |     |
|-------------------------------------|---------------------|-----------------------|----------|-----|-----|-----|-----|
|                                     |                     |                       | 5-6      | 5-2 | 6-3 | 6-5 | 6-6 |
| 11. Equipment Status                | a. fully oper'l     | X                     | ✓        | ✓   | ✓   | -   | ✓   |
|                                     | b. ineffective LRF  | X                     | ✓        | -   | -   | ✓   | -   |
|                                     | c. mult rtns        | -                     | -        | -   | -   | -   | -   |
|                                     | d. no symbols       | -                     | -        | -   | -   | -   | ✓   |
|                                     | e. crswnd snr fail  | -                     | -        | -   | -   | -   | -   |
|                                     | f. cant snr fail    | -                     | -        | -   | -   | -   | -   |
|                                     | g. lead snr fail    | -                     | -        | -   | -   | -   | -   |
|                                     | h. GPS fail         | -                     | -        | -   | -   | -   | -   |
|                                     | i. GPS/TIS fail     | X                     | -        | ✓   | ✓   | -   | -   |
|                                     | j. stab fail        | -                     | -        | -   | -   | -   | -   |
|                                     | k. turret pwr fail  | -                     | -        | -   | -   | -   | -   |
| 12. Number of Crewmen               | a. four             | X                     | ✓        | ✓   | ✓   | ✓   | ✓   |
|                                     | b. three            | X                     | ✓        | -   | -   | ✓   | -   |
| 13. Supply Shortages                | a. none             | X                     | ✓        | ✓   | ✓   | ✓   | ✓   |
|                                     | b. ammo             | -                     | -        | -   | -   | -   | -   |
|                                     | c. fuel             | -                     | -        | -   | -   | -   | -   |
| 14. Mission                         | a. offense (moving) | X                     | ✓        | -   | ✓   | ✓   | ✓   |
|                                     | b. defense (st'ry)  | X                     | -        | ✓   | -   | -   | -   |
| 15. Fire Control                    | a. single tank      | X                     | ✓        | ✓   | ✓   | ✓   | ✓   |
|                                     | b. frontal (sc'n)   | -                     | -        | -   | -   | -   | -   |
|                                     | c. cross (sc'n)     | -                     | -        | -   | -   | -   | -   |
|                                     | d. depth (sc'n)     | -                     | -        | -   | -   | -   | -   |
|                                     | e. frontal (pltn)   | -                     | -        | -   | -   | -   | -   |
|                                     | f. cross (pltn)     | -                     | -        | -   | -   | -   | -   |
|                                     | g. depth (sc'n)     | -                     | -        | -   | -   | -   | -   |
| 16. Movement Formation              | a. column           | -                     | -        | -   | -   | -   | -   |
|                                     | b. echelon lft/rt   | -                     | -        | -   | -   | -   | -   |
|                                     | c. stgr'd column    | -                     | -        | -   | -   | -   | -   |
|                                     | d. line             | -                     | -        | -   | -   | -   | -   |
|                                     | e. wedge            | -                     | -        | -   | -   | -   | -   |
|                                     | f. herringbone      | -                     | -        | -   | -   | -   | -   |
|                                     | g. vee              | -                     | -        | -   | -   | -   | -   |
|                                     | h. coil             | -                     | -        | -   | -   | -   | -   |
| 17. Special Engagement Requirements | a. surprise tgts    | -                     | -        | -   | -   | -   | -   |
|                                     | b. assault fire     | -                     | -        | -   | -   | -   | -   |
|                                     | c. support by fire  | -                     | -        | -   | -   | -   | -   |
| 18. Space                           | a. spt-by-fire int  | -                     | -        | -   | -   | -   | -   |
|                                     | b. fire & man int   | -                     | -        | -   | -   | -   | -   |
|                                     | c. assault int      | -                     | -        | -   | -   | -   | -   |
|                                     | d. fire pos int     | -                     | -        | -   | -   | -   | -   |
| 19. Visibility                      | a. unlimited-day    | X                     | -        | ✓   | ✓   | -   | -   |
|                                     | b. limited-day      | -                     | -        | -   | -   | -   | -   |
|                                     | c. w/o ill-nite     | X                     | ✓        | -   | -   | ✓   | ✓   |
|                                     | d. w/ill-nite       | X                     | -        | -   | -   | -   | -   |

(table continues)

| Parameter              | Conditions | Gunnery<br>Table VIII | Exercise |     |     |     |     |
|------------------------|------------|-----------------------|----------|-----|-----|-----|-----|
|                        |            |                       | 5-6      | 5-2 | 6-3 | 6-5 | 6-6 |
| 20. Terrain Grade      | a. flat    | X <sup>d</sup>        | ✓        | ✓   | ✓   | ✓   | ✓   |
|                        | b. hilly   | X <sup>d</sup>        | ✓        | ✓   | ✓   | ✓   | ✓   |
| 21. Terrain Vegetation | a. none    | X <sup>d</sup>        | ✓        | ✓   | ✓   | ✓   | ✓   |
|                        | b. brush   | X <sup>d</sup>        | -        | -   | -   | -   | -   |
|                        | c. trees   | X <sup>d</sup>        | ✓        | ✓   | ✓   | ✓   | ✓   |

Notes. X = condition is used to define Gunnery Table IV. ✓ = condition is covered by exercise.  
 - = condition is not used to define Gunnery Table VII, or not covered by exercise.

<sup>a</sup>Friendly vehicles may be added to the target array at the commander's discretion. <sup>b</sup>Simulate NBC engagement by requiring that Tasks 2 and 3 be fired with crew wearing protective masks. <sup>c</sup>Exercise simulates failure of TIS only. <sup>d</sup>Terrain features are range dependent.

## Appendix D

### Sample Annual Gunnery Training Program

This appendix presents a sample program for training armor gunnery at the company (armory) level in the Army National Guard (ARNG). The program was derived using the principles of the detailed training strategy described in the body of this report. Figure D-1 presents the program in the form of a training schedule. This training schedule demonstrates how that strategy can be applied to the development of an annual training schedule; actual company-level training schedules will vary as a result of such factors as the availability of range areas, preplanned on-tank training events, and other company training responsibilities. In addition to device training, the schedule shows the gunnery and tactical gate tables; however, it does not show training events unrelated to tank gunnery or other events unrelated to training.

The sample schedule was developed under the assumption that the most manageable gunnery training program would incorporate a generic schedule that outlines the training to be conducted by crews at different levels of training and the company's preplanned training events. Crews would then be placed into that schedule based upon their level of training proficiency, as determined by diagnostic testing. Another assumption was that the unit is able to arrange access, when scheduled, to all devices at its disposal. This includes the use of Simulation Networking (SIMNET)--or its planned successor, the Mobile Close Combat Tactical Trainer (M-CCTT)--during annual training, as recommended by the Armor Training Strategy, ST 17-12-7 (U.S. Army Armor School [USAARMS], 1990).

The Tank Crew Gunnery Skills Test (TCGST) is to be administered to all crews in the company during the month following annual training (AT). In addition, crews that did not complete the previous gunnery cycle will conduct preliminary training on those tasks the commander decides warrant remedial training. Crews that have completed the previous gunnery cycle (i.e., those in sustainment training) will be administered crew-level diagnostic exercises on the devices. Those crews that fail both the intermediate and basic diagnostics will begin training at the basic level; those that fail the intermediate, but not the basic diagnostic, will begin at the intermediate level; and those that pass the intermediate level will conduct additional training on the devices, given device availability. This additional training should be used to provide crews an opportunity to complete training on the devices (e.g., to achieve certification on the Mobile Conduct-of-Fire Trainer [M-COFT], to complete the Guard Unit Armory Device Full-Crew Interactive Simulation Trainer, Armor [GUARD FIST I] evaluation exercises). In keeping with the strategy, those crews that pass the first administration of the intermediate diagnostic are to be retested during the sixth month of the schedule to determine if they have retained their skills. Crews that fail are to conduct device training at the intermediate level. If the crew once again passes the diagnostic, it is to continue additional training on devices.

Three months are allotted for device training at both the basic and intermediate levels for the crews conducting initial training. However, crews may complete device training at a particular level in less than three months by attaining the goal for that device for that phase (i.e., by reaching the

desired proficiency level or by passing the device diagnostic). In such cases, those crews should not continue training beyond the goal. Instead, the remaining device time should be reallocated to crews that have not yet met the goal.

Crews in sustainment training are also allotted three months for device training at both the basic and intermediate levels. The strategy states that crews in sustainment training should require about half of the time on devices as crews in initial training. However, the strategy also states that crews at the lower levels of training are to receive priority in scheduling time on devices. Consequently, although crews in sustainment should be able to complete device basic or intermediate training in much less than three months, three months are allotted to allow adequate time to schedule their sessions on the devices around those of crews with a higher priority. As in initial training, the time allotted to crews that complete training for a level in less than three months should be reallocated to crews that have not completed training for that level.

Note that the amount of device time allocated to initial training in a month may in some cases exceed the amount of time available for training during a weekend drill. As a result, alternate methods may have to be used to alleviate demand for the device. Some of those methods, which are described in the text of this report, include (a) the use of split assemblies, (b) concurrent use of training devices, and (c) cooperative learning on devices. Another method that may be used is the reallocation of Unit Training Assemblies (UTAs), which are 4-hr training periods, to extend the amount of time available for training during weekend drills. Additional training assemblies (ATAs) can also be used to reduce the demand for devices. The use of ATAs for this purpose is consistent with the Armor Training Strategy, ST 17-12-7 (USAARMS, 1990) which recommends ATAs be held every other month to conduct device training. Also, although the present training schedule includes all devices applicable at each level, it is unlikely that units will have access to all devices. Lack of access to certain devices would, in effect, reduce the amount of time required for device training.

This schedule and the sample gunnery training plan presented in the Mobile Conduct-of-Fire Trainer Microstrategy, ST 17-12-7-2 (USAARMS, 1990) are similar in that they both show when during the gunnery year the various training devices should be used, and when gates for on-tank training should be conducted. The schedules are also alike in that they use the number and length of device training sessions recommended in the Armor Training Strategy, ST 17-12-7 (USAARMS, 1990). However, the two sample training programs differ in three ways. First, the program presented in ST 17-12-7-2 divides device usage evenly over the entire gunnery year--that is, the devices are to be used on either a monthly, bi-monthly, or quarterly basis. In the present schedule, on the other hand, device usage is determined by the level of gunnery training being conducted--that is, the devices are to be used during the phases of training that they support. Second, through the use of device diagnostics, the present program specifies the level at which crews conducting sustainment should begin; the Armor School's program does not suggest how to handle crews at different levels of proficiency. Third, the present program is more realistic because it shows when device training takes place in relation to training in the field.

| MONTH <sup>a</sup>            | 1                                                                                                             | 2                                                                                                                                      | 3                                                                                                                                         | 4                                                                                                         | 5                                                                     | 6                                                                                                                                             |
|-------------------------------|---------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Unit Training Events          | Administer Crew Device Diagnostics & TCGST                                                                    | Device Training                                                                                                                        | Device Training                                                                                                                           | Device Training                                                                                           | Field Training                                                        | Device Training                                                                                                                               |
| Crews in Initial Training     | No diagnostics. Crews conduct PRELIMINARY training, as deemed necessary by commander, using TopGun/VIGS/GF-I. | Begin BASIC Training<br>- TopGun: 4 20-min sessions<br>- VIGS: 2 1-hr sessions<br>- M-COFT: 2 2-hr sessions<br>- GF-I: 2 1-hr sessions | Continue BASIC Training<br>- TopGun: 4 20-min sessions<br>- VIGS: 2 1-hr sessions<br>- M-COFT: 2 2-hr sessions<br>- GF-I: 2 1-hr sessions | Complete BASIC Training<br>- VIGS: 2 1-hr sessions<br>- M-COFT: 2 2-hr sessions<br>- GF-I: 1 1-hr session | Conduct Gunnery Table IV or Tank Commanders Proficiency Course (TCPC) | Begin INTERMEDIATE Training<br>- TopGun: 4 20-min sessions<br>- VIGS: 2 1-hr sessions<br>- M-COFT: 2 2-hr sessions<br>- GF-I: 2 1-hr sessions |
|                               | Crews that fail Intermediate & Basic diagnostics conduct BASIC Training.                                      | Begin BASIC Training using<br>- TopGun<br>- VIGS<br>- M-COFT<br>- GF-I                                                                 | Continue BASIC Training using<br>- TopGun<br>- VIGS<br>- M-COFT<br>- GF-I                                                                 | Complete BASIC Training using<br>- VIGS<br>- M-COFT<br>- GF-I                                             | Conduct Gunnery Table IV or Tank Commanders Proficiency Course (TCPC) | Begin INTERMEDIATE Training using<br>- TopGun<br>- VIGS<br>- M-COFT<br>- GF-I                                                                 |
| Crews in Sustainment Training | Crews that fail Intermediate diagnostic conduct INTERMEDIATE Training.                                        | Begin INTERMEDIATE Training using<br>- TopGun<br>- VIGS<br>- M-COFT<br>- GF-I                                                          | Continue INTERMEDIATE Training using<br>- TopGun<br>- VIGS<br>- M-COFT<br>- GF-I                                                          | Complete INTERMEDIATE Training using<br>- VIGS<br>- M-COFT<br>- GF-I                                      | Conduct Gunnery Table IV or Tank Commanders Proficiency Course (TCPC) | Conduct additional device training as needed, given device availability.                                                                      |
|                               | Crews that pass Intermediate diagnostic conduct additional device training.                                   | Conduct additional device training as needed, given device availability.                                                               | Continue additional device training.                                                                                                      | Continue additional device training.                                                                      | Conduct Gunnery Table IV or Tank Commanders Proficiency Course (TCPC) | Administer Intermediate diagnostic. If failed, begin INTERMEDIATE training. If passed, continue additional device training.                   |

<sup>a</sup>The numbers in the row labeled MONTH correspond to the number of months since annual training.

Figure D-1. Sample annual gunnery training schedule.

| MONTH <sup>a</sup>            | 7                                                                                                                                                | 8                        | 9                                                                                                                                                                 | 10                                                    | 11                                                    | 12                                                                                                       |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| Unit Training Events          | Device Training                                                                                                                                  | Field Training           | Device Training & Administer SIMNET Diagnostic                                                                                                                    | Field Training                                        | Field Training                                        | Annual Training -Device & Field Training                                                                 |
| Crews in Initial Training     | Continue INTERMEDIATE Training<br>- TopGun: 4 20-min sessions<br>- VIGS: 2 1-hr sessions<br>- M-COFT: 3 2-hr sessions<br>- GF-I: 2 1-hr sessions | Conduct Gunnery Table IV | Complete INTERMEDIATE Training<br>- VIGS: 2 1-hr sessions<br>- M-COFT: 2 2-hr sessions<br>- GF-I: 1 1-hr session (if needed)<br>- SIMNET: 2 4-hr platoon sessions | Prepare for Gunnery Table VIII, Tactical Tables F & I | Prepare for Gunnery Table VIII, Tactical Tables F & I | Conduct Gunnery Table VIII, Tactical Tables F & I. If needed, conduct 2 4-hr platoon sessions on SIMNET. |
|                               | Continue INTERMEDIATE Training using<br>- TopGun<br>- VIGS<br>- M-COFT<br>- GF-I                                                                 | Conduct Gunnery Table IV | Complete INTERMEDIATE Training using<br>- VIGS<br>- M-COFT<br>- GF-I (if needed)<br>- SIMNET: 2 4-hr platoon sessions                                             | Prepare for Gunnery Table VIII, Tactical Tables F & I | Prepare for Gunnery Table VIII, Tactical Tables F & I | Conduct Gunnery Table VIII, Tactical Tables F & I. If needed, conduct 2 4-hr platoon sessions on SIMNET. |
| Crews in Sustainment Training | Continue additional device training.                                                                                                             | Conduct Gunnery Table IV | Continue additional device training. If needed, conduct 2 4-hr platoon sessions on SIMNET.                                                                        | Prepare for Gunnery Table VIII, Tactical Tables F & I | Prepare for Gunnery Table VIII, Tactical Tables F & I | Conduct Gunnery Table VIII, Tactical Tables F & I. If needed, conduct 2 4-hr platoon sessions on SIMNET. |
|                               | Continue INTERMEDIATE training or additional device training.                                                                                    | Conduct Gunnery Table IV | Continue INTERMEDIATE or additional device training. If needed, conduct 2 4-hr platoon sessions on SIMNET.                                                        | Prepare for Gunnery Table VIII, Tactical Tables F & I | Prepare for Gunnery Table VIII, Tactical Tables F & I | Conduct Gunnery Table VIII, Tactical Tables F & I. If needed, conduct 2 4-hr platoon sessions on SIMNET. |

<sup>a</sup>The numbers in the row labeled MONTH correspond to the number of months since annual training.

Figure D-1. Sample annual gunnery training schedule (continued).