TC 3-22.50

HEAVY MACHINE GUN
M2 Series

MAY 2017

This publication supersedes FM 3-22.65, 3 March 2005.

Headquarters, Department of the Army

Training Circular
No. 3-22.50

Headquarters
Department of the Army
Washington, DC, 19 May 2017

Heavy Machine Gun M2 Series

Contents

		Page
	PREFACE	**viii**
	INTRODUCTION	**ix**
Chapter 1	**OVERVIEW**	**1-1**
	Safe Weapons Handling	1-1
	Rules of Firearms Safety	1-2
	Weapon Safety Status	1-3
	Weapon Control Status	1-4
	Overmatch	1-4
Chapter 2	**PRINCIPLES OF OPERATION**	**2-1**
	Description	2-1
	Major Components	2-1
	Cycle of Function	2-4
	Cooling	2-22
Chapter 3	**AIMING DEVICES**	**3-1**
	Functions	3-1
	Units of Angular Measurement	3-1
	Electromagnetic Spectrum	3-4
	Iron Sight	3-7
	Thermal Sight	3-8
	Pointers, Illuminators, and Lasers	3-10
Chapter 4	**MOUNTABLE EQUIPMENT**	**4-1**
	M3 Machine Gun Tripod	4-1
	M205 Lightweight Machine Gun Tripod	4-4
	MK 64 Machine Gun Mount	4-9
	MK 93 Machine Gun Mount	4-10
	Adaptive Rail System	4-10
	Mounted Lights	4-10
Chapter 5	**EMPLOYMENT**	**5-1**
	Firing Situations	5-1
	Shot Process	5-2
	Target Acquisition	5-3

This publication supersedes FM 3-22.65, 3 March 2005.

Chapter 6 **STABILITY** **6-1**
Support 6-1
Muscle Relaxation 6-7
Natural Point of Aim 6-7
Recoil Management 6-7
Shooter–gun Angle 6-8
Field of View 6-8
Stabilization 6-8
Firing Positions 6-9
Chapter 7 **AIM** **7-1**
Common Engagements 7-1
Weapon Orientation 7-1
Sight Alignment 7-3
Sight Picture 7-4
Point of Aim 7-5
Desired Point of Impact 7-5
Common Aiming Errors 7-5
Complex Engagements 7-6
Target Conditions 7-9
Environmental Conditions 7-15
Gunner Conditions 7-20
Compound Conditions 7-20
Chapter 8 **CONTROL** **8-1**
Arc of Movement 8-1
Trigger Control 8-2
Breathing Control 8-3
Workspace Management 8-3
Calling the Shot 8-3
Rate of Fire 8-3
Follow-through 8-4
Malfunctions 8-5
Chapter 9 **MOVEMENT** **9-1**
Movement Techniques 9-1
Movement of the Gun to Other Mounts 9-5
Appendix A **AMMUNITION** **A-1**
Appendix B **BALLISTICS** **B-1**
Appendix C **MACHINE GUN THEORY** **C-1**
Appendix D **DRILLS** **D-1**
Appendix E **ZEROING** **E-1**
Appendix F **QUALIFICATION** **F-1**
GLOSSARY **Glossary-1**
REFERENCES **References-1**
INDEX **Index-1**

Figures

Figure 1-1. Accuracy, precision, and consistency 1-1
Figure 1-2. Small unit range overmatch 1-6
Figure 2-1. Major components 2-2
Figure 2-2. Rear view of ammunition belt held in the feedway by the belt-holding pawl 2-5
Figure 2-3. Bolt to the rear, belt feed slide extended out the side of cover 2-6
Figure 2-4. Belt feed slide moving back into cover with belt feed pawl behind first round 2-7
Figure 2-5. Extractor withdrawing first round from the feedway 2-8
Figure 2-6. Cartridge entering the T-slot in the bolt 2-9
Figure 2-7. Cartridge fully inside T-slot 2-10
Figure 2-8. Chambering procedure 2-11
Figure 2-9. Recoiling groups moving forward initiating the locking process 2-12
Figure 2-10. Recoiling groups locked together 2-13
Figure 2-11. Firing 2-14
Figure 2-12. Breech lock being forced out of its recess in the bolt 2-15
Figure 2-13. Unlocking—recoil movement completed 2-17
Figure 2-14. Extracting 2-18
Figure 2-15. Ejecting 2-19
Figure 2-16. Recoiling group forward, gun not cocked 2-20
Figure 2-17. Hooked notch of the firing pin extension engaged by the sear notch 2-21
Figure 2-18. Recoiling groups forward, gun cocked 2-22
Figure 3-1. Minute of angle example 3-2
Figure 3-2. Mil, example 3-3
Figure 3-3. Stadia reticle example 3-4
Figure 3-4. Electromagnetic spectrum 3-6
Figure 3-5. Iron sight 3-7
Figure 3-6. Thermal weapon sight, example 3-8
Figure 3-7. Weapon thermal sights 3-9
Figure 3-8. AN/PEQ-2, TPIAL 3-12
Figure 3-9. AN/PEQ-15, ATPIAL 3-14
Figure 3-10. AN/PEQ-15A, DBAL-A2 3-16
Figure 3-11. AN/PSQ-23, STORM 3-18
Figure 4-1. M3 tripod, pintle and traversing and elevating mechanism 4-2
Figure 4-2. T&E mechanism attached to the M3 tripod 4-3
Figure 4-3. T&E mechanism 4-4
Figure 4-4. M205 lightweight machine gun tripod components 4-5
Figure 4-5. M205 pintle assembly 4-5
Figure 4-6. M205 pintle assembly fully and not fully seated 4-6
Figure 4-7. M205 T&E assembly components 4-7
Figure 4-8. MK 64 carriage and cradle assembly 4-9

Figure 4-9. MK 93 carriage and cradle assembly 4-10
Figure 6-1. Seated position firing one handed 6-3
Figure 6-2. Prone position firing one handed 6-4
Figure 6-3. Seated position firing two handed 6-5
Figure 6-4. Prone position firing two handed 6-6
Figure 6-5. Firing position stability example 6-9
Figure 6-6. Standing position, example 6-10
Figure 6-7. Seated position, crossed ankle 6-11
Figure 6-8. Seated position, open-legged, legs over tripod 6-11
Figure 6-9. Seated position, example 6-12
Figure 6-10. Prone position, example 6-14
Figure 7-1. Horizontal weapons orientation 7-2
Figure 7-2. Vertical weapons orientation 7-3
Figure 7-3. Front sight post or reticle aim focus 7-4
Figure 7-4. Immediate hold locations for windage and lead example 7-7
Figure 7-5. Oblique target example 7-9
Figure 7-6. Mil relation 7-13
Figure 7-7. Adjusted aiming point method of fire adjustment 7-14
Figure 7-8. Wind value 7-16
Figure 7-9. Wind effects 7-17
Figure 7-10. Compound wind and lead-determination example 7-21
Figure 8-1. Arc of movement, example 8-2
Figure 8-2. Ruptured cartridge case extractor 8-9
Figure 8-3. Ruptured cartridge case extractor aligned with the chamber 8-9
Figure 9-1. Dragging of the gun into position 9-2
Figure 9-2. Two-man carry 9-3
Figure 9-3. Three-man carry with hot barrel 9-4
Figure 9-4. Three-man carry with cold barrel 9-5
Figure A-1. Small arms ammunition cartridges A-1
Figure A-2. Cartridge case A-2
Figure A-3. Propellant A-2
Figure A-4. Caliber .50 primer detail A-3
Figure A-5. Bullet example, armor-piercing cartridge A-3
Figure A-6. Ball cartridge A-4
Figure A-7. Ball with tracer cartridge A-4
Figure A-8. Armor-piercing incendiary cartridge A-5
Figure A-9. Plastic practice ball cartridge A-5
Figure A-10. Blank cartridge A-5
Figure A-11. Dummy cartridge A-6
Figure B-1. External ballistic terms B-2
Figure B-2. Firing table data with max ordinate, example B-5
Figure B-3. Crosswind example B-6

Figure B-4. Change in range example B-7
Figure B-5. Lethal zone B-12
Figure C-1. Maximum ordinates at key ranges C-2
Figure C-2. Cone of fire C-3
Figure C-3. Classes of fire with respect to the ground C-4
Figure C-4. Classes of fire with respect to the target C-5
Figure C-5. Classes of fire with respect to the gun C-7
Figure C-6. Linear target and one gun C-9
Figure C-7. Linear target with depth C-10
Figure C-8. Engagement of linear targets with depth C-11
Figure C-9. Deep target C-12
Figure C-10. Engagement of deep targets C-13
Figure C-11. Engagement of area targets (objective) C-14
Figure C-12. Components of minimum clearance C-15
Figure C-13. Application of gunner's rule C-16
Figure C-14. Application of leader's rule C-17
Figure C-15. Minimum and maximum position defilade, partial defilade, and direct lay areas C-18
Figure C-16. Aiming point method C-19
Figure C-17. Line of aim and placement of center of beaten zone on target C-21
Figure C-18. April column with four machine guns C-23
Figure D-1. Release front leg cam handle D-4
Figure D-2. Place front leg in the deployed position D-5
Figure D-3. Remove T&E from mounting bracket D-6
Figure D-4. Spread rear tripod legs D-6
Figure D-5. Align the traverse bar index notch with dowel pin D-7
Figure D-6. Lock traverse bar D-7
Figure D-7. Extend tripod legs D-8
Figure D-8. Remove pintle from front leg D-9
Figure D-9. Install pintle onto front mounting point D-9
Figure D-10. Seat pintle onto tripod D-10
Figure D-11. Mount elevation bracket onto rear mounting point of weapon D-11
Figure D-12. Position recoiling parts in preparation for barrel installation D-12
Figure D-13. Install barrel D-13
Figure D-14. Inspect barrel and barrel extension D-14
Figure D-15. Place weapon on automatic fire D-14
Figure D-16. Charge weapon to ensure barrel moves freely D-15
Figure D-17. Place weapon on safe and single shot mode D-15
Figure D-18. Load ammunition D-20
Figure D-19. Remove ammunition D-21
Figure D-20. Clear chamber and T-slot D-21
Figure E-1. Rear sight setting for 10-meter zero E-2

Figure E-2. 10-meter zero sight picture E-3
Figure E-3. 10-meter zero group size E-3
Figure E-4. Rear sight setting for field zero E-5
Figure E-5. Windage zero E-5
Figure E-6. Sight alignment of double E-type silhouettes at 500 meters E-6
Figure E-7. Marking shot groups E-7
Figure E-8. Horizontal and vertical diagnostic shots E-10
Figure F-1. Basic machine gun target F-2
Figure F-2. Common errors found on the basic machine gun target F-3
Figure F-3. Completed DA Form 7448, example F-10
Figure F-4. Completed DA Form 7449, example. F-12
Figure F-5. Completed DA Form 7450, example F-17
Figure F-6. Completed DA Form 7451 (front), example F-20
Figure F-7. Completed DA Form 7451 (back), example F-22

Tables

Table 1-1. Weapon safety status 1-4
Table 1-2. Weapon control status 1-4
Table 2-1. M2 and M2A1 weapon data 2-4
Table 3-1. Laser aiming devices for the M2 3-10
Table 4-1. M3 tripod equipment data 4-1
Table 4-2. M205 tripod equipment data 4-8
Table 5-1. Shot process example 5-2
Table 7-1. Standard lead for a moving dismount target 7-8
Table 7-2. Standard lead for a moving truck target 7-8
Table 7-3. Recognition of dismounted target 7-11
Table 7-4. Recognition method 7-11
Table 7-5. Wind hold dismount example 7-19
Table 7-6. Wind hold truck example 7-19
Table 8-1. Malfunctions and their causes 8-6
Table A-1. Small arms color codes and package marking A-7
Table A-2. Caliber .50, M33, ball A-8
Table A-3. Caliber .50, M17, tracer A-9
Table A-4. Caliber .50, M8, API A-10
Table A-5. Caliber .50, M20, API-T A-11
Table A-6. MK 211 MOD 0, API A-12
Table A-7. Caliber .50, MK 257, API-DT A-13
Table A-8. Caliber .50, M903, SLAP A-14
Table A-9. Caliber .50, M962 SLAP-T A-15
Table A-10. Caliber .50, M858, SRTA A-16

Table A-11. Caliber .50, M860, SRTA A-17
Table A-12. Caliber .50, M1A1, blank A-18
Table B-1. Level of thickness required for protection B-9
Table B-2. Maximum penetration for armor-piercing cartridge B-9
Table B-3. Maximum penetration for ball cartridge B-10
Table D-1. Barrel change frequency D-20
Table F-1. Ammunition requirements F-1
Table F-2. 10-Meter Practice Fire F-4
Table F-3. Firing Table I, Day Practice F-7
Table F-4. Firing Table II, Day Qualification F-11
Table F-5. Firing Table III, Night Practice F-13
Table F-6. Firing Table IV, Night Qualification F-19

Preface

Training Circular (TC) 3-22.50 uses joint terms where applicable. Selected joint and Army terms and definitions appear in both the glossary and the text. Terms for which TC 3-22.50 is the proponent publication (the authority) are marked with an asterisk (*) in the glossary. Definitions for which TC 3-22.50 is the proponent publication are boldfaced in the text. For other definitions shown in the text, the term is italicized and the number of the proponent publication follows the definition.

Training Circular 3-22.50 familiarizes the Soldier with the M2 and M2A1 caliber .50 machine guns including their operation, components, and attachments. The intent of TC 3-22.50 is to train Soldiers on tactics and techniques. The appendices in this TC discuss ammunition charts, ballistic information, machine gun theory, drills, zero procedures, and qualifications.

The principal audience for TC 3-22.50 is the Soldier firing the machine gun in training and combat and the machine gun team's leader. Commanders, staffs, and subordinates ensure that their decisions and actions comply with applicable United States, international, and in some cases host-nation laws and regulations. Commanders at all levels ensure that their Soldiers operate in accordance with the law of war and the rules of engagement. (See FM 27-10.)

Uniforms depicted in this manual were drawn without camouflage for clarity of the illustration.

This publication applies to the active Army, the Army National Guard (ARNG)/Army National Guard of the United States (ARNGUS), and the United States Army Reserve (USAR).

The proponent of TC 3-22.50 is the United States Army Maneuver Center of Excellence. The preparing agency is the Maneuver Center of Excellence, Fort Benning, Georgia. Send comments and recommendations on DA Form 2028 (*Recommended Changes to Publications and Blank Forms*) to Commander, Maneuver Center of Excellence, Directorate of Training and Doctrine, Doctrine and Collective Training Division, ATTN: ATZB-TDD (TC 3-22.50), 1 Karker Street, Fort Benning GA 31905-5410; by email to usarmy.benning.mcoe.mbx.doctrine@mail.mil, or submit an electronic DA Form 2028.

Introduction

TC 3-22.50 covers the M2 and M2A1 heavy barrel caliber .50 machine guns in the ground-mount role. The same principles and techniques apply to mounted weapons as well. The head space and timing are fixed on the M2A1 and it has a different barrel assembly and a few other subtle differences. Most of the book assumes use of the M2A1 with the M205 lightweight tripod. Soldiers using the M2 or the M3 tripod should read their respective technical manuals.

TC 3-22.50 has nine chapters and six appendices. Each chapter and appendix builds on the one before. TC 3-22.50 supports (but does not cover) the Army's training strategy for the weapon at the individual level. TC 3-22.50 describes the aiming devices for the M2/M2A1 that enhance the Soldier's target detection and acquisition skills. TC 3-22.50 provides key recognition information to build the Soldier's skills in correctly identifying potential targets as friend, foe, or noncombatant (neutral) once detected.

Chapters 1 through 4 provides an overview of the weapon (chapter 1) and discusses principles of operation (chapter 2), aiming devices (chapter 3), and mountable and mounting equipment (chapter 4).

Chapters 5 through 9 explain employment, stability, aiming, control, and movement, while focusing on the Soldier skills needed to produce well-aimed shots.

Appendixes A and B provide detailed information about ammunition and ballistics. Appendix C discusses advanced engagement concepts. Appendix D provides common tactical drills used in training and combat that directly support tactical engagements. Appendix E describes zeroing procedures. Appendix F provides qualification.

This page intentionally left blank.

Chapter 1
Overview

Chapter 1 describes safe weapon handling, tactical applications, and control measures for handling the weapons, and surveys the concepts of overmatch as it pertains to a Soldier's individual weapon.

Each Soldier must place accurate fires on threat targets. To do this, the Soldier must understand the functional elements of the shot process (chapter 5), the weapon's principles of operation (chapter 2), ammunition differences and ballistics (appendix A), and the various engagement techniques (chapter 8) that are essential to build proficiency with the weapon. This combination of knowledge and practice builds and sustains the skills Soldiers need to place accurate and precise shots consistently during combat operations (see figure 1-1).

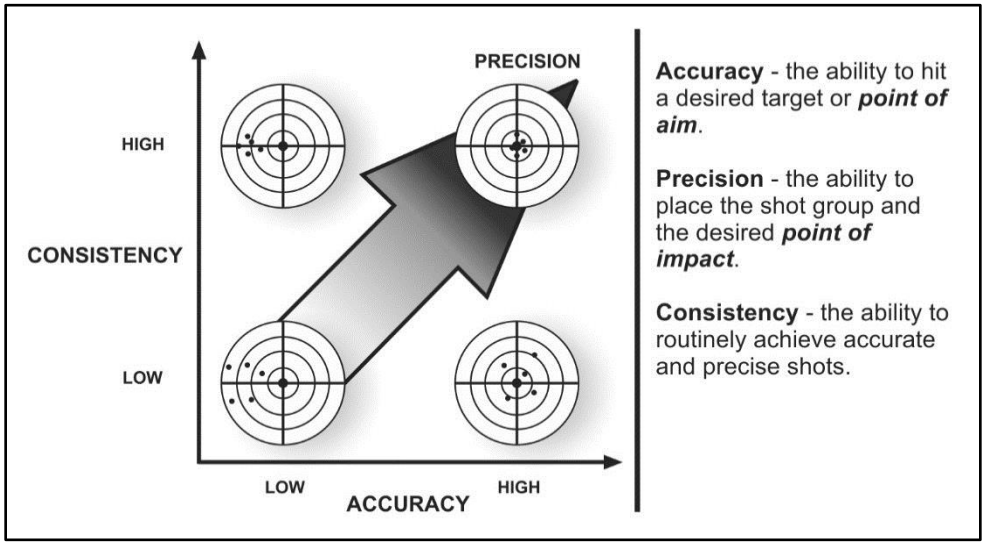


Figure 1-1. Accuracy, precision, and consistency

SAFE WEAPONS HANDLING

1-1. Safe weapons handling procedures offer a standardized way for Soldiers to handle, operate, and employ the weapon safely and effectively:

- The Soldier must maintain situational understanding of friendly forces, the status of the weapon, and the environment to properly handle the weapon. The smart, adaptive, and disciplined Soldier is the primary safety mechanism for all weapons under their control.
- The weapon is the primary tool of the Soldier to defeat threats in combat. The Soldier must know how to operate the mechanical safeties built into the weapons they employ, as well as the principles of operation.

- The environment is the Soldier's surroundings. The Soldier must be aware of muzzle discipline, the nature of the target, and what is behind the target. Threats commonly mix with noncombatants, so the Soldier needs to be able to quickly tell the difference.

1-2. Soldiers must be cognitively aware of three distinct weapons handling measures to safely and effectively handle weapons The weapons handling measures are—

- Rules of firearms safety.
- Weapons safety status.
- Weapons control status.

1-3. The weapons handling measures provide redundant safety measures when handling any weapon or weapon system in training and operational environments. A Soldier would have to violate two of the rules of firearms safety or violate a weapon safety status in order to have a negligent discharge.

Note. Unit standard operating procedures (SOPs), range SOPs, or the operational environment may dictate additional safety protocols; however, the rules of firearms safety are always applied. If a unit requires Soldiers to violate these safety rules for any reason, such as for the use of blank rounds or other similar training munitions during training, the unit commander must take appropriate risk mitigation actions.

RULES OF FIREARMS SAFETY

1-4. The rules of firearms safety are standardized for any weapon a Soldier may employ. Soldiers must adhere to these precepts during training and combat operations, regardless of the type of ammunition employed, except as noted above.

RULE 1: TREAT EVERY WEAPON AS IF IT WERE LOADED

1-5. Any weapon handled by a Soldier must be treated as if it is loaded and prepared to fire. Whether or not a weapon is loaded should not affect how a Soldier handles the weapon in any instance.

1-6. Soldiers must take the appropriate actions to ensure the proper weapon status is applied during operations, whether in combat or training.

RULE 2: NEVER POINT THE WEAPON AT ANYTHING YOU DO NOT INTEND TO DESTROY

1-7. Soldiers must be aware of the orientation of their weapon's muzzle and what is in the path of the projectile if the weapon fires. Soldiers must ensure the path between the muzzle and target is clear of friendly forces, noncombatants, or anything the Soldier does not want to strike.

1-8. When this is unavoidable, the Soldier must minimize the amount of time the muzzle is oriented toward people or objects they do not intend to shoot while simultaneously applying the other three rules of firearms safety.

RULE 3: KEEP THUMB STRAIGHT AND OFF THE TRIGGER UNTIL READY TO FIRE

1-9. Soldiers must not place their thumb on the trigger unless they intend to fire the weapon. The Soldier is the most important safety feature on any weapon. Mechanical safety devices are not available on all types of weapons. When mechanical safeties are present, Soldiers must not rely upon them solely for safe operation knowing that mechanical measures may fail.

1-10. Whenever possible, Soldiers should move the weapon to mechanical safe when a target is not present. If the weapon does not have a traditional mechanical safe, the thumb acts as the primary safety.

RULE 4: ENSURE POSITIVE IDENTIFICATION OF THE TARGET AND ITS SURROUNDINGS

1-11. The disciplined Soldier can positively identify the target and knows what is in front of and what is beyond it. The Soldier is responsible for all bullets fired from their weapon including the projectile's final destination.

1-12. Application of this rule minimizes the possibility of fratricide, collateral damage, or damage to infrastructure or equipment. It also prepares the Soldier for any follow-on bursts that may be required.

WEAPON SAFETY STATUS

1-13. Weapon safety status is a standard code that uses common colors (green, amber, red, and black) to represent the level of readiness for a given weapon. Each color represents a specific series of actions that are applied to a weapon. The colors are used in training and combat to place or maintain a level of safety relevant to the current task or action of a Soldier, small unit, or group. If the component, assembly, or part described is unclear, refer to the weapon's technical manual (TM 9-1005-213-10) or chapter 2 of this publication. Table 1-1, page 1-4, shows weapons safety status by color code.

GREEN

1-14. Set the trigger block to SAFE, place the bolt latch release in the single-shot position. Remove the weapon's ammunition belt, ensure the chamber and T-slot are empty, the bolt is forward.

Note. The command given to direct a GREEN safety status is GREEN AND CLEAR or GO GREEN

AMBER

1-15. Set the trigger block to SAFE, the bolt latch release is in the single-shot or automatic position (based upon the situation). Load a belt of ammunition into the feed way until the belt-holding pawls hold the first cartridge, the chamber and T-slot are empty, and the bolt is forward.

Note. The command given to direct an AMBER safety status is LOAD AMMUNITION.

RED

1-16. Set the trigger block to SAFE, the bolt latch release is in the single-shot or automatic position (based upon the situation). Load a belt of ammunition into the feed way until the first cartridge is held by the belt-holding pawls. The machine gun is charged twice, moving a round into the chamber, the bolt is forward and locked.

Note. The command given to direct a RED safety status is MAKE READY.

BLACK

1-17. A belt of ammunition is loaded into the feed way until the first cartridge is held by the belt-holding pawls of the weapon. The machine gun is charged twice, moving a round into the chamber. The bolt is forward and locked. Set the trigger block to Fire, the bolt latch release is in the single-shot or automatic position (based upon the situation). The Soldier's thumb(s) are in position to fire the machine gun. Upon completion of the engagement or the order to cease fire is given the Soldier will immediately place the weapon into the red status.

Note. The command given to direct a BLACK safety status is driven by the unit's SOP, ROE, or the command, FIRE.

Table 1-1. Weapon safety status

STATUS	GREEN	AMBER	RED	BLACK
Function	**CLEAR**	**PREPARED**	**READY, SAFE**	**READY, FIRE**
Commands	**GREEN AND CLEAR**	**LOAD AMMUNITION**	**MAKE READY**	**SOP / ROE / FIRE**
Ammunition	None	Belt in feed way	Belt in and round chambered	Belt in and round chambered
Bolt	Forward	Forward	Forward	Forward
Chamber	Empty	Empty	Locked	Locked
Safety	Safe	Safe	Safe	Fire
Trigger	OFF	Off	Off	On
Legend: SOP – standard operating procedure; ROE – rules of engagement				

WEAPON CONTROL STATUS

1-18. A weapon control status is a tactical method of fire control given by a leader. The weapon control status incorporates the tactical situation, rules of engagement for the area of operations, and expected or anticipated enemy contact. The weapon control status outlines the target identification conditions under which friendly elements may engage a perceived threat with direct fire.

1-19. Table 1-2 describes the standard weapon control status used in tactical operations, both in training and combat. They describe when the gunner is authorized to engage a threat target once the threat conditions have been met.

Table 1-2. Weapon control status

WEAPONS HOLD	Engage only if engaged or ordered to engage.
WEAPONS TIGHT	Engage only if target is positively identified as enemy.
WEAPONS FREE	Engage targets not positively identified as friendly.

1-20. Both a weapon control and a weapon safety status are implemented and available to leaders to prevent fratricide and limit collateral damage. These postures or statuses are typically developed for a particular area of operations or type of mission. Leaders should clearly outline both for all Soldiers, typically in the operation order, warning order, or fragmentary order.

OVERMATCH

1-21. Overmatch includes applying learned skills, employing equipment, using technology effectively, and applying the proper force to create an unfair fight in favor of the Soldier. To achieve and maintain this advantage, the Soldier must have the following attributes:

- Smart, the ability to routinely generate understanding through changing conditions.
- Fast, the ability to physically and cognitively outmaneuver adversaries.
- Lethal, deadly in the application of force.
- Precise, consistently accurate in the application of power to ensure delivery of the right effects in time, space, and purpose.

1-22. This requires the Soldier to understand the key elements that build an unfair advantage, and exploit them at every opportunity during tactical operations. The components of overmatch are:

- Target detection, acquisition, and identification is the ability of the Soldier to detect and positively identify any suspected target as hostile at greater distances than their adversary can. The Soldier

must rely upon their training and their ability to leverage the capabilities of their optics, thermals, and sensors.

- Engagement range provides the Soldier with weapons, aiming devices, and ammunition weapons, aiming devices, and ammunition capable of striking and defeating a threat at a greater range than the adversary can detect or engage the friendly force with effective fires.
- Limited visibility gives the Soldier an advantage through technology and techniques and compounds the adversary's disadvantages during limited visibility conditions.
- Precision provides a weapon and ammunition package that enhances the Soldier's consistent application of bursts with a level of precision greater than the adversary's.
- Speed is the weapon, aiming devices, and accessories a Soldier employs, which must work in unison seamlessly, be intuitive to use, and leverage natural motion and manipulations to facilitate rapid initial and subsequent bursts during an engagement at close quarters, mid, and extended ranges.
- Terminal performance ensures that precise bursts delivered at extended ranges provide the highest probability to defeat the threat through exceptional ballistic performance.

1-23. Although not a component of overmatch, exceptional training is critical to create smart, fast, lethal, and precise Soldiers. Training builds proficiency in a progressive, logical, and structured way and gives Soldiers the skills needed to achieve overmatch against any adversary. This requires the training program to provide experience to the Soldier in all the components of overmatch to their fullest extent possible in the shortest amount of time.

TARGET DETECTION, ACQUISITION, AND IDENTIFICATION

1-24. The first component of overmatch at the Soldier level is the ability to detect targets as far away as possible during limited and low visibility conditions. This manual describes the aiming devices for the MK19 that enhance the Soldier's target detection and acquisition skills. The Soldier must be able to detect, acquire, and identify targets at ranges beyond the maximum effective range of their weapon and ammunition. In addition, this manual also provides key recognition information to build the Soldier's skills in correctly identifying potential targets as friend, foe, or noncombatant (neutral) once detected.

ENGAGEMENT RANGE

1-25. To ensure small unit success, the Soldier requires a weapon system that can engage threats at ranges greater than those of their adversaries. The weapon system creates a standoff distance advantage that allows the Soldier and other friendly forces to destroy the target outside the threat's maximum effective range.

1-26. Range overmatch provides a tactical engagement buffer that accommodates the Soldier's time to engage with precision fires. For example, a Soldier that can effectively engage personnel targets at 500 meters will have range overmatch of 10 to 20 percent over a threat rifleman. That 10 to 20 percent range difference is equivalent to a distance of 40 to 80 meters, which is about the distance a maneuvering threat can traverse in 15 to 40 seconds.

1-27. Figure 1-2, page 1-6, shows the battlefield from the Soldier's perspective. With mobile, maneuvering threats, the target acquisition capabilities must complement the engagement of those threats at the maximum effective range of the weapon, optic, and ammunition.

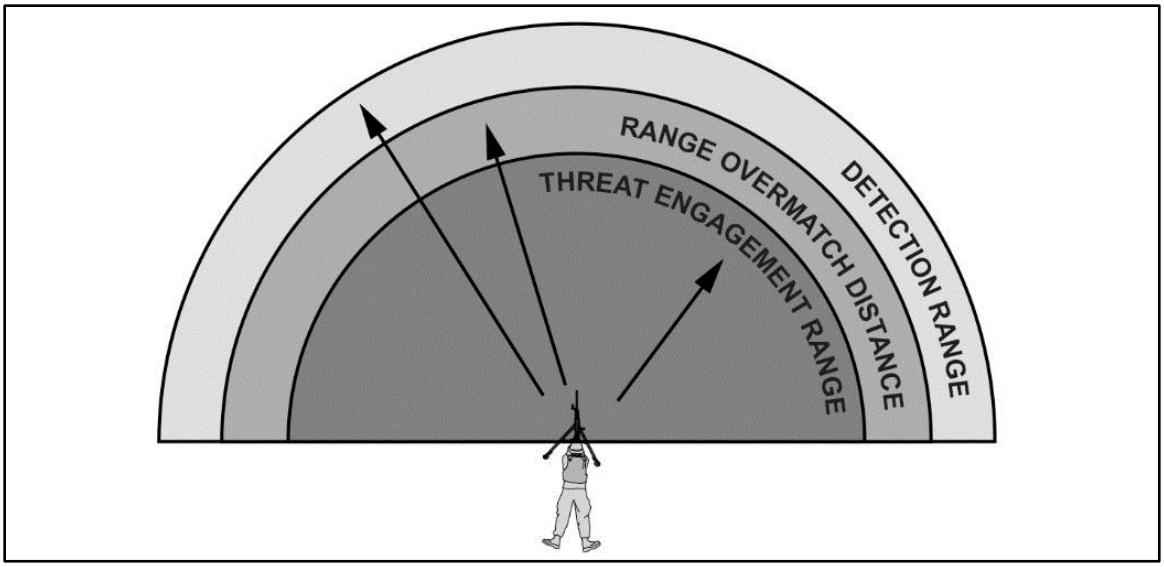


Figure 1-2. Small unit range overmatch

LIMITED VISIBILITY

1-28. Soldiers must be able to detect, acquire, identify, and engage threats in all light conditions, regardless of the tactical situation. Aiming devices minimize the effects of limited visibility without eliminating it completely.

1-29. Image intensifiers and thermal optics provide a significant overmatch capability, but they also have limitations and disadvantages. A general discussion of their capabilities, particularly what those systems can view within the spectrum of light is provided in chapter 3. Soldiers must understand what can be seen or viewed and what cannot be seen or viewed when using their assigned equipment. Understanding the advantages and limitations of their equipment directly impacts force protection, fratricide, collateral damage prevention, and maintaining overmatch during tactical operations.

PRECISION

1-30. The M2 and M2A1 are accurate to their maximum effective ranges of 1829 meters. Magnified aiming devices and superior ammunition increase consistency, reliability, and accuracy. The Soldier must build the skills to use the weapons and their aiming devices and ammunition effectively to deliver precision fires during tactical engagements.

SPEED

1-31. The close fight requires rapid manipulations, a balance of speed and accuracy, and few environmental concerns. Soldiers must move quickly and efficiently through their manipulations of fire control to maintain the maximum amount of muzzle orientation on the threat through the shot process. This second-nature efficiency of movement only comes from regular practice, drills, and repetition.

1-32. The foundation of speed of action is built through understanding the weapon, ammunition, ballistics, and principles of operation of the associated aiming devices. It is reinforced during drills (refer to appendix D), and the training program of the unit.

1-33. The goal of training to overmatch is to increase the speed at which the Soldier detects a threat, identifies it as hostile, and executes the shot process with the desired target effect.

TERMINAL BALLISTIC PERFORMANCE

1-34. Terminal ballistic performance is the action of a projectile from the time it strikes an object downrange until it comes to rest. The ammunition used with the M2/M2A1 performs exceptionally well out to its maximum effective range and beyond. (Refer to appendix A and appendix B.)

1-35. Soldiers must understand the capabilities of their ammunition, whether designed for training or combat use. That knowledge creates a respect for the weapon and ammunition. It also reinforces safe weapons handling procedures and builds the skills needed to deliver lethal fires.

1-36. Soldiers who know how and why their weapon systems, aiming devices, and ammunition function, and who undergo a rigorous training program that builds and strengthens their skills, become proficient Soldiers. The proficiencies and skills learned during training translate into smart, fast, lethal and precise Soldiers for the small unit during decisive action combat operations.

This page intentionally left blank.

Chapter 2

Principles of Operation

Chapter 2 provides the general characteristics, descriptions, available components, and cycles of function for the M2- and M2A1-series weapons. It summarizes how weapons operate, and key terms and definitions related to their functioning.

DESCRIPTION

2-1. The M2 (flexible) is a belt-fed, recoil-operated, air-cooled, crew-served machine gun. It provides automatic suppressive fire for offensive and defensive purposes. It can be used effectively against personnel, light armored vehicles, and low/slow flying aircraft. It can fire single shot and automatic, left- or right-hand feed. It can be ground mounted on the M3 tripod or the newer M205 lightweight tripod. The MK 93 Mod 0 and Mod 1 mounts can also be incorporated for use with the tripods.

2-2. The M2A1 has fixed headspace and timing. M2A1 parts should never be installed on the M2 at operator level. Also, the barrel extension assembly and bolt have been serialized and are unique to one particular weapon that shares the last four digits of the serial number on the receiver. If a new barrel extension or bolt is required, the headspace and timing must be adjusted at field maintenance. The M2A1 is used as a ground gun and mounted on the same equipment as the M2.

MAJOR COMPONENTS

2-3. Each weapon system has components, assemblies, subassemblies, and individual parts. The Soldier must be familiar with each of these and how it interacts with the others during the operation of the weapon. The M2 and M2A1 have the following eight major components: barrel assembly, backplate assembly, driving spring rod assembly, bolt assembly, barrel extension assembly, barrel buffer body assembly, barrel buffer assembly, and receiver assembly. These components are described below including their associated assemblies, subassemblies, and parts (see figure 2-1, page 2-2):

- Components are uniquely matched to their respective groups of fitted parts, pieces, assemblies or subassemblies that are required and necessary to perform a distinctive function in the operation of the weapon. Components are usually removable in one piece and are considered indivisible for a particular purpose or use.
- Assemblies are a group of subassemblies and parts that are fitted to perform specific set of functions during operation, and cannot be used independently for any other purpose.
- Subassemblies are a group of parts that are fitted to perform a specific set of functions during operation. Subassemblies are compartmentalized to complete a single specific task. They may be grouped with other assemblies, subassemblies and parts to create a component.
- Parts are the individual items that perform a function when attached to a subassembly, assembly, or component that serves a specific purpose.

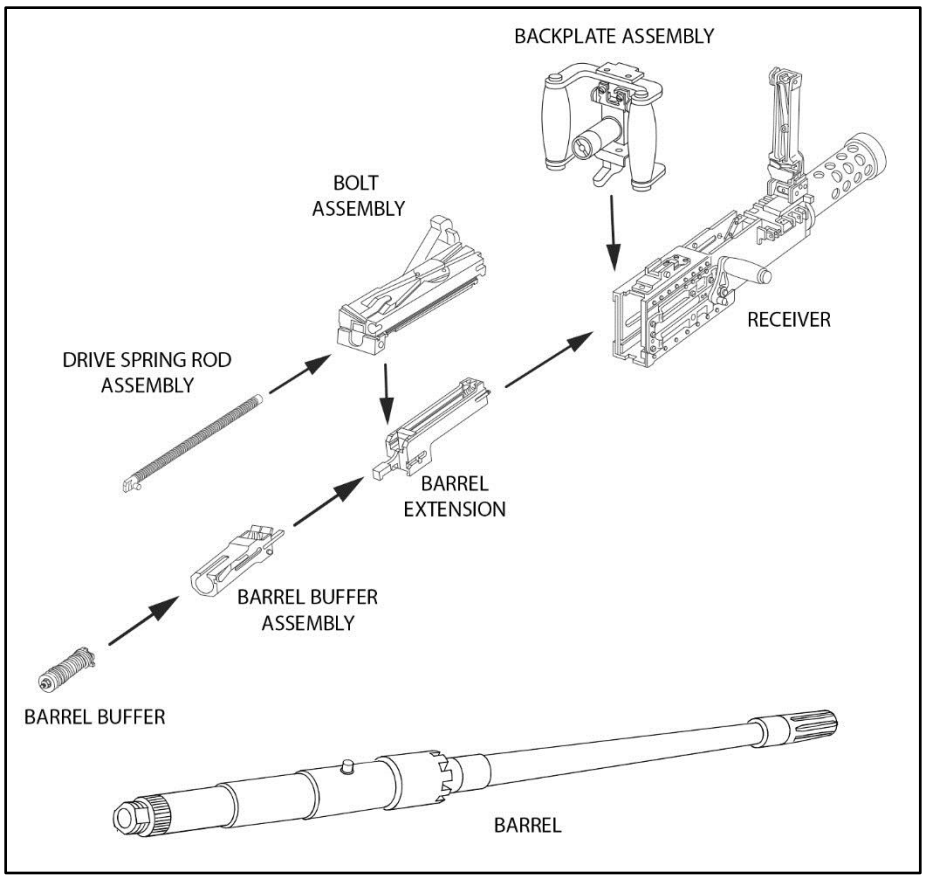


Figure 2-1. Major components

BARREL ASSEMBLY

2-4. The barrel assembly includes the barrel, barrel carrier assembly and, if installed, the flash suppressor. Rifling inside the barrel give bullets spin for accuracy and a chamber for firing the cartridge. The barrel carrier assembly allows quick connection/disconnection of the barrel, and is secured to locking and retaining grooves of the barrel. The flash suppressor reduces muzzle flash when firing and is installed on the muzzle end of barrel. The M2A1 barrel has a flash suppressor, barrel-carrying handle, and barrel alignment pin. The barrel support has an alignment and retention slot. The M2A1 barrel installs differently than the M2 barrel (TM 9-1005-213-10).

BACKPLATE ASSEMBLY

2-5. The backplate houses the trigger, the buffer tube, and a trigger block described below. Attached to the backplate are the handle grips.

- Trigger. The trigger controls the firing of the machine gun. The trigger is designed to be fired with the thumb of one or both hands while the Soldier grasps one or both of the handle grips. Stabilizing the hand(s) allows for maximum control while pressing the trigger with the thumb(s).
- Buffer tube sleeve. The buffer tube sleeve locks the bolt latch release in the open position to permit the machine gun to fire automatic or the unlocked position for single shot (flexible type only).
- Trigger block. The trigger block slides to select fire (F) or safe (S). The trigger block acts as a positive block for manual operation of the trigger.

DRIVE SPRING ROD ASSEMBLY

2-6. The drive spring rod assembly, installed into the bolt assembly, is secured to the right receiver side plate by a retaining pin. The driving spring rod assembly absorbs recoil shock and provides the energy for the bolt assembly to feed, strip, chamber, and fire the following round in the belted ammunition.

BOLT ASSEMBLY

2-7. The bolt assembly is located on top of the barrel extension assembly inside the receiver assembly. The bolt assembly houses the components necessary to cock, chamber, fire, extract, and eject ammunition. The top of the bolt assembly provides grooves that interact with the belt feed lever.

BARREL EXTENSION ASSEMBLY

2-8. The barrel extension assembly is forward, inside the receiver assembly. The barrel extension contains the parts necessary to attach the barrel, house and lock the bolt, and provide headspace. The barrel extension interfaces with the barrel buffer assembly to assists recoil and counter recoil.

BARREL BUFFER ASSEMBLY

2-9. The barrel buffer assembly is located to the rear of the barrel extension assembly, inside the receiver assembly. The barrel buffer assembly is part of the action group of the machine gun. It buffers and stops the rearward movement of the barrel assembly and barrel extension assembly by action of a helical compression spring.

RECEIVER ASSEMBLY

2-10. The receiver houses the action groups and, through a series of cams and levers, controls functioning of the internal groups. The receiver supports the retracting slide assembly, front and rear sights, and cover assembly described below. The receiver also provides the attachment points for various mounts. The serial number is located on the right side of the receiver assembly. The M2 and M2A1 machine guns have subtle differences. The primary differences are shown in table 2-1, page 2-4.

- Retracting slide assembly. The retracting slide assembly is secured to and operated from the right side of the receiver assembly. The charging handle manually charges or recharges the machine gun. The charging handle moves the bolt carrier group to the rear of the machine gun, stripping one round from the belt and placing it on the face of the bolt carrier group for insertion into the breech.
- Front sight. The front sight is located in front of the cover assembly and is a fixed post protected by a gunsight cover.
- Rear sight. The gun has a leaf-type rear sight. The scale ranges from 100 to 2600 in yards, and from 0 to 62 in mils. The windage knob permits 5-mil deflection changes to right or left of center.
- Cover assembly. The cover assembly is located on top of the receiver assembly. The cover assembly houses and protects the feed mechanism. The feed mechanism moves the cartridge belt, and positions and holds the cartridges for chambering. The feed mechanism, actuated by the bolt assembly, brings the belted cartridge against the cartridge stops. The feed mechanism must be repositioned when converting the M2 machine gun from left-hand to right-hand feed.

Table 2-1. M2 and M2A1 weapon data

Weight of gun (approximate)	84 pounds (38.10 kilograms)
Weight of barrel	26 pounds (11.79 kilograms)
Length of gun (M2A1)	67 inches (172.10 centimeters)
Length of gun	65 inches (165.43 centimeters)
Length of barrel with flash suppressor (M2A1)	47 inches (119.38 centimeters)
Length of barrel	45 inches (114.30 centimeters)
Length of rifling (approximate)	41.88 inches (106.38 centimeters)
Number of lands and grooves	Eight
Twist, right hand	One turn in 15 inches (38.10 centimeters)
Feed	Link belt
Operation	Recoil
Cooling	Air
Muzzle velocity (approximate)	3,050 feet per second (929.64 meters per second)
Maximum range (approximate)	7,400 yards (6,767 meters)
Maximum effective range (approximate)	2,000 yards (1,829 meters)
Head space (M2)	Manually set and checked
Head space (M2A1)	Fixed

CYCLE OF FUNCTION

2-11. During operation, the weapon follows a mechanical cycle of function. The cycle begins when the gunner manually operates the recoiling groups, which places the first round into the chamber. From this state, the cycle executes the sequential phases of the cycle of functioning to fire a round and prepare the weapon for the next round. The cycle of function are (some of these steps may occur at the same time)—

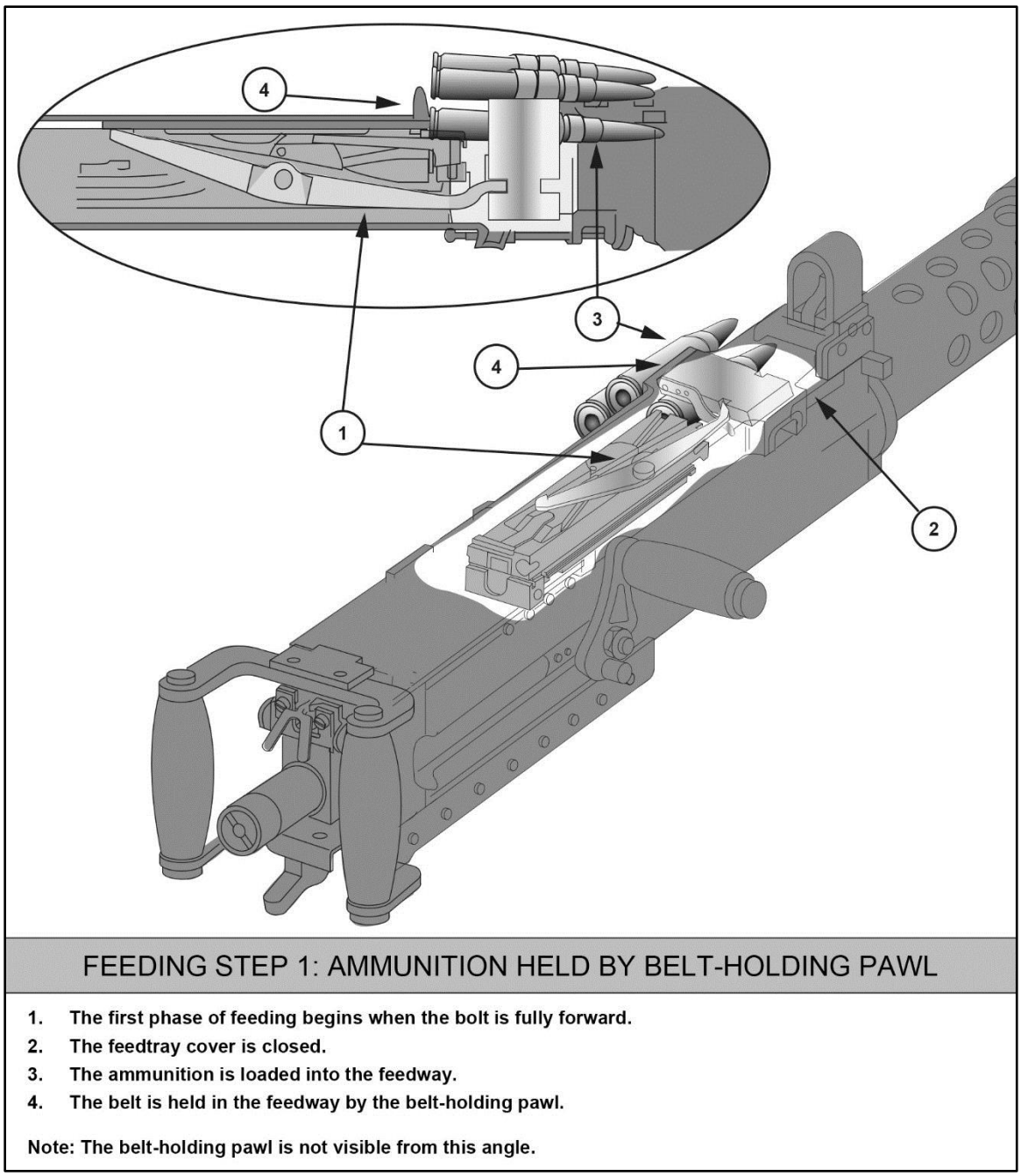
- Feeding.
- Chambering.
- Locking.
- Firing.
- Unlocking.
- Extracting.
- Ejecting.
- Cocking.

FEEDING

2-12. Feeding is the act of placing a cartridge in the receiver, and onto the face of the bolt, ready for chambering. Feeding occurs in two steps. Step one is the movement of the belt of ammunition. Step two is the stripping and positioning of the round for chambering.

Step 1

2-13. The first step of feeding is defined as the movement of a new belt of ammunition into the feedway until the round is positioned where the extractor can grip it (see figure 2-2).



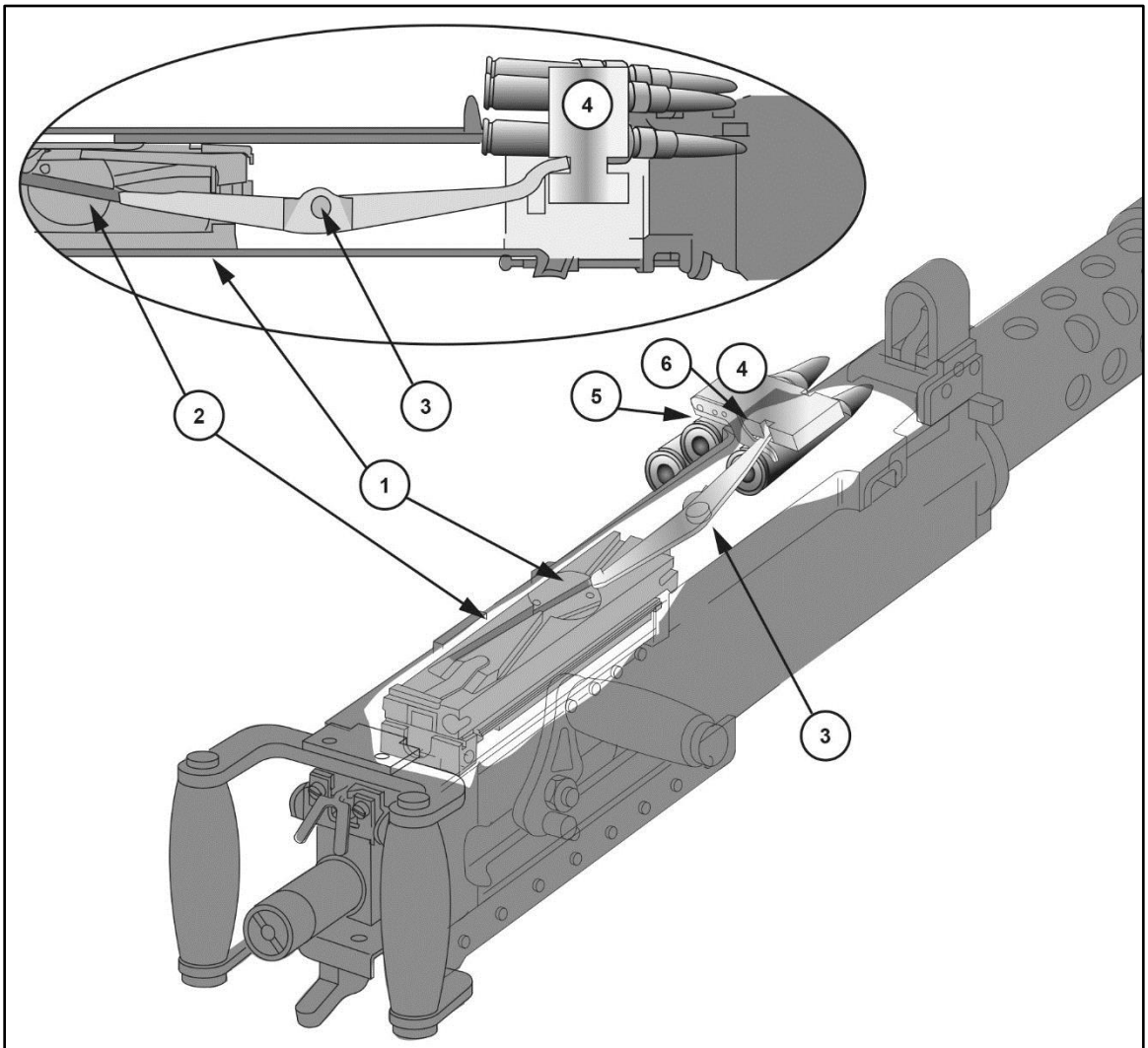
FEEDING STEP 1: AMMUNITION HELD BY BELT-HOLDING PAWL

1. The first phase of feeding begins when the bolt is fully forward.
2. The feedtray cover is closed.
3. The ammunition is loaded into the feedway.
4. The belt is held in the feedway by the belt-holding pawl.

Note: The belt-holding pawl is not visible from this angle.

Figure 2-2. Rear view of ammunition belt held in the feedway by the belt-holding pawl

2-14. As the bolt moves to the rear, its cam grooves guide the belt feed lever lug, pivoting the lever and moving the slide out the side of the cover. The belt is held stationary by the belt-holding pawl, while the belt feed pawl pivots, compressing its spring, and rides up over the link holding the first round. When the bolt is all the way to the rear, the belt feed slide moves out far enough to allow the belt feed pawl spring to force the pawl down behind the first round (see figure 2-3).



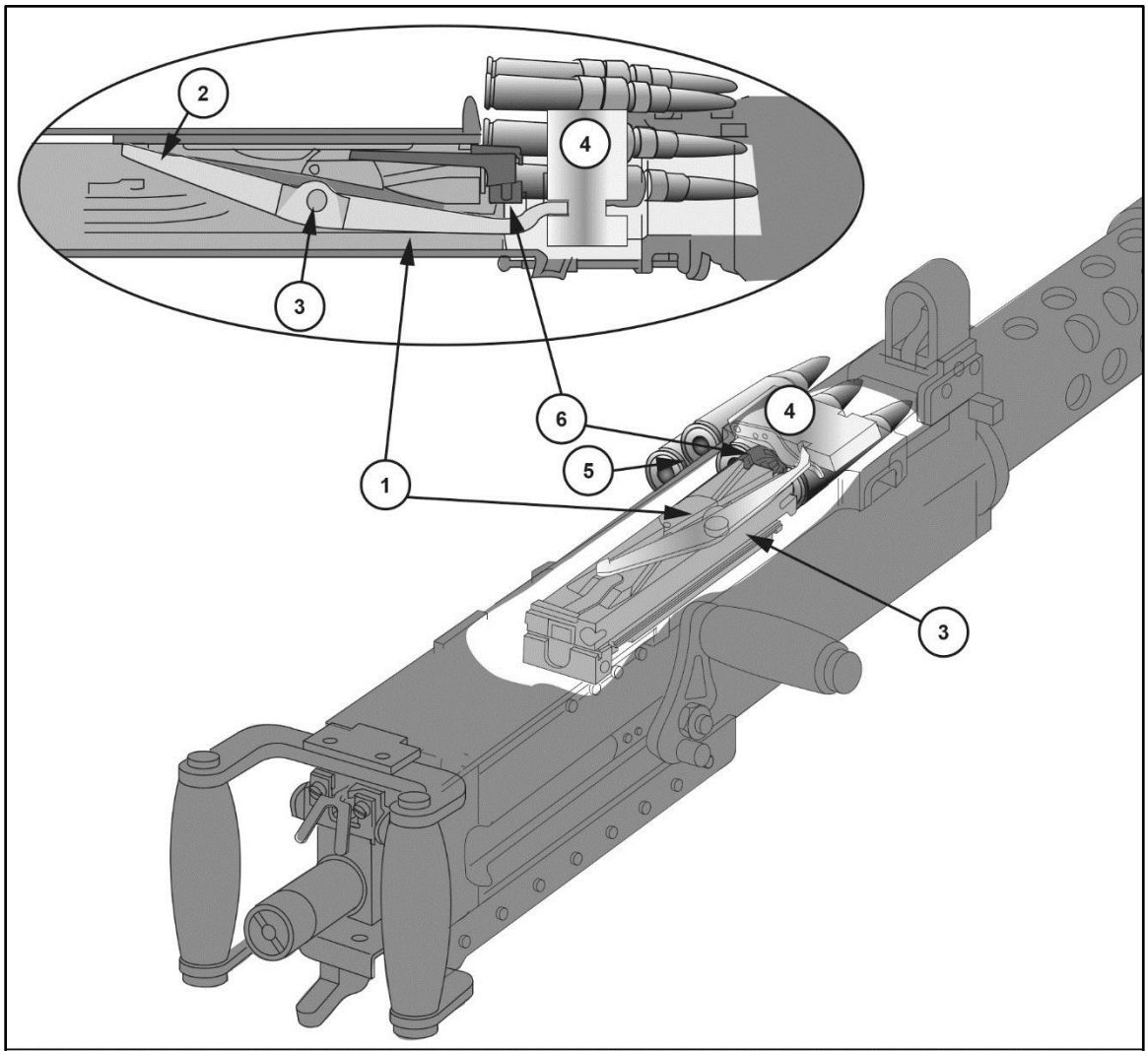
FEEDING STEP 1 CONTINUED: BOLT PULLED TO THE REAR

1. The bolt moves to the rear.
2. The bolt's cam grooves guide the belt feed lever lug.
3. The belt feed lever pivots.
4. This causes the belt feed lever to move the slide out the side of the cover.
5. The belt is held stationery by the belt-holding pawl. (Not shown for clarity)
6. The belt feed pawl pivots, compressing its spring, and rides up over the link holding the first round. When the bolt is all the way to the rear, the belt feed slide moves out far enough to allow the belt feed spring to force the pawl down behind the first round.

Note: The belt-holding pawl is not visible from this angle.

Figure 2-3. Bolt to the rear, belt feed slide extended out the side of cover

2-15. As the bolt moves forward, the belt feed lever moves the slide back into the receiver. The belt is pushed in by the belt feed pawl. The next round rides over the belt holding pawl, compressing its spring and forcing the pawl down until the round passes (see figure 2-4). When the bolt is fully forward, the slide is back in the cover, and the extractor engages the first round.



FEEDING STEP 1 CONTINUED: BOLT MOVED TO FORWARD POSITION

1. The bolt moves forward.
2. The bolt's cam grooves guide the belt feed lever lug.
3. The belt feed lever pivots and moves the slide back into the receiver.
4. The belt is pushed into the tray by the belt feed pawl.
5. The next round rides over the belt-holding pawl, compressing its spring, and forcing the pawl down until the round passes.
6. When the bolt is fully forward, the slide is back in the cover, and the extractor engages the first round.

Note: The belt-holding pawl is not visible from this angle

Figure 2-4. Belt feed slide moving back into cover with belt feed pawl behind first round

Step 2

2-16. The second step is defined as the extractor stripping a round from the belt of ammunition and placing the round into the T-slot in preparation for chambering. The second step begins as the recoiling groups are again moved to the rear. The extractor grips the first round in the feedway and as the recoiling parts move to the rear, withdraws it from the ammunition belt. Initially, the grip of the extractor is held secure by the downward pressure of the cover extractor spring (see figure 2-5).

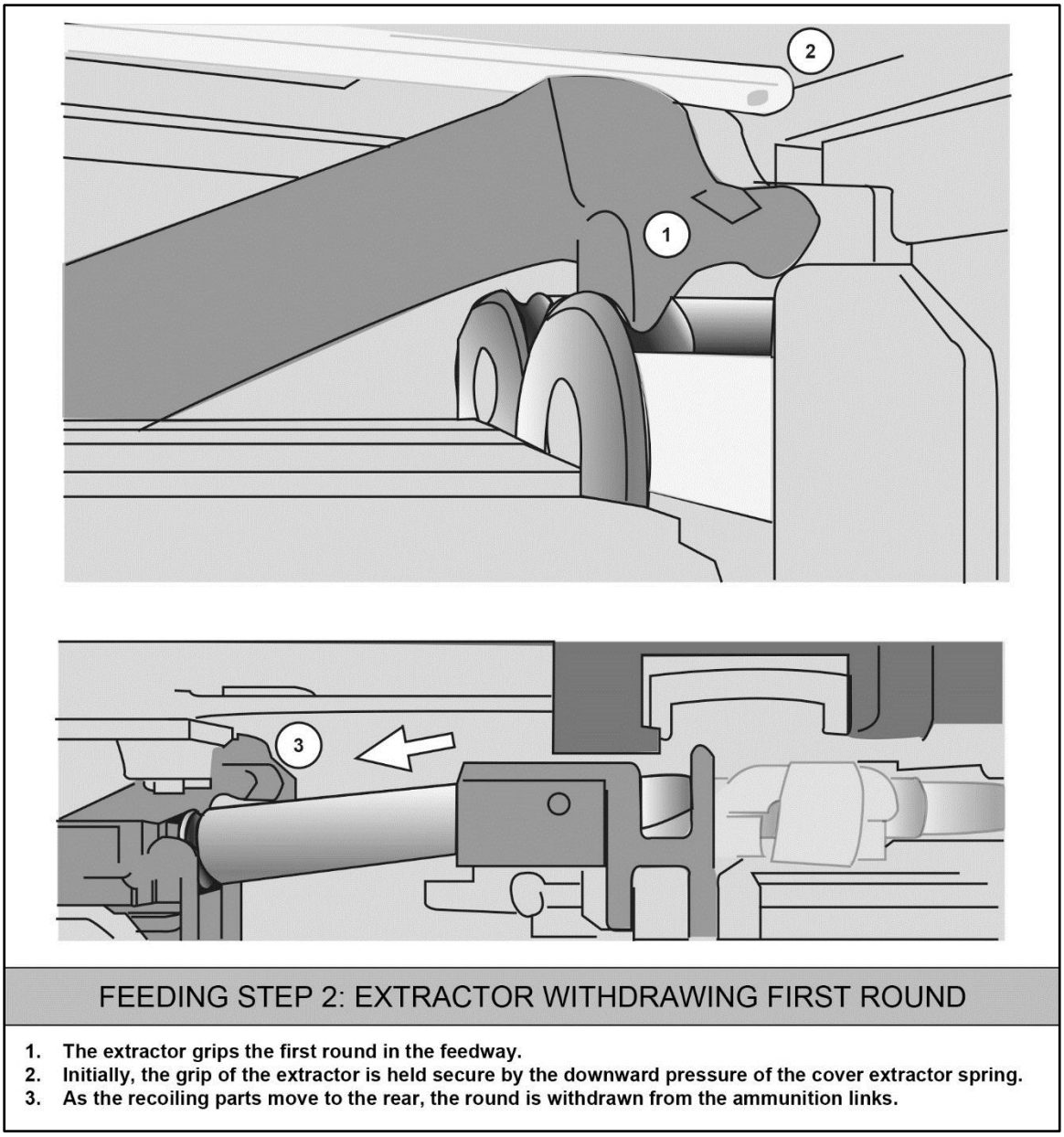
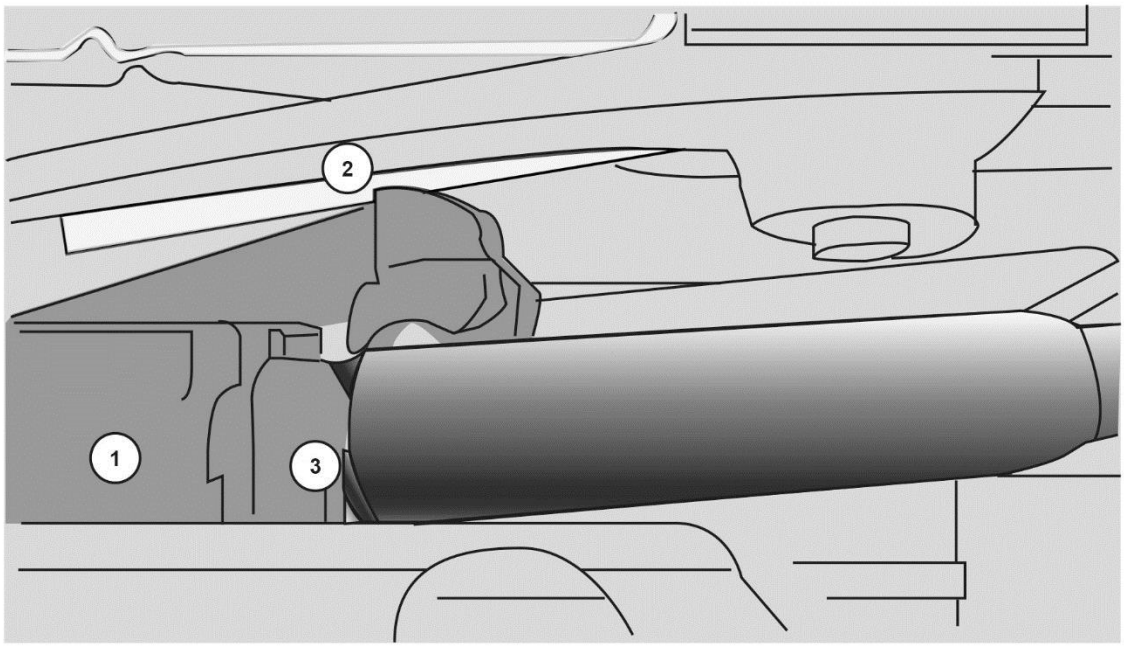


Figure 2-5. Extractor withdrawing first round from the feedway

2-17. As the bolt continues its movement to the rear, the cover extractor cam forces the extractor down, causing the cartridge to enter the T-slot in the bolt (see figure 2-6).

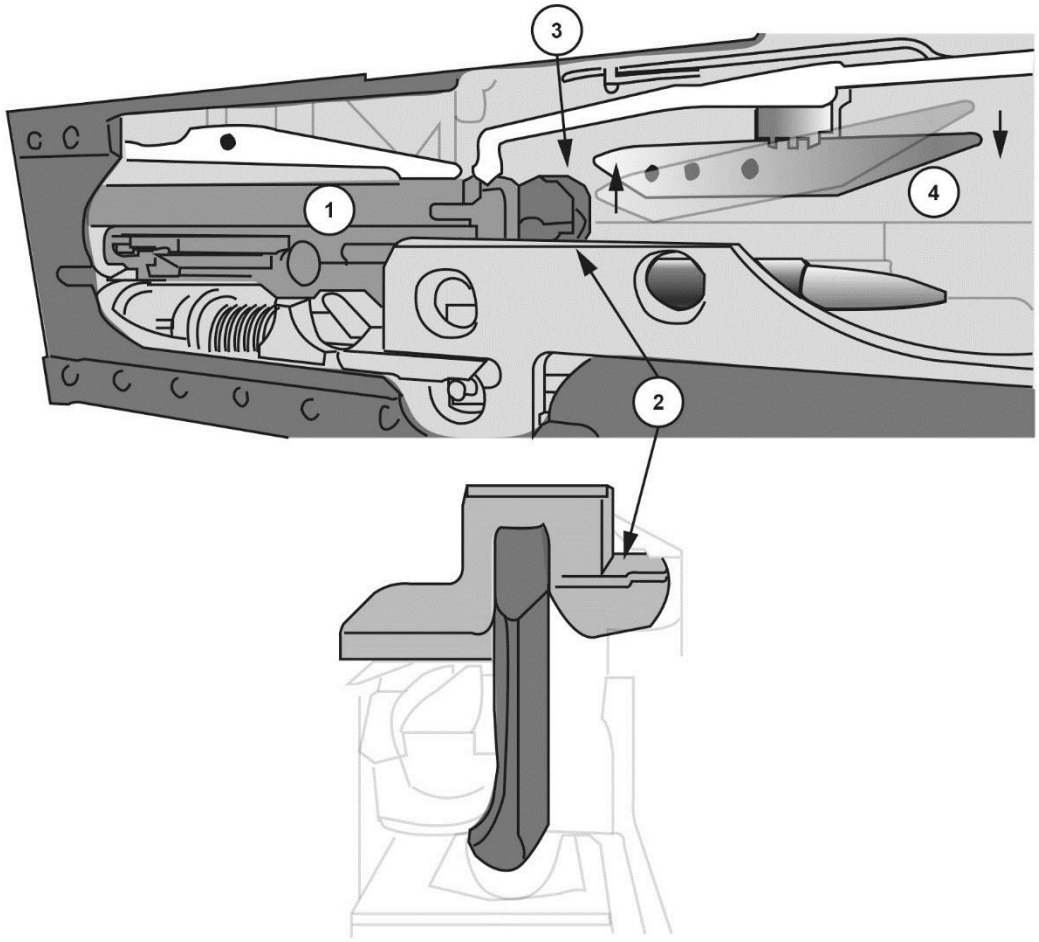


FEEDING STEP 2 CONTINUED: CARTRIDGE ENTERING T-SLOT

1. The bolt continues its movement to the rear.
2. The cover extractor cam forces the extractor down.
3. The cartridge enters the T-slot in the bolt.

Figure 2-6. Cartridge entering the T-slot in the bolt

2-18. As the bolt moves to the rear and the extractor is forced down, the extractor lug, riding along the top of the extractor switch, forces the rear end of the extractor switch downward. Near the end of the rearward movement, the extractor lug overrides the end of the switch and the switch snaps back into position (see figure 2-7).



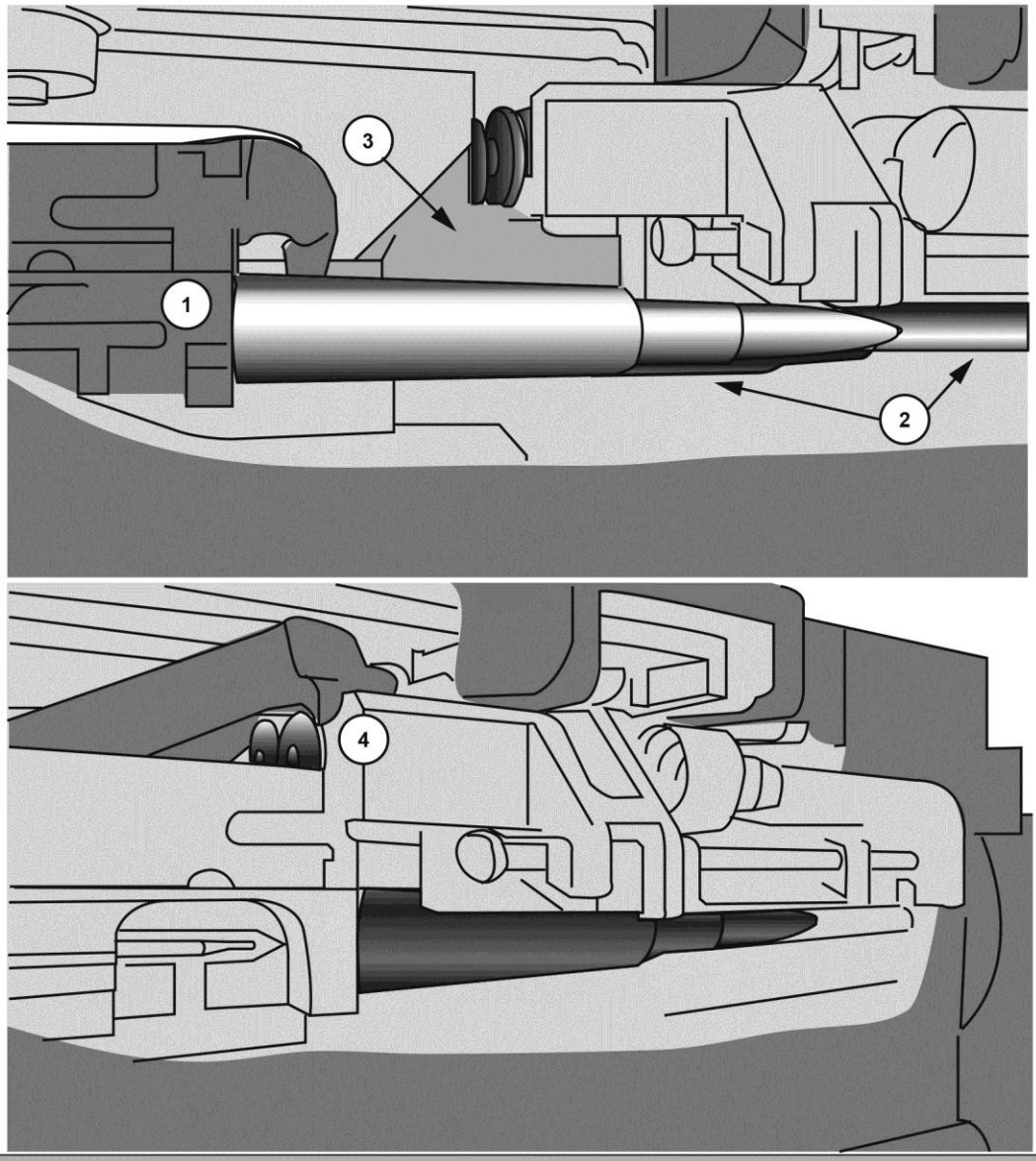
FEEDING STEP 2 CONTINUED: CARTRIDGE FULLY INSIDE T-SLOT

1. The bolt moves to the rear, and the extractor is forced down.
2. The extractor lug rides along the top of the extractor switch.
3. The extractor lug forces the rear end of the extractor switch downward.
4. Near the end of the rearward movement, the extractor lug overrides the end of the switch, and the switch snaps back into position.

Figure 2-7. Cartridge fully inside T-slot

CHAMBERING

2-19. As the bolt moves forward, the new round is held by the T-slot and the extractor assembly. The extractor stop pin (on the left side of the bolt) only lets the extractor assembly go down only far enough to align the new round with the chamber. As the bolt continues forward, the new round chambers. As this action takes place, the extractor lug rides up the extractor cam, compresses the cover extractor spring, and through pressure of the spring, snaps in the next cartridge (see figure 2-8).



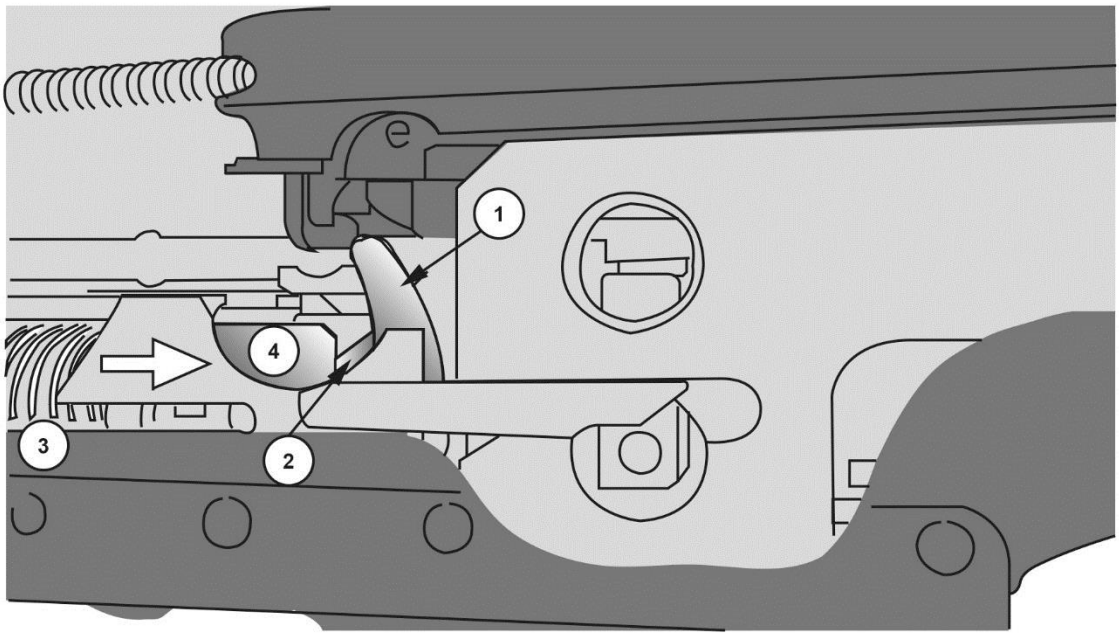
CHAMBERING

1. As The bolt moves forward, the new round is held by the T-slot and the extractor assembly. The extractor stop pin (on the left side of the bolt) aligns the new round with the chamber.
2. As the bolt continues forward, the new round chambers.
3. As this action takes place, the extractor lug rides up the extractor cam.
4. The extractor lug compresses the cover extractor spring, and snaps into the next cartridge.

Figure 2-8. Chambering procedure

LOCKING

2-20. Initially, the bolt is forced forward in counter-recoil by the energy stored in the driving spring group and the compressed buffer disks. At the start of counter-recoil, the buffer body tube lock keeps the accelerator tips from bouncing up too soon, and catching in the breech lock recess in the bolt. However, after the bolt travels forward about five inches, the lower rear projection of the bolt strikes the tips of the accelerator, turning the accelerator forward. This unlocks the barrel extension from the buffer body group and releases the buffer spring. The buffer spring expands, forcing the piston rod forward (see figure 2-9).



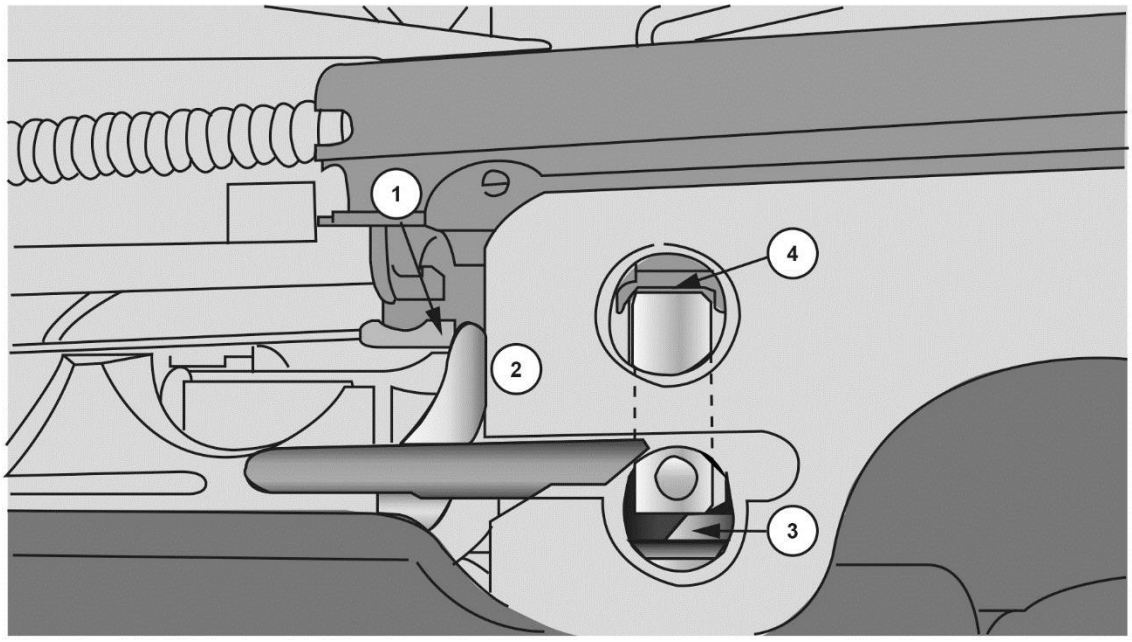
LOCKING

1. After the bolt travels forward 5", the lower rear projection of the bolt strikes the tip of the accelerator, turning the accelerator forward.
2. This unlocks the barrel extension from the buffer body group, and releases the buffer spring.
3. The buffer spring expands, forcing the piston rod forward.
4. The cross groove in the piston rod engages the notch on the barrel extension shank. The barrel extension and barrel are also forced forward by the action of the buffer spring.

Figure 2-9. Recoiling groups moving forward initiating the locking process

2-21. Since the cross groove in the piston rod engages the notch on the barrel extension shank, the barrel extension and barrel are also forced forward by the action of the buffer spring. Some of the forward motion of the bolt is transmitted to the barrel extension through the accelerator. As the accelerator rotates forward, the front of the accelerator speeds up the barrel extension; at the same time, the accelerator tips slow down the bolt (see figure 2-10).

2-22. Locking begins 1-1/8 inches before the recoiling groups (bolt, barrel extension, and barrel) are fully forward. The breech lock in the barrel extension rides up the breech lock cam in the bottom of the receiver into the breech lock recess in the bottom of the bolt, locking the recoiling groups together three-fourths of an inch before the groups are fully forward (see figure 2-10).



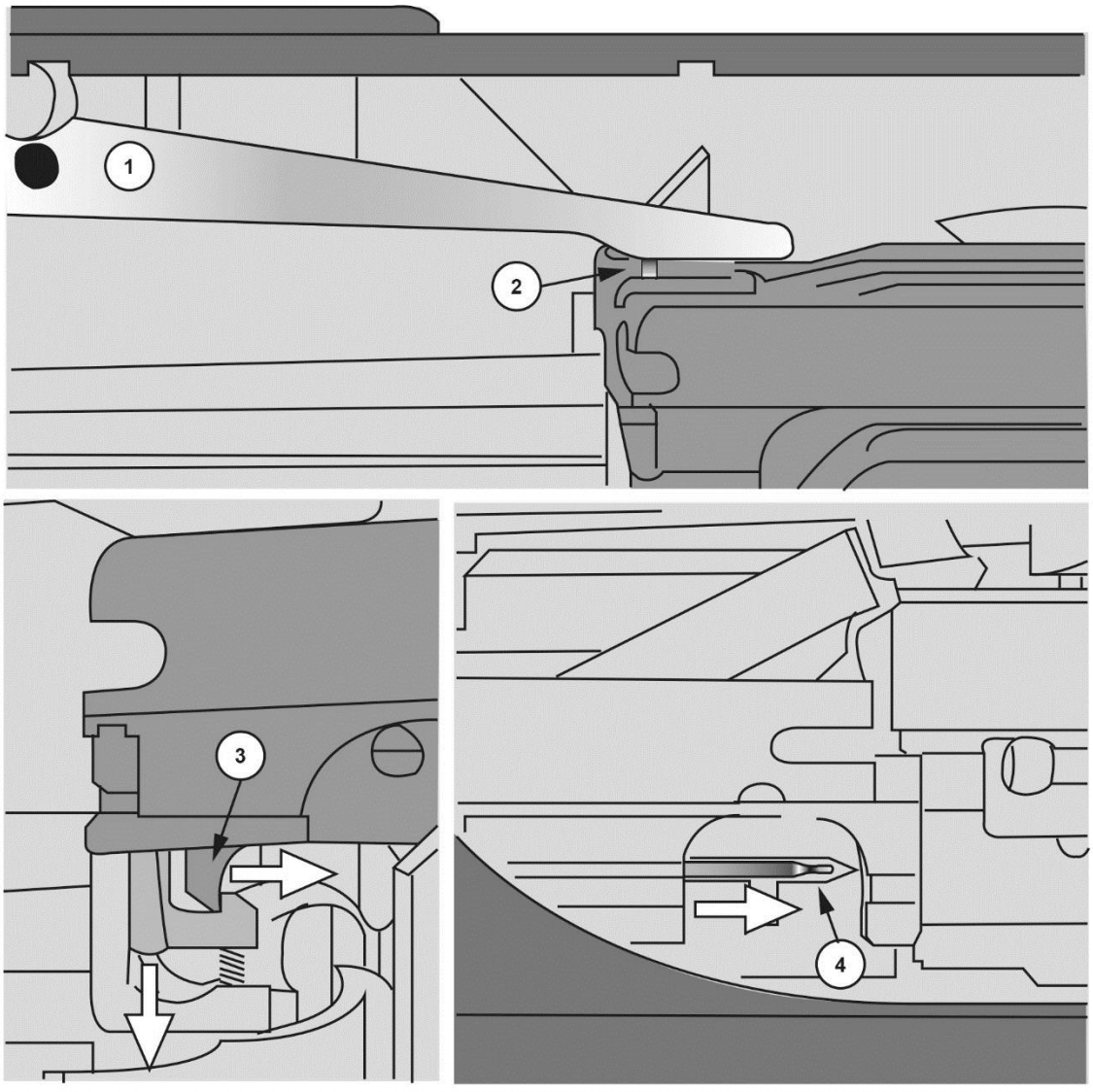
LOCKING CONTINUED

1. Some of the forward motion of the bolt is transmitted to the barel extension through the accelerator.
2. As the accelerator rotates forward, the front of the accelerator speeds up the barrel extension. Simultaneously, the accelerator tip slows the bolt.
3. Locking begins 1-1/8" before the recoiling groups (bolt, barrel extension, and barrel) are fully forward. The breech lock in the barrel extension rides up the breech lock cam in the bottom of the receiver.
4. The breech lock is forced into the recess in the bottom of the bolt. The recoiling groups are locked together 3/4" before the groups are fully forward.

Figure 2-10. Recoiling groups locked together

FIRING

2-23. As the Soldier presses down on the trigger, the trigger pivots on the trigger pin. The trigger cam on the inside of the backplate engages, and raises the rear end of the trigger bar, in turn, pivots on the trigger bar pin, causing the front end of the trigger bar to press down on the top of the sear stud. The sear is forced down until the hooked notch of the firing pin extension disengages from the sear notch. The firing pin and firing pin extension are driven forward by the firing pin spring; the striker of the firing pin hits the primer of the cartridge, firing the round (see figure 2-11).



FIRING

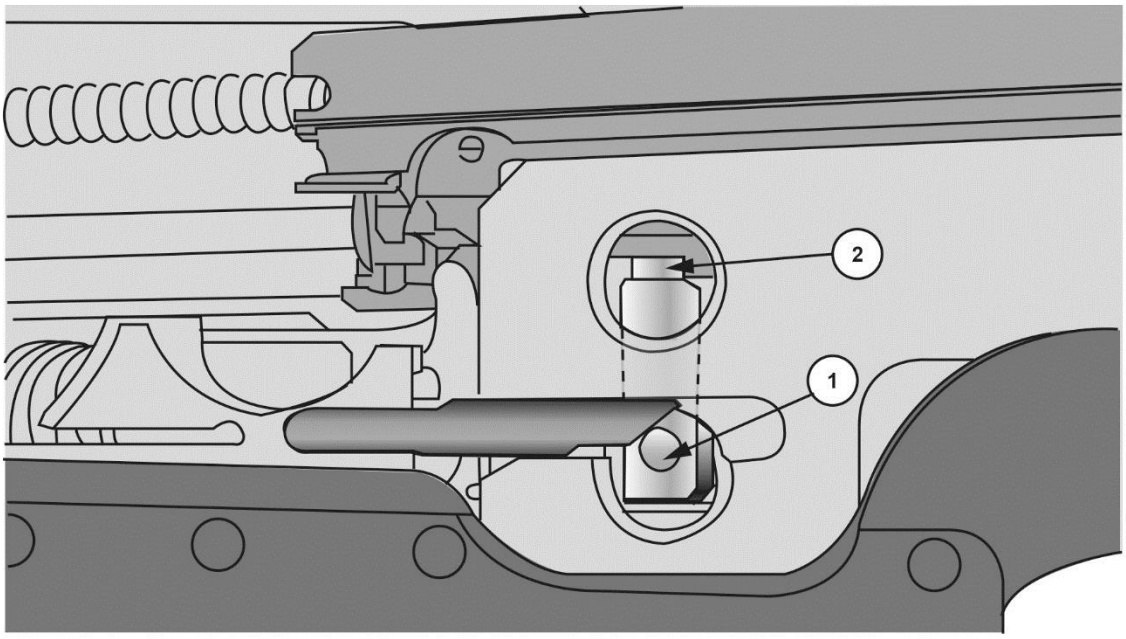
1. As you press down on the trigger, the trigger pivots onto the trigger pin. The trigger cam inside the backplate engages, and raises the rear end of the trigger bar, which pivots on the trigger bar pin.
2. This causes the front end of the trigger bar to press down on the sear stud.
3. The sear is forced down to disengage the hooked notch of the firing pin extension from the sear notch.
4. The firing pin and firing pin extension are driven forward by the firing pin spring, and the firing pin striker hits the primer of the cartridge to fire the round.

Figure 2-11. Firing

2-24. For automatic firing, the bolt-latch release must be locked or held depressed so that the bolt latch will not engage the notches in top of the bolt, holding the bolt to the rear as in single-shot firing. The trigger is pressed and held down. Each time the bolt travels forward in counter-recoil, the trigger lever depresses the sear, releasing the firing pin extension assembly and the firing pin. This automatically fires the next round when the forward movement of the recoiling groups is nearly completed. The gun should fire about one-sixteenth of an inch before the recoiling groups are fully forward. Only the first round should fire with the parts fully forward. The gun fires automatically as long as the Soldier holds down the trigger and bolt latch and feeds ammunition into the gun.

UNLOCKING

2-25. The bolt is unlocked from the barrel and barrel extension at the instant of firing, the bolt is locked to the barrel extension and against the rear end of the barrel by the breech lock, which is on top of the breech lock cam and in the breech lock recess in the bottom of the bolt. When the cartridge explodes, the bullet travels out of the barrel; the force of recoil drives the recoiling groups rearward. During the first three-fourths of an inch, the recoiling groups are locked together. As this movement takes place, the breech lock moves off the breech lock cam stop, allowing the breech lock depressors (acting on the breech lock pin) to force the breech lock down, out of its recess from the bottom of the bolt . At the end of the first three-fourths of an inch of recoil, the bolt is unlocked, free to move to the rear independent of the barrel and barrel extension (see figure 2-12).

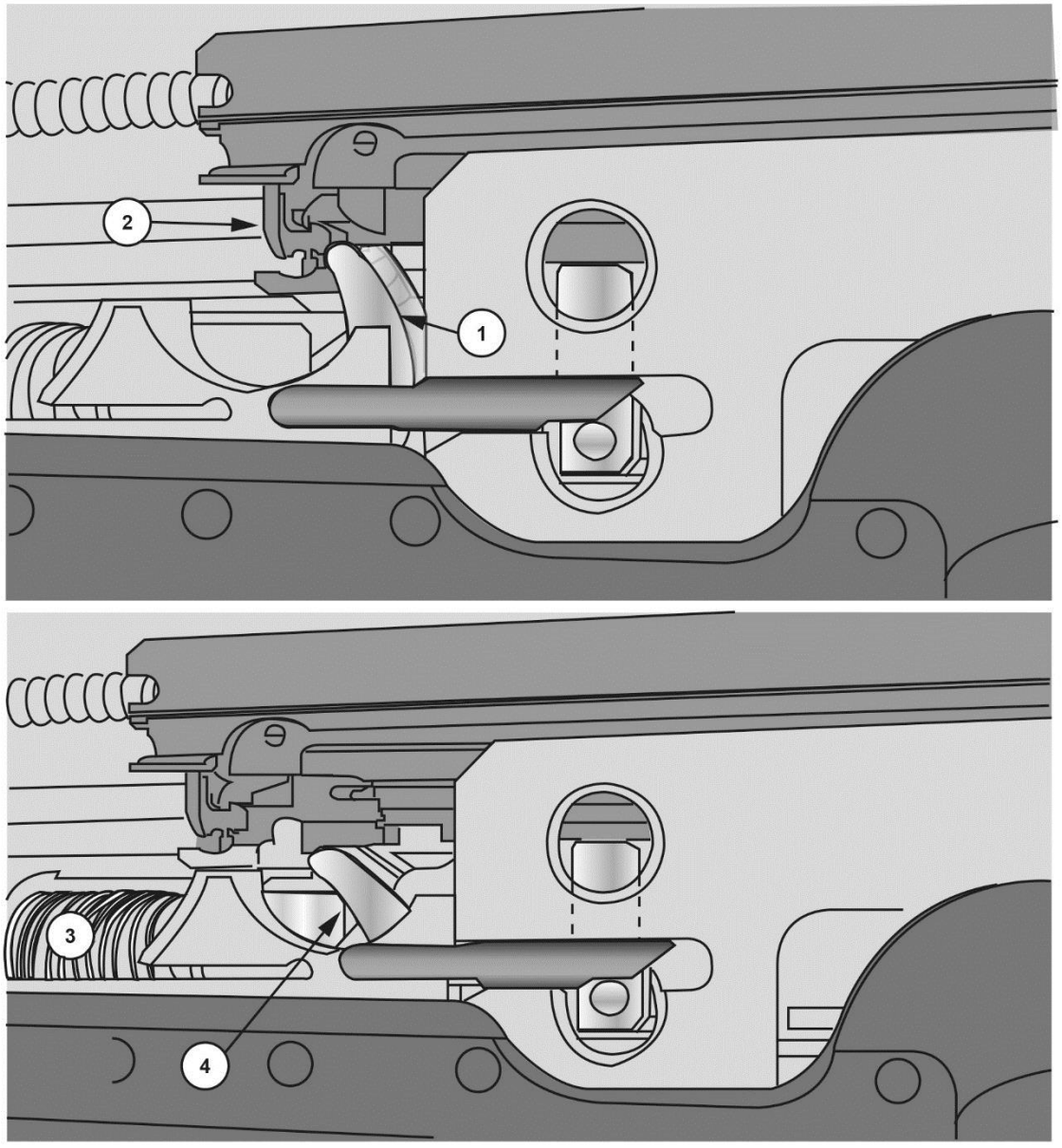


UNLOCKING

1. During the first 3/4", the recoiling groups are locked together. During the movement, the breech lock moves off the breech lock cam stop, allowing the breech lock depressors to force the breech lock down.
2. After 3/4" of recoil, the bolt is unlocked, and free to move to the rear independent of the barrel and barrel extension.

Figure 2-12. Breech lock being forced out of its recess in the bolt

2-26. As the recoiling groups move to the rear, the barrel extension causes the tips of the accelerator to rotate rearward. The accelerator tips strike the lower rear projection of the bolt, accelerating the movement of the bolt to the rear. The barrel and barrel extension continue to travel to the rear an additional 3/8 of an inch, or an approximate total distance of 1-1/8 inches, until the barrel buffer assembly stops them. During the recoil of 1-1/8 inches, the barrel extension shank compresses the barrel buffer spring, since the cross groove in the piston rod head engages the notch on the shank. The claws of the accelerator lock the spring in the compressed position. The claws engage the shoulders of the barrel extension shank. After its initial travel of 3/4 inch, the bolt travels an additional 6-3/8 inches to the rear, after it is unlocked from the barrel and barrel extension, for a total of 7-1/8 inches. During this movement, the driving springs are compressed. The rearward movement of the bolt is stopped as the bolt strikes the buffer plate. The driving spring rod assembly stores part of the recoil energy of the bolt, and the buffer disks in the backplate absorb part of it as well (see figure 2-13).



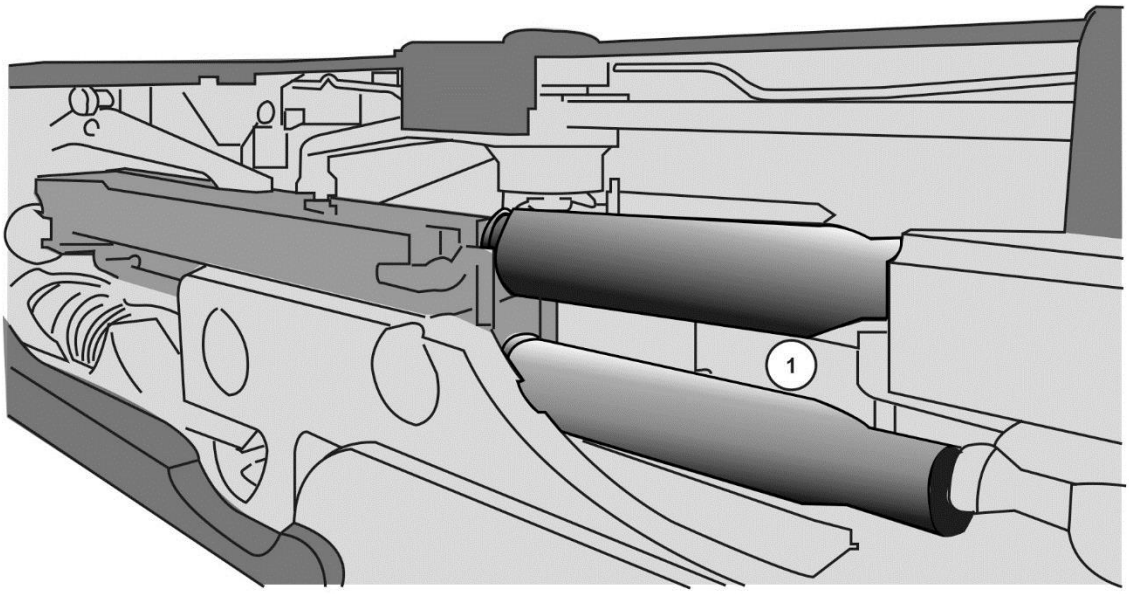
UNLOCKING CONTINUED

1. As the recoiling groups move to the rear, the barrel extension causes the tips of the accelerator to rotate rearward.
2. The accelerator tip strikes the lower projection of the bolt, accelerating its movement to the rear.
3. The barrel and barrel extension continue to travel to the rear an additional 3/8", or an approximate total distance of 1-1/8", until the barrel buffer assembly stops them.
4. During the recoil, the barrel extension shank compresses the barrel buffer spring, as the piston rod head engages the notch on the shank. The claws of the accelerator lock the spring in the compressed position. The claws engage the shoulders of the barrel extension shank.

Figure 2-13. Unlocking—recoil movement completed

EXTRACTING

2-27. The empty cartridge case is pulled from the chamber. The empty case, held by the T-slot, has been expanded by the force of the explosion; therefore, it fits snugly in the chamber. If the case is withdrawn from the chamber too rapidly, it may be torn. To prevent this, and to ensure slow initial extraction of the case, the top forward edge of the breech lock and the forward edge of the lock recess in the bolt are beveled. As the breech lock is unlocked, the initial movement of the bolt away from the barrel and barrel extension is gradual. The slope of the locking faces facilitates locking and unlocking, and prevents sticking. The leverage of the accelerator tips on the bolt speed's extraction after it is started by kicking the bolt to the rear to extract the empty case from the chamber (figure 2-14).



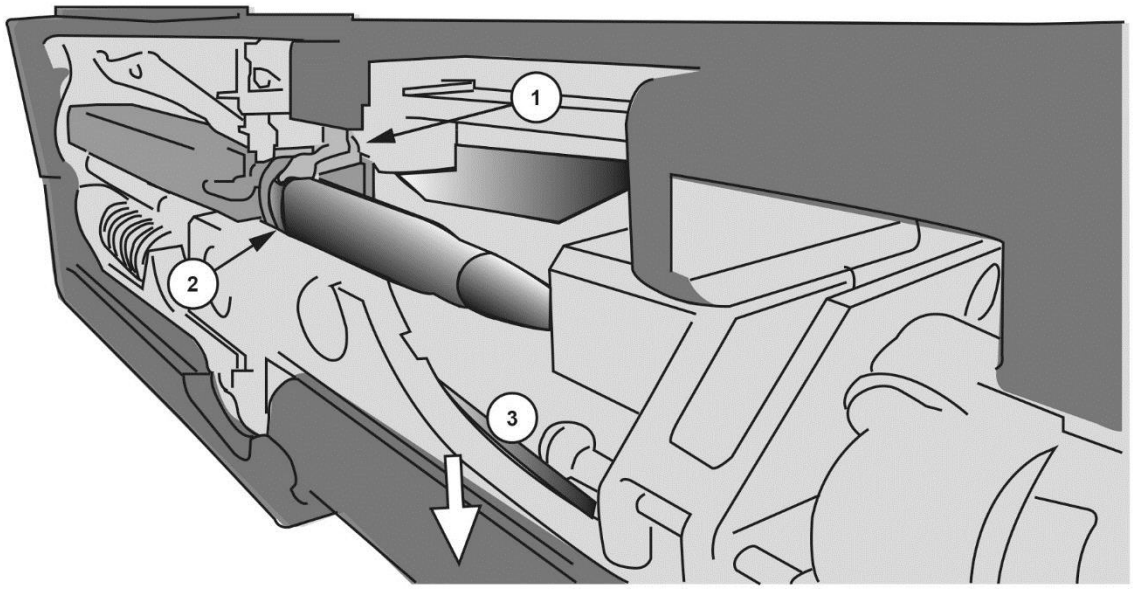
EXTRACTING

1. The empty cartridge case is pulled from the chamber. The empty case, held by the T-slot, has been expanded by the force of the explosion; therefore, it fits snugly in the chamber. If the case is withdrawn from the chamber too rapidly, it may be torn. To prevent this, and to ensure slow initial extraction of the case, the top forward edge of the breech lock and the forward edge of the lock recess in the bolt are beveled. As the breech lock is unlocked, the initial movement of the bolt away from the barrel and barrel extension is gradual. The slope of the locking faces facilitates locking and unlocking, and prevents sticking. The leverage of the accelerator tips kick the bolt to the rear. This extracts the empty case from the chamber.

Figure 2-14. Extracting

EJECTING

2-28. The empty cartridge case is expelled from the receiver. As the bolt starts its forward movement (counter-recoil), the extractor lug rides below the extractor switch. This forces the extractor assembly farther down until the round is in the center of the T-slot of the bolt. The round, still gripped by the extractor, ejects the empty case from the T-slot. The last empty case of an ammunition belt is pushed out by the ejector (figure 2-15).



EJECTING

1. The empty cartridge case is expelled from the receiver. The bolt starts its forward movement, called "counter-recoil", and the extractor lug rides below the extractor switch.
2. This forces the extractor assembly farther down until the round is in the center of the T-slot of the bolt.
3. The round, still gripped by the extractor, ejects the empty case from the T-slot. The last empty case of an ammunition belt is pushed out by the ejector.

Figure 2-15. Ejecting

COCKING

2-29. The firing pin is withdrawn into the cocked position. When the recoiling groups are fully forward, the top of the cocking lever rests on the rear half of the V-slot in the top plate bracket (figure 2-16).

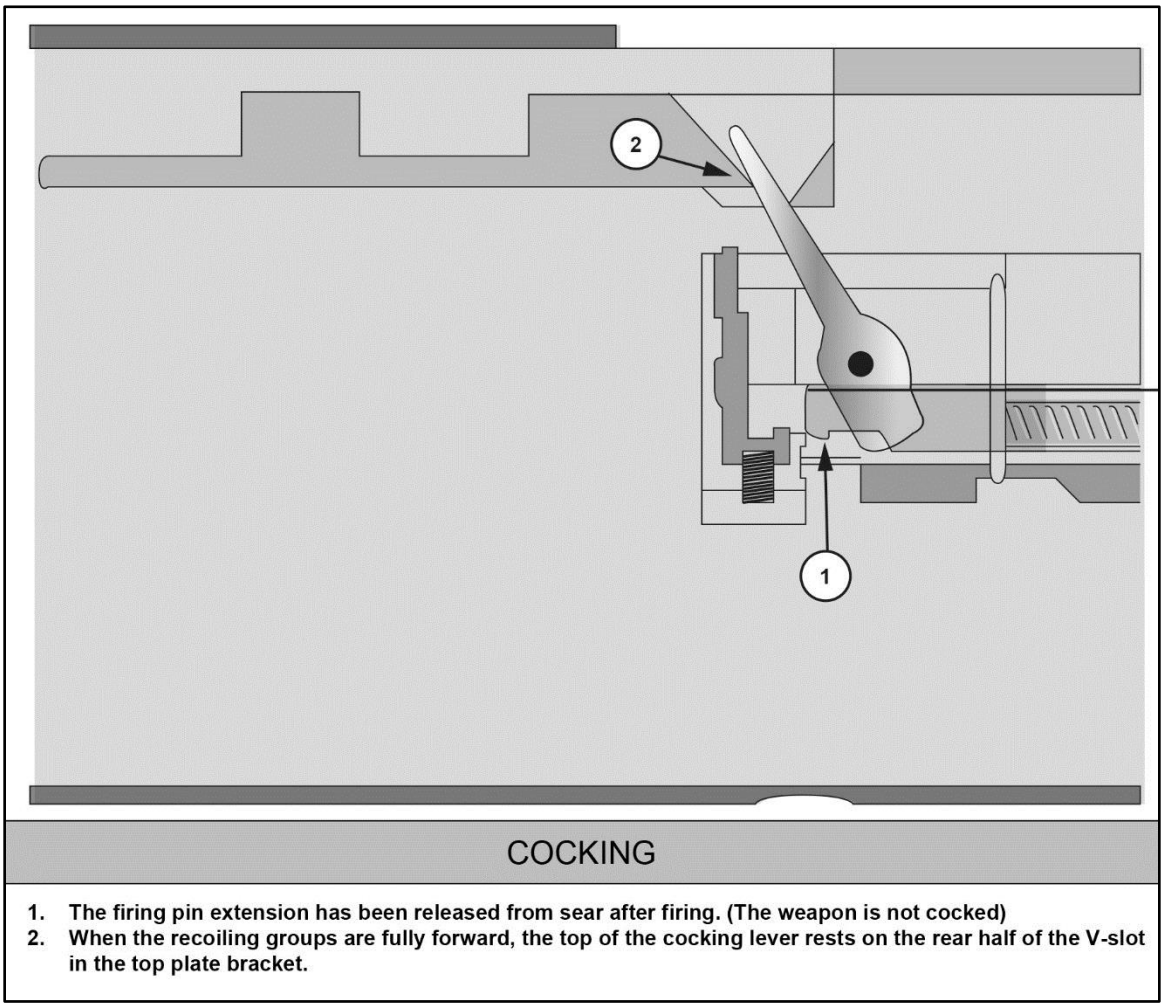
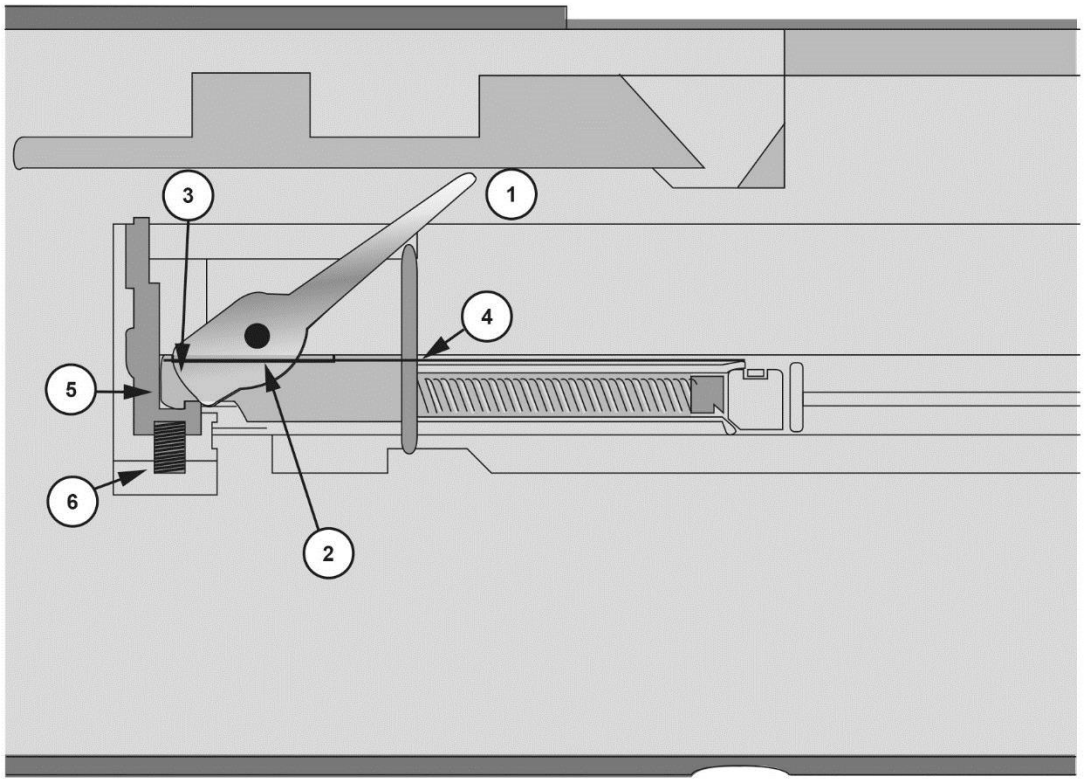


Figure 2-16. Recoiling group forward, gun not cocked

2-30. As the bolt moves to the rear, the top of the cocking lever is forced forward. The lower end pivots to the rear on the cocking lever pin. The rounded nose of the cocking lever, which fits through the slot in the firing pin extension, forces the extension to the rear, compressing the firing pin spring against the sear stop pin. As the firing pin extension is pressed to the rear, the hooked notch of the extension rides over the sear notch, forcing the sear down. The sear spring forces the sear back up after the hooked notch of the firing pin extension has entered the sear notch. The pressure of the sear and firing pin springs holds the two notches locked together. There is a slight overtravel of the firing pin extension in its movement to the rear to ensure proper engagement with the sear (figure 2-17).

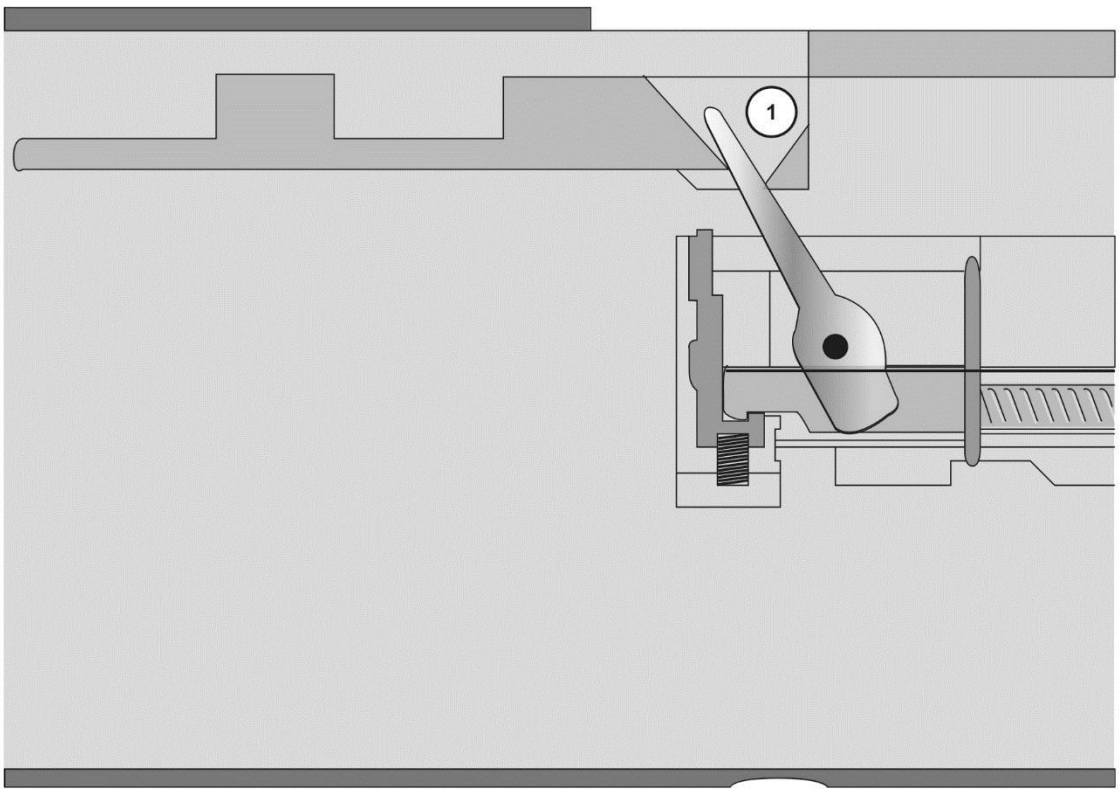


COCKING CONTINUED

1. As the bolt moves to the rear, the top of the cocking lever is forced forward.
2. The lower end pivots to the rear on the cocking lever pin.
3. The rounded nose of the cocking lever, which fits through the slot in the firing pin extension, forces the extension to the rear.
4. The extension compresses the firing pin spring against the sear stop pin.
5. As the firing pin extension is pressed to the rear, the hooked notch of the extension rides over the sear notch, forcing the sear down.
6. The sear spring forces the sear back up after the hooked notch of the firing pin extension has entered the sear notch. The pressure of the sear and firing pin spring holds the two notches locked together. There is a slight overtravel of the firing pin extension in its movement to the rear to ensure proper engagement with the sear.

Figure 2-17. Hooked notch of the firing pin extension engaged by the sear notch

2-31. As the bolt starts forward, the overtravel is taken up and completed when the cocking lever enters the V-slot of the top plate bracket and is cammed toward the rear. Pressure on the cocking lever is relieved as the bolt starts forward (see figure 2-18).



COCKING CONTINUED

1. As the bolt starts forward, the overtravel is taken up and completed when the cocking lever enters the V-slot of the top plate bracket and is cammed toward the rear. Pressure on the cocking lever is relieved as the bolt starts forward.

Figure 2-18. Recoiling groups forward, gun cocked

COOLING

2-32. Cooling is the process of dissipating heat from the weapon during firing. Although not part of the cycle of function, cooling the weapon during firing is critical to ensure the weapon continues to operate efficiently. Firing a round generates heat and pressure within the chamber and bore, which radiates outward through the metal of the barrel.

2-33. The temperature generated by the burning of propellant powders is over one thousand degrees Fahrenheit. The chamber, bore, and barrel retain some heat after firing and poses a significant hazard to the gunner.

2-34. How this heat is absorbed by the weapon, and dissipated or removed, is determined by the design. Maximum surface of the barrel and receiver are exposed to permit air cooling. Perforations in the barrel support allow air to circulate around the breach end of the barrel and help in cooling the parts. A heavy barrel is used to retard early overheating.

2-35. There are three methods to reduce the thermal stress on a weapon and facilitate continuous operation. The M2- and M2A1-series of weapons use all three of these methods to some degree to cool the chamber, bore, and barrel. These methods of cooling are radiation cooling, conduction cooling, and convection cooling.

RADIATIONAL COOLING

2-36. Radiational cooling allows for the dissipation of heat into the surrounding cooler air. This is the least efficient means of cooling, but is common to most small arms weapons.

CONDUCTION COOLING

2-37. Conduction cooling occurs when a heated object is in direct physical contact with a cooler object. Conduction cooling on a weapon usually results from high chamber operating temperatures being transferred into surrounding surfaces such as the barrel and receiver of the weapon. The transfer from the chamber to the cooler metals cools the chamber. Thermal energy is then carried away by other means, such as radiation cooling, from these newly heated surfaces.

CONVECTION COOLING

2-38. Convection cooling requires moving air. The moving air has greater potential to carry away heat. The perforations in the barrel support are designed to facilitate air movement.

2-39. Soldiers should know how the gun's cooling methods affect their line of sight when they are viewing a target through an aiming device. For example, dissipating heat along the length of the barrel can create a mirage effect in the line of sight. This can then cause a significant error to the true point of aim when using magnified optics.

This page intentionally left blank.

Chapter 3

Aiming Devices

Every weapon has a fixed or attached device for aiming. Soldiers must be familiar with the various aiming devices, how they operate, and how to employ them correctly for the best effect. Chapter 3 provides the principles of operation of the most widely available aiming devices, and provides general information concerning their capabilities, function and use.

An aiming device is used to align the Soldier, the weapon, and the target to make an accurate and precise shot. Each aiming device functions in a different manner. To employ the weapon system to its fullest capability, the Soldier must understand how their aiming devices function

The caliber .50 uses three types of aiming devices: iron sights, thermal weapon sight (TWS), and available pointing devices.

FUNCTIONS

3-1. Soldiers use an aiming device to align themselves, the weapon, and the target to make an accurate and precise shot. Each aiming device functions in a different manner. The Soldier must understand how the aiming device functions to employ the weapon system to its fullest capability.

3-2. The following aiming devices are described within this chapter:

- Iron sights. The iron sight represents the mechanical sighting system available on the weapon. The mechanical sighting system consists of the rear aperture and the front sight post.
- Thermal. Thermals are electronic sighting systems that provide a view of the field of view based on temperature variations. The numerous variants of thermal optics are grouped into one type, which is the TWS.
- Pointer, illuminator, laser. The pointer, illuminator, laser aiming devices use either a laser beam, flood light, or other light to aim the weapon at the target. The automatic rifle/light machine gun uses four types of pointers, illuminators, and lasers listed below:
  - Infrared aiming light.
  - Advanced target pointer illuminator aiming light (ATPIAL).
  - Dual beam aiming laser–advanced (DBAL-A2).
  - Illuminator, integrated, small arms (STORM).

UNITS OF ANGULAR MEASUREMENT

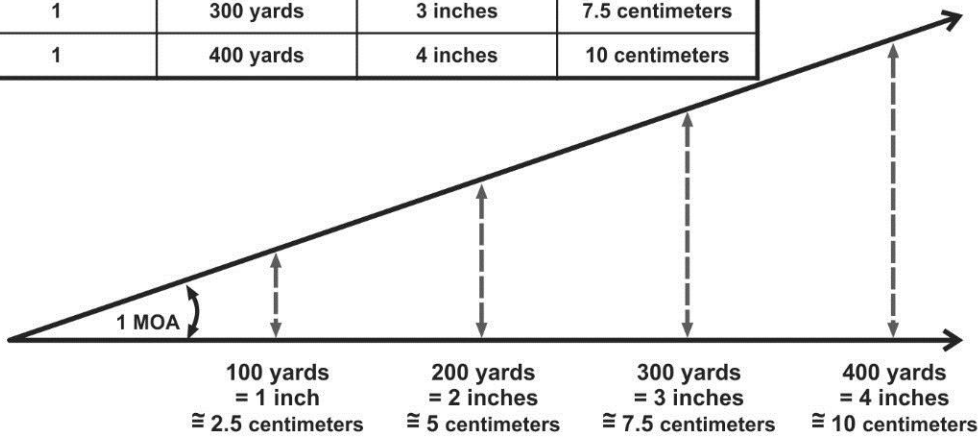
3-3. Two major units of angular measurement the Army uses: milliradians (mils) and minutes of angle (MOA). Mils and MOAs describe a measurement of accuracy when firing a weapon, system, or munition. Mils and MOAs typically include the accuracy of a specific weapon, the performance of ammunition, and the ability of a shooter to fire the weapon.

MINUTE OF ANGLE

3-4. One minute of angle equals 1/60 of a degree (see figure 3-1). The most common use of minute of angle is to describe the distance of change required when zeroing a weapon.

3-5. One minute of angle equals 1.047 inches per 100 yards. For most applications, a Soldier can round this to 1 inch at 100 yards or 1.1 inches at 100 meters to simplify their arithmetic.

MOA	At Distance	Equals	
1	100 yards	1 inch	2.5 centimeters
1	200 yards	2 inches	5 centimeters
1	300 yards	3 inches	7.5 centimeters
1	400 yards	4 inches	10 centimeters



Angle dimension exaggerated for clarity. Examples are not to scale. Centimeter (cm) conversions are approximate.

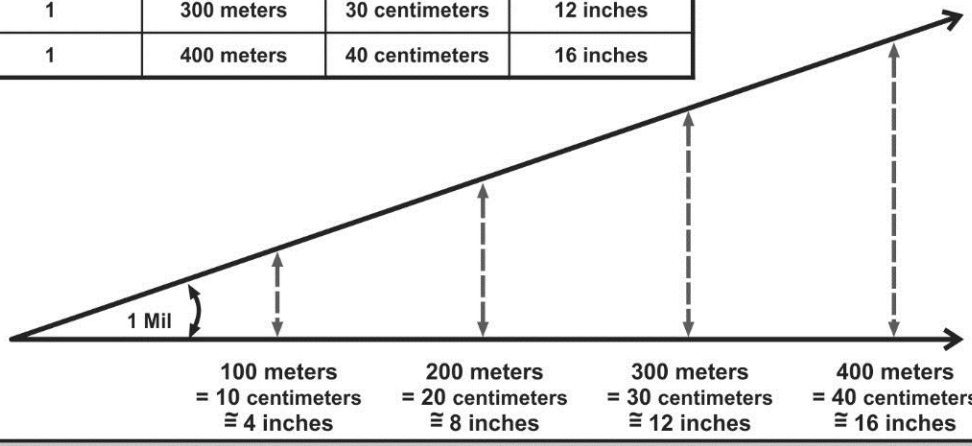
Minute of Angle (MOA) Unit of Measurement	
Degree = 60 MOA	360 degrees x 60 MOA = 21,600 MOA
Circle = 360 degrees	1 MOA at 100 yards = 1 inch.
Smaller measurements of an MOA are described in fractions (such as 1/2 MOA), not seconds.	

Figure 3-1. Minute of angle example

MIL

3-6. The mil is a common unit of angular measurement that is used in direct fire and indirect fire applications (see figure 3-2). The mil-to-degree relationship is used when describing military reticles, ballistic relationships, aiming devices, and on a larger scale, for map reading and indirect fire.

Mil	At Distance	Equals	
1	100 meters	10 centimeters	4 inches
1	200 meters	20 centimeters	8 inches
1	300 meters	30 centimeters	12 inches
1	400 meters	40 centimeters	16 inches



MILS Unit of Measurement	
Degree = 17.78 mils	360 degrees x 17.78 mils
Circle = 360 degrees	1 mil at 100 meters = 10 centimeters.

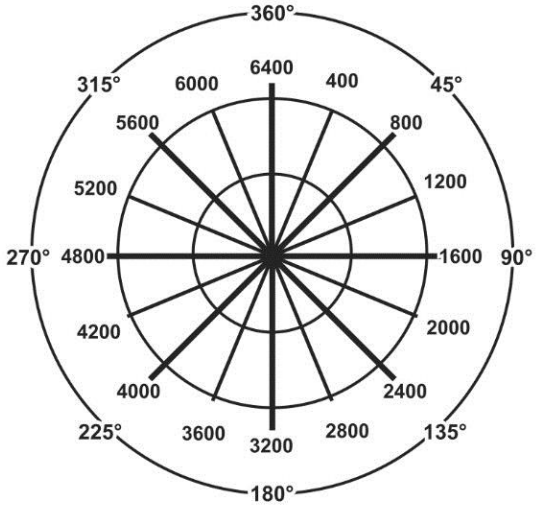


Figure 3-2. Mil, example

STADIA RETICLE (STADIAMETRIC RETICLE)

3-7. A reticle is a series of fine lines in the eyepiece of an optic. The reticle in a TWS is used as a measuring scale with included aiming or alignment points. Reticles use either mils or minute of angle for their unit of measurement (see figure 3-3, page 3-4).

3-8. Commonly used in the thermal weapon sight, a stadia reticle provides a means of rapidly determining the approximate range-to-target of a viewed threat, based on its standard dimensions. The stadia reticle (sometimes referred to as stadiametric or choke sight) can provide approximate range-to-target information using the height of a five-foot tall person or width of a 10-foot tank using standard threat dimensions.

3-9. The M2 reticle has two stadia reticles in the thermal weapons sight. The vertical stadia reticle (located in the upper right portion of the display) is used to determine range to a 10-foot wide tank. The horizontal stadia reticle (located in the lower left portion of the display) is used to determine range to a five-foot tall person. In WFOV the stadiametric range is 100 to 1000 meters. In NFOV the stadiametric range is 100 to 2000 meters. In addition to the stadiametric reticles, the soldier also has the option of using the vertical and horizontal lines located to the left or right side of the aiming points to determine the range. The horizontal lines are used to determine range to a 10 foot wide tank. The vertical lines are used to determine the range to a five-foot tall person.

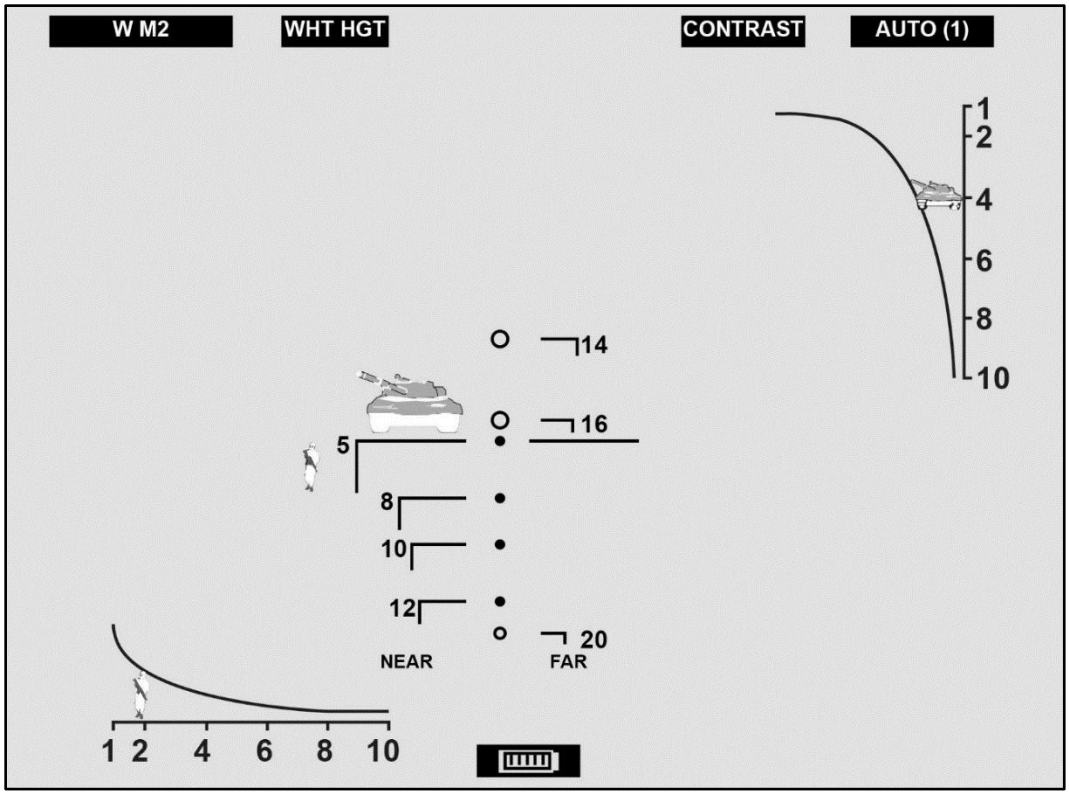


Figure 3-3. Stadia reticle example

ELECTROMAGNETIC SPECTRUM

3-10. A major concern for the planning and use of thermal and other optics to aid in the detection process is understanding how they function, but more appropriately, what they can see. Each device develops a digital representation of the scene or view it is observing based on what frequencies or wavelengths it can detect within the electromagnetic spectrum.

Note. Thermal devices, see differences in heat.

THERMAL OPTICS

3-11. Thermal optics equipment operates in the mid- and far-wavelength of the infrared band, which is the farthest of the infrared wavelengths from visible light. Thermal optics cannot translate (see) visible light.

Thermal optics cannot see illumination produced by infrared equipment such as infrared strobe lights, infrared chemical lights, illuminators, or laser pointers. They can only identify emitted radiation in the form of heat (see figure 3-4, page 3-6).

IMAGE INTENSIFIERS

3-12. Image intensifiers (I2), such as night vision devices, use the near area of the infrared spectrum closest to the frequencies of visible light, as well as visible light to create a digital picture of the scene. These systems cannot detect heat or heat sources.

3-13. These sights generally operate by convection, conduction, or radiation (mentioned in chapter 2 of this TC). The sight picks up or translates the infrared wavelength (or light), which emits from a target scene by one of these three methods. Remember when planning to consider that that these optics have difficulty imaging through—

- Rain absorbs the infrared emitted by the target, making it difficult to see.
- Water acts as a mirror and generally reflects infrared, providing a false thermal scene.
- Glass acts similar to water, interfering with the sensor's ability to accurately detect emitted radiation behind the glass.

3-14. Situations where infrared can see better are the following:

- Smoke only obscures a target if the chemical obscurant is extremely hot and dense, or if the target is sitting on top of the smoke source.
- Dust may interfere with the accurate detection of the emitted thermal signature if sufficiently dense or if similar in temperature to the target.

3-15. Figure 3-4 shows the areas of the electromagnetic spectrum. The figure details the various wavelengths within the spectrum where the aiming devices, night vision devices, and equipment operate. Figure 3-4, page 3-6, shows where these items can and cannot detect the others, within their operating range.

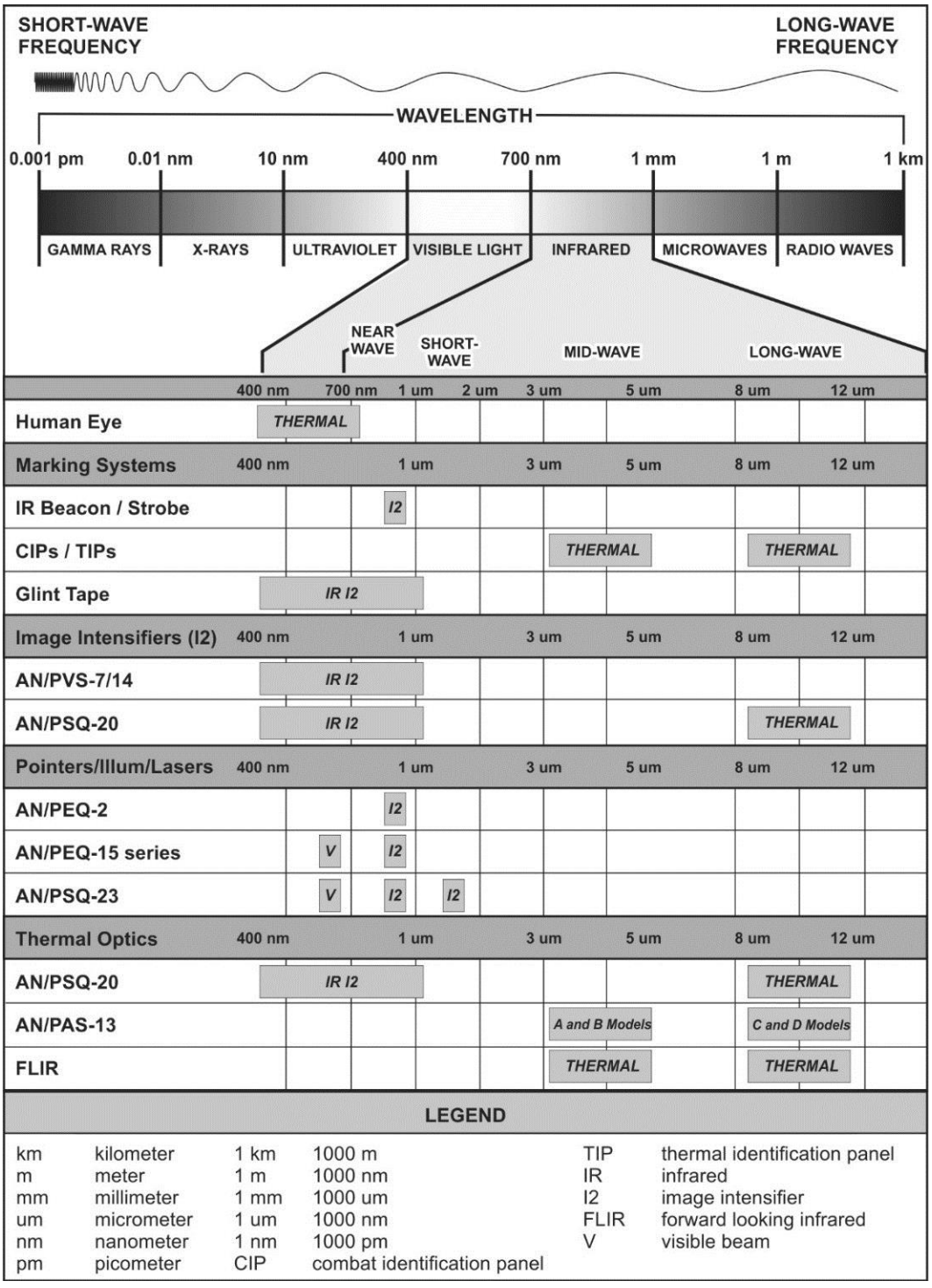


Figure 3-4. Electromagnetic spectrum

IRON SIGHT

3-16. The gun has a leaf type rear sight (see figure 3-5), graduated in both yards and mils. The scale dial ranges from 100 to 2600 in yards, and from 0 to 62 in mils. The windage knob permits deflection changes to right or left of center. The front sight is a fixed blade-type with cover. The battle sight is preset at a range of 750 yards. The sight does not require setting.

3-17. The integrated rear aperture includes adjustments for both azimuth (wind) and elevation (range). (See appendix E and the technical manual(s) for zeroing instructions.)

3-18. The leaf sight uses the fixed front sight post to create the proper aim. Soldiers use the front sight post centered in the rear aperture (see figure 3-5).

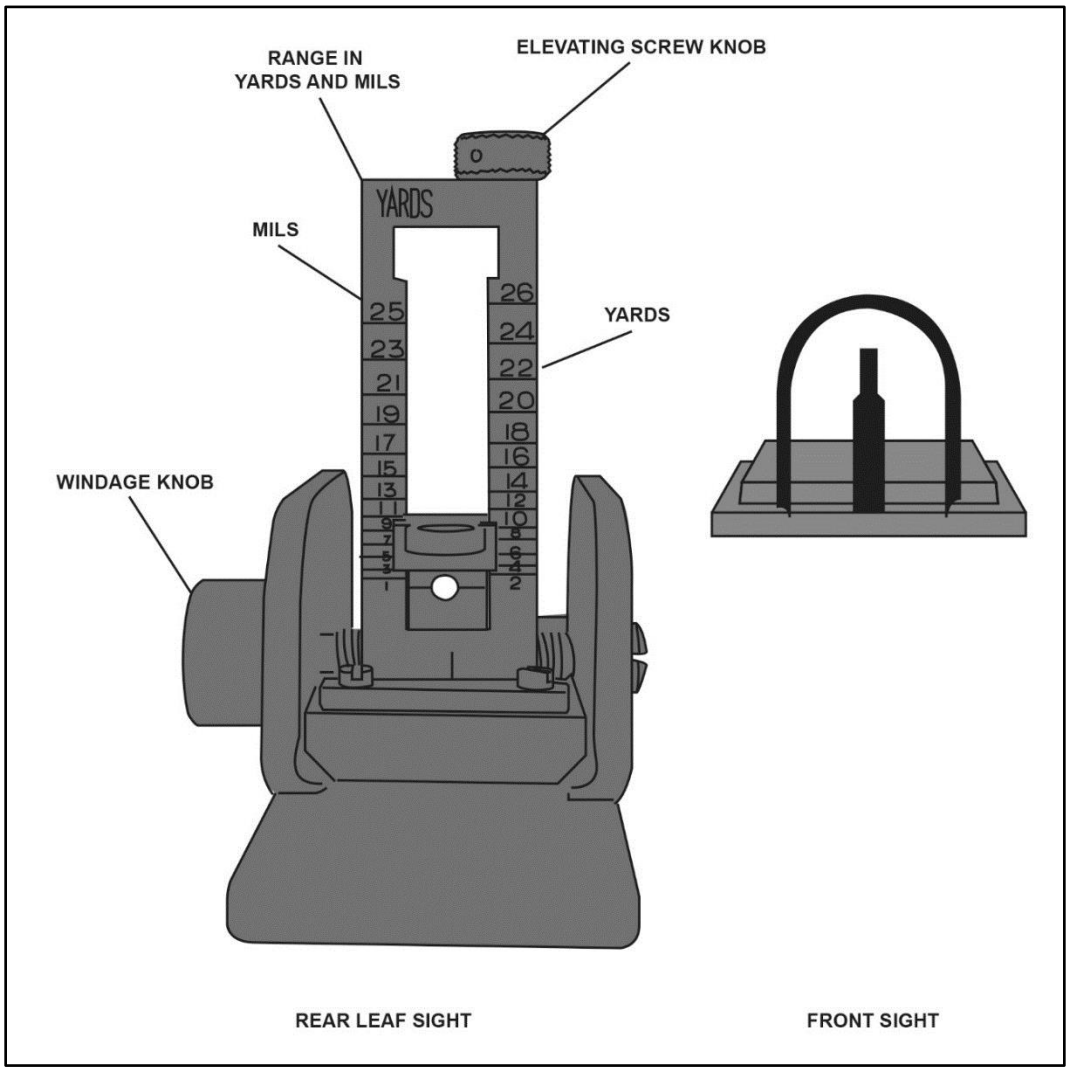


Figure 3-5. Iron sight

THERMAL SIGHT

3-19. Thermal sights are target acquisition and aiming sensors that digitally replicate the field of view based on an estimation of the temperature. They use advanced forward-looking infrared technology that identify the infrared emitted radiation (heat) of a field of view, and translate those temperatures into a gray- or color-scaled image. The TWS is capable of target acquisition under conditions of limited visibility, such as darkness, smoke, fog, dust, and haze, and operates effectively during the day and night.

FUNCTIONAL GROUPS ADDED

3-20. The TWS has five functional groups (see figure 3-6):

- Objective lens. The lens receives infrared light emitting from an object and its surroundings. The objective lens magnifies and projects the infrared light.
- Detector assembly. The assembly senses the infrared light and coverts it to a video signal.
- Sensor assembly. The sensor electronics process the video for display on the liquid crystal display (LCD) array in the field of view.
- LCD array and eyepiece. The LCD array provides the infrared image along with the reticle selected. The light from the LCD array is at the eyepiece.
- User controls. The control electronics allow the user to interface with the device to adjust contrast, thermal gain, sensitivity, reticle display, and magnification.

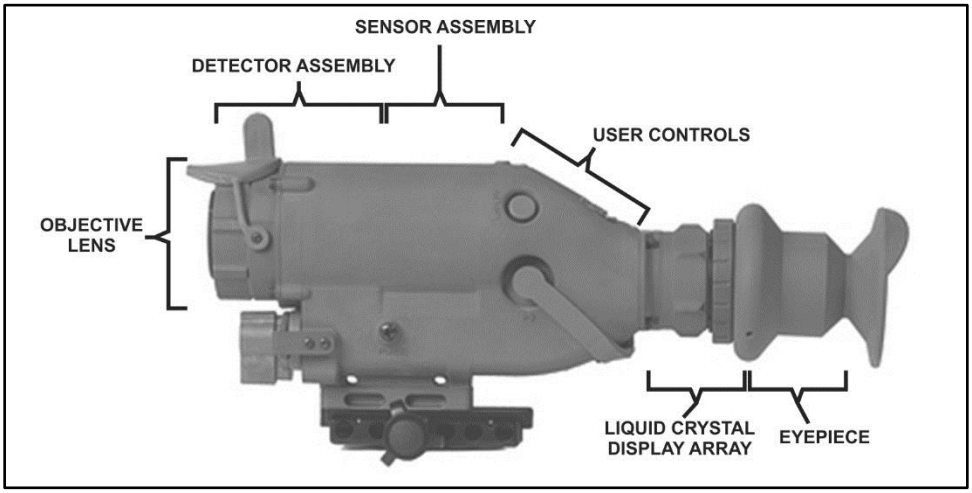


Figure 3-6. Thermal weapon sight, example

3-21. A small detector used in thermal sensors or optics to identify IR radiation with wavelengths between 3 and 30 µm (micrometer). The thermal optic calculates and processes the thermal scene into a correlating video image signal based on the temperature identified. These optics can differentiate thermal variations of 1 degree Celsius of the viewable scene. These variations generate a corresponding contrasting gradient that develops a thermal representation on the LCD screen in the eyepiece.

AN/PAS-13 SERIES OF THERMAL WEAPONS SIGHT

3-22. There are several versions of weapons thermal sights available for use across the force. Soldiers must be familiar with their model and version of the weapon thermal sight. They must know the specific procedures for alignment and operation of their weapon thermal sight. The official model nomenclature identifies the various models and versions as listed below:

- Version 1 (v 1). Light weapons thermal sight (LWTS).
- Version 2 (v 2). Medium weapons thermal sight (MWTS).
- Version 3 (v 3). Heavy weapons thermal sight (HWTS).

3-23. Weapons thermal sights are silent, lightweight, and compact, and have durable battery-powered infrared imaging sensors that operate with low battery consumption. (See figure 3-7.)

VERSION		
Light Weapon Thermal Sight (LWTS)	**Medium Weapon Thermal Sight (MWTS)**	**Heavy Weapon Thermal Sight (HWTS)**
AN/PAS-13C (v1)	AN/PAS-13C (v2)	AN/PAS-13C (v3)
AN/PAS-13D (v1)	AN/PAS-13D (v2)	AN/PAS-13D (v3)
AN/PAS-13E (v1)	AN/PAS-13E (v2)	AN/PAS-13E (v3)

NOTE: The MWTS does not include the ballistic reticle for the M4- or M16-series weapons.

Figure 3-7. Weapon thermal sights

Advantages

3-24. Military grade thermal weapon sights have the following traits—

- Portable. Small and lightweight.
- Relevant. Devices provide real-time video of the thermal scene immediately after power on.
- Long lasting. Low power consumption over time means long battery life.
- Reliable. Long mean time between failures (known as MTBF).
- Quiet. The lack of a cooling element allows for a very low operating noise level.
- Versatile. One optic fits on multiple weapons. The adaptive rail system rail-mounting bracket allows one optic to be used on other weapons.
- Efficient. The F and G models attach in front of other aiming devices to improve their capabilities and eliminate the zeroing procedures for the device.

Disadvantages

3-25. These devices have limitations that Soldiers should consider, particularly during combat operations. The primary disadvantages are:

- Cannot interpret multispectral infrared. These systems view a limited range of wavelengths (heat variations), and so cannot see all aiming and marking devices at night.
- Rely on rechargeable batteries and charging stations. Although the batteries are commonly available and have fairly long battery lives, additional equipment is required to charge them. If common nonrechargeable (alkaline) batteries are used, a separate battery adapter is typically required.
- Cannot interpret thermal signatures behind glass or water effectively.

- Cannot always detect friendly marking systems worn by dismounts.

POINTERS, ILLUMINATORS, AND LASERS

3-26. Pointers, illuminators, and laser devices for small arms weapons emit a collimated beam of infrared light for precise aiming and a separate infrared beam for illumination. These devices operate in one single mode at a time, as selected by the user. The laser is activated by a selector switch on the device or by a remote mechanism installed on the weapon. The basic two modes or functions are pointer and illuminator.

- Pointer. When used as a pointer or aiming device, a small, pin-point beam is emitted from the device. The infrared beam provides an infrared visible point when it strikes an object or target. The infrared beam operates in the 400 to 800 nanometer wavelength and can only be seen by I2 optics, such as the AN PVS-7 or -14 night-vision devices.
- Illuminator. Typically used to illuminate a close quarters area as an infrared flood light. The illuminator provides a flood-light effect for the Soldier when used in conjunction with I2 night-vision devices.

Note. Laser is an acronym for light amplified stimulated emitted radiation, but is predominantly used as a proper noun.

3-27. The devices shown in table 3-1 are the most common laser pointing devices available for use on the M2 weapons.

Table 3-1. Laser aiming devices for the M2

Laser Aiming Device	*Device Name*	*Reference*
AN/PEQ-2A	Target Pointer/Illuminator/Aiming Light (TPIAL)	TM 9-5855-1915-13&P
AN/PEQ-15	Advanced Target Pointer/Illuminator/Aiming Light (ATPIAL)	TM 9-5855-1914-13&P
AN/PEQ-15A	Dual Beam Aiming Laser–Advanced 2 (DBAL–A2)	TM 9-5855-1912-13&P
AN/PSQ-23	Illuminator, Integrated, Small Arms (STORM)	TM 9-5855-1913-13&P

Note. The ATPIAL, DBAL-A2, and STORM have collocated infrared and visible aiming lasers. A single set of adjusters move both aiming beams. Although the aiming lasers are collocated, Soldiers should zero the laser they intend to use as their primary pointer to ensure accuracy and consistency during operation.

AN/PEQ-2A TARGET POINTER, ILLUMINATOR, AIMING LIGHT (TPIAL)

3-28. AN/PEQ-2A aiming devices (see figure 3-8) are Class IIIB laser devices that emit a collimated beam of infrared light for precise aiming and a separate infrared beam for illumination of the target or target area. Both beams can be independently zeroed to the weapon and to each other. The beams can be operated individually or in combination in both high and low power settings.

Note. The infrared illuminator has an adjustable bezel to vary the size of the illumination beam based on the size and distance of the target.

3-29. The aiming devices are used with night observation devices. Soldiers can use the devices as handheld illuminators or pointers, or they can mount the devices on the weapon with the included brackets and

accessory mounts. In the weapon-mounted mode, the aiming devices can be used for direct fire and to illuminate and designate targets.

3-30. The aiming light is activated by pressing on either the ON/OFF switch lever, or the button on the optional cable switch. Either switch connects power from two AA batteries to an internal electronic circuit which produces the infrared laser. Internal lenses focus the infrared light into a narrow beam. The direction of the beam is controlled by rotating the mechanical Adjusters with click detents. These adjusters are used to zero the aiming light to the weapon.

3-31. Once zeroed to the weapon, the aiming light projects the beam along the line of fire of the weapon. The optical baffle prevents off-axis viewing of the aiming light beam by the enemy.

CAUTION

A safety block is provided for training purposes to limit the operator from selecting high power modes of operation.

TM 9-5855-1915-13&P		
DIMENSIONS		
LENGTH	6.4 in	16.3 cm
WIDTH	2.8 in	7.1 cm
HEIGHT	1.2 in	3 cm
WEIGHT	9.5 oz	269 g

POWER	
BATTERY LIFE	100 hours >32°
	36 hours <32°
POWER SOURCE	2 each AA batteries

MODE OF OPERATION			
MODE	**MARKINGS**	**TGT LASER**	**ILLUM LASER**
O	OFF	OFF	OFF
1	AIM LO	LOW POWER	OFF
2	DUAL LO	LOW POWER	LOW POWER
3	AIM HI	HIGH POWER	OFF
4	DUAL LO/HI	HIGH POWER	LOW POWER
5	DUAL HI	HIGH POWER	HIGH POWER

LASER	**DIVERGENCE**	**WAVELENGTH**
IR BEAM	0.3 mRad	820-850 nm
IR ILLUMINATOR	3.0 mRad	820-850 nm

LEGEND					
cm	centimeters	IR	infrared	oz	ounces
g	grams	mRad	milliradians		
in	inches	nm	nanometers		

Figure 3-8. AN/PEQ-2, TPIAL

AN/PEQ-15 Advanced Target Pointer, Illuminator, Aiming Light (ATPIAL)

3-32. The AN/PEQ-15 ATPIAL is a multifunctional laser that emits both a visible and infrared light for precise weapon aiming and target/area illumination. This ruggedized system can be used as a handheld illuminator/pointer or can be mounted to weapons equipped with an M4- or M5-adapter rail system (Military Standard [MIL STD] 1913).

- Visible light can be used to boresight the device to a weapon without the need of night vision goggles. A visible red-dot aiming laser can also be selected to provide precise aiming of a weapon during daylight or night operations.
- Infrared lasers emit a highly collimated beam of infrared light for precise weapon aiming. A separate infrared-illuminating laser can be adjusted from a flood light mode to a single point spot-divergence mode.

3-33. The lasers can be used as handheld illuminator pointers, or can be weapon-mounted with included hardware. The co-aligned visible and infrared aiming lasers emit through laser ports in the front of the housing. These highly capable aiming lasers allow for accurate nighttime aiming and system boresighting.

3-34. The AN/PEQ-15 has an integrated rail grabber molded into the body to reduce weight and additional mounting hardware. (Refer to TM 9-5855-1914-13&P for more information.)

CAUTION

The AN/PEQ-15 can be used during force-on-force training in the low power modes only. High power modes can be used on live-fire ranges exceeding 220 meters only.

3-35. The AN/PEQ-15, ATPIAL's (see figure 3-9) visible aiming laser provides for active target acquisition in low light and close-quarters combat, and allows users to zero using the borelight without using night observation devices. When used with night observation devices, its infrared aiming and illumination lasers provide for active, covert target acquisition in low light or complete darkness.

3-36. The ATPIAL visible and infrared aiming lasers are co-aligned. A single set of adjusters moves both aiming beams, and the user can boresight and zero using either aiming laser. The following information is an extract from the equipment's technical manual for Soldier reference.

TM 9-5855-1914-13&P		
DIMENSIONS		
LENGTH	4.6 in	11.7 cm
WIDTH	2.8 in	7.1 cm
HEIGHT	1.9 in	4.1 cm
WEIGHT	7.5 oz	213 g

POWER	
BATTERY LIFE	>6 hours in DUAL HIGH (DH) mode
POWER SOURCE	1 each DL-123A, 3 volt

MODE OF OPERATION

POSITION	MODE	REMARKS
VIS AL	Vis Aiming Laser	Visible Aim Laser ON
O	OFF	Prevents inadvertent laser burst
P	Program	Sets the desired IR pulse rate
AL	AIM LOW	Low power of Aiming Laser
DL	DUAL LOW	Aiming Laser and Illuminator on LOW
AH	AIM HIGH	Aiming Laser set to HIGH
IH	ILLUM HIGH	IR Illuminator set to HIGH
DH	DUAL HIGH	IR Aim and Illuminator set to HIGH

LASER	DIVERGENCE	WAVELENGTH
IR BEAM	0.5 mRad	820-850 nm
IR ILLUMINATOR	1.0 to 105 mRad	820-850 nm
VISIBLE AIMING	0.5 mRad	605-665 nm

LEGEND

cm	centimeters	IR	infrared	oz	ounces
g	grams	mRad	milliradians		
in	inches	nm	nanometers		

Figure 3-9. AN/PEQ-15, ATPIAL

AN/PEQ-15A, DUAL BEAM AIMING LASER – ADVANCED 2 (DBAL-A2)

3-37. The AN/PEQ-15A, DBAL-A2 is a multifunctional laser device that emits infrared pointing and illumination light, as well as a visible laser for precise weapon aiming and target/area illumination. The visible and infrared aiming lasers are co-aligned enabling the visible laser to be used to boresight both aiming lasers to a weapon without the need for night vision devices. Soldiers can use the ruggedized system as a handheld illuminator and pointer or they can mount it to weapons equipped with an M4 or M5 adapter rail system (MIL-STD-1913).

- Visible light can be used to boresight the device to a weapon without the need of night vision goggles. A visible red-dot aiming laser can also be selected to provide precise aiming of a weapon during daylight or night operations.
- Infrared laser emits a tightly focused beam of infrared light for precise aiming of the weapon. A separate infrared illumination provides supplemental infrared illumination of the target or target area. The infrared illuminator is equipped with an adjustable bezel to vary the size of the illumination beam on the size and distance to the target (flood to point divergence).

3-38. The lasers can be used as hand-held illuminator pointers, or can be weapon-mounted with included hardware. These highly capable aiming lasers allow for accurate nighttime aiming and system boresighting.

3-39. The AN/PEQ-15A, DBAL-A2 (see figure 3-10, page 3-15) visible aiming laser provides for active target acquisition in low light conditions and close quarters combat situations, and allows users to zero using the borelight without using night observation devices. When used with night observation devices, its infrared aiming and illumination lasers provide for active, covert target acquisition in low light or complete darkness.

3-40. The DBAL-A2 visible and infrared aiming lasers are co-aligned. A single set of adjusters moves both aiming beams, and the user can boresight/zero using either aiming laser. The following information is an extract from the equipment's technical manual for Soldier reference.

TM 9-5855-1912-13&P		
DIMENSIONS		
LENGTH	3.5 in	8.7 cm
WIDTH	2.9 in	7.4 cm
HEIGHT	1.9 in	4.8 cm
WEIGHT	8 oz	224 g

POWER	
BATTERY LIFE	>5.5 hours in IR DUAL HIGH mode
POWER SOURCE	1 each DL-123A, 3 volt

MODE OF OPERATION

POSITION	MODE	REMARKS
AL	LOW POWER	Low power for aim laser
AH	HIGH POWER	High power for aim laser
VIS A	VIS AIM RED	Aiming or marking laser for daylight
VIS A	VIS AIM GREEN	Aiming or marking laser for daylight

LASER	DIVERGENCE	WAVELENGTH
IR BEAM	0.3 mRad	840 nm
IR ILLUMINATOR	0.5 to 75 mRad	840 nm
VISIBLE AIM, RED	0.3 mRad	635 nm
VISIBLE AIM, GREEN	0.5 mRad	532 nm

LEGEND

cm	centimeters	IR	infrared	oz	ounces
g	grams	mRad	milliradians		
in	inches	nm	nanometers		

Figure 3-10. AN/PEQ-15A, DBAL-A2

AN/PSQ-23, ILLUMINATOR, INTEGRATED, SMALL ARMS (STORM)

3-41. The AN/PSQ-23 is a battery-operated laser range finder and digital magnetic compass with integrated multifunctional lasers. The illuminator, integrated, small arms device is commonly referred to as the STORM laser. The visible and infrared aiming lasers are co-aligned enabling the visible laser to be used to boresight both aiming lasers to a weapon without the need for night vision devices. This ruggedized system can be used as a handheld illuminator/pointer or can be mounted to weapons equipped with an M4 or M5 adapter rail system (MIL-STD-1913).

- Laser range finder provides range to target information from 20 meters to 10,000 meters with an accuracy of +/- 1.5 meters.
- Digital magnetic compass provides azimuth information and limited elevation information to the operator. The azimuth accuracy is +/- 0.5 degrees to +/- 1.5 degrees. The elevation accuracy is +/- 0.2 degrees. The digital magnetic compass can identify bank or slopes up to 45 degrees with an accuracy of +/- 0.2 degrees.
- Visible light provides for active target acquisition in low light and close quarters combat situations without the need for night vision devices. It can be used to boresight the device to a weapon without the need of night vision devices. A visible red-dot aiming laser can also be selected to provide precise aiming of a weapon during daylight or night operations.
- Infrared laser emits a tightly focused beam of infrared light for precise aiming of the weapon. A separate infrared illumination provides supplemental infrared illumination of the target or target area. The infrared illuminator is equipped with an adjustable bezel to vary the size of the illumination beam on the size and distance to the target (flood to point divergence).
- Infrared illuminator the STORM features a separately adjustable infrared illuminator with adjustable divergence. It is fixed in the device housing and is set parallel to the rail mount.

Note. The STORM'S laser range finder and digital magnetic compass may be used in combination to obtain accurate positioning information for targeting purposes and other tactical applications.

3-42. The integrated visible aim laser and illumination lasers provide for active, covert target acquisition in low light or complete darkness when used with night vision devices. The STORM is also equipped with a tactical engagement simulation laser allowing it to be used in a laser-based training environment.

3-43. The AN/PEQ-15A, DBAL-A2 visible aiming laser provides for active target acquisition in low light conditions and close-quarters combat situations, and allows users to zero using the borelight without using night observation devices. When used with night observation devices, its infrared aiming and illumination lasers provide for active, covert target acquisition in low light or complete darkness. The following information is an extract from the equipment's technical manual for Soldier reference (see figure 3-11, page 3-17).

TM 9-5855-1913-13&P		
DIMENSIONS		
LENGTH	7.3 in	18.5 cm
WIDTH	3.5 in	9.0 cm
HEIGHT	1.9 in	4.8 cm
WEIGHT	20.8 oz	590 g

POWER	
BATTERY LIFE	>5.5 hours in IR DUAL HIGH mode
POWER SOURCE	2 each DL-123A, 3 volt

MODE OF OPERATION		
POSITION	**MODE**	**REMARKS**
VH	VIS HIGH	Aiming or marking in daylight/indoor
AH	AIM HIGH	IR operates on high power
IH	ILLUM HIGH	IR illum operates on high power
DH	DUAL HIGH	IR/Illum both operate on high power
BUTTON	**MODE**	**REMARKS**
L	Laser activate	Activates aiming laser
R	Range/Compass	Press/Hold 3 sec to enter menu power

LASER	**DIVERGENCE**	**WAVELENGTH**
IR BEAM	0.5 mRad	820-850 nm
IR ILLUMINATOR	1.0 to 100 mRad	820-850 nm
VISIBLE AIM, RED	0.5 mRad	605-665 nm
LASER RANGE FINDER	1.0 mRad	1570 nm

LEGEND					
cm	centimeters	IR	infrared	oz	ounces
g	grams	mRad	milliradians		
in	inches	nm	nanometers		

Figure 3-11. AN/PSQ-23, STORM

Chapter 4

Mountable Equipment

The M2 takes a wide variety of attachments, which increase Soldier lethality, situational awareness, and overmatch. Soldiers must understand what the attachments are, how they are correctly positioned, how to align them with the weapon system, and how to use them.

Chapter 4 discusses the M3 and M205 machine gun tripods and traversing and elevating (T&E) mechanism used by today's Soldiers. These provide a stable platform for crew-served weapons and increase accuracy and control. Gunners can easily extend, collapse, carry and store tripods and mounts, METT-TC dependent. This chapter also explains how to use the M2 mounting bracket with various attachments. For information about other tripods and mounts, refer to their respective technical manuals.

M3 MACHINE GUN TRIPOD

4-1. The M3 machine gun tripod is the standard ground system for the M2. It has a folding tripod with three telescopic tubular legs connected at the tripod head. Each leg ends in a metal shoe that can be stamped into the ground for greater stability. The two rear legs are joined together by a traversing bar. The traversing bar serves as a support for the traversing and elevating mechanism, which in turn supports the rear of the weapon. The tripod head provides a front support for the weapon that is further supported by the front leg.

EQUIPMENT DATA

4-2. Table 4-1 shows the equipment data for the M3 machine gun tripod.

Table 4-1. M3 tripod equipment data

WEIGHT:	M3 tripod .....44 pounds (19.98 kilograms)
LENGTH:	Stowed .....45.5 inches (116 centimeters) Legs extended .....76 inches (193 centimeters)
WIDTH:	Stowed .....8 inches (20 centimeters) Legs extended .....61.5 inches (156 centimeters)
HEIGHT:	On hard surface .....14 inches (36 centimeters) Stowed .....7 inches (18 centimeters)
ELEVATION:	Free gun.....285 milliradian (16 degrees) T&E engaged .....100 milliradian (6 degrees)
DEPRESSION:	Free gun.....335 milliradian (19 degrees) T&E engaged .....250 milliradian (14 degrees)
TRAVERSE:	Free gun.....6400 milliradian (360 degrees) T&E engaged .....400 milliradian (22 degrees left or right) Traverse hand wheel .....25 milliradian (1 degrees left or right)

COMPONENTS

4-3. The major components of the M3 machine gun tripod (figure 4-1) consist of the following:

- The tripod (1) has three telescopic tubular legs connected at the tripod head. A traversing bar joins the two rear legs.
- The pintle (2) provides a means of attaching the M2 to the tripod. The pintle inserts into a brass bushing sleeve on the head assembly of the tripod. The weapon is secured to the pintle with a bolt, nut, and pin.
- The T&E mechanism (3) lets the Soldier control manipulation and allows the Soldier to engage predetermined targets. The elevating mechanism allows for traversing, elevating, and locking of T&E to traverse bar.

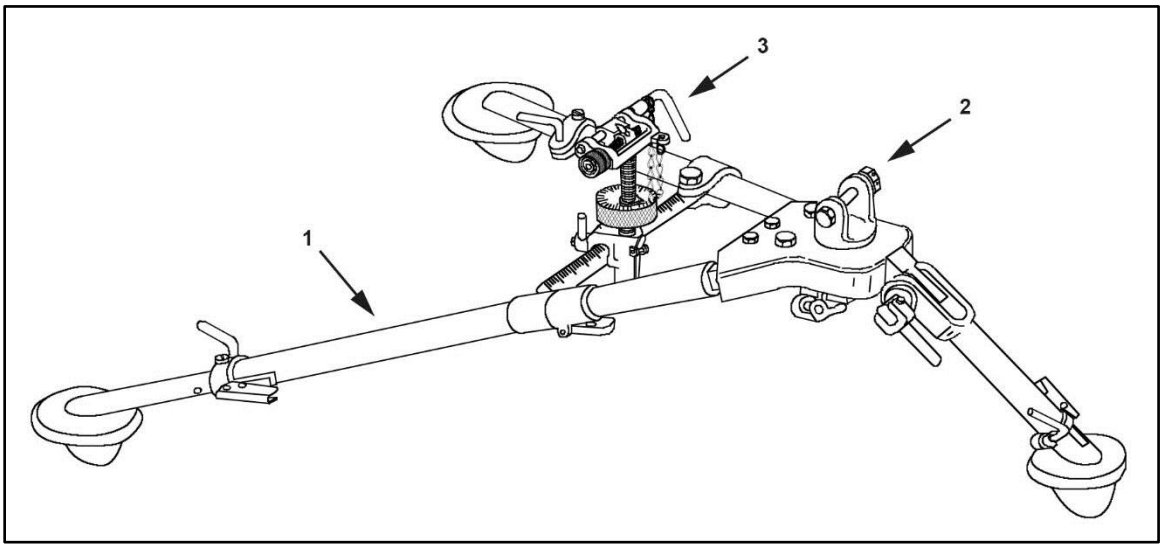


Figure 4-1. M3 tripod, pintle and traversing and elevating mechanism

EMPLOYMENT

4-4. The M3 machine gun tripod is a folding tripod with three telescopic tubular legs connected at the tripod head. The two rear legs are joined together by a traversing bar. Each leg ends in a metal shoe that can be stamped into the ground for greater stability. The traversing bar is hinged on one side with a sleeve and on the other side with a sleeve latch. The traversing bar serves as a support for the traverse and elevating mechanism, which in turn support the rear of the weapon.

4-5. The T&E mechanism is used to engage preselected target areas. The elevation scale shows 250-milliradian depression and 100-milliradian elevation, graduated in 1-milliradian increments. The traverse scale shows 400-milliradian traverse to the right or left. The T&E is clamped in place by a traversing slide lock lever. The head provides a front support for the weapon through a pintle attached to the weapon and tripod.

TRAVERSING AND ELEVATING MECHANISM

4-6. When the T&E is locked to the traverse bar, center the traversing handwheel. To change direction (right or left), loosen the traversing lock lever (1, figure 4-2), and move the sleeve along the traverse bar (2, figure 4-2). The T&E will traverse 400 milliradian left or right from the zero index.

Note. The traverse bar is graduated in 5-milliradian increments and is numbered every 100 milliradian from the zero index (right or left) up to 400 milliradian.

4-7. Read the traverse bar from the left side of the traversing sleeve. To make changes of 25 milliradian or less (right or left), turn the traversing handwheel (3, figure 4-2). The head will appear to move along the traverse screw, and the weapon will move right or left. Each click of the traversing handwheel (3, figure 4-2) is 1 milliradian deflection (see figure 4-3, page 4-4). The traverse screw can traverse 50 milliradian.

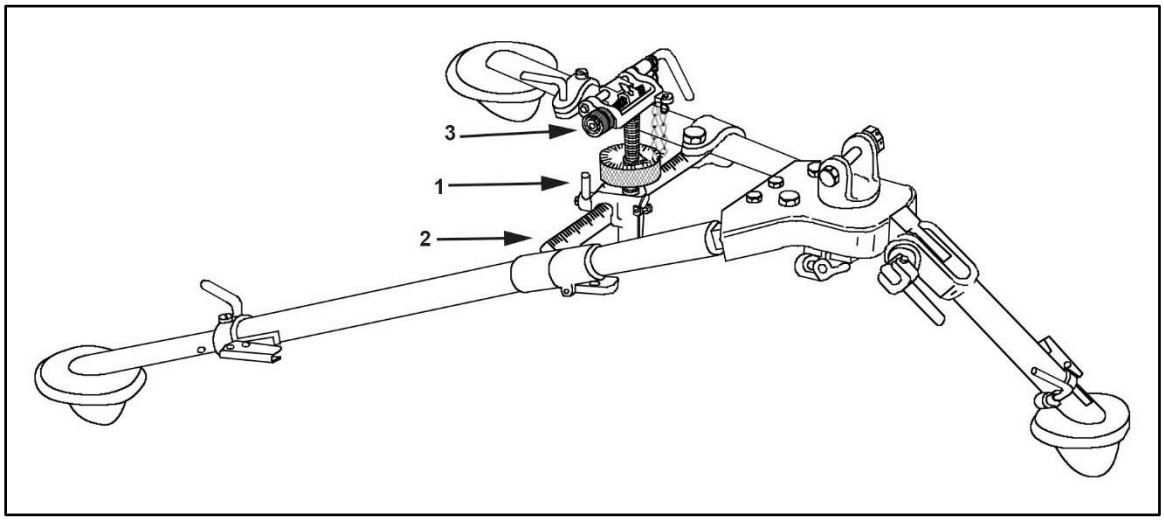


Figure 4-2. T&E mechanism attached to the M3 tripod

THEORY OF OPERATION

4-8. The T&E elevation portion consists of the upper (20, figure 4-3) and lower (21, figure 4-3) elevating screw and elevating handwheel (22, figure 4-3). The upper screw has a scale that is graduated in 50-milliradian increments (+ 200-milliradian). The handwheel has a dial scale that is graduated in 5-milliradian increments (50-milliradian total). Each click of the handwheel indicates 1-milliradian of elevation or depression. Turn the handwheel clockwise to depress and counterclockwise to elevate.

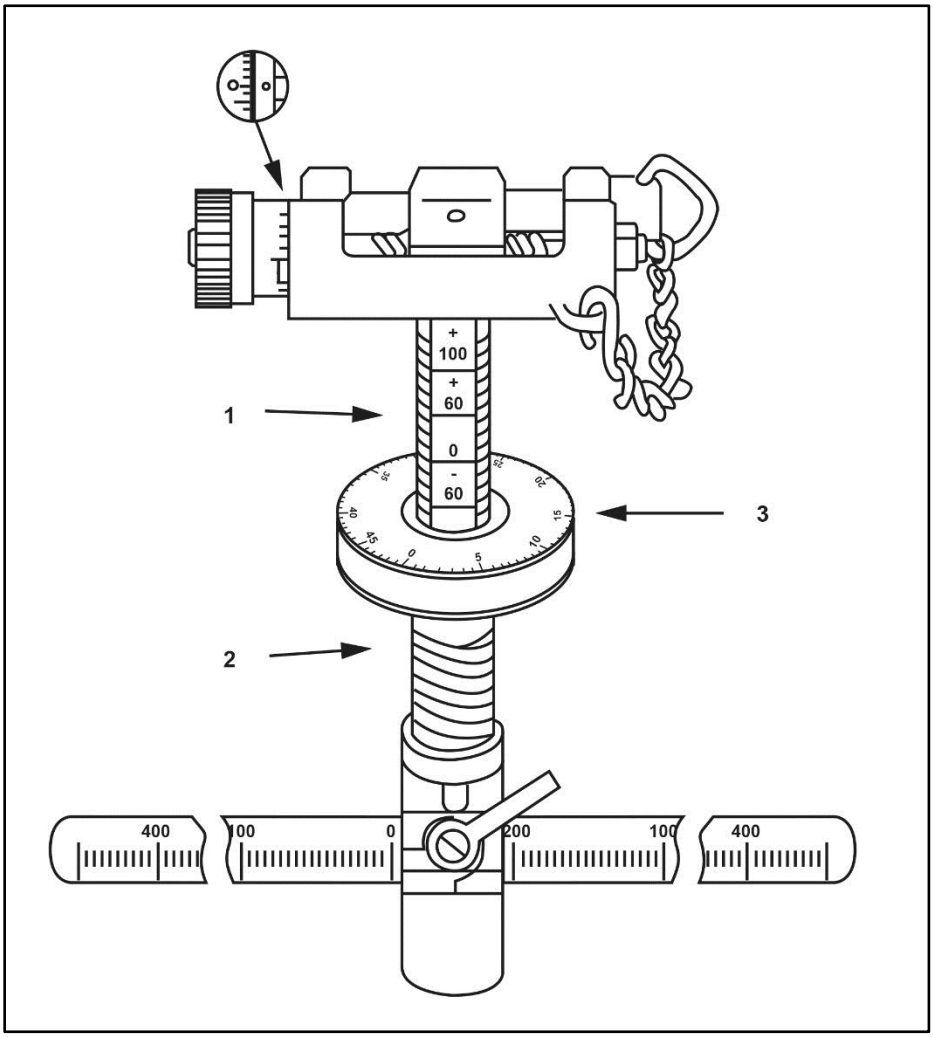


Figure 4-3. T&E mechanism

M205 LIGHTWEIGHT MACHINE GUN TRIPOD

4-9. The M205 is a lightweight tripod for use with the M2/M2A1 and other machine guns that use the MK 93 mount. The M205 is a modified, nondevelopmental item with a 32 percent weight savings (16 pounds) over the M3 tripod. The M205 lightweight tripod mount (see figure 4-4) for the M2 and M2A1 has the following components:

- Front leg assembly (1).
- Tri-head assembly (2).
- Pintle assembly (3).

- Traversing and elevating assembly (4).
- Right rear leg assembly (5).
- Left rear leg assembly (6).

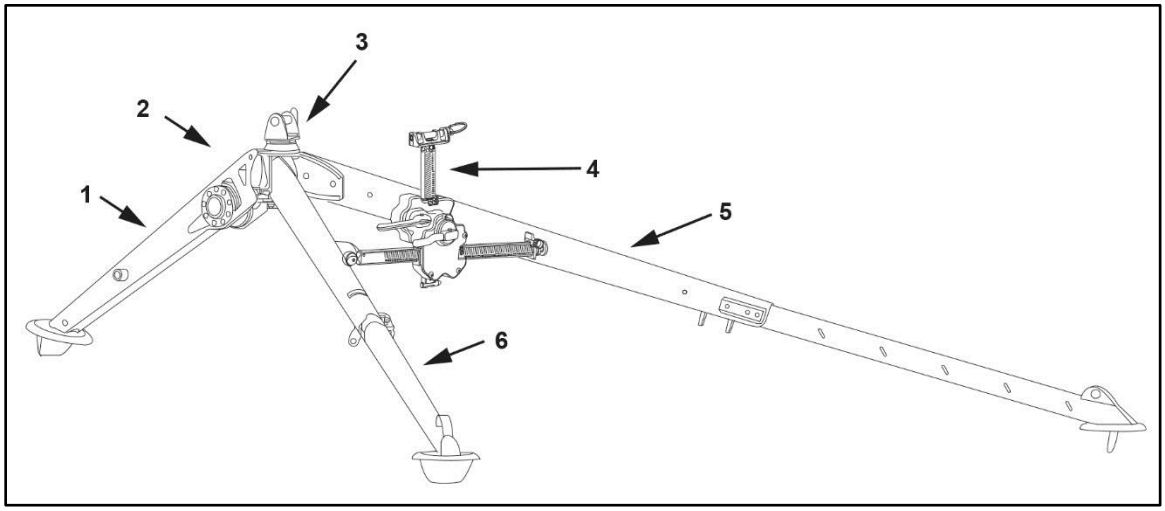


Figure 4-4. M205 lightweight machine gun tripod components

4-10. The front leg is fully adjustable. The tri-head assembly accepts the M205 pintle, the M3 tripod pintle, or the MK 93 dual mount. The tri-head assembly includes a cam handle, which allows the Soldier to adjust the front leg assembly from stowed to deployed positions.

4-11. The pintle assembly consists of the pintle (1), and pintle mounting pin assembly (2).The pintle assembly provides a means of attaching the M2 heavy machine gun or the M2A1 machine gun. Figure 4-5 shows the pintle assembly.

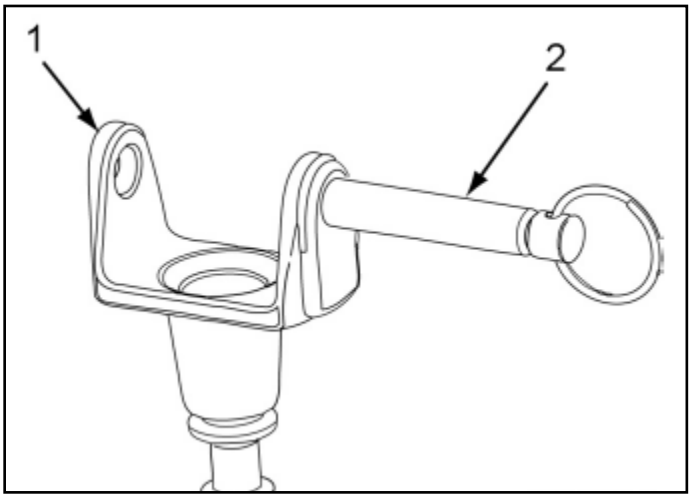


Figure 4-5. M205 pintle assembly

4-12. Before the Soldier operates the weapon, they secure the pintle assembly to it, and fully seat the pintle assembly in the tripod mount (see figure 4-6). Failure to secure the weapon could prevent the Soldier from controlling the point of aim, and cause serious injury to the Soldier. The Soldier might have to press the pintle latch release to help seat the MK93 pintle onto the M205 lightweight tripod mount.

WARNING

Secure the weapon to avoid serious injury.

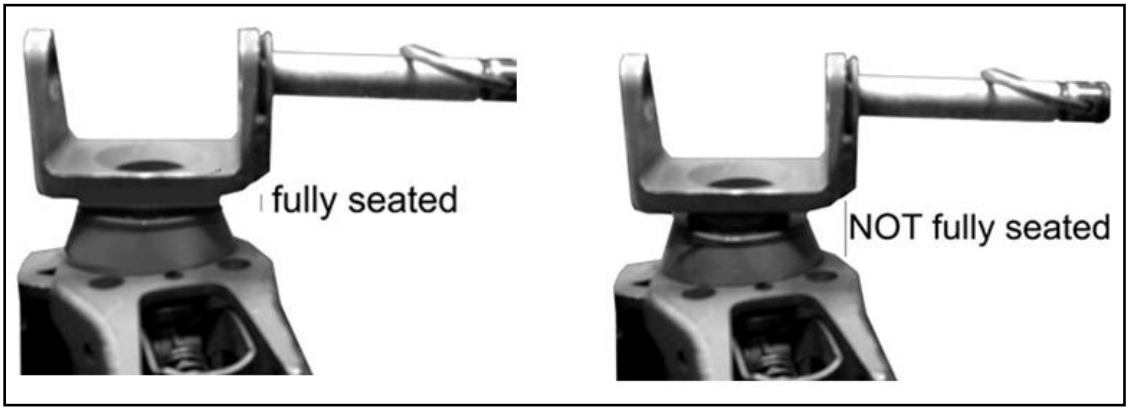


Figure 4-6. M205 pintle assembly fully and not fully seated

TRAVERSING AND ELEVATING ASSEMBLY

4-13. The T&E mechanism allows the Soldier to control traversing and elevating by hand. The Soldier can make bold adjustments throughout the full range and fine adjustments down to 1 milliradian. Figure 4-7 shows the components of the T&E assembly below:

- Elevation handle (1).
- Elevation bracket assembly (2).
- Elevation bar assembly (3).
- Traverse handle (4).
- Traverse stop (5).
- Traverse bar assembly (6).

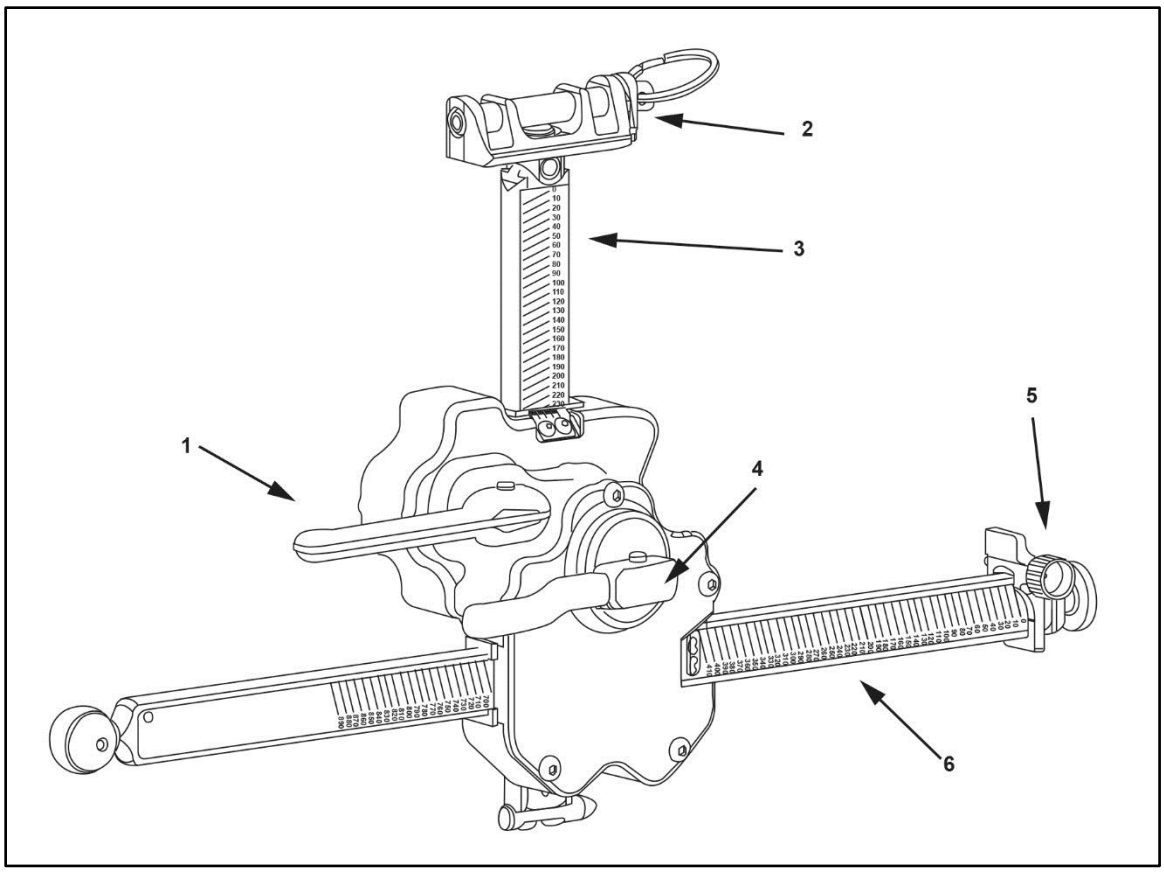


Figure 4-7. M205 T&E assembly components

REAR LEG ASSEMBLY AND EQUIPMENT DATA

4-14. Rear legs can extend and retract without tools. The leg latch locks at each position to enable deployment of the gun on varying terrain. The right rear leg has two lugs to stow the elevation bracket. The left rear leg has one lug. This stows the elevation bar and secures the T&E assembly to the legs. Table 4-2 shows the equipment data for the M205 lightweight machine gun tripod.

Table 4-2. M205 tripod equipment data

WEIGHT:	*M205 tripod*	34 pounds(15 kilograms)
LENGTH:	*Stowed*	46 inches (117 centimeters)
	Deployed (maximum)	75 inches (191 centimeters)
WIDTH:	*Stowed*	12 inches (30 centimeters)
	Deployed (maximum)	69 inches (175 centimeters)
HEIGHT:	*Stowed*	8 inches (20 centimeters)
	Deployed (maximum)	25 inches (64 centimeters)
ELEVATION AND DEPRESSION	*Total range*	0 to 460 milliradians
TRAVERSE:	*Total range*	0 to 900 milliradians

Note. Weight includes tripod, pintle assembly, and T&E assembly.

Theory of Operation

4-15. The M205 lightweight tripod mount is a lightweight ground mount for use with both guns. The M205 lightweight tripod mount includes a light, unique pintle that is also compatible with the M3 tripod pintle, MK 93 dual mount, caliber .50 ammunition can, PA 120 and M548 mounting bracket assembly.

4-16. The M205 lightweight tripod mount can be carried, deployed, emplaced, and stowed in its carrying configuration by a single operator without the use of tools. An integrated, permanently-attached traverse and elevation assembly provides infinite fine adjustment and rapid bold adjustment of the point of aim. Traverse and elevation motions can be controlled together or independently and traverse travel can be limited by setting the adjustable traverse limit stop located to the right of the T&E housing.

4-17. The M205 lightweight tripod mount includes an adjustable, fixed-length front leg, and telescoping rear legs. It comes with a new, lightweight pintle that stows on the front leg when not in use. The front leg can be rotated and clamped through a range of more than 180 degrees for stowage, to accommodate uneven terrain, and to set the height of the tripod when deployed. The length of the two rear legs can be independently adjusted to accommodate uneven terrain.

4-18. The T&E assembly provides the rear support point for the weapon and allows the user to control the direction of fire. An adjustable traverse limit stop is incorporated on the traverse bar and located to the right of the T&E housing. The integrated T&E Assembly is permanently attached to the left leg. When deployed, T&E Assembly is attached to the traverse bar locking lug on the right leg. The weapon is attached to the top of the elevation bar with a retained quick release pin.

4-19. When the M205 lightweight tripod mount is in the stowed configuration, the tripod legs protect the T&E assembly during transport. The lightweight pintle can be securely stowed on the front leg using the integrated quick release pin.

MK 64 MACHINE GUN MOUNT

4-20. The MK 64 carriage and cradle assembly (see figure 4-8) provides a mounting platform for machine guns and ammunition brackets. The carriage (1) holds the cradle (2) and attaches to a machine gun tripod or pintle adapter by pintle (3).

4-21. In the center of the cradle is a caliber .50 pintle bushing (5) and lock to enable mounting of the M2. The lower rear retaining pinholes (8) receive the T&E retaining pin. Each carriage and cradle assembly is issued with a depression stop that consists of a machine bolt (9) and nut (10) to control muzzle depression.

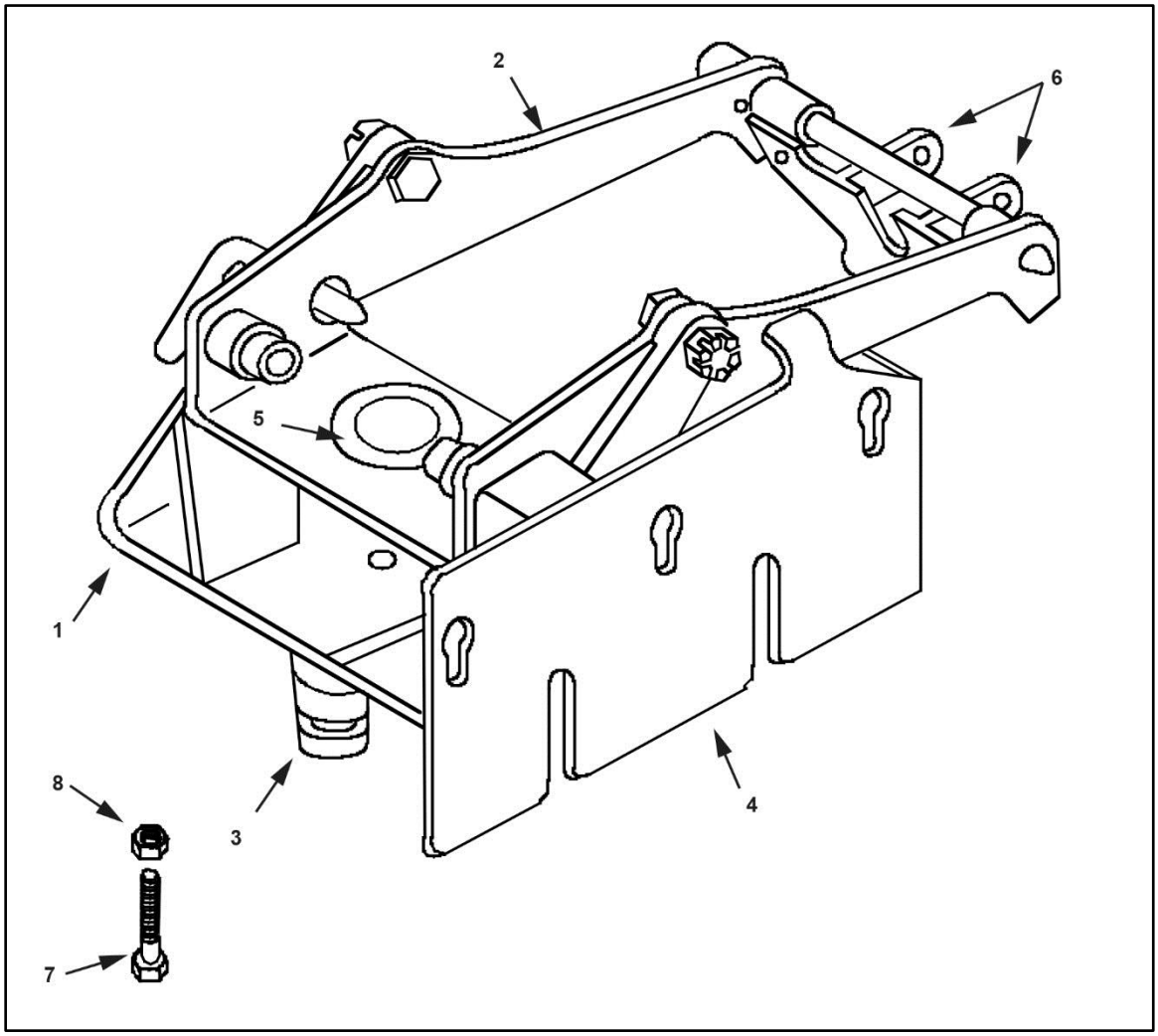


Figure 4-8. MK 64 carriage and cradle assembly

MK 93 MACHINE GUN MOUNT

4-22. The mount consists of the carriage assembly (1) and cradle assembly (2). The MK 93 mounts the MK 19 MOD 3 and M2 machine guns onto the M3 tripod and vehicles for defensive applications. (See figure 4-9.)

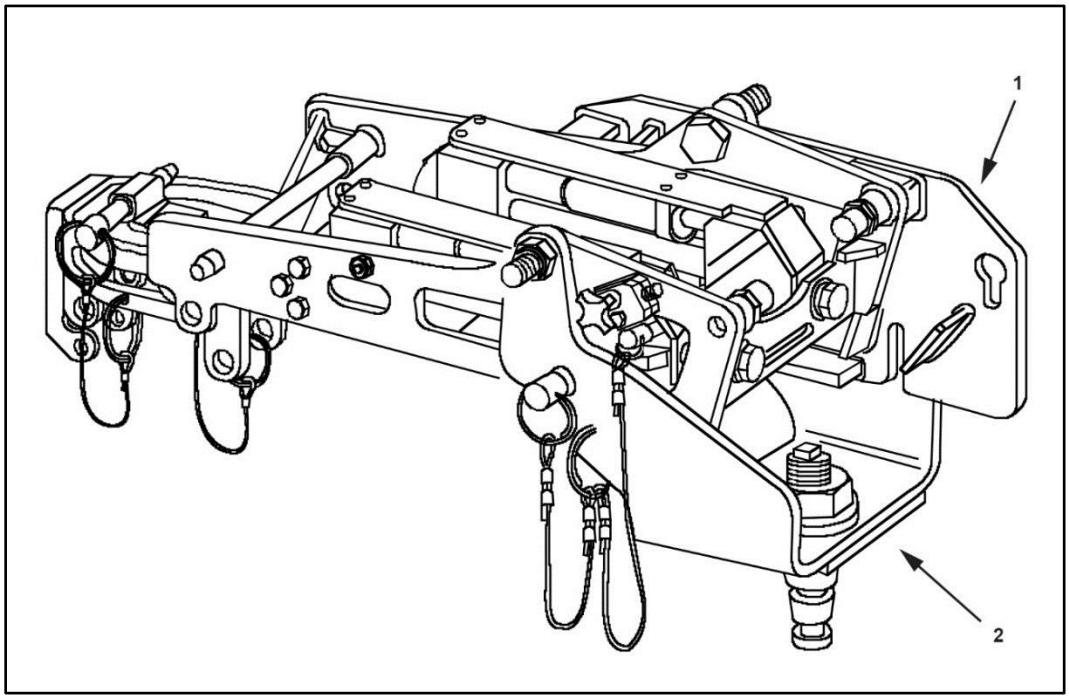


Figure 4-9. MK 93 carriage and cradle assembly

ADAPTIVE RAIL SYSTEM

4-23. The M2 mounting bracket incorporates the adaptive rail system and rail grabbers designed for other weapons.

4-24. The adaptive rail system provides a secure mounting point for aiming devices and other accessories, which may be mounted on top of the weapon.

4-25. Soldiers should record the equipment's serial number (if applicable), the location of the attachment (for example, markings between lugs), and any boresight or alignment settings specific to the equipment at that location.

4-26. Once complete, the Soldier should mark the mounting bracket to identify the tightened position with a permanent marker. Marking the mounting bracket allows for rapid identification of loosening hardware during firing. Soldiers must periodically check during operation to ensure mounting hardware does not loosen. When zeroing or confirming zero, Soldiers should retighten the mounting hardware after the first five rounds.

4-27. Soldiers must ensure the equipment is firmly affixed to the adaptive rail system before tie-down is complete. If the attachments are loose, their accuracy and effectiveness will be degraded.

MOUNTED LIGHTS

4-28. Weapon-mounted lights provide selection between white light and infrared capabilities. Employment of the weapon mounted light is based upon mission, enemy, terrain and weather, troops and support available, time available, civil considerations (METT-TC) and unit SOP. The weapon-mounted lights should be mounted where the Soldier can activate and deactivate them easily, where they do not hinder the use of any other attachment or accessory, and where they cannot be turned on unintentionally.

Chapter 5
Employment

Although the machine gun has changed since it first appeared on the battlefield, its role has not. In battle, the mission of machine guns is to deliver fires when and where the leader wants them, both in offense and defense. Machine guns rarely have independent missions. Instead, they provide the unit with the accurate, heavy fires needed to accomplish the mission. Chapter 5 discusses the general-purpose employment of machine guns.

The machine gunner's primary role is to engage the enemy with well-aimed shots. The gunner must acquire the target and perform the shot process. (Refer to ATP 3-21.8 for more information.) Consistently hitting a target with precision is a complex interaction of factors immediately before, during, and after the round fires. These interactions include maintaining postural steadiness, establishing and maintaining the proper aim on the target, stabilizing the weapon while pressing the trigger, and adjusting for environmental and battlefield conditions.

FIRING SITUATIONS

5-1. Every Soldier must adapt to the firing situation, integrate the rules of firearms safety, manipulate the fire control, and instinctively know when, how, and where to fire. It is directly influenced by the Soldier's ability to hit the target under conditions of extreme stress. To be successful, Soldiers need to—

- Accurately interpret and act upon perceptual cues related to the target, front and rear sights, machine gun movement, and body movement.
- Execute minute movements of the hands, elbows, legs, and feet.
- Coordinate gross-motor control of their body positioning with fine-motor control of the hands and digits that are manipulating the trigger and T&E.

5-2. Regardless of the weapon system, the goal of firing a weapon remains constant: well-aimed shots or bursts. To achieve this end state there are two truths. Soldier's must master sight alignment, sight picture, and trigger control, which are defined below:

- Sight alignment. Sight alignment is the relationship between the aiming device and the firer's eye. To achieve proper and effective aim, focus on the front sight post or reticle. Maintain sight alignment throughout the aiming process.
- Sight picture. The sight picture is the placement of the aligned sights on the target.
- Trigger control. The skillful manipulation of the trigger that causes the machine gun to fire without disturbing the aim.

Note. A burst is a series of shots fired automatically with a single pressure on the trigger. The number of shots to be used in any one burst of fire depends upon the nature of the targets, the steadiness of firing, and ammunition supply.

SHOT PROCESS

The shot process is the basic outline of an individual engagement sequence all gunners consider during an engagement. Using the shot process helps the Soldier make the decisions, perform the calculations, and take the actions that lead to the shlot. The Soldier can stop the shot process at any time before disengaging the sear and firing the weapon. The shot process has three distinct phases:

- Pre-shot.
- Shot.
- Post-shot.

5-3. To achieve consistent, accurate, well-aimed shots or bursts, Soldiers must understand and correctly apply the shot process. The sequence of the shot process does not change. However, the application of each element varies based on the conditions of the engagement.

5-4. Every shot and burst that the Soldier takes has a separate, complete shot process. Grouping, for example, is simply moving through the shot process several times in rapid succession.

5-5. The shot process allows the Soldier to focus on one cognitive task at a time. The Soldier must maintain the ability to mentally organize the shot process' tasks and actions into a disciplined mental checklist, and focus their attention on activities that produce the desired outcome; a well-aimed shot or burst.

5-6. The level of attention allocated to each element during the shot process is proportional to the conditions of each individual shot. Table 5-1 provides an example of a shot process.

Table 5-1. Shot process example

Pre-shot	Position Natural Point of Aim Sight Alignment/Picture Hold
Shot	Refine Aim Breathing Control Trigger Control
Post-shot	Follow-through Recoil management Call the Shot Evaluate

FUNCTIONAL ELEMENTS OF THE SHOT PROCESS

5-7. Functional elements of the shot process are the linkages among the Soldier, the weapon system, the environment, and the target that directly impacts the shot process and ultimately the consistency, accuracy, and precision of the burst. When used appropriately, the functional elements build a greater understanding of any engagement. The functional elements are interdependent. An accurate burst, regardless of the weapon system, requires the Soldier to establish, maintain, and sustain all of the four functional elements defined below:

- Stability. The Soldier stabilizes the weapon to provide a consistent base to fire from and maintain through the shot process until the recoil pulse stops. This process includes how the Soldier holds the weapon and uses structures or objects for stability, and it includes the Soldier's posture on the ground during an engagement.
- Aim. The continuous process of orienting the weapon correctly, aligning the sights, aligning on the target, and applying the appropriate lead and elevation (hold) during a target engagement.
- Control. All the conscious actions of the Soldier before, during, and after the shot process that the Soldier specifically controls. The first of these is trigger control. This includes whether, when, and

how to engage. It incorporates the Soldier as a function of safety, as well as the ultimate responsibility of firing the weapon.

- Movement. The process of the Soldier moving during the engagement process. It includes the Soldier's ability to move laterally, forward, diagonally, and in a retrograde manner while maintaining stabilization, appropriate aim, and control of the weapon. M2 gunners are unable to fire the weapon while moving due to its size, however the gun can be moved tactically when not in use.

5-8. The functional elements define the tactical engagements that require the Soldier to make adjustments to determine appropriate actions, and compensate for external influences on their shot process. Soldiers can rapidly engage targets with precision when all functional elements are applied.

5-9. The shooter must consider the functional elements of time, target size, target distance, and their own skills and capabilities to minimize induced errors of the burst.

5-10. Each weapon, tactical situation, and sight system will have preferred techniques for each step in the shot process and within the functional elements to produce precision and accuracy in a timely manner. How fast or slow the shooter progresses through the process is based on target size, target distance, and shooter capability.

5-11. The most complex form of shooting is under combat conditions when the Soldier or the enemy is moving under limited visibility conditions. Soldiers and leaders must refine their skills continuously and move training from the simplest engagement to the most complex. Applying the functional elements during the shot process builds a firer's speed while maintaining consistency, accuracy, and precision during complex engagements. Each of the functional elements and the Soldier's actions to consider during the shot process are described later in this manual.

TARGET ACQUISITION

5-12. Target acquisition is the ability of a Soldier to rapidly recognize threats to the friendly unit or formation. Target acquisition is a critical Soldier function performed before any shot process begins. Target acquisition includes the Soldier's ability to use all available optics, sensors, and information to detect potential threats as quickly as possible.

5-13. Target acquisition requires the Soldier to apply an acute attention to detail in a continuous process based on the tactical situation. The target acquisition process includes all the actions a Soldier must execute rapidly:

- Detect potential threats (target detection).
- Identify the threat as friend, foe, or noncombatant (target identification).
- Prioritize the threat(s) based on the level of danger presented (target prioritization).

TARGET DETECTION

5-14. Effective target detection requires a series of skills that Soldiers must master. Detection is an active process during combat operations, with or without a clear or known threat presence. All engagements are enabled by the Soldier's detection skills, and are built upon three skill sets:

- Scan and search. A rapid sequence of various techniques to identify potential threats. Soldier scanning skills determine potential areas where threats are most likely to appear.
- Acquire. A refinement of the initial scan and search, based on irregularities in the environment.
- Locate. The ability to determine the general location of a threat to engage with accuracy or inform the small unit leader of contact with a potential threat.

Scan and Search

5-15. Scanning and searching are the art of observing an assigned sector. The goal of the scan and search is a deliberate detection of potential threats based on irregularities in the surrounding environment. This includes irregular shapes, colors, heat sources, movement, or actions the Soldier perceives as being out of

place, as compared to the surrounding area. Soldiers use five basic search and scan techniques to detect potential threats in combat situations:

- Rapid scan. Rapid scan is used to detect obvious signs of threat activity quickly. It is usually the first method used, whether on the offense or fighting in the defense.
- Slow scan. Soldiers conduct the more deliberate scan using various optics, aiming devices, or sensors. The slow scan is best conducted in the defense or during slow movement or tactical halts.
- Horizontal scan. Soldiers use horizontal scan when operating in restricted or urban terrain. It is a horizontal sweeping scan that focuses on key areas where potential threats may be over watching their movement or position.
- Vertical scan. The vertical scan is an up-and-down scan in restricted or urban environments to identify potential threats that may be observing the unit from an elevated position.
- Detailed search. Soldiers use a detailed search when no threats are detected using other scanning methods. The detailed search uses aiming devices, thermal weapon systems, magnified optics, or other sensors to slowly and methodically review locations of interest where the Soldier would be positioned if they were the threat. (Where would I be if I were them?)

Acquire

5-16. Target acquisition is the discovery of any object in the operational environment such as personnel, vehicles, equipment, or objects of potential military significance. Target acquisition occurs during target scan and search as a direct result of observation and the detection process.

5-17. During the scan and search, Soldiers are looking for target signatures, which are signs or evidence of a threat. Tactically, Soldiers will be looking for threat personnel, obstacles, or mines. This includes possible improvised explosive devices (IEDs), vehicles, or antitank missile systems. These target signatures can be identified with sight, sound, or smell.

Locate

5-18. Target location is the determination of where a target is in the operational environment in relation to the gunner, small unit, or element. Locating a target or series of targets occurs as a result of the search and acquisition actions of each Soldier in the small unit.

5-19. Once a target is located, the threat location can be rapidly and efficiently communicated to the rest of the unit. Methods used to announce a located target depend on the individual's specific position, graphic control measures for the operation, unit SOP, and time available.

Detection Best Practices

5-20. Threat detection is a critical skill that requires thoughtful application of the sensors, optics, and systems at the Soldier's disposal. Finding potential threats as quickly and effectively as possible provides the maximum amount of time to defeat the threat. Detecting threats is more difficult when operating in a chemical, biological, radiological, nuclear (CBRN) environment. Practice detection skills with personal protective equipment (PPE)/individual protective equipment (IPE) and understand the increased constraints and limitations, day and night. Soldiers should be familiar with the following best practices to increase target detection:

- Scan with the unaided eye first, then with a magnified optic.
- Practice using I2 and thermal optics in tandem during limited visibility.
- Understand the difference between I2 and thermal optics; what they can see and what they cannot.

Note. Thermal optics are the preferred sight for target acquisition and engagement, day or night.

- Do not search in the same area as others in the small unit. Overlap, but avoid focusing on the same sector.
- Practice extreme light discipline during limited visibility including infrared light discipline.
- Think as the threat. Search in areas that would be most advantageous from their perspective.

TARGET IDENTIFICATION

5-21. Identifying (or discriminating between) a target as friend, foe, or noncombatant (neutral) is the second step in the target acquisition process. Identification is complicated by the increasing likelihood of having to discriminate between friend/foe and combatant/noncombatant in urban settings or restricted terrain. To mitigate fratricide and collateral damage, Soldiers use all of the situational understanding tools available and develop tactics, techniques, and procedures for discriminating targets.

Classifications

5-22. The Soldier must be able to positively identify the threat into one of three classifications:

- Friend. Any force, U.S. or allied, that is jointly engaged in combat operations with an enemy in a theater of operation.
- Foe (enemy combatant). Any individual who has engaged acts against the U.S. or its coalition partners in violation of the laws and customs of war during an armed conflict.
- Noncombatants. Personnel, organizations, or agencies that are not taking a direct part in hostilities. This includes individuals such as medical personnel, chaplains, United Nations observers, or media representatives or those out of combat such as the wounded or sick. Organizations like the Red Cross or Red Crescent can be classified as noncombatants.

Fratricide Prevention

5-23. Units have other means of distinguishing friendly from enemy vehicles. Typically, these marking systems derive from the unit tactical standard operating procedure (TACSOP) or other standardization publications, and they apply to personnel, small units, or vehicles:

- Markings. Unit markings are defined in the unit SOP. They clearly identify a vehicle as friendly in a standardized manner.
- Panels. VS-17 panels provide a bright recognition feature that allows Soldiers to identify friendly vehicles through the day sight during unlimited visibility. Panels do not provide a thermal signature.
- Lighting. Chemical or light-emitting diodes provide a means of marking vehicles at night. However, chemical lights are not visible through a thermal sight. An infrared variant is available for use with night vision devices. Lighting systems do not provide for thermal identification during day or limited visibility operations.
- Beacons and strobes. Beacons and strobes are procured by the unit. These small, compact, battery-operated flashing devices that operate in the near infrared wavelength. They are clearly visibly through night vision optics, but cannot be viewed through thermal optics.

Note. Beacons and strobes generate illumination signals that can only be viewed by I2 optics. The signal cannot be viewed by thermal optics. When developing their SOPs and when using them in training or combat.

Beacons and strobes can be seen by enemy elements with night vision capabilities. Units should tailor use of the beacon based on METT-TC.

- Symbols. Unit symbols may be used to mark friendly vehicles. An inverted V, for example, painted on the flanks, rear, and fronts of a vehicle, aid in identifying a target as friendly. These are typically applied in an area of operations and not during training. Symbol marking systems do not provide for thermal identification during day or limited visibility operations.

TARGET PRIORITIZATION

5-24. When faced with multiple targets, the Soldier must prioritize them and carefully plan their shots or bursts to ensure successful engagement. Mental preparedness and the ability to make split-second decisions are the keys to a successful engagement of multiple targets. The proper mindset will allow the Soldier to react instinctively and control the pace of the battle, rather than reacting to the adversary threat.

Threat Levels

5-25. Targets are prioritized into three threat levels—

- Most dangerous. A threat that can defeat the friendly force and is preparing to do so. These targets must be defeated immediately.
- Dangerous. A threat that has can defeat the friendly force, but is not prepared to do so. These targets are defeated after all most dangerous targets are eliminated.
- Least dangerous. Any threat without the ability to defeat the friendly force, but with the ability to coordinate with other threats that are more prepared. These targets are defeated after all threats of a higher threat level are defeated.

Multiple Targets

5-26. When multiple targets of the same threat level are encountered, the targets are prioritized according to the threat they represent. The standard prioritization of targets establishes the order of engagement. Gunners engage similar threats by the following guide:

- Near before far.
- Frontal before flank.
- Stationary before moving.

5-27. The prioritization of targets provides a control mechanism for the gunner, and helps in maintaining overmatch over the presented threats. Gunners should be prepared to deviate from the prioritization guide based on the situation, collective fire command, or changes to the target's activities.

Chapter 6
Stability

Stability is the ability of the Soldier to create a stable firing platform for the engagement. The Soldier stabilizes the weapon to provide a consistent base from which to fire and maintain through the shot process until the recoil impulse has ceased. This process includes how the Soldier uses structures or objects to provide stability, and the Soldier's posture on the ground during an engagement. A stable firing platform is essential during the shot process.

Chapter 6 provides the principles of developing a stable firing platform, describes the interaction between the Soldier, weapon, the surroundings, and the methods to achieve the greatest amount of stability in various positions. Chapter 6 explains how the stability functional element supports the shot process and interacts and integrates the other three elements. Stability provides a window of opportunity to maintain sight alignment and sight picture for the most accurate shot or burst.

SUPPORT

6-1. Stability is provided through four functions: support, muscle relaxation, natural point of aim, and recoil management. These functions provide the Soldier the means to best stabilize their weapon system during the engagement process.

6-2. This includes the placement or arrangement of sandbags, equipment, or structures to directly support the weapon for increased stability. Means of support that contribute to stability include tripods, traversing and elevating mechanisms, and bone and muscle.

6-3. Support can be natural, artificial, or both. Natural support comes from a combination of the gunner's bones and muscles. Artificial support comes from objects outside the gunner's body. The more support a position provides, the more stable the weapon.

LEG POSITION

6-4. The position of the legs varies greatly depending on the firing position used. The firing position may require the legs to support the weight of the Soldier's body, support the firing elbow, or meet other requirements. When standing, the body is upright with the legs staggered and knees slightly bent. In the prone, the gunner's legs may be spread apart flat on the ground or bent at the knee. In the sitting position, the legs may also serve as an intricate part of the firing position.

STANCE AND CENTER OF GRAVITY

6-5. This refers to the physical position of a Soldier before, during, and after the shot or burst that relates to the gunner's balance and posture. The position or center of gravity does not apply when firing from the prone position. The position or center of gravity specifically relates to the Soldier's ability to maintain the stable firing platform during firing, absorbing the recoil impulses, and the ability to aggressively lean toward the target area during the shot process.

FIRING ELBOW

6-6. Each firing event presents a unique set of challenges and the gunner must determine how to create the greatest amount of stability necessary to eliminate the threat. The Soldier should consider whether to fire with one hand or two. Proper elbow placement provides consistent firing hand placement and support stability while in the standing, sitting, and prone positions. If firing with both hands, replicate elbow placement on the nonfiring side. Obviously two hands are more stable than one, but other advantages and disadvantages apply:

Advantages of Firing with Both Hands

- More support allows for a smaller arc of movement, which improves sight picture and firing precision.
- The ability to center the body directly behind the weapon improves the accuracy of sight alignment.
- Recoil is easier to manage, which improves follow through, resulting in tighter shot groups and cones of fire.

Disadvantages of Firing with Both Hands

- Adjusting fire requires the gunner to move the nonfiring hand and locate the azimuth and elevation controls of the T&E. This slows subsequent or supplemental engagements.
- Searching and traversing area targets requires repeated movement of the nonfiring hand.
- Moving targets must be engaged with free gun, using the tracking or trapping lead method.

Advantages of Firing with One Hand

- The nonfiring hand can rapidly and precisely adjust the T&E for subsequent and supplemental engagements.
- By using the nonfiring hand to pull out on the traverse lever on the M205 T&E or loosen the traverse lever on the T&E on the M3 tripod, the gunner can maintain a constant elevation while engaging a linear area target or applying lead, or can traverse or track a target area in azimuth in a smooth motion.

Disadvantages of Firing with One Hand

- Gunner is forced to manage recoil and provide stability with one side of the body. This enlarges shot groups and cones of fire.
- Gunner lacks the symmetry provided with two-handed firing as to ensure they are directly behind the weapon, which could lead to sight misalignment.

NONFIRING ELBOW, ONE-HANDED FIRING

6-7. The Soldier's placement of the nonfiring elbow during the shot process supports the hand while manipulating the T&E in all positions (figure 6-1 and figure 6-2, page 6-4). The nonfiring elbow must be used with the firing elbow to stabilize the weapon when being fired in the free gun state. The gunner stabilizes the machine gun while firing the machine gun with two hands by tucking both elbows into the their side while standing, on the inside of their thighs while sitting (figure 6-3, page 6-5), and by placing both elbows on the ground while in the prone position (see figure 6-4, page 6-6).

Figure 6-1. Seated position firing one handed

Figure 6-2. Prone position firing one handed

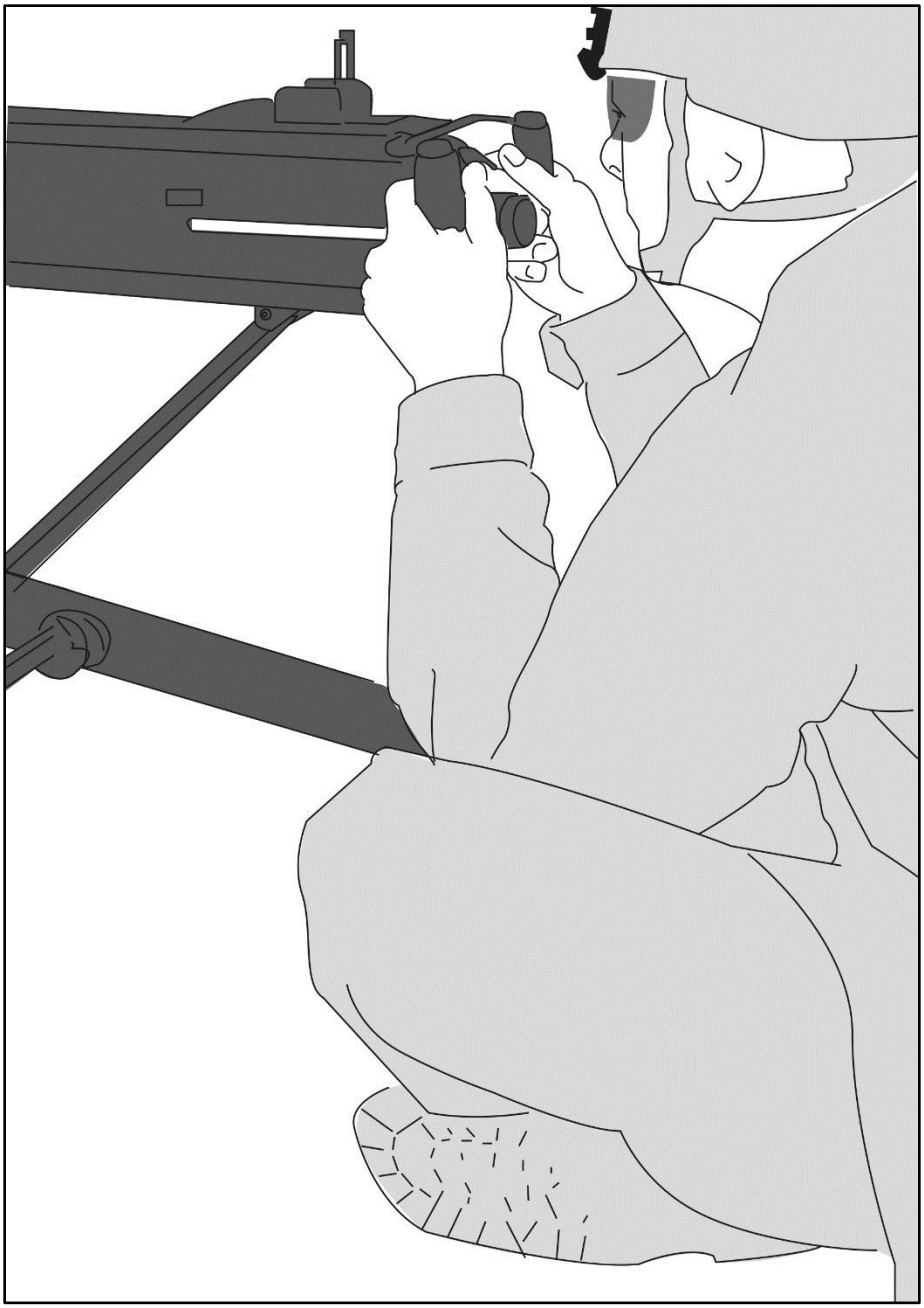


Figure 6-3. Seated position firing two handed

Figure 6-4. Prone position firing two handed

Firing Hand

6-8. Proper placement of the firing hand will aid in trigger control, recoil management, and stability. The Soldier's hand grasps the spade grip with the thumb in a position to press the trigger. The Soldier places the grip in the V formed between the thumb and index finger. The pressure applied is similar to a firm handshake grip. Different Soldiers have different size hands and lengths of fingers, so there is no set position of the thumb on the trigger. To grip the weapon, the Soldier wraps their fingers around the spade grip.

Nonfiring Hand

6-9. Proper placement of the nonfiring hand is based on the firing position and placement of the nonfiring elbow to provide the stability of the hand manipulating the T&E or spade grip if firing with both hands. Placement is adjusted to maximize stability (see figures 6-1, 6-2, 6-3, 6-4, above).

6-10. If possible, the gunner should strive to have the nonfiring hand provide downward force on the hand wheel of the older style T&E used with the M3 tripod. The pressure will provide the necessary force to assist in the management of the wobble area resulting from recoil.

MUSCLE RELAXATION

6-11. Muscle relaxation is the ability of the Soldier to maintain orientation of the weapon appropriately during the shot process while keeping the major muscle groups from straining to maintain the weapon system's position. Relaxed muscles contribute to stability provided by support.

- Strained or fatigued muscles detract from stability.
- As a rule, the more support from the gunner's bones the less the gunner requires from their muscles.
- The more skeletal support, the more stable the position, as bones do not fatigue or strain.
- As a rule, the less muscle support required, the longer the gunner can stay in position.

6-12. Soldiers may have difficulty obtaining optimal muscle relaxation while in the prone position due to differences in body types, operational gear, and fighting positions. To aid in muscle relaxation while in the prone position gunners should use available resources to build their fighting position while still remaining behind available cover. Examples of items that can be used to aid in muscle relaxation are: sand bags, assault pack, or built up earth from around the fighting position.

NATURAL POINT OF AIM

6-13. The natural point of aim is the point where the barrel naturally orients when the gunner's muscles are relaxed and support is achieved. The natural point of aim is built upon the following principles:

- The closer the natural point of aim is to the target, the less muscle support required.
- The more stable the position, the more resistant to recoil it is.
- More of the gunner's body on the ground equals a more stable position.
- More of the gunner's body on the ground equals less mobility for the gunner.

6-14. When a Soldier aims at a target, the lack of stability creates a wobble area, where the sights oscillate slightly around and through the point of aim. This is especially prevalent while firing the weapon in the free gun state. If the wobble area is larger than the target, the Soldier requires a steadier position or a refinement to their position to decrease the size of their wobble area before and while the trigger is depressed.

Note. The steadier the position, the smaller the wobble area. The smaller the wobble area, the more precise the shot or burst.

6-15. To check a gunner's natural point of aim, the Soldier should assume a good steady position and get to the natural pause. Close their eyes, go through one cycle, and then open their eyes on the natural pause. Where the sights are laying at this time, is the natural point of aim for that position. If it is not on their point of aim for their target, they should make small adjustments to their position to get the reticle or front sight post back on their point of aim. The Soldier will repeat this process until the natural point of aim is on the point of aim on their target.

RECOIL MANAGEMENT

6-16. Recoil management is the result of a Soldier assuming and maintaining a stable firing position which mitigates the disturbance of one's sight picture during the cycle of function of the weapon.

6-17. The Soldier's firing position manages recoil using support of the weapon system, tripod, T&E, sand bags, the weight of their body, and the placement of the weapon during the shot process. Proper recoil management allows the sights to rapidly return to the target and allows for faster follow up shots or bursts.

SHOOTER–GUN ANGLE

6-18. The gunner gun-angle is the relationship between the gunners' upper body and the direction of the weapon. This angle is typically different from firing position to firing position, and directly relates to the Soldier's ability to control recoil. Significant changes in the gunner-gun angle can result in eye relief changes.

FIELD OF VIEW

6-19. The field of view is the extent that the human eye can see at any given moment. The field of view is based on the Soldier's view without using magnification, optics, or thermal devices. The field of view is what the Soldier sees, and includes the areas where the Soldier can detect potential threats.

STABILIZATION

6-20. The Soldier must stabilize the weapon, while firing from a stationary position. To create a stabilized platform, the Soldier must understand the physical relationship between the weapon system, the tripod, the T&E, the body, the ground, and any other objects touching the weapon or body. The amount of contact with the ground determines stability and effectiveness of the position. The situation and tactics determine which position to use.

6-21. When a gunner assumes a stable firing position, movement from muscle tension, breathing, and other natural activities within the body transfer to the weapon. The gunner must compensate for these.

6-22. The absence of an effective firing platform is a stabilization failure. Specifically, a stabilization failure occurs when a Soldier fails to—

- Control the movement of the barrel during the arc of movement.
- Adequately support the weapon system.
- Achieve their natural point of aim.

6-23. These failures compound the errors, affecting accuracy. To improve stability during the shot process, the Soldier correctly assumes various firing positions. Positions that are lower to the ground usually provide more stability. Alternatively, when the center of gravity elevates, stability drops (see figure 6-5).

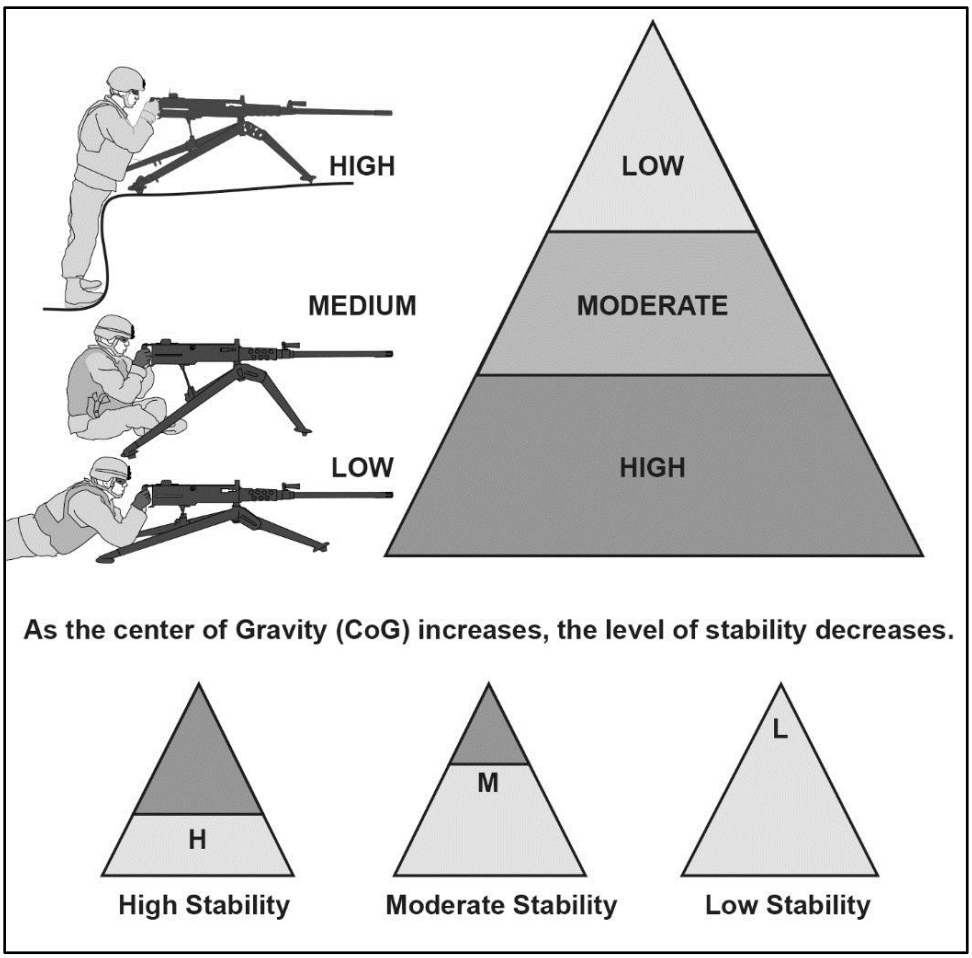


Figure 6-5. Firing position stability example

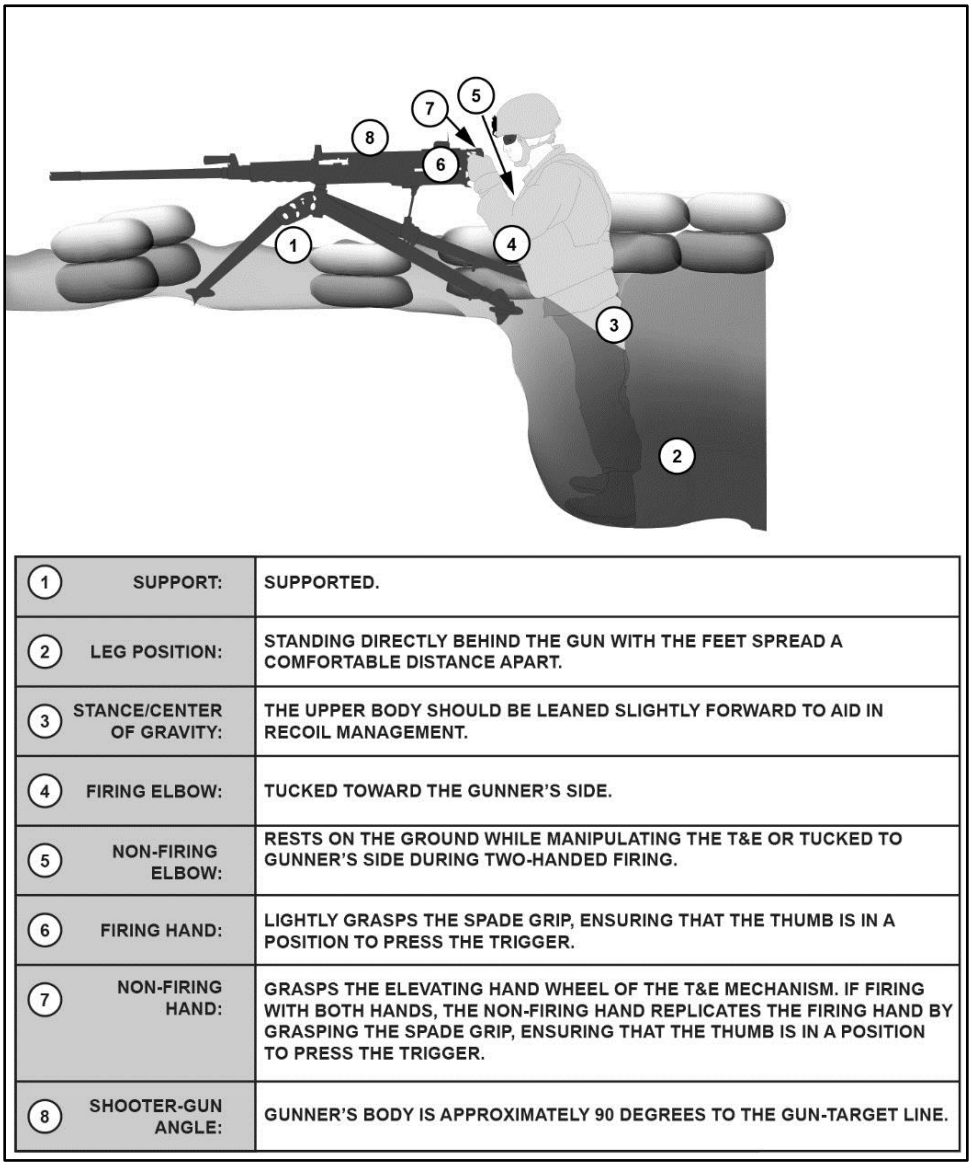
FIRING POSITIONS

6-24. The nature of combat will not always allow time for a Soldier to get into a particular position. Soldiers need to practice firing in a variety of positions. There are three firing positions with variations that are common to all Soldiers. The positions are listed highest to lowest.

STANDING

6-25. The standing position is used when the gunner is firing from a fighting position. This position is assumed by standing directly behind the gun with the feet spread a comfortable distance apart. This position is the least stable firing positon. However if the gun is connected to the T&E and the tripod is emplaced properly and sand bagged this position can be extremely stable. This position provides the greatest amount of movement for the gunner and allows for rapid sight adjustment, correction of malfunctions, and during loading and unloading procedures.

6-26. The gunner grasps the elevating handwheel of the T&E mechanism with the nonfiring hand. The gunner grasps the spade grip with the firing hand, ensuring that the thumb is in a position to press the trigger. Adjustment of the body is allowed to align the firing eye with the sights on the weapon. The upper body should be leaned slightly forward to aid in recoil management. The key focus areas for the standing supported position are applied as described in figure 6-6.



1 SUPPORT:	SUPPORTED.
2 LEG POSITION:	STANDING DIRECTLY BEHIND THE GUN WITH THE FEET SPREAD A COMFORTABLE DISTANCE APART.
3 STANCE/CENTER OF GRAVITY:	THE UPPER BODY SHOULD BE LEANED SLIGHTLY FORWARD TO AID IN RECOIL MANAGEMENT.
4 FIRING ELBOW:	TUCKED TOWARD THE GUNNER'S SIDE.
5 NON-FIRING ELBOW:	RESTS ON THE GROUND WHILE MANIPULATING THE T&E OR TUCKED TO GUNNER'S SIDE DURING TWO-HANDED FIRING.
6 FIRING HAND:	LIGHTLY GRASPS THE SPADE GRIP, ENSURING THAT THE THUMB IS IN A POSITION TO PRESS THE TRIGGER.
7 NON-FIRING HAND:	GRASPS THE ELEVATING HAND WHEEL OF THE T&E MECHANISM. IF FIRING WITH BOTH HANDS, THE NON-FIRING HAND REPLICATES THE FIRING HAND BY GRASPING THE SPADE GRIP, ENSURING THAT THE THUMB IS IN A POSITION TO PRESS THE TRIGGER.
8 SHOOTER-GUN ANGLE:	GUNNER'S BODY IS APPROXIMATELY 90 DEGREES TO THE GUN-TARGET LINE.

Figure 6-6. Standing position, example

SEATED

6-27. There are four types of seated positions: crossed ankle (see figure 6-7), open-leg feet on rear tripod legs, open-leg with legs over the rear tripod legs (see figure 6-8), and open–leg with legs under tripod. All positions are easy to assume, present a medium silhouette, provide some body contact with the ground, and form a stable firing position. These positions, listed below, allow easy access to the sights for zeroing:

- Seated position, crossed ankle.
- Seated position, open leg, feet on tripod.
- Seated position, open leg, legs over tripod.
- Seated position, open leg, legs under tripod.

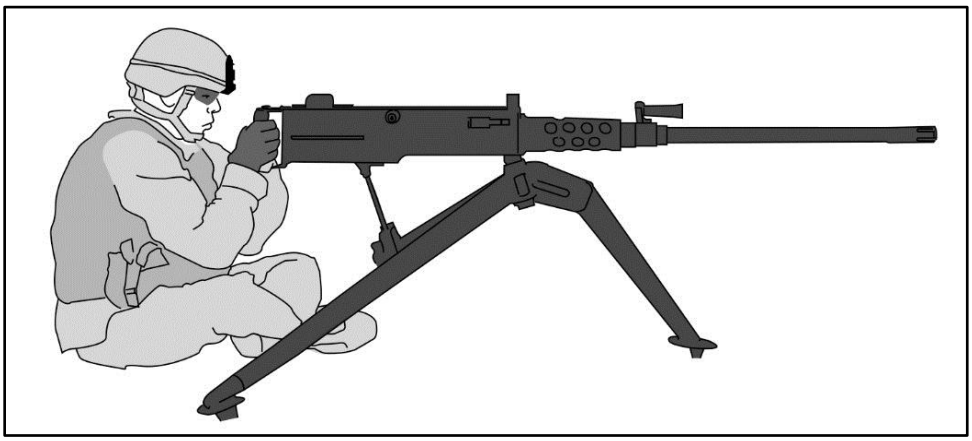


Figure 6-7. Seated position, crossed ankle

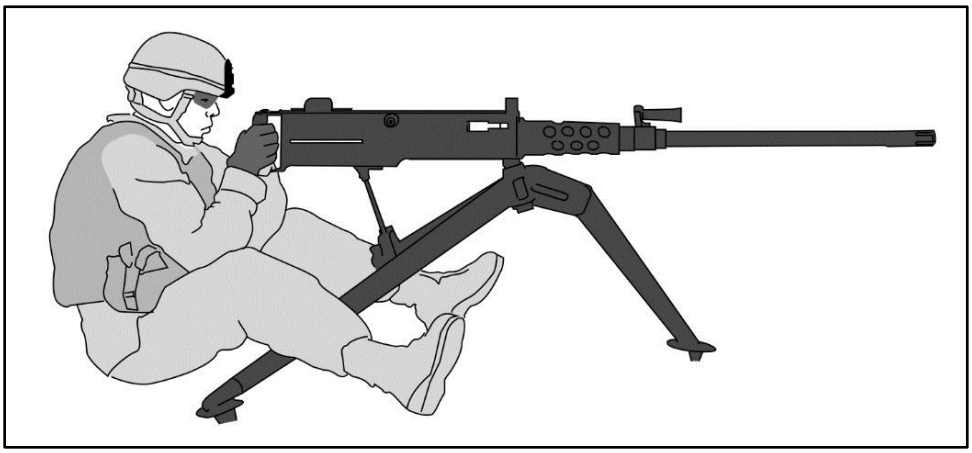
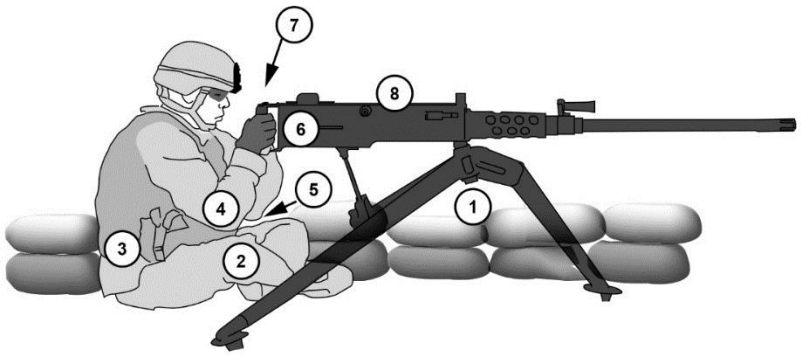


Figure 6-8. Seated position, open-legged, legs over tripod

6-28. The seated position can be used when the tripod is set in a high or low position. Gunner's wearing body armor may find it difficult to fire from the seated position if the tripod is too low. The body armor restricts the amount the upper can bend due to the ceramic plates. The tripod should be adjusted to height that provides the gunner with a comfortable natural point of aim.

6-29. The gunner sits directly behind the gun between the legs of the tripod. The gunner may extend their legs under, over the tripod, or cross them. Gunners can also place their feet on the rear legs of the tripod. Placement of the legs and feet will change depending on the lateral angle of the target being engaged. The gunner then places both elbows on the inside of thighs to get the best support. The gunner grasps the elevating handwheel of the T&E mechanism with the nonfiring hand, and lightly grasps the spade grip with the firing hand. If firing with two hands, the nonfiring hand and elbow are positioned in the same manner as the firing hand and elbow. The gunner must ensure that the thumb is in position to press the trigger. The seated position

provides a broad base of support and places most of the body weight behind the weapon (see figure 6-9). This allows quick shot recovery and recoil impulse absorption.



1 SUPPORT:	SUPPORTED.
2 LEG POSITION:	GUNNER MAY EXTEND HIS LEGS UNDER OR OVER THE TRIPOD OR CROSS THEM, DEPENDING ON PHYSIQUE.
3 STANCE/CENTER OF GRAVITY:	THE UPPER BODY SHOULD BE LEANED SLIGHTLY FORWARD TO AID IN RECOIL MANAGEMENT.
4 FIRING ELBOW:	INSIDE OF THIGH TO GET THE BEST SUPPORT.
5 NON-FIRING ELBOW:	INSIDE OF THIGH TO GET THE BEST SUPPORT.
6 FIRING HAND:	LIGHTLY GRASPS THE SPADE GRIP, ENSURING THAT THE THUMB IS IN A POSITION TO PRESS THE TRIGGER.
7 NON-FIRING HAND:	GRASPS THE ELEVATING HAND WHEEL OF THE T&E MECHANISM. IF FIRING WITH BOTH HANDS, THE NON-FIRING HAND REPLICATES THE FIRING HAND BY GRASPING THE SPADE GRIP, ENSURING THAT THE THUMB IS IN A POSITION TO PRESS THE TRIGGER.
8 SHOOTER-GUN ANGLE:	GUNNER'S BODY IS APPROXIMATELY 45 TO 90 DEGREES TO THE GUN-TARGET LINE.

Figure 6-9. Seated position, example

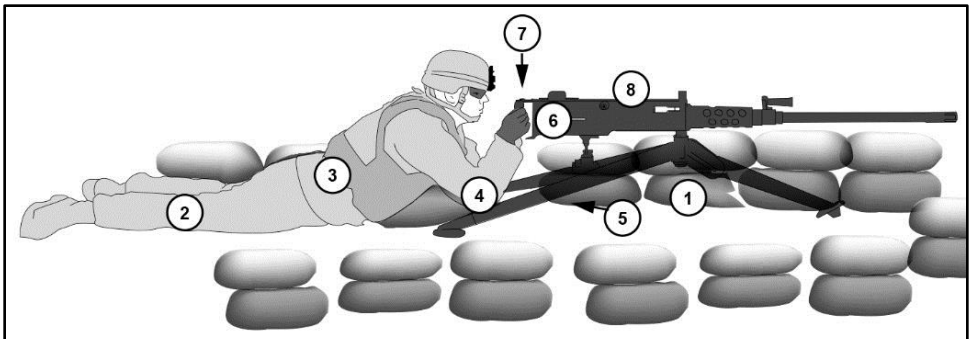
PRONE

6-30. The prone position is the most stable firing position due to the amount of the Soldier's body in contact with the ground. The majority of the gunner's frame is behind the machine gun to assist with recoil management. However this position limits the gunners' amount of movement when adjusting sights, correcting malfunctions, and during loading and unloading procedures.

6-31. Soldiers must practice the positions dry frequently to establish their natural point of aim for each position, and develop an understanding of the restrictive nature of their equipment during execution. With each dry repetition, the Soldier's ability to change positions rapidly and correctly are developed, translating into efficient movement and consistent stable firing positions.

6-32. The prone position is used when firing from a tripod that is set in a low position. Gunners may need to supplement this position with artificial support to provide sufficient muscle relaxation, stability, and allow the Soldier to see through the sights.

6-33. The prone position is assumed by lying on the ground directly behind the gun. The gunner spreads their legs a comfortable distance apart with their toes turned outward. The nonfiring elbow rests on the ground, and the nonfiring hand grasps the elevating handwheel of the T&E mechanism. The firing hand lightly grasps the spade grip with the thumb in a position to press the trigger. The position of the body must be adjusted to position the firing eye in alignment with the sights of the weapon. Soldiers must build a stable, consistent position that focuses on the key areas (see figure 6-10, page 6-14).



1 SUPPORT:	SUPPORTED.
2 LEG POSITION:	THE GUNNER SPREADS HIS LEGS A COMFORTABLE DISTANCE APART WITH HIS TOES TURNED OUTWARD.
3 STANCE/CENTER OF GRAVITY:	PRONE POSITION MAXIMIZES THE SOLDIER'S FRAME AGAINST THE GROUND FOR MAXIMUM STABILITY.
4 FIRING ELBOW:	FIRING ELBOW RESTS ON THE GROUND.
5 NON-FIRING ELBOW:	NON-FIRING ELBOW RESTS ON THE GROUND.
6 FIRING HAND:	LIGHTLY GRASPS THE SPADE GRIP, ENSURING THAT THE THUMB IS IN A POSITION TO PRESS THE TRIGGER.
7 NON-FIRING HAND:	GRASPS THE ELEVATING HAND WHEEL OF THE T&E MECHANISM. IF FIRING WITH BOTH HANDS, THE NON-FIRING HAND REPLICATES THE FIRING HAND BY GRASPING THE SPADE GRIP, ENSURING THAT THE THUMB IS IN A POSITION TO PRESS THE TRIGGER.
8 SHOOTER-GUN ANGLE:	GUNNER'S BODY IS NEARLY PERPENDICULAR TO THE GUN-TARGET LINE.

Figure 6-10. Prone position, example

Chapter 7
Aim

The functional element aim of the shot process is the continuous process of orienting the weapon correctly, aligning the sights, aligning on the target, and the application of the appropriate lead and elevation during a target engagement. Aiming is a continuous process conducted through pre-shot, shot, and post-shot, to effectively apply lethal fires in a responsible manner with accuracy and precision.

Aiming is the application of perfectly aligned sights on a specific part of a target. Sight alignment is the first and most important part of this process.

COMMON ENGAGEMENTS

7-1. The aiming process for engaging stationary targets consists of the following Soldier actions, regardless of the optic, sight, or magnification used by the aiming device:

- Weapon orientation. The direction of the weapon as it is aimed in a stabilized manner.
- Sight alignment. The physical alignment of the aiming device, which includes—
  - Leaf sight and the front sight post.
  - Optic reticle.
  - Ballistic reticle (day or thermal).
- Sight picture. The target as viewed through the line of sight.
- Point of aim. The point of aim is the specific location where the line of sight intersects the target.
- Desired point of impact. The point of impact is the desired location of the strike of the round to achieve the desired outcome (incapacitation or lethal strike).

7-2. The aim of the weapon is typically applied to the largest, most lethal area of any target presented. Sights can be placed on target by using battlesight zero, center base of visible mass. The weapon is aimed at the center base of visible mass to maximize the beaten zone as discussed in appendix C. The center base of visible mass is the initial point of aim on a target of what can be seen by the Soldier. It does not include what the target size is expected or anticipated to be. For example, a target located behind a car exposes the upper portion of the enemy soldier's body. The center base of visible mass is in the center bottom of the enemy Soldier's torso, not the estimated location of the center base of the overall target behind the car.

WEAPON ORIENTATION

7-3. The Soldier orients the weapon in the direction of the detected threat. Weapon orientation includes both the horizontal plane (azimuth) and the vertical plane (elevation). Weapon orientation is complete once the sight and threat are in the Soldier's field of view.

7-4. The quickest method of orienting the weapon is by disengaging the T&E. This permits increased changes in weapons orientation and increased rate of directional changes. However this reduces stability and accuracy of the weapon.

7-5. A moderately quick method of laying the weapon for deflection is accomplished by loosening the traverse slide lever on the older style T&E or by pulling the traverse or elevation levers toward the gunner on the M205 tripod T&E. This permits the weapon to move smoothly along the traverse and elevation bar rapidly. This method also has the added benefit of stability provided by the T&E. The gunner can then make refined 1 milliradian changes in elevation and deflection by utilizing the hand wheel's on the older T&E or

by depressing or elevating the levers on the M205 tripod with T&E. However, this method limits the change in weapons orientation to the limits of the traverse and elevating mechanism and tripod, and takes an increased amount of time to lay the weapon for deflection and elevation.

Note. The older style T&E does not have a lever that enables a gunner to make rapid adjustments in elevation.

HORIZONTAL WEAPONS ORIENTATION

7-6. Horizontal weapons orientation covers the frontal arc of the Soldier, spanning the area from the left limit of fire, across the Soldier's front, to the area across the right limit of fire (see figure 7-1).

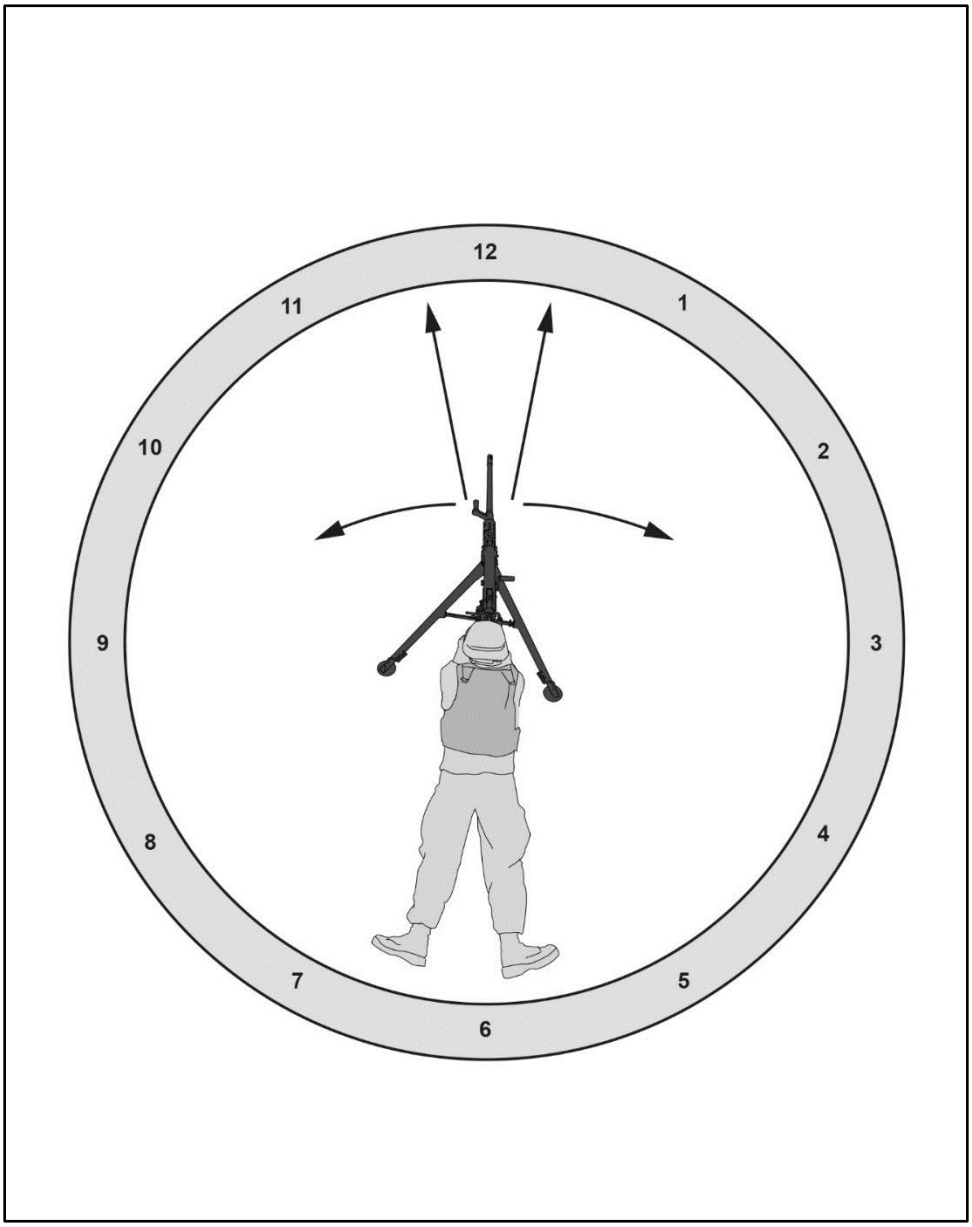


Figure 7-1. Horizontal weapons orientation

VERTICAL WEAPONS ORIENTATION

7-7. Vertical weapons orientation includes all the aspects of orienting the weapon at a potential or confirmed threat in elevation. This is most commonly applied in restricted, mountainous, or urban terrain where threats present themselves in elevated or depressed firing positions (see figure 7-2).

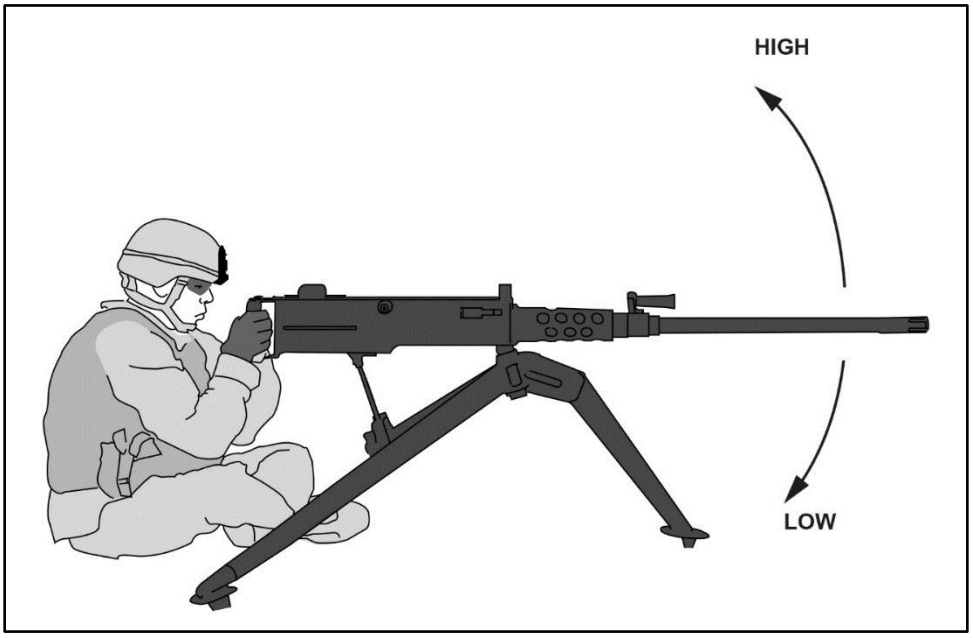


Figure 7-2. Vertical weapons orientation

SIGHT ALIGNMENT

7-8. Sight alignment is the relationship between the aiming device and the gunner's eye. The process used by a Soldier depends on the aiming device employed with the weapon.

- Leaf sight. When using a leaf sight, the relationship is between the front sight post, rear sight aperture, and the gunner's eye. The gunner aligns the tip of the front sight post in the center of the rear aperture their eye. The gunner must remain cognizant of the position of their head and distance from the rear sight in order to consistently replicate sight alignment. It is recommended that a gunner keep the sights 6 to 8 inches from their firing eye. The gunner will maintain focus on the front sight post, simultaneously centering it in the rear aperture. The gunner must remain directly behind the machine gun in order to have proper sight alignment.
- Thermal sight. When using a thermal sight, the relationship is between the gunner's eye, the eyepiece, and the reticle.
- Pointers, illuminators, and lasers. When using these, the relationship is between the gunner's eye, the night vision device placement and focus, and the laser aiming point on the target.

Note. Small changes matter - 1/1000-inch deviation at the weapon can produce up to an 18 inch deviation at 300 meters.

7-9. The human eye can only focus clearly on one object at a time. To achieve proper and effective aim, the gunner's eye needs to be on the front sight post or reticle (see figure 7-3). This provides the most accurate sight alignment for the shot process.

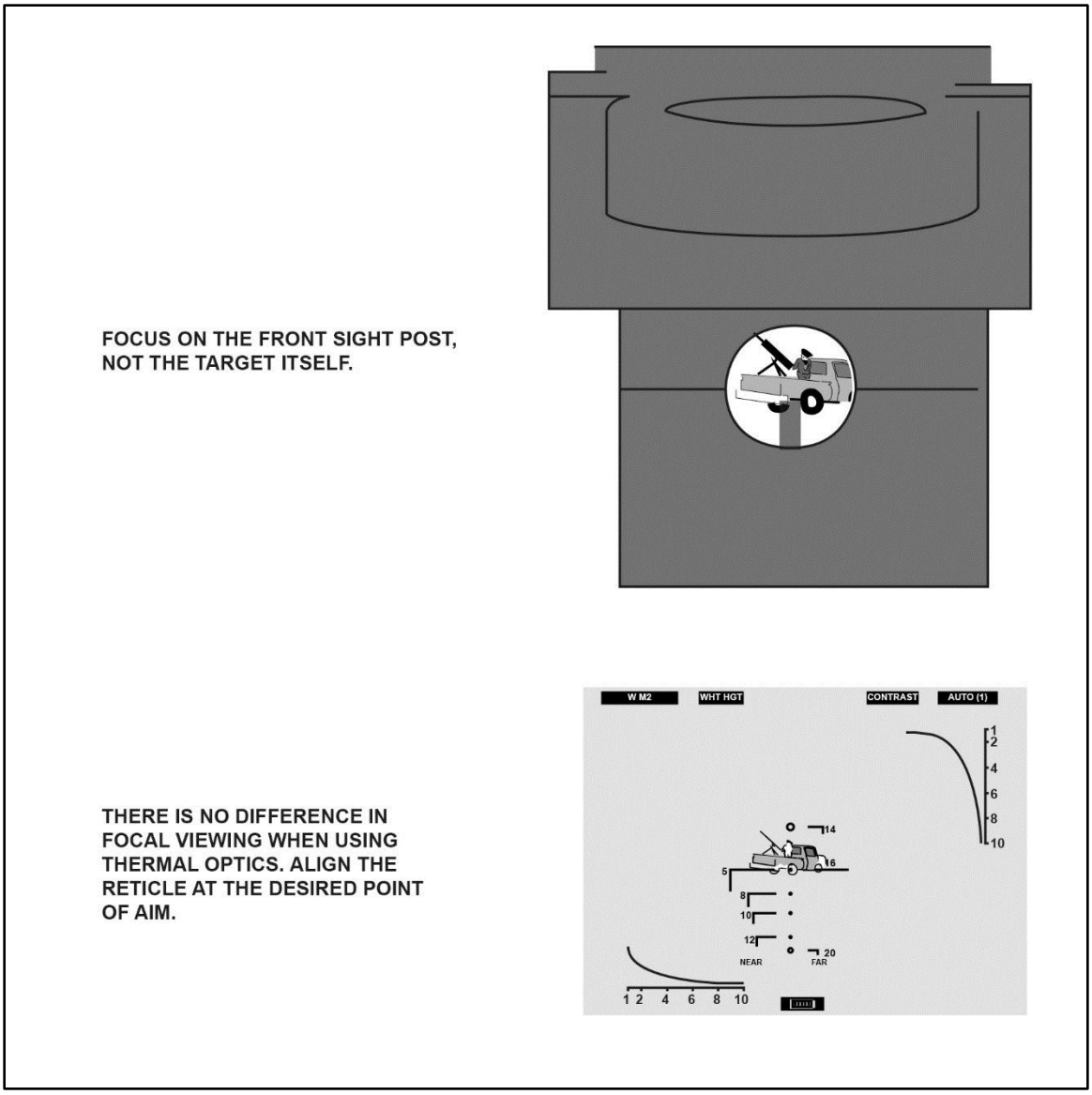


Figure 7-3. Front sight post or reticle aim focus

7-10. The first step in proper sighting is finding a natural, comfortable spot where the gunner is able to see the front sight blade through the rear peep sight. It is important that the gunner understands that the spot they choose to sight from must be constant throughout their firing. If the gunner's head placement is subjected to change during the firing process or between shots or bursts, the Soldier will experience difficultly achieving accurate shot groups and bursts.

SIGHT PICTURE

7-11. The sight picture is the placement of the aligned sights on the target itself. The Soldier must maintain sight alignment throughout the positioning of the sights. Sight picture is not the same as sight alignment.

7-12. There are two sight pictures used during the shot process; pre-shot and post-shot. Soldiers must remember the sight pictures of the shot or burst to complete the overall shot process.

- Pre-shot sight picture encompasses the original point of aim, sight picture, and any holds for target or environmental conditions.
- Post-shot sight picture is what the Soldier must use as the point of reference for any sight adjustments for any subsequent shot or bursts.

POINT OF AIM

7-13. The point on the target that is the continuation of the line created by sight alignment. The point of aim is a point of reference used to calculate any hold the Soldier deems necessary to achieve the desired results of the round's impact.

7-14. For engagements against stationary targets, with negligible wind, and a weapon that has a confirmed zero, the point of aim should be the center base of visible mass of the target. The point of aim does not include ANY hold-off or lead changes necessary.

DESIRED POINT OF IMPACT

7-15. The desired point of impact is the location where the Soldier wants the projectile to strike the target. Typically, this is the center of visible mass. At ranges different from the weapon's zero distance, the Soldier's desired point of impact and their point of aim will not align, unless the soldier changes the range setting on the weapons leaf sight or uses the corresponding range line in the heavy weapon thermal sight. If a Soldier does not use the range scale on the leaf sight or adjust utilizing the range lines in the heavy weapon thermal sight, the Soldier will be required to determine the necessary hold-off to achieve the desired point of impact.

COMMON AIMING ERRORS

7-16. Orienting and aiming a weapon correctly is a practiced skill. Through drills and repetitions, Soldiers build the ability to repeat proper weapons orientation, sight alignment, and sight picture as a function of muscle memory. The most common aiming errors include:

- Nondominant eye use. The Soldier gets the greatest amount of visual input from their dominant eye. Eye dominance varies Soldier to Soldier. Some Soldier's dominant eye will be the opposite of the dominant hand. For example, a Soldier who writes with their right hand and learns to fire right handed might learn that their dominant eye is the left eye. This is called cross-dominant. Soldiers with strong cross-dominant eyes should consider firing using their dominant eye side while firing from their non-dominant hand side. Soldiers can be trained to fire from either side of the weapon, but may not be able to shoot effectively using their non-dominant eye.
- Incorrect zero. Regardless of how well a Soldier aims, if the zero is incorrect, the round will not travel to the desired point of impact without adjustment with subsequent rounds. (See appendix E of this publication.)
- Light conditions. Limited visibility conditions contribute to errors aligning the sight, selecting the correct point of aim, or determining the appropriate hold. Soldiers may offset the effects of low light engagements with image intensifier (I2) optics, use of thermal optics, or the use of laser pointing devices with I2 optics.
- Battlefield obscurants. Smoke, debris, and haze are common conditions on the battlefield that will disrupt the Soldier's ability to correctly align their sights, select the proper point of aim, or determine the correct hold for a specific target.
- Incorrect sight alignment. Soldiers may experience this error when failing to focus on the front sight post or reticle.
- Incorrect sight picture. Incorrect sight picture occurs typically when the threat is in a concealed location, is moving, or sufficient winds between the gunner and target exist that are not accounted for during the hold determination process. This failure directly impacts the Soldier's ability to create and sustain the proper sight picture during the shot process.
- Improper range determination. Improper range determination will result in an improper hold at ranges greater than the zeroed range for the weapon.

COMPLEX ENGAGEMENTS

7-17. A complex engagement includes any shot that cannot use the center base of visible mass as the point of aim to ensure a target hit. Complex engagements require a Soldier to apply various points of aim to successfully defeat the threat. These engagements have an increased level of difficulty due to environmental, target, or gunner conditions that create a need for the gunner to rapidly determine a ballistic solution and apply that solution to the point of aim. Increased engagement difficulty is typically characterized by one or more of the following conditions:

- Target conditions:
  - Range to target.
  - Moving targets.
  - Oblique targets.
  - Evasive targets.
  - Limited exposure targets.
- Environmental conditions:
  - Wind.
  - Limited visibility.
- Gunner conditions:
  - Canted weapon engagements.
  - CBRN operations engagements.

7-18. Each of these firing conditions may require the Soldier to determine an appropriate aim point that is not the center base of visible mass. This Soldier calculated aim point is called the hold. During any complex engagement, the Soldier serves as the ballistic computer during the shot process. The hold represents a refinement or alteration of the center base of visible mass point of aim at the target to counteract certain conditions during a complex engagement for—

- Range to target.
- Lead for targets based on their direction and speed of movement.
- Wind speed, direction, and duration between the gunner and the target at ranges greater than 700 meters.
- Greatest lethal zone presented by the target to provide the most probable point of impact to achieve immediate incapacitation.

7-19. The Soldier will apply the appropriate aim (hold) based on the firing instances presented. Hold determinations will be discussed only for the immediate hold format. Should the gunner require subsequent rounds to defeat the threat the adjusted aim point method of engagement should be used.

7-20. All Soldiers must be familiar with the immediate hold determination methods. They should be naturally applied when the engagement conditions require. These determinations are provided in target form measurements.

IMMEDIATE HOLD DETERMINATION

7-21. Immediate holds are based on the values of a target form, where the increments shown are sufficient for rapid target hits without ballistic computations. The immediate hold determinations are used for complex target engagements at less than 1500 meters for lightly armored targets and 500 for dismounted targets.

7-22. Immediate hold locations for azimuth (wind or lead): The technique of engaging a moving target differs from that of engaging a stationary target. The gun must be aimed ahead of the moving target a sufficient distance to cause the bullet and target to arrive at the aiming point at the same time. The distance is measured in target lengths. One target length as seen by the gunner is one lead. Leads are measured from the center of mass. The lead depends upon range, speed, and direction of movement of the target. To hit the target, the gunner aims at a point ahead of the target equal to the estimated number of leads, maintains the lead by tracking the target (manipulating the gun at the same angular speed as that of the target), and then fires. Fire is adjusted by observation of strike and tracer (see figure 7-4).

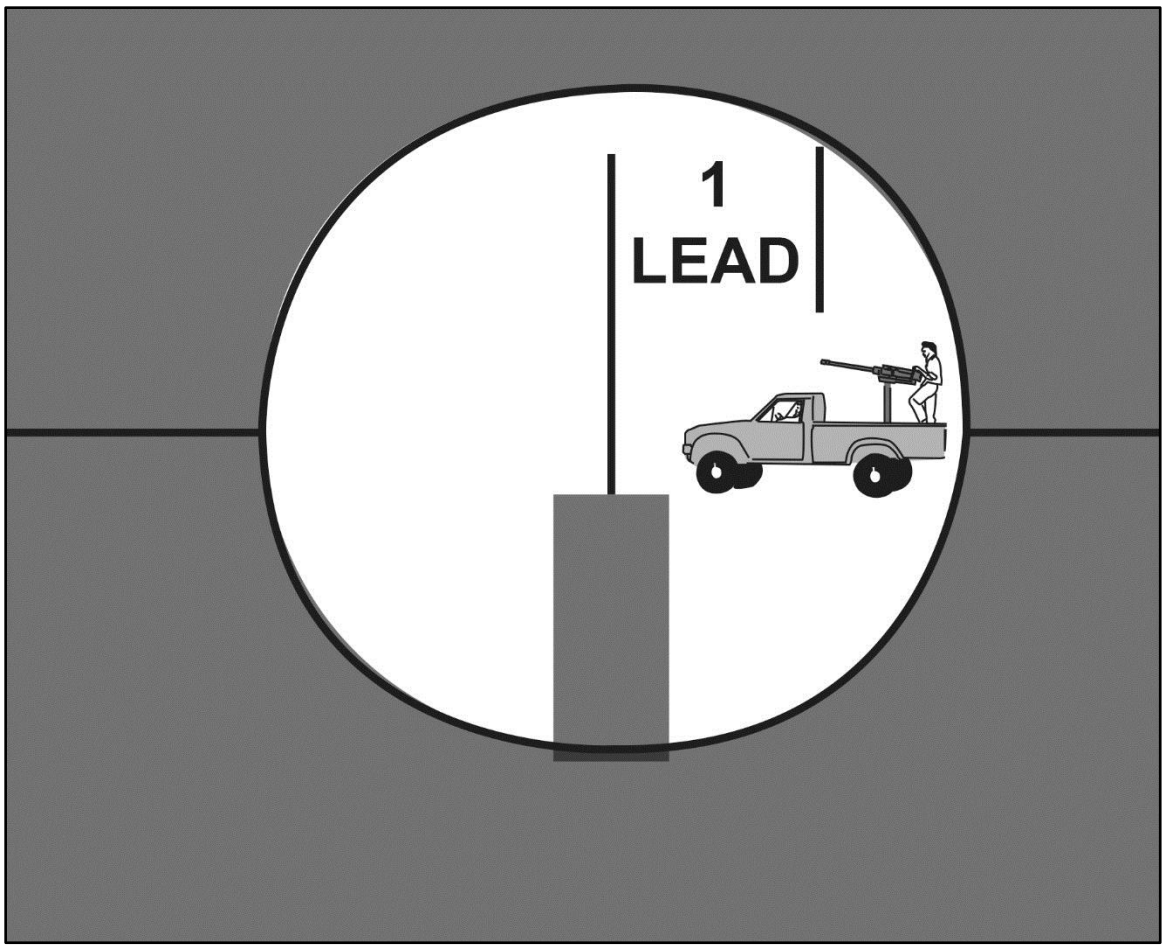


Figure 7-4. Immediate hold locations for windage and lead example

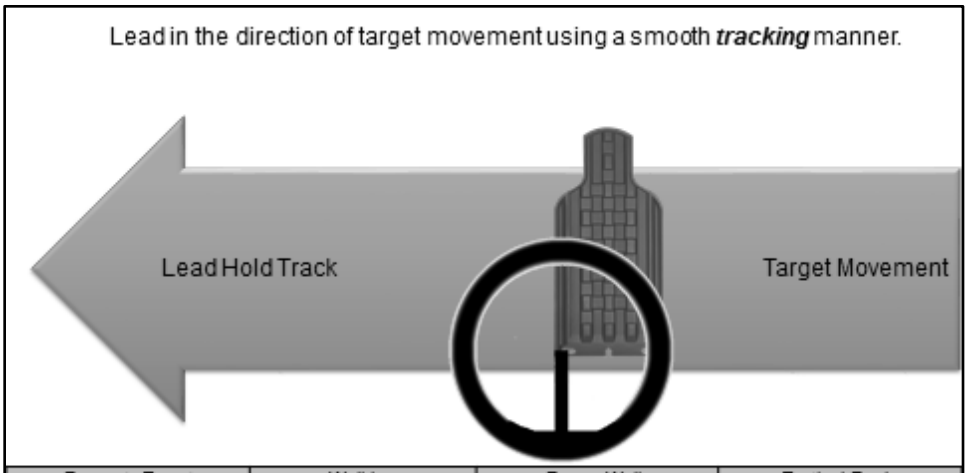
MOVING TARGETS

7-23. Moving targets are those threats that appear to have a consistent pace and direction. Targets on any battlefield do not remain stationary for long periods of time, particularly once a firefight begins. Soldiers must have the ability to deliver lethal fires at a variety of moving target types and be comfortable and confident in the engagement techniques. There are two methods for defeating moving targets, tracking and trapping.

7-24. Mathematical computation or use of voluminous lead tables to obtain immediate hold locations for elevation (range to target): exact leads on a moving target is impractical in combat. The simple lead table shown in tables 7-1 and 7-2, page 7-8, give the amount of lead necessary to hit a target moving at right angles (90 degrees) to the direction of fire to hit at speeds and ranges indicated.

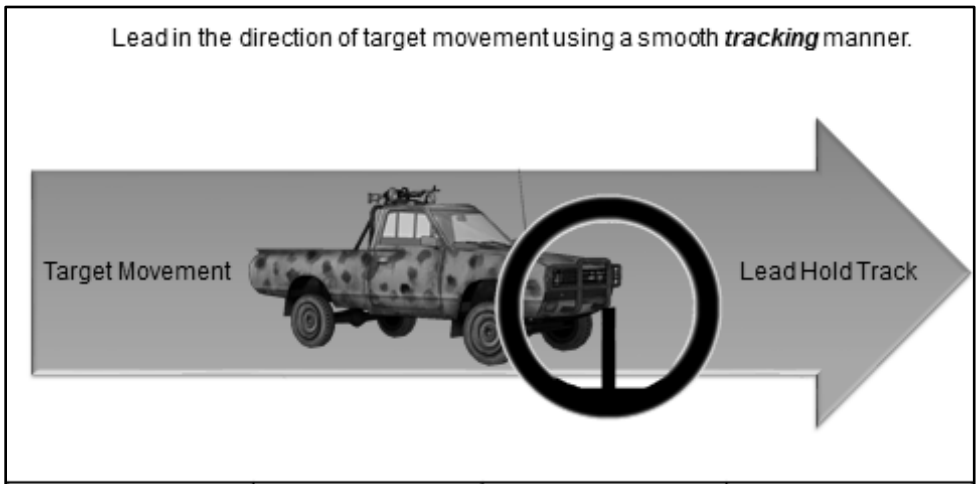
7-25. The gunner must correct the lead as conditions change. The angle at which the target is moving also alters the amount of lead taken. If the angle between the line of fire and the line of travel of the target is less than 45 degrees, use half the lead shown in the table.

Table 7-1. Standard lead for a moving dismount target



Range to Target	Walking	Range Walk	Tactical Rush
500m	3 FORM	4 ½ FORM	9 ½ FORM
400m	2 FORM	3 ½ FORM	7 ½ FORM
300m	1 ½ FORM	2 ½ FORM	5 ½ FORM
200m	1 FORM	2 FORM	3 ½ FORM
100m	1/2 EDGE	1 FORM	1 ½ FORM

Table 7-2. Standard lead for a moving truck target



Range to Target	5 mph	10 mph	15 mph
1500m	1 FORM	2 ½ FORM	3 ½ FORM
1200m	1 FORM	1 ½ FORM	2 ½ FORM
900m	1/2 EDGE	1 FORM	2 FORM
600m	1/2 EDGE	1/2 EDGE	1 FORM
300m	CBoVM	1/2 EDGE	1/2 EDGE

OBLIQUE TARGETS

7-26. Threats that are moving diagonally toward or away from the gunner are called oblique targets. They offer a unique problem set to gunners where the target may be moving at a steady pace and direction; however, their oblique direction of travel makes them appear to move slower.

7-27. Soldiers should adjust their hold based on the angle of the target's movement from the gun-target line. The following guide will help Soldiers determine the appropriate change to the moving target hold to apply to engage the moving oblique threats (see figure 7-5).

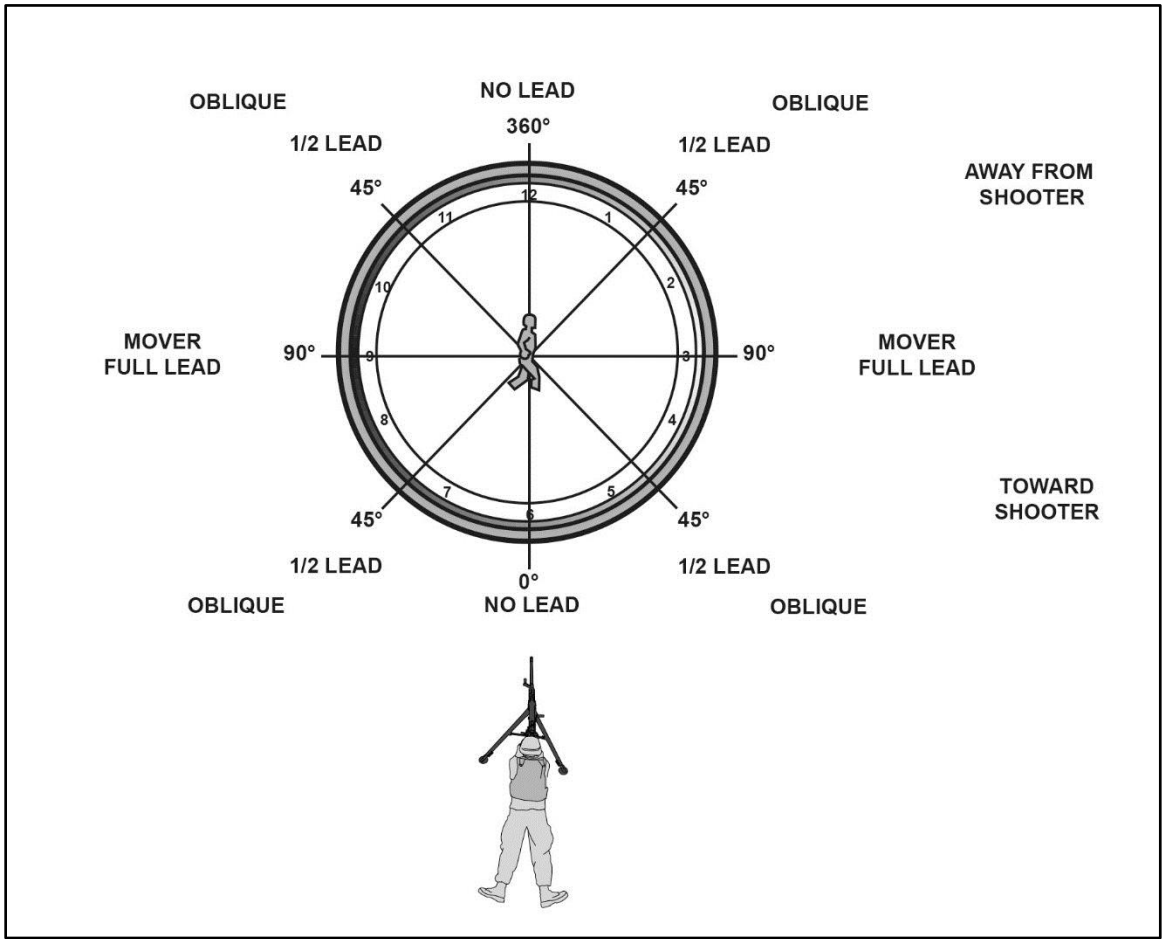


Figure 7-5. Oblique target example

7-28. For targets moving directly toward the gun, the point of aim is placed on the center base of visible mass. For targets moving directly away from the gun, the point of aim is placed on the center upper edge of the target. Too much lead is better than too little because the target runs into the fire; also, the observation of strike is easier. Intelligent use of the lead table includes immediate application of fire with estimated lead followed by necessary corrections based upon observation of the strike or tracer.

TARGET CONDITIONS

7-29. Soldiers must consider several aspects of the target to apply the proper point of aim on the target. The target's posture, or how it is presenting itself to the gunner, consists of—

- Range to target.
- Nature of the target.
- Nature of the terrain (surrounding the target).

RANGE TO TARGET

7-30. Rapidly determining an accurate range to target is critical to the success of the Soldier at mid and extended ranges. There are several range determination methods gunners should be confident in applying to determine the proper hold-off for pending engagements. There are two types of range determination methods, immediate and deliberate.

IMMEDIATE RANGE DETERMINATION

7-31. Immediate methods of range determination afford the gunner the most reliable means of determining the most accurate range to a given target. The immediate methods include—

- Close quarters engagement.
- Use of laser range finder.
- Lateral distance.
- Firing of the gun.
- Use of recognition method.
- Use of 100-meter unit-of-measure method.
- Observation and adjustment of fire.

Close Quarters Engagements

7-32. Short-range engagements are probable in close terrain (such as urban or jungle) with engagement ranges typically less than 50 meters. Soldiers must be confident in their equipment, zero, and capabilities to defeat the threats encountered utilizing a free gun method of engagement.

7-33. Employment skills include swift presentation and application of the shot process (such as quick acquisition of sight picture) to maintain overmatch. At close ranges, perfect sight alignment is not as critical to the accurate engagement of targets. The weapon is presented rapidly and the shot or burst is fired with the front sight post placed roughly center base of visible mass on the desired target area. The front sight post must be in the rear sight aperture.

Laser Range Finder

7-34. Equipment like the AN/PSQ-23, STORM has an on-board laser range finder that is accurate to within +/-5 meters. Soldiers with the STORM attached can rapidly determine the most accurate range to target and apply the necessary hold-offs to ensure the highest probability of incapacitation, particularly at extended ranges.

Lateral Distance

7-35. Lateral distance measure is a method that the gunner may use to determine the distance from one target to another from left to right or right to left. When the gun is mounted on the M3 or M205 tripod, width can be measured by aiming on a point and manipulating the traversing handwheel or lever, counting the clicks from one point to another point of aim. Each click equals 1 meter at 1000 meters or one-half meter at 500 meters. This method is accurate but time-consuming.

Firing of the Gun

7-36. Firing the gun is another method of determining range. In this method, the gunner opens fire on the target at the estimated range and moves the center of the beaten zone into the center base of the target by means of the T&E handwheels. The gunner resets the sight so the new line of aim is at the center base of the target and notes the range setting on the rear sight. The range setting may apply only to this gun. When the ground in the vicinity of the target does not permit observation of the strike of the rounds, or when surprise fire on the target is desired, fire is adjusted on a point that offers observation and is known to be the same range as the target. The gunner then lays their gun on the target when ordered. When moving into position occupied by other units, range cards prepared by those units can furnish valuable range information on

targets, suspected targets, and various terrain features. When the tactical situation and time permits, range may be determined by pacing off the distance.

Recognition Method

7-37. When observing a target, the amount of detail seen at various ranges gives the gunner a solid indication of the range to target. Gunners should study and remember the appearance of a person when they are standing at 100 meters increments. During training, Soldiers should note the details of size and the characteristics of uniform and equipment for targets at those increments.

7-38. Once Soldiers are familiar and memorize the characteristics of standing threats at 100 meter increments out to 500 meters, they should study the targets in a kneeling and then in the prone position. By comparing the appearance of these positions at known ranges from 100 meters to 500 meters, gunners can establish a series of mental images that will help determine range on unfamiliar terrain. They should also study the appearance of other familiar objects such as weapons and vehicles at different distances. This practice will build muscle memory in how the same objects can appear in different distances (see table 7-3):

Table 7-3. Recognition of dismounted target

Distance	*Level of Detail*
100 meters	The target can be clearly observed in detail, and facial features can be distinguished.
200 meters	The target can be clearly observed, although there is a loss of facial detail. The color of the skin and equipment is still identifiable.
300 meters	The target has a clear body outline, face color usually remains accurate, but remaining details are blurred.
400 meters	The body outline is clear, but remaining detail is blurred.
500 meters	The body shape begins to taper at the ends. The head becomes indistinct from the shoulders.

7-39. With practice, range determination by recognition is quick and accurate; however, this method will not work with passive or thermal sights. The principle of the recognition method is simple. When the gunner sees a target, they can determine the range according to what they recognize. For example, if a target can be recognized as a truck with the unaided eye, it is within 1500 meters; if a target can be recognized as a truck through magnifying optics (such as binoculars), it is within 5000 meters. Table 7-4 gives range estimations for targets as seen with the unaided eye and through magnifying optics (binoculars).

Table 7-4. Recognition method

Range Determination	*Recognition Method*	
Target	Unaided Eye	Magnification 8 power
Tank crew, troops, machine gun, mortar, antitank gun, antitank missile launchers	500m	2000m
Tank, personnel carrier, truck (by model)	1000m	4000m
Tank, howitzer, personnel carrier, truck	1500m	5000m
Armor vehicle, wheel vehicle	2000m	6000m

100-meter Unit-of-measure Method

7-40. To determine the total distance to the target using the 100 meter unit of measure method, gunners must visualize a distance of 100 meters (generally visualizing the length of a football field) on the ground. Soldiers then estimate how many of these units can fit between the gunner and the target.

7-41. The greatest limitation of the unit of measure method is that its accuracy is directly related to how much of the terrain is visible. This is particularly true at greater ranges. If a target appears at a range of 500 meters or more and only a portion of the ground between the Soldier's gunner and the target can be seen, it becomes difficult to use the unit of measure method of range estimation with accuracy.

7-42. Proficiency in the unit of measure method requires constant practice. Throughout training, comparisons should be continually made between the range estimated by the Soldier's gunner and the actual range as determined by pacing or other, more accurate measurement.

Observation and Adjustment of Fire

7-43. The purpose of observation and adjustment of fire practice is to teach the adjustment of fire by observing the strike of the bullets and the flight of the tracers, or by frequent relaying on the target using sights.

7-44. Observation is used when firing on the 10-meter range because the impact of the round is visible on the target. When firing at greater distances, the strike of the round on the ground may cause dust to rise that is visible to the gunner; however, during wet weather, the strike cannot always be seen. In this case, use tracer ammunition that allows the gunner to note the strike of the burst in relation to the target.

7-45. Adjustments on the target can be made using the mil relation; that is, one click of traversing or elevating handwheel moves the strike of the round one-half inch on the target at 10 meters. When firing on field targets, adjustment is made by moving the burst into the target. One click of traverse will move the strike of the round one-half meter at 500 meters, or one meter at 1000 meters (see figure 7-6). However, the distance one click of elevation will move the strike of the round depends on the range to the target and the slope of the ground. The gunner determines the number of mils necessary to move the center of the strike into the target, and manipulates the gun to the required number of mils. This does not require the use of sights. For example, should the gunner fire on a target at 500 meters and observe the strike 10 meters to the right of the target and short about 50 meters, they would traverse the gun to the left 20 clicks (mils) and add one or more clicks (mils), depending on the slope.

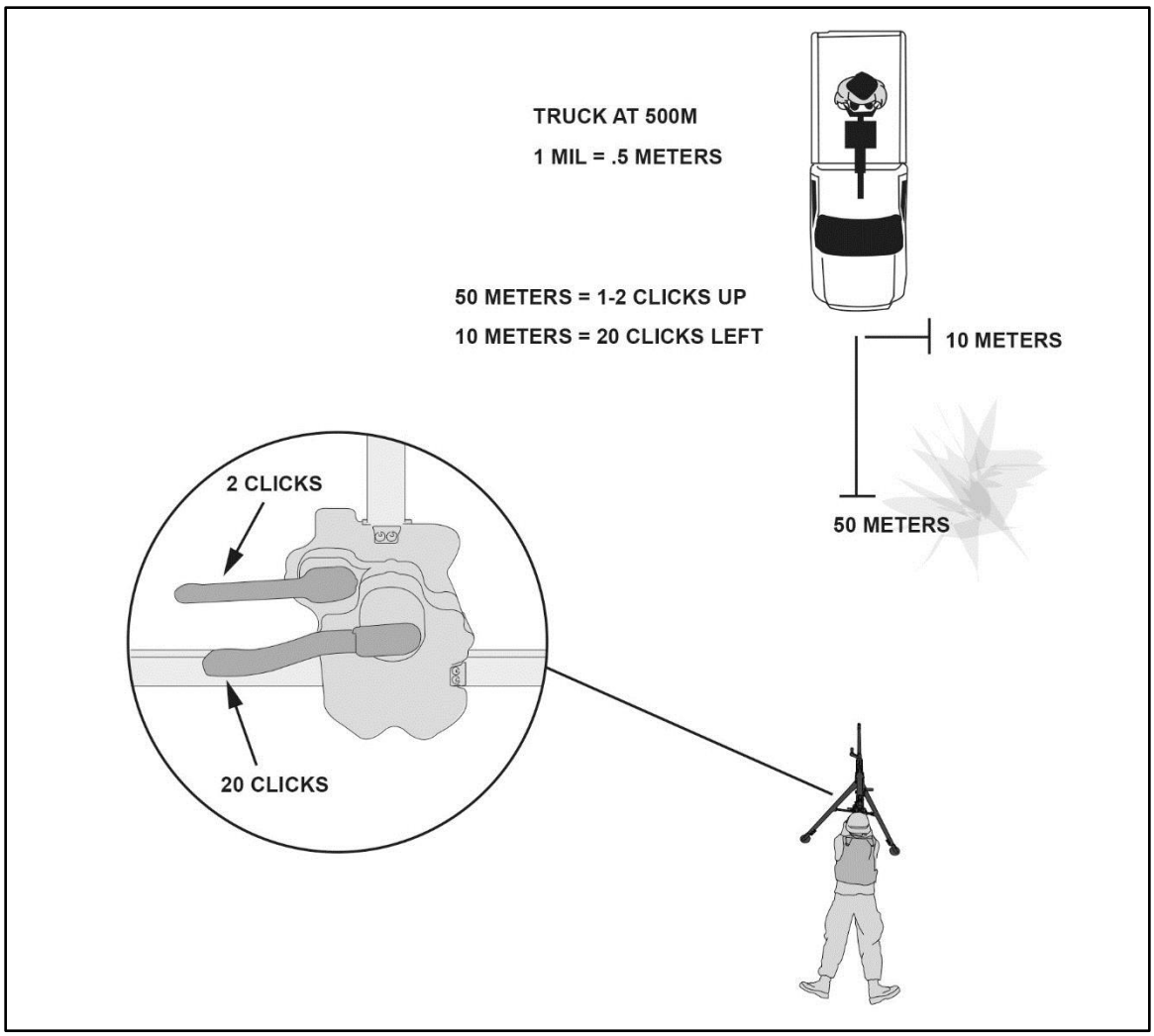


Figure 7-6. Mil relation

7-46. The gunner may use the adjusted aiming point method to adjust the fire. In this method, the gunner must use their sights. The gunner selects an aiming point that will place the next burst on target. For example, when the gunner fires on a target at 500 meters and estimates that the rounds impacted 20 meters short and 10 meters to the left, they would rapidly select an aiming point about 20 meters beyond the target and 10 meters to the right of it and lay on that aiming point and fire (see figure 7-7).

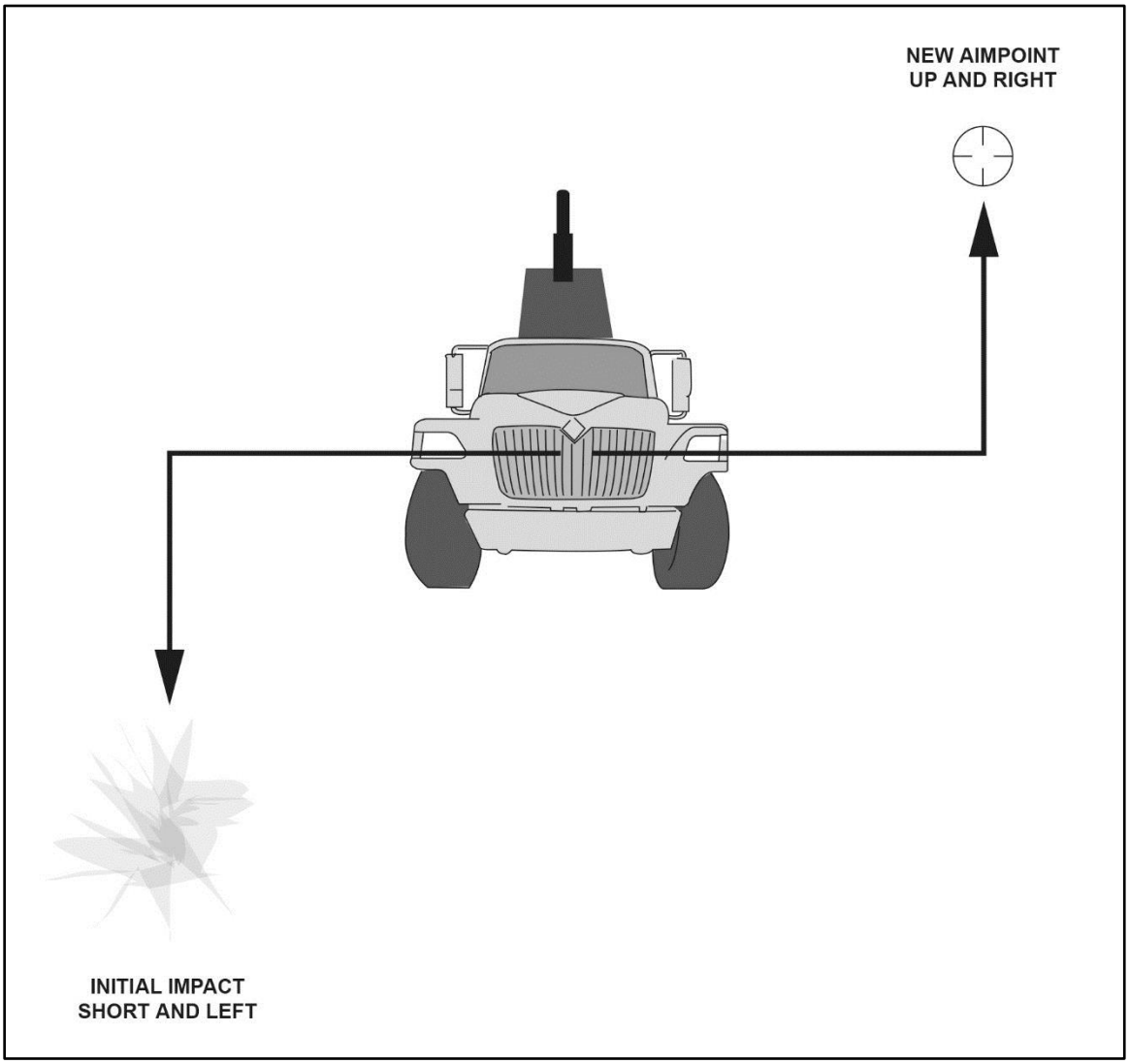


Figure 7-7. Adjusted aiming point method of fire adjustment

ENVIRONMENTAL CONDITIONS

7-47. Wind and limited visibility can complicate the shot process. Soldiers must know how to offset or compensate for both. This includes when multiple complex conditions compound the ballistic solution during the firing occasion.

WIND

7-48. Wind is the most common variable and has the greatest effect on ballistic trajectories, where it physically pushes the projectile during flight off the desired trajectory (appendix B). The effects of wind can be compensated for by the gunner provided they understand how wind effects the projectile and the terminal point of impact. The elements of wind effects are—

- The time the projectile is exposed to the wind (range).
- The direction from which the wind is blowing.
- The velocity of the wind on the projectile during flight.

Wind Direction and Value

7-49. Winds from the left blow the projectile to the right, and winds from the right blow the projectile to the left. The amount of the effect depends on the duration of exposure and on wind speed and direction. To compensate for the wind, the gunner determines the wind direction and value.

7-50. The clock system can be used to determine the direction and value of the wind. Picture a clock with the gunner oriented downrange towards 12 o'clock.

7-51. Once the direction is determined, the value of the wind is next. Wind value is the measure of the effect of the wind on the projectile. Winds from certain directions have less effect on projectiles. Figure 7-8, page 7-16, shows that winds from 2 to 4 o'clock and from 8 to 10 o'clock are full-value winds, meaning they affect the projectile the most. Winds from 1, 5, 7, and 11 o'clock are considered half-value winds and will affect the projectile half as much. Winds from 6 and 12 o'clock are considered no-value winds, because they affect the projectile little or none.

EXAMPLE

A 10 mph (miles per hour) wind blowing from the 1 o'clock direction would be a half-value wind. It would have the same effect on the projectile as a 5 mph, full-value wind.

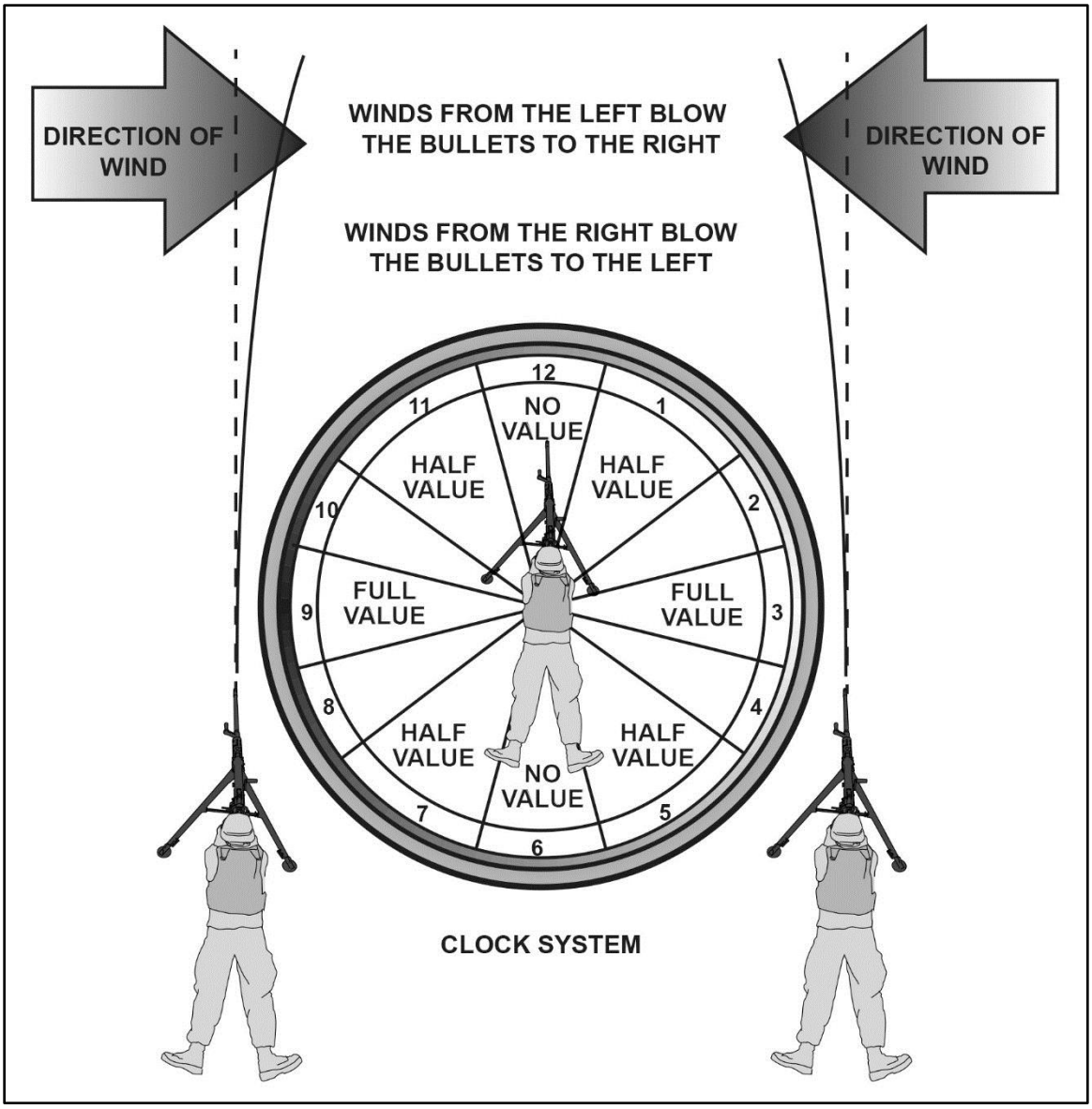


Figure 7-8. Wind value

7-52. Wind pushes projectiles in the direction it is blowing (see figure 7-9). The amount of effect on a projectile depends on the duration of exposure and on wind speed and direction. To compensate for wind, the Soldier uses a hold in the direction of the wind (into the wind).

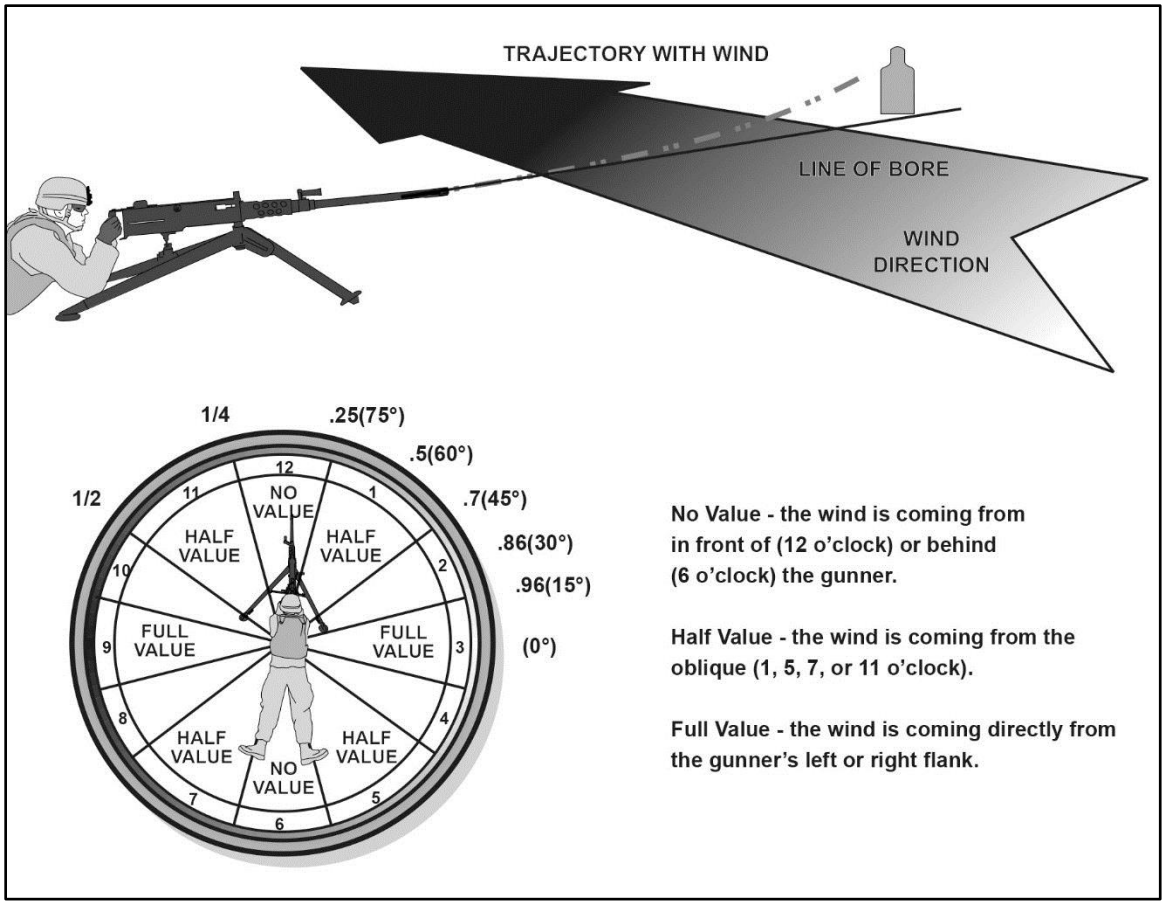


Figure 7-9. Wind effects

Wind Speed

7-53. Wind speeds can vary from the firing line to the target. Wind speed can be determined by taking an average of the winds blowing on the range. The gunner's focus should be on the winds between the midrange point and the target. The wind at the one half to two thirds mark will have the most effect on the projectile since that is the point where most projectiles have lost a large portion of their velocity and are beginning to destabilize.

7-54. The Soldier can observe the movement of items in the environment downrange to determine wind speed. Each environment will have different vegetation that reacts differently. Downrange wind indicators include the following:

- 0 to 3 mph = Hardly felt, but smoke drifts.
- 3 to 5 mph = Felt lightly on the face.
- 5 to 8 mph = Keeps leaves in constant movement.
- 8 to 12 mph = Raises dust and loose paper.
- 12 to 15 mph = Causes small trees to sway.

Note. The wind blowing at the Soldier's location may not be the same as the wind blowing on the way to the target.

Wind Estimation

7-55. Soldiers must be comfortable and confident in their ability to judge the effects of the wind to consistently make accurate and precise shots. Soldiers will use wind indicators between the Soldier and the target that provide windage information to develop the proper compensation or hold-off. To estimate the effects of the wind on the shot, Soldiers need to determine three windage factors:

- Velocity (speed).
- Direction.
- Value.

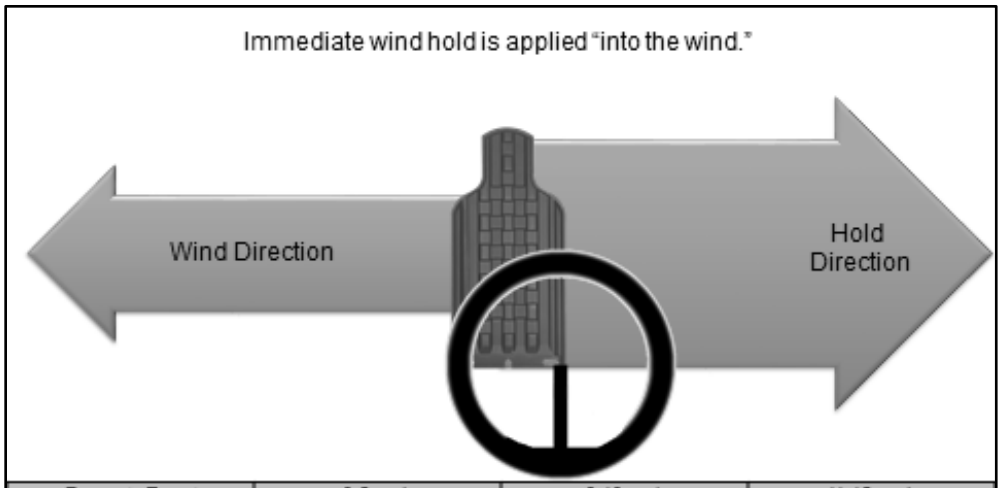
Immediate Wind Hold

7-56. Using a hold involves changing the point of aim to compensate for the wind drift. For example, if wind causes the bullet to drift ½ form to the left, the aiming point must be moved ½ form to the right (table 7-5 and 7-6).

7-57. Gunners must adjust their points of aim into the wind to compensate for its effects. If they miss a distant target and wind is blowing from the right, they should aim to the right for the next shot.

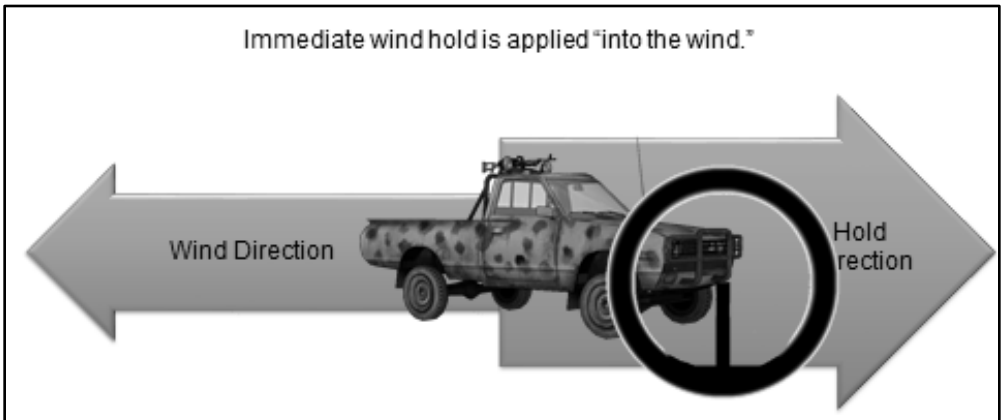
7-58. Newly assigned Soldiers should aim at the target's center base of visible mass for the first shot or burst, and then adjust for wind when they are confident that wind caused the miss. Experienced gunners should apply the appropriate hold for the first shot or burst, but should follow the basic rule—when in doubt, aim at the center base of mass.

Table 7-5. Wind hold dismount example



Range to Target	0-5 mph	6-10 mph	11-15 mph
500m	CBoVM	½ EDGE	1 FORM
400m	CBoVM	CBoVM	1/2 EDGE
300m	CBoVM	CBoVM	CBoVM
200m	CBoVM	CBoVM	CBoVM
100m	CBoVM	CBoVM	CBoVM

Table 7-6. Wind hold truck example



Range to Target	0-5 mph	6-10 mph	11-15 mph
1000m-1500m	1/2 EDGE	1 FORM	1 ½-2 FORM
500m-1000m	CBoVM	1/2 EDGE	1 FORM
100m-500m	CBoVM	CBoVM	1/2 EDGE

LIMITED VISIBILITY

7-59. Soldiers must be lethal at night and in limited visibility conditions, as well as during the day. That lethality depends largely on whether Soldier can fire effectively with today's technology: night vision devices, infrared aiming devices, and TWSs.

7-60. Limited visibility conditions may limit the viewable size of a threat, or cause targets to be lost after acquisition. In these situations, Soldiers may choose to apply a hold for where a target is expected to be rather than wait for the target to present itself for a more refined reticle lay or sight picture.

7-61. Soldiers may switch between optics, thermals, and pointers to refine their point of aim. To rapidly switch between aiming devices during operations in limited visibility, the Soldier must ensure accurate alignment, boresighting, and zeroing of all associated equipment. Confidence in the equipment is achieved through drills related to changing the aiming device during engagements, executing repetitions with multiple pieces of equipment, and practicing nonstandard engagement techniques using multiple aiming devices in tandem (infrared pointer with night vision devices for example).

GUNNER CONDITIONS

7-62. The ability to aim properly while the weapon is canted (tilted to one side or the other), or is fighting in a CBRN environment creates additional difficulties to achieve the appropriate point of aim. These gunner conditions can be mitigated to ensure effective point of aim and target defeat.

CANTED WEAPON

7-63. If the weapon must be tilted (canted) in one direction or another to engage a target, the strike of the bullet will be in the direction of the canted weapon and low. When firing a canted weapon, the elevation becomes the azimuth, and the azimuth becomes the elevation in relation to the aim point.

CLOSE RANGE

7-64. At close range, the effects of cant are specific to the line of sight and the axis of the bore. Soldiers should apply the offset to the target based on the angle of the cant.

EXTENDED RANGE

7-65. The general rule is to apply the aim point in an equal amount in the opposite direction of the cant to ensure the highest probability of hit.

COMPOUND CONDITIONS

7-66. When combining difficult target firing occasion information, Soldiers can apply the rules specific to the situation together to determine the appropriate amount of hold-off to apply.

7-67. The example in figure 7-10, shows the application of different moving target directions with varying wind directions. It shows how to apply multiple hold-off information to determine complex ballistic solutions for an engagement. This same concept is applied to immediate and deliberate methods of determining hold.

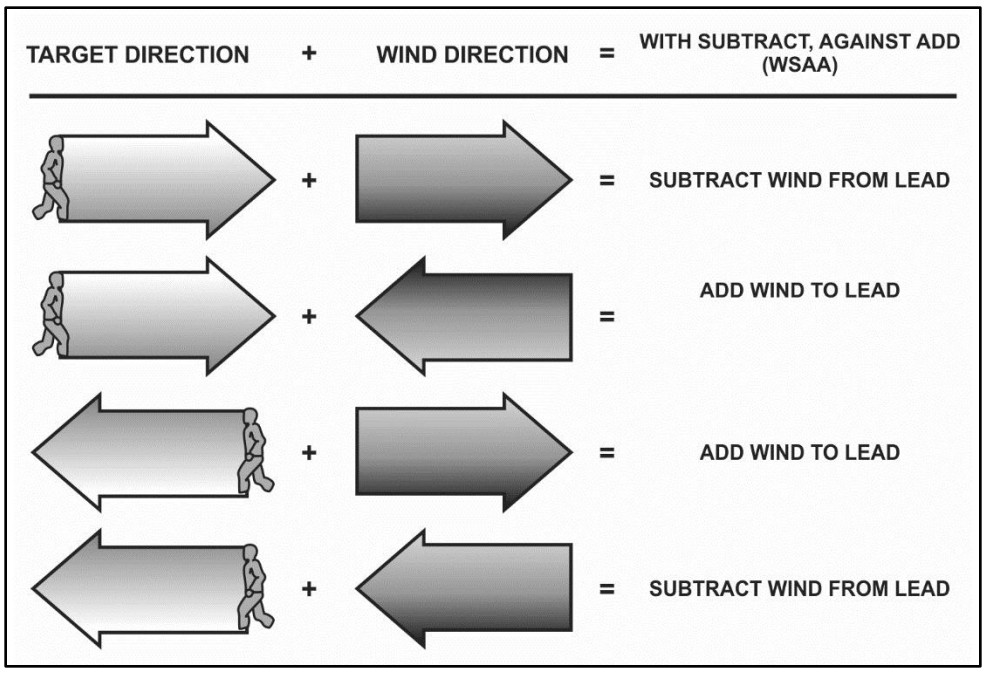


Figure 7-10. Compound wind and lead-determination example

This page intentionally left blank.

Chapter 8
Control

Chapter 8 discusses the engagement techniques that Soldiers must adapt to continuously changing combat engagements. The control element of employment considers all the conscious actions that the Soldier's specifically controls before, during, and after the shot process. It incorporates the Soldier as a function of safety, as well as the person ultimately responsible for firing the weapon.

Combat is the ultimate test of a Soldier's ability to apply the functional elements of the shot process and firing skills. Soldiers must apply the employment skills mastered during training to all combat situations (for example, attack, assault, ambush, or urban operations). Although these tactical situations present problems, the application of the functional elements of the shot process require two additions: changes to the rate of fire and alterations in weapon and target alignment.

ARC OF MOVEMENT

8-1. When firing, the Soldier is the weapon's fire control system, ballistic computer, stabilization system, and means of mobility. Control refers to the Soldier's ability to regulate these functions and maintain the discipline to execute the shot process at the appropriate time. Control is extremely important when the machine gun is fired in the free gun state. When the machine gun is fired without the T&E, the weapon becomes fully exposed to the arc of movement that would normally will be minimized by the T&E.

8-2. Regardless of how well trained or physically strong a Soldier is, a wobble area (or arc of movement) is present, even when sufficient physical support of the weapon is provided. The arc of movement may be observed as the sights moving in a W shape, vertical (up and down) pulses, circular, or horizontal arcs depending on the individual Soldier, regardless of their proficiency in applying the functional elements. The wobble area or arc of movement is the extent of lateral horizontal and front-to-back variance in the movement that occurs in the sight picture (see figure 8-1, page 8-2).

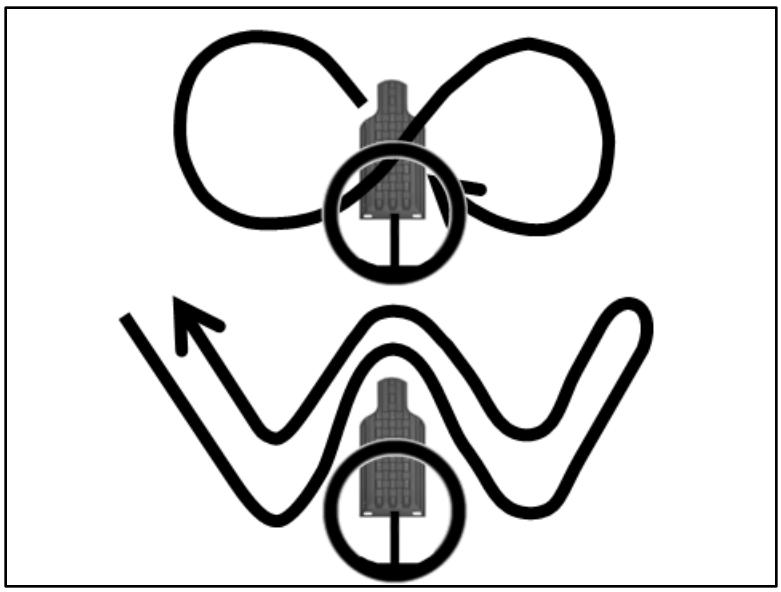


Figure 8-1. Arc of movement, example

8-3. The control element consists of several supporting Soldier functions, and includes all the actions to minimize the Soldier's induced arc of movement. Executed correctly, it provides for the best engagement window of opportunity to the gunner. The Soldier physically maintains positive control of the shot process by managing—

- Trigger control.
- Breathing control.
- Workspace management.
- Calling the shot (firing or shot execution).
- Follow-through.

TRIGGER CONTROL

8-4. Trigger control is the act of firing the weapon while maintaining proper aim and adequate stabilization until the bullet leaves the muzzle. Trigger control and the shooter's position work together to keep the sights on the target long enough for the shooter to fire the weapon and the bullet to exit the barrel.

8-5. Stability and trigger control complement each other and are integrated during the shot process. A stable position assists in aiming and reduces unwanted movements during trigger press without inducing unnecessary movement or disturbing the sight picture. A smooth, consistent trigger press, regardless of speed, allows the shot to fire at the Soldier's moment of choosing. When both a solid position and a good trigger press are achieved, any induced firing errors can be attributed to the aiming process for refinement.

8-6. Placing the finger where it naturally lays on the trigger facilitates smooth trigger control. Natural placement of the thumb on the trigger will allow for the best mechanical advantage when applying forward pressure to the trigger.

8-7. When combined, the elements of trigger control will give the Soldier better results:

- Trigger finger placement. The thumb lays naturally on the trigger after achieving the proper grip. There is no specified point on the thumb that must be used. The trigger finger will not be the same for all Soldiers due to different size hands. Trigger placement allows the Soldier to engage the trigger in the most effective manner.
- Trigger press. The Soldier presses the trigger smoothly and consistently, adding pressure until the weapon fires. Regardless of the speed of fire, the trigger control is always smooth.
- Trigger reset. The Soldier must retain focus on the sights while resetting the trigger.

BREATHING CONTROL

8-8. The shooter controls their breathing to reduce the amount of movement of the weapon during the shot process. During training, the Soldier learns a method of breathing control that best suits their firing style and preference. Breathing control is the relationship between the respiratory process (free or under stress) and the decision to execute the shot with trigger press.

8-9. Breathing induces unavoidable body movement that contributes to wobble or otherwise affects the arc of movement during the shot process. Soldiers cannot completely eliminate all motion during the shot process, but they can greatly reduce the effects through practice and technique. Firing on the natural pause is a common technique used during grouping and zeroing.

8-10. Vertical dispersion during grouping is unlikely to be caused by breathing. It is more likely to be caused by a failure to maintain proper aiming and trigger control. (Refer to appendix E of this publication for proper target analysis techniques.)

WORKSPACE MANAGEMENT

8-11. The workspace is the area surrounding the functional assemblies of the receiver. The workspace is where most of the weapons manipulations take place.

8-12. Manipulations in the workspace allow the Soldier to keep their eyes oriented towards a threat or their individual sector of fire while conducting critical weapons tasks that require hand and eye coordination. Use of the workspace increases efficiency by minimizing the distance the Soldier has to move between the firing position and the workspace and back.

8-13. Location of the workspace will change slightly in different firing positions. There are various techniques for using the workspace.

8-14. Workspace management includes the ability to perform the following functions:

- Trigger block. To change the weapon's status from safe to fire.
- Charging handle. To smoothly use the charging handle during operation. This includes any corrective actions to overcome malfunctions, loading, unloading, or clearing procedures.
- Bolt latch release. To operate the bolt latch release mechanism to select single shot or automatic fire.
- Feed tray cover. To smoothly operate the feed tray cover while reloading or clearing the weapon, or correcting a malfunction.
- Chamber check. To use a particular sequence to verify the status of the weapon's chamber.

CALLING THE SHOT

8-15. Knowing precisely where the sights are when the weapon discharges is critical for shot or burst analysis. Errors such as flinching or jerking of the trigger can be seen in the sights before discharge.

8-16. Calling a shot refers to a firer stating exactly where they think a single shot or burst strikes by recalling the sight's relationship to the target when the weapon fired. Normally, calling a shot is expressed in clock direction and distance from the desired point of aim.

8-17. The Shooter is responsible for the point of impact of every round fired from their weapon. Therefore, the Soldier must ensure the target area is clear of friendly and neutral actors, in front of and behind the target. The Soldier must be aware of the environment around the target, particularly in urban settings. Friendly or neutral actors may be present in other areas of a structure that the projectile could pass through.

RATE OF FIRE

8-18. The gunner must determine HOW to engage the threat with the weapon, on the current shot or burst as well as subsequent shots or bursts. Following the direction of the leader, the Soldier controls the rate of fire to deliver consistent, lethal, and precise fires against the threat.

SINGLE SHOT

8-19. Single shot fire is moderately paced at the gunner's discretion. Single shot fire is typically used in a training environment or a secure defensive position at about 12 to 15 rounds per minute. All Soldiers learn the techniques of single shot fire during their introduction to the machine gun during initial training. This type of fire gives the gunner the most time to focus on the functional elements in the shot process, and it reinforces all previous training. The gunner places the gun in the single-shot mode and engage the target with aimed shots. The machine gun is accurate out to 1500 meters.

SUSTAINED FIRE

8-20. Sustained fire consists of less than 40 rounds per minute, in bursts of six to nine rounds, fired at 10- to 15-second intervals. Once the Soldier has suppressed the enemy, they fire at the sustained rate. Sustained fire conserves ammunition and requires only infrequent barrel changes, but it might not be enough volume of fire to effectively suppress or destroy.

RAPID FIRE

8-21. Rapid rate of fire places an exceptionally high volume of fire on an enemy position. Rapid fire consists of more than 40 rounds per minute, fired in bursts of six to nine rounds, at 5- to 10-second intervals. Machine gunners normally engage targets at the rapid rate to suppress the enemy quickly. Rapid fire requires much more ammunition than sustained fire and requires frequent barrel changes. Soldier use rapid fire when they are required to provide suppressive fires with accuracy, and when the need for precise fires, although desired, is not as important. Rapid fire drastically decreases the probability of hit due to the rapid succession of recoil impulses and the inability of the gunner to maintain proper sight alignment and sight picture on the target.

8-22. Soldiers who display a lack of knowledge of employment skills should not advance to rapid fire training until these skills are learned and mastered

CYCLIC RATE

8-23. The cyclic rate represents the maximum amount of ammunition that a gun can expend without a break in firing. The cyclic rate of the caliber .50 machine gun is 450 to 600 rounds per minute.

FOLLOW-THROUGH

8-24. Follow-through is the continued mental and physical application of the functional elements of the shot process after the shooter fires. The firer's head stays in the same position, their firing eye remains open, and their body position and breathing remain steady. The firer's thumb holds the trigger forward through recoil, and then lets off enough to reset the trigger after a desired burst or single shot.

8-25. Follow-through consists of all the actions the shooter controls after the bullet leaves the muzzle. Firers must complete the shot process with follow-through. Follow-through will significantly impact the consistency and size of the machine gun's cone of fire and beaten zone. The shooter executes the follow-through actions in a general sequence as follows:

- Recoil management. Includes the bolt carrier group recoiling completely and returning to battery. The most effective way for the firer to manage the recoil of the machine gun is by using the T&E, supporting the positions their nonfiring and firing elbows, properly emplacing the tripod, and adding additional support to the tripod such as sand bags.
- Recoil recovery. Returning to the same pre-shot position and reacquiring the sight picture. Get a good sight picture before and after the shot. The M2 machine gun does not have a buttstock to help the firer memorize landmarks for obtaining the same sight picture. For this reason, the firer must focus on aligning the sight by remaining squarely and directly behind the machine gun and maintain a constant distance of the Soldier's head to the rear sight.
- Sight picture adjustment. Counteracting the physical changes in the sight picture caused by recoil impulses and returning the sight picture onto the target aiming point. The condition and material of the surface the firer emplaces the tripod on affects the point of aim after each shot or burst. The

firer might need to adjust the point of aim until they can further brace the tripod. For example, if the firer emplaces the tripod in sandy or loose soil, the shoes of the tripod will continue to dig downward and away from the direction of fire.

- Engagement assessment. Once the sight picture returns to the original point of aim, the firer confirms the strike of the round, assesses the target's state, and immediately selects one of the following courses of action:
  - Subsequent engagement. The target requires more (subsequent) rounds to achieve the desired target effect. The gunner starts the pre-shot process over using the adjusted aim point method, based on their observed impact of the rounds or tracer.
  - Supplemental engagement. The gunner determines the desired target effect is achieved and whether another target requires servicing. The gunner starts the pre-shot process.
  - Sector check. All threats have been adequately serviced to the desired effect. The gunner then checks their sector of responsibility for additional threats as the tactical situation dictates. The unit SOP will dictate any vocal announcements required during the post-shot sequence.
  - Correction of malfunction. If the gunner determines during the follow-through that the weapon failed in one of the phases of the cycle of function, they make the appropriate announcement to their team, and immediately execute corrective action.

MALFUNCTIONS

8-26. A malfunction occurs when a weapon fails to complete any phase of the cycle of function correctly. When a malfunction occurs, the Soldier's priority to defeat the target as quickly as possible remains. The malfunction, Soldier capabilities, and secondary weapon capabilities determine if, when, and how to transition to a secondary weapon system.

SECONDARY WEAPON

8-27. The Soldier controls which actions to take to defeat the target as quickly as possible based on secondary weapon availability and capability, and due to the level of threat presented by the range to target and its capability:

- Secondary weapon can defeat the threat. Gunner transitions to secondary weapon for the engagement. If no secondary weapon is available, gunner announces status to the small team, and moves to a covered position to correct the malfunction.
- Secondary weapon cannot defeat the threat. Gunner quickly moves to a covered position, announces status to the small team, and takes corrective action.
- No secondary weapon. Gunner quickly moves to a covered position, announces status to the small team, and takes corrective action.

CORRECTIVE ACTION

8-28. The end state of any of corrective action is a properly functioning weapon. Typically, the phase where the malfunction occurred within the cycle of function identifies the general problem that must be corrected. From a practical, combat perspective, malfunctions are recognized by their symptoms. Although some symptoms do not specifically identify a single point of failure, they provide the best indication on which corrective action to apply.

8-29. To overcome the malfunction, the Soldier must first avoid over analyzing the issue. The Soldier must train to execute corrective actions immediately without hesitation or investigation during combat conditions.

8-30. No single corrective action solution will resolve all or every malfunction. Soldiers need to understand what failed to occur, as well as any specific sounds or actions of the weapon in order to apply the appropriate correction measures. The two general types of corrective action follow:

- Immediate Action. This is a set of simple, rapid actions to correct basic disruptions in the cycle of function. The gunner takes immediate action when, after the gunner presses the trigger, the firing pin clicks, but the weapon fails to fire.

- Remedial Action. This is a set of actions that require greater skill. The gunner performs remedial actions when immediate action fails to correct a specific problem or issue with the weapon—when the cycle of function is interrupted.

8-31. Although there are other types of malfunctions or disruptions to the cycle of function, those listed in table 8-1 are the most common. Any other malfunction will require additional time to determine the true point of failure and an appropriate remedy.

Table 8-1. Malfunctions and their causes

Malfunction Type	*Description*	*Common Causes*
Failure to feed	Occurs when the round is prevented from being properly positioned in the receiver group.	• Defective ammunition belt. • Defective feed mechanism parts. • Defective extractor. • Improperly loaded belt. • Short round. • Weapon improperly assembled. • Worn or defective driving rod spring assembly. • Burred, cracked, or broken extractor switch and deformed, broken, or weak extractor switch spring.
Failure to chamber	Occurs when the round fails to chamber completely. When the round is feeding into the chamber, and the bolt assembly fails to seat forward fully, the round fails to chamber.	• Broken part or obstruction in T-slot or chamber. • Separated (ruptured) case. • Too thick or thin rim. • Bulging round. • Protruding primer. • Bent or broken belt feed lever in top cover assembly. • Burred, cracked, or broken extractor switch and deformed, broken, or weak extractor switch spring. • Worn or defective driving rod spring assembly. • Burred, broken, or bent cartridge extractor. • Burred, scored, loose, or deformed extractor cam.
Failure to Lock	Breech lock fails to correctly seat in its recess in the bolt.	• Incorrect headspace. • Damaged bolt or broken parts. • Battered breech lock. • Battered breech lock cam. • Faulty breech lock cam adjustment. • Burred, cracked, chipped, or broken buffer accelerator or broken or collapsed coils on buffer spring.
Failure to fire	Round is locked into the chamber, and the weapon is ready to fire. That is, the weapon is placed on single shot or automatic and the trigger pressed, the firing pin activates (audible click), and the weapon fails to fire.	• Defective ammunition. • Incorrect timing. • Burred, broken, cracked, or bent firing pin and firing pin extension assembly. • Incorrectly assembled or damaged cocking lever. • Broken, defective or improperly assembled sear. • Worn or defective driving rod spring assembly. • Bent, cracked, or broken trigger.

Table 8-1. Malfunctions and their causes (continued)

Malfunction Type	*Description*	*Common Causes*
Failure to unlock	Something prevents the breech lock from moving out of its recess in the bolt.	• Broken parts in receiver. • Worn or faulty breech lock cam or faulty adjustment. • Obstruction in receiver. • Burrs, cracks, or chipping in bolt assembly bottom slot that matches up with the breech lock in barrel extension.
Failure to extract	Occurs when the cartridge remains inside the chamber after the bolt has moved to the rear manually or automatically.	• Dirty chamber. • Defective cartridge case. • Pitted chamber and burred or chipped threads and locking lugs. • Burrs on bolt assembly and inside of receiver which may cause insufficient recoil. • Cracks, dents, or excessive wear on the face of the bolt. • Burrs on rails of barrel extension assembly. • Burrs on rails of bolt assembly. • Broken T-slot in bolt. • Defective or weak barrel locking spring.
Failure to eject	Occurs when something prevents the ejection of the expended cartridge from the receiver.	• Defective ejector. • Burred T-slot. • Burred, broken, cracked, or bent firing pin.
Failure to cock	Occurs when the firing pin extension is prevented from being engaged with the sear.	• Broken sear. • Worn sear notch. • Weak sear spring. • Worn hooked notch on firing pin extension. • Broken cocking lever.

Note. When malfunctions occur in combat, the Soldier must announce, stoppage, and then quickly move to a covered location and correct the malfunction. If the threat is too close to the Soldier or friendly forces, the Soldier should immediately transition to a secondary weapon, if available, to defeat the target prior to correcting the malfunction.

RULES FOR CORRECTING A MALFUNCTION

8-32. To clear a malfunction, the Soldier must apply certain rules systematically.

- Apply Rule No. 1. Remain aware of the weapon and continue to treat it as if it were loaded when correcting malfunctions.
- Apply Rule No. 2. Ensure the weapon's orientation is appropriate for the tactical situation and not flag other friendly forces when correcting malfunctions.
- Apply Rule No. 3. Take the thumb off the trigger.
- Do not try to place the weapon on safe (unless otherwise noted). Trying to place the weapon on SAFE will waste time and potentially damage the weapon.
- Treat the symptom. Each problem will have its own specific symptoms. Soldiers can quickly correct the malfunction if they react to what the weapon is telling them.
- Maintain focus on threat. The Soldier must keep their head and eyes looking downrange at the threat, not at the weapon. If the initial corrective action fails to correct the malfunction, the Soldier must be able to quickly move to the next most probable corrective action.

- Check the weapon. Once the malfunction is clear and the threat is eliminated, deliberately check the weapon when in a covered location. Look for potential issues or factors that may have caused the malfunction and correct them.

PERFORM IMMEDIATE ACTION

8-33. The Soldier should perform the following immediate actions instinctively:

- Pull retracting slide handle rearward.
- Observe if round or fired case is ejected, release retracting slide handle.
- Attempt to fire.
- If weapon does not fire and the barrel is hot enough to cause a cook-off (100 rounds per minute), place the bolt in the forward position and place the weapon in single shot mode. Follow the procedures listed in TM 9-1005-213-10.

PERFORM REMEDIAL ACTION

8-34. When a malfunction occurs that requires the Soldier to execute immediate action, and at least two tries fail to correct the malfunction, the Soldier performs remedial action.

8-35. Remedial action requires the Soldier to quickly identify one of three issues and apply a specific technique to correct the malfunction. When immediate action does not correct the malfunction, the quickest way to resume firing is to replace the defective part. The following procedures will assist the gunner to apply remedial action. Remedial action is required to correct several types of malfunctions or symptoms.

DANGER

Never open the cover on a hot weapon. An open cover cook-off could occur. Keep the weapon pointed down range while performing remedial action. Failure to comply can cause death or injury to personnel.

Remove Stuck Cartridge

8-36. If the cartridge does not fall out—

1. Open the cover assembly and remove ammunition belt.
2. Check for faulty ammunition or an obstruction in the barrel assembly and chamber.
3. Pull the retracting slide handle to the rear.
4. If no cartridge ejects, lock the bolt to the rear, and return retracting slide handle forward.
5. If a cartridge is present in the chamber, with a second man standing to the side of the weapon, insert a cleaning rod into the muzzle end of the machine gun and gently tap the round/case from the chamber.

Note. If the Soldier discovers that the cartridge has ruptured, they follow the steps for removal.

6. The weapon is now clear.
7. Return the bolt to the forward position.

Remove Ruptured Cartridge

8-37. Perform the following steps referring to figures 8-2 and 8-3:

1. Remove a ruptured (separated) cartridge case with a cleaning rod or ruptured cartridge extractor.
2. When using the ruptured cartridge extractor, raise the cover and pull the bolt to the rear.

3. Place the extractor in the T-slot of the bolt, the same as for a cartridge, so that it is held in line with the bore by the ejector of the extractor assembly of the gun.
4. With the extractor aligned with the bore and held firmly in the T-slot, let the bolt go forward into the ruptured case.

Note. The shoulders will spring out in front of the case.

5. Pull the bolt to the rear and remove the ruptured case and extractor.

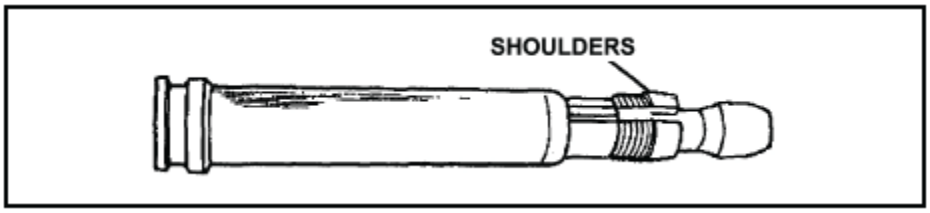


Figure 8-2. Ruptured cartridge case extractor

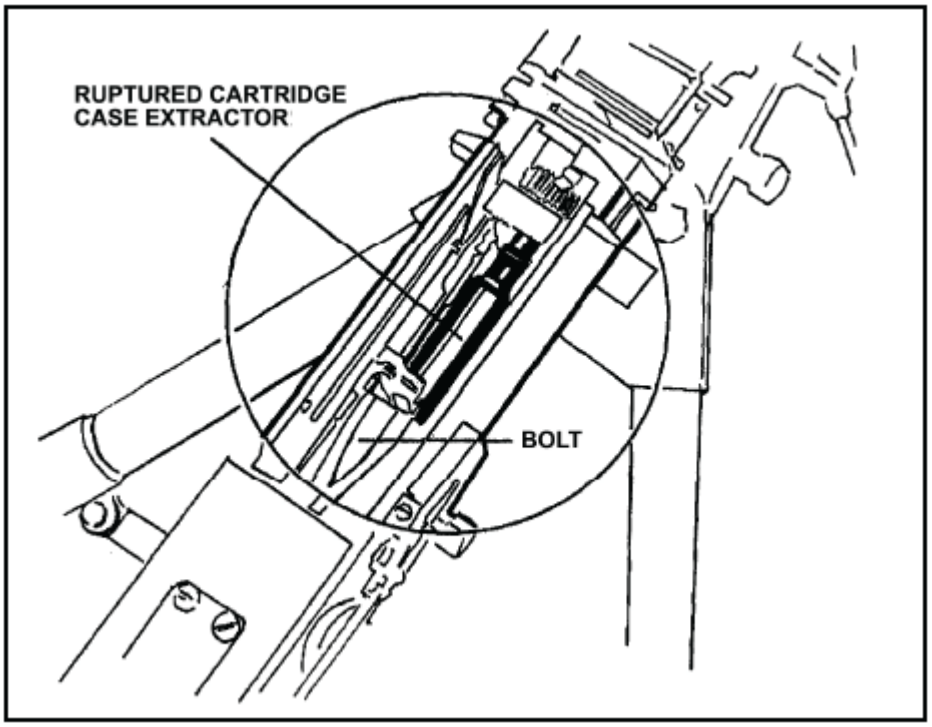


Figure 8-3. Ruptured cartridge case extractor aligned with the chamber

Cook-off

8-38. Rapid and continuous firing of several belts of ammunition in sequence without cooling will severely elevate chamber temperatures. While unlikely, this elevated temperature may cause a malfunction known as a cook-off. A cook-off may occur for either of two reasons: the round overheats while locked in the chamber, due to excessive heating of the ammunition or the rapid exposure to the cooler air outside of the chamber, due in part to the change in pressure. If the Soldier determines that the potential exists for a cook-off, they—

1. Leave the weapon directed at the target, or in a known safe direction.
2. Follow proper weapon-handling procedures until the barrel of the weapon cools.
3. If the round has not been locked in the chamber for 10 seconds, the Soldier ejects it as quickly as possible.
4. If the round has been locked in the chamber for longer than 10 seconds, or if the Soldier does not know how long it has been in there, and if it is tactically sound, the Soldier follows the same procedures until the weapon cools.
5. If the Soldier must remove the round before the weapon cools, use care, as the ejected round could cook off due to rapid cooling in open air.

WARNING

Ammunition cook-offs are unlikely in well maintained weapons, when those weapons are used within normal training and combat parameters.

Soldiers and unit leaders need to consider the risks of keeping rounds chambered in weapons whose temperatures are elevated due to excessive firing, or of clearing ammunition that could cook off when exposed to colder air outside the chamber.

Exposure to colder air outside the chamber can cause ammunition to cook off, as can keeping ammunition chambered in extremely hot conditions.

Note. For more information about troubleshooting malfunctions and replacing components, see organizational and direct support maintenance manuals

Chapter 9
Movement

The movement functional element is the process of the Soldier moving tactically during the engagement process. It includes the Soldier's ability to move laterally, forward, diagonally, and in a retrograde manner. Due to the nature and physical characteristics of the M2, it cannot be fired on the move while in a ground mount role. However, the gun may be moved or repositioned several ways without completely taking it out of action. This chapter will discuss some techniques for doing either one rapidly and tactically in order to maintain flexibility and lethality.

MOVEMENT TECHNIQUES

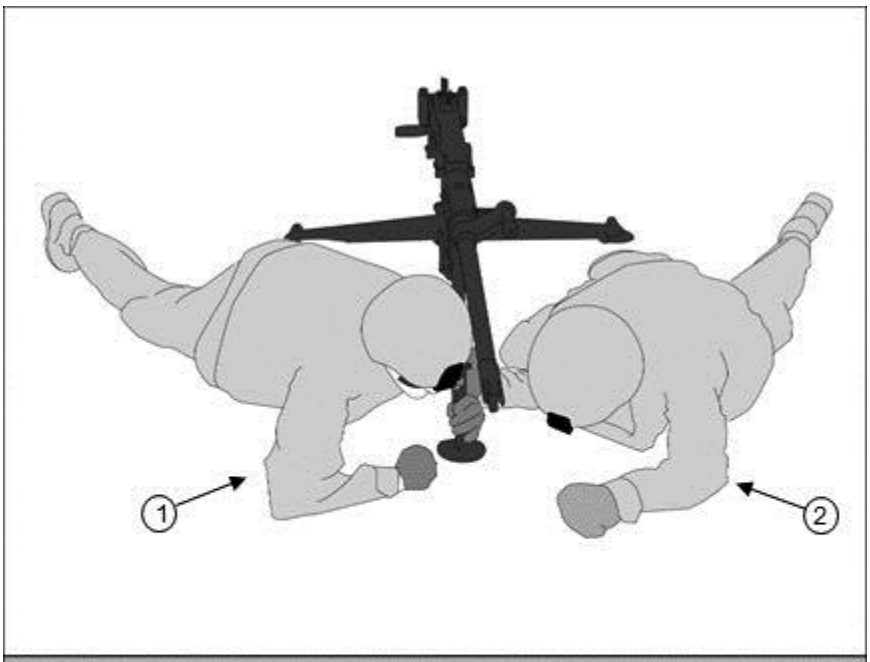
9-1. Not all combat actions can be engaged in the same manner. Therefore, Soldiers need to know a variety of movement techniques. Each technique varies in its effect on different situations. Choosing the right technique for the right operation could be a critical factor in the outcome of the mission.

RELOCATION OF TRIPOD-MOUNTED GUN

9-2. When the gun is mounted on the tripod, it can be moved for short distances by dragging or by a two- or three-man carry. (In the latter, the men should move in step to make carrying easier.) The machine gun must be cleared any time the gun is to be moved. When carrying the gun with the barrel carrying handle unlock the barrel carrying handle so the barrel can rotate freely inside of the sleeve. The pitch of the weapon will keep the carrying handle in its position.

DRAGGING

9-3. The gun is dragged when there is limited cover, or when the situation requires the gun to be moved in this manner. The gunner and assistant gunner drag the mounted gun to the desired position (see figure 9-1).



TWO MAN DRAG

1. The gunner positions himself on the right side of the machine gun and with his left hand grasps the front tripod leg. In unison with the assistant gunner they high crawl forward and then drag the machine gun and then repeat as necessary.
2. The assistant gunner positions himself on the left side of the machine gun and with his right hand grasps the front tripod leg. In unison with the gunner they high crawl forward and then drag the machine gun and then repeat as necessary.

Figure 9-1. Dragging of the gun into position

TWO-MAN CARRY

9-4. The gun can be moved by the gunner and assistant gunner when the situation requires it be moved in this manner (see figure 9-2). If the barrel is hot, use the barrel carrying handle and asbestos mitten. Carrying the machine gun by the barrel carrying handle could cause damage to the machine gun.

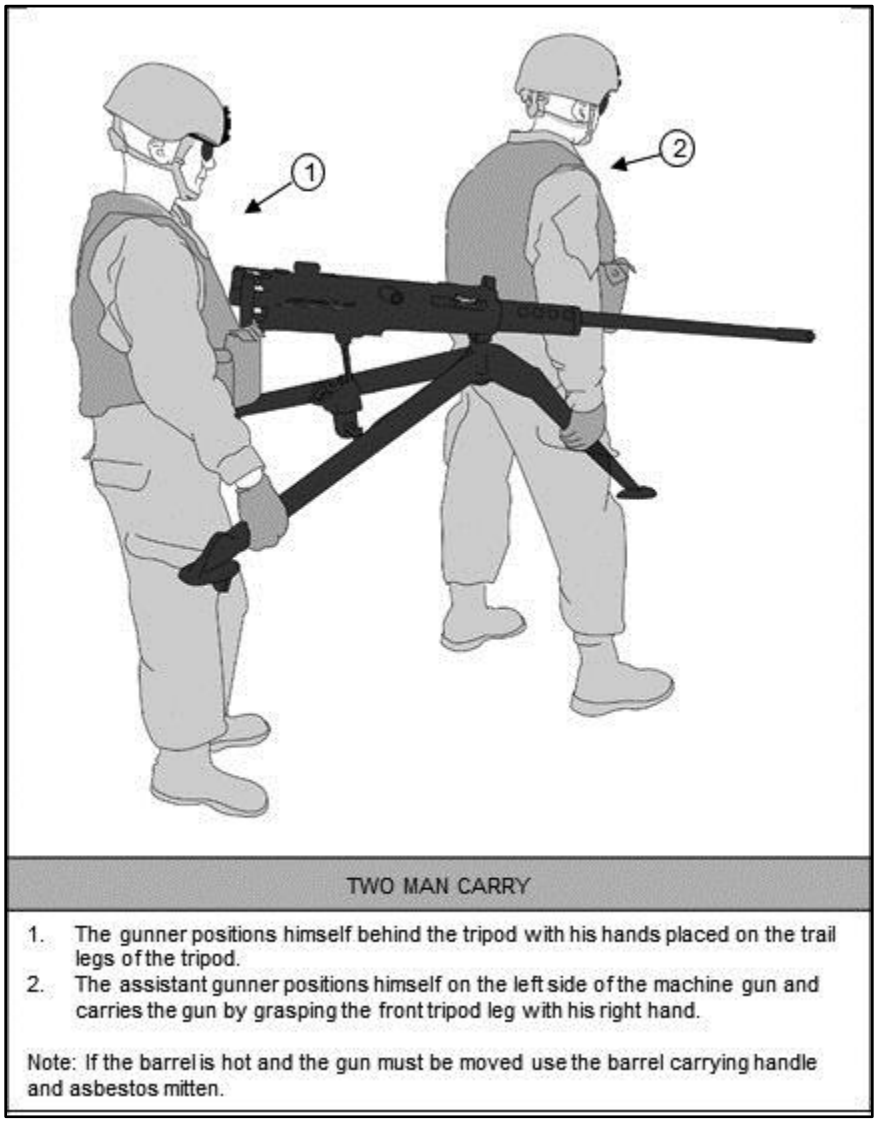
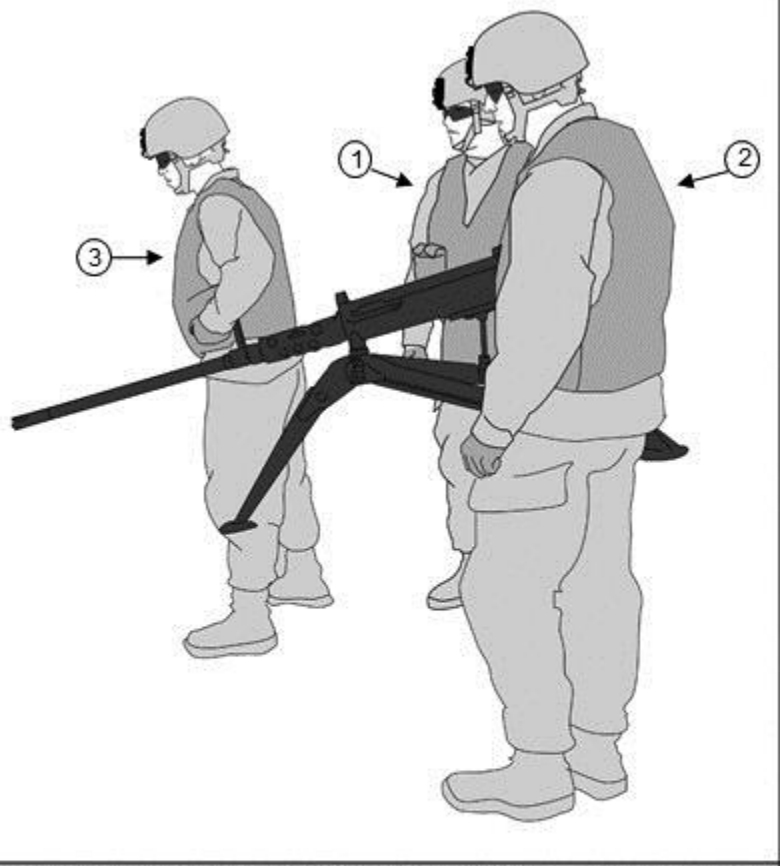


Figure 9-2. Two-man carry

THREE-MAN CARRY

9-5. The gun can be moved by the gunner, assistant gunner and ammunition bearer when the situation requires it be moved in this manner. There are two variations of this carry and are used based upon the temperature of the barrel (see figure 9-3 and figure 9-4).



THREE MAN CARRY HOT BARREL

1. The gunner positions himself on the ride side of the machine gun and carries the gun by grasping the right trail tripod leg with his left hand.
2. The assistant gunner positions himself on the left side of the machine gun and carries the gun by grasping the left trail tripod leg with his right hand.
3. The ammunition bearer positions himself on the right side of the machine gun and carries the gun by grasping the barrel carrying handle with his left hand.

Note: The asbestos mitten should be worn when handling a hot barrel.

Figure 9-3. Three-man carry with hot barrel

THREE MAN CARRY COLD BARREL

1. The gunner positions himself behind the tripod with his hands placed on the trail legs of the tripod.
2. The assistant gunner positions himself on the left side of the machine gun and carries the gun by grasping the front tripod leg with his right hand.
3. The ammunition bearer positions himself on the right side of the machine gun and carries the gun by grasping the front leg with his left hand.

Figure 9-4. Three-man carry with cold barrel

MOVEMENT OF THE GUN TO OTHER MOUNTS

9-6. With the mount prepared to receive the gun, the cradle of the mount is placed in a horizontal position. To move the gun to the mount, the gunner carries the right spade grip in their left hand and a box of ammunition in their right. The assistant gunner grasps the carrying handle with their right hand and a box of ammunition in their left hand. When they get to the mount, the gunner and assistant gunner place their ammunition boxes near the mount. The gunner removes the rear mounting (gun-locking) pin with their right hand. The assistant gunner removes the front mounting (gun-locking) pin with their left hand. They place the gun on the mount. The gunner aligns the holes in the rear mounting lugs of the receiver with the rear-mounting bracket and inserts the rear-mounting pin. The assistant gunner aligns the front mounting hole in the front of the receiver with the front mounting bracket and inserts the front mounting pin.

This page intentionally left blank.

Appendix A

Ammunition

Appendix A discusses the characteristics and capabilities of the different ammunition available for the M2-series weapons. It also includes general ammunition information such as packaging, standard and North Atlantic Treaty Organization (NATO) marking conventions, the components of ammunition, and general principles of operation. The information within this appendix is caliber .50 for the M2-series weapons only.

SMALL ARMS AMMUNITION CARTRIDGES

A-1. Ammunition for use in machine guns is described as a cartridge. A small arms cartridge (see figure A-1) is an assembly consisting of a cartridge case, a primer, a quantity of propellant, and a bullet. The following terminology describe the general components of all small arms ammunition cartridges:

- Cartridge case. The cartridge case is a brass, rimless, center-fire case that provides a means to hold the other components of the cartridge.
- Propellant. The propellant (or powder) provides the energy to propel the projectile through the barrel and downrange towards a target through combustion.
- Primer. The primer is a small explosive charge that provides an ignition source for the propellant.
- Bullet. The bullet or projectile is the only component that travels to the target.

Note. Dummy cartridges have a cartridge case and bullet, with no primer or propellant. Some dummy cartridges contain inert granular materials to simulate the weight and balance of live cartridges.

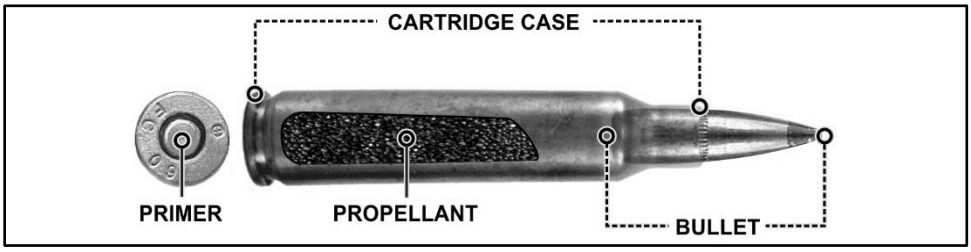


Figure A-1. Small arms ammunition cartridges

A-2. There are multiple types of bullets used for various purposes. These include ball, tracer, incendiary, armor-piercing, armor piercing incendiary, saboted light armor penetrator (SLAP), dummy, blank, and short range training.

A-3. The cartridge case is made of steel, aluminum, or a brass combination (70 percent copper and 30 percent zinc) for military use. The M2-series weapons use a rimless cartridge case that provides an extraction groove (shown in figure A-2, page A-2). These cartridge cases are designed to support center-fire operation.

A-4. Center-fire cases have a centrally located primer well/pocket in the base of the case, which separates the primer from the propellant in the cartridge case. These cases are designed to withstand pressures generated during firing and are used for most small arms.

A-5. All caliber .50 ammunition uses the rimless cartridge case. A rimless cartridge is where the rim diameter is the same as the case body, and uses an extractor groove to facilitate the cycle of function.

A-6. When the round is fired, the cartridge case assists in containing the burning propellant by expanding the cartridge case tightly to the chamber walls to provide rear obturation.

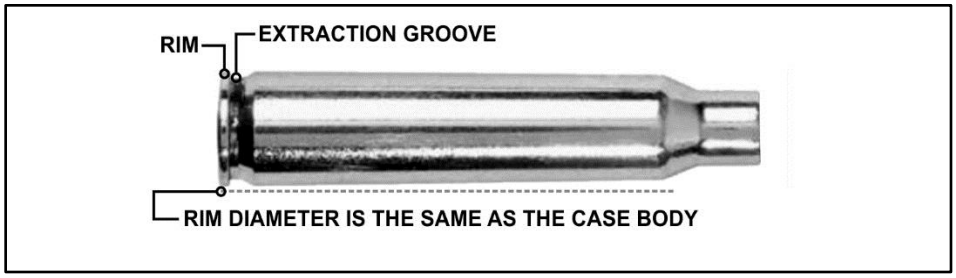


Figure A-2. Cartridge case

PROPELLANT

A-7. Cartridges are loaded with various propellant weights that impart sufficient velocity, within safe pressure, to obtain the required ballistic projectile performance. The propellants are either a single-base (nitrocellulose) or double-base (nitrocellulose and nitroglycerine) composition.

A-8. The propellant (see figure A-3) may be a single-cylindrical or multiple-perforation, a ball, or a flake design to facilitate rapid burning. Most propellants are coated to assist the control of the combustion rate. A final graphite coating facilitates propellant flow and eliminates static electricity in loading the cartridge.

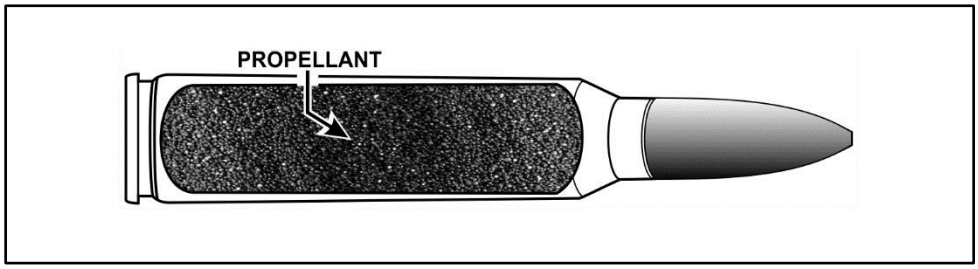


Figure A-3. Propellant

PRIMER

A-9. Center-fire small arms cartridges contain a percussion primer assembly. The assembly consists of a brass or gilding metal cup (see figure A-4). The cup contains a pellet of sensitive explosive material secured by a paper disk and a brass anvil.

A-10. The weapon firing pin striking the center of the primer cup base compresses the primer composition between the cup and the anvil. This causes the composition to explode. Holes or vents located in the anvil or closure cup allow the flame to pass through the primer vent, igniting the propellant.

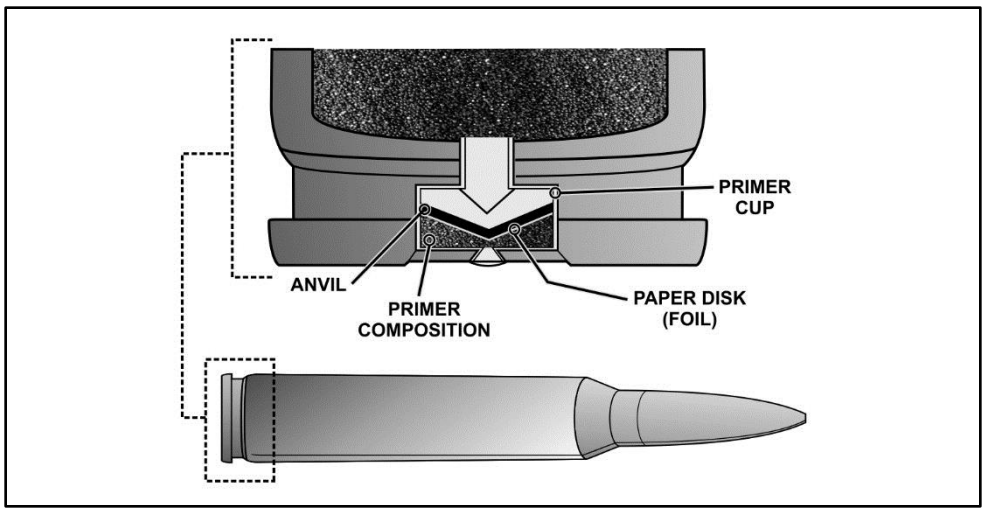


Figure A-4. Caliber .50 primer detail

BULLET

A-11. The bullet is a cylindrically shaped lead or alloy projectile that engages with the rifling of the barrel. The bullets used today are either lead (lead alloy), or assemblies of a jacket and a lead or steel core penetrator. The lead used in lead-alloy bullets is combined with tin, antimony or both for bullet hardness. The alloying reduces barrel leading and helps prevent the bullet from striping (jumping) the rifling during firing.

A-12. Jacketed bullets (see figure A-5) are used to obtain high velocities and are better suited for semiautomatic and automatic weapons. A bullet jacket may be either gilding metal, gilding metal-clad steel, or copper plated steel. In addition to a lead or steel core, they may contain other components or chemicals that provide a terminal ballistic characteristic for the bullet type.

A-13. Some projectiles may be manufactured from plastic, wax, or plastic binder and metal powder, two or more metal powders, or various combinations based on the cartridge's use.

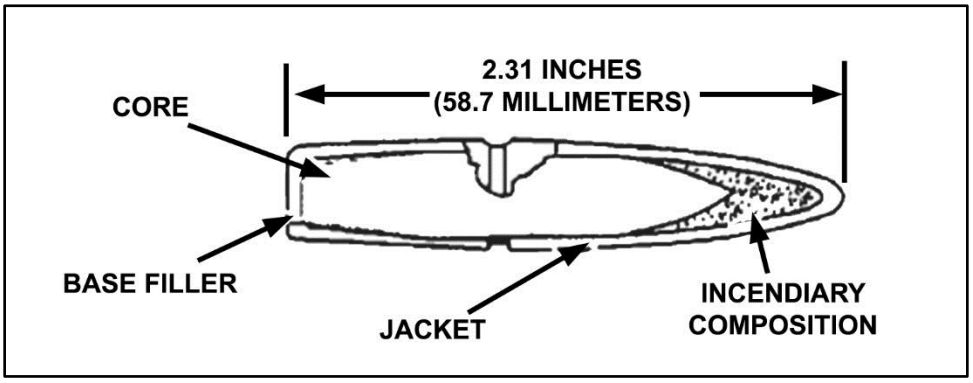


Figure A-5. Bullet example, armor-piercing cartridge

SMALL ARMS AMMUNITION TYPES

A-14. There are eleven types of small arms ammunition for the M2-series weapons that are used for training and combat. Each of these ammunition types provides a different capability and has specific characteristics

A-15. The M2 uses several types of standard caliber .50 ammunition. Soldiers may only use authorized ammunition manufactured to US and NATO specifications. Ammunition for the M2 is issued in a disintegrating, metallic, split-linked belt. The following section will provide a brief description of the different types commonly used caliber .50 ammunition for training and combat. Some types of caliber .50 ammunition may have more than one applicable Department of Defense Identification Code Department of Defense Identification Code (known as DODIC). DODICs are provided for the clarity and ease of the unit's ammunition resource manager.

BALL

A-16. The ball cartridge (see figure A-6) is intended for use against personnel and unarmored targets. The bullet, is designed for combat and training requirements, normally consist of a metal jacket and a lead slug.

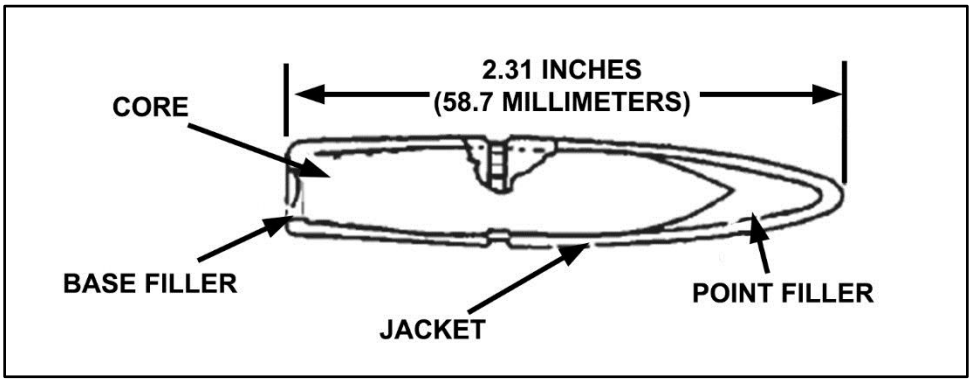


Figure A-6. Ball cartridge

TRACER

A-17. A tracer round contains a pyrotechnic composition in the base of the bullet to permit visible observation of the bullet's in-flight path or trajectory and point of impact (see figure A-7). The pyrotechnic composition is ignited by the propellant when the round is fired, emitting a bright flame visible by the gunner. Tracer rounds may also be used to pinpoint enemy targets to ignite flammable materials and for signaling purposes.

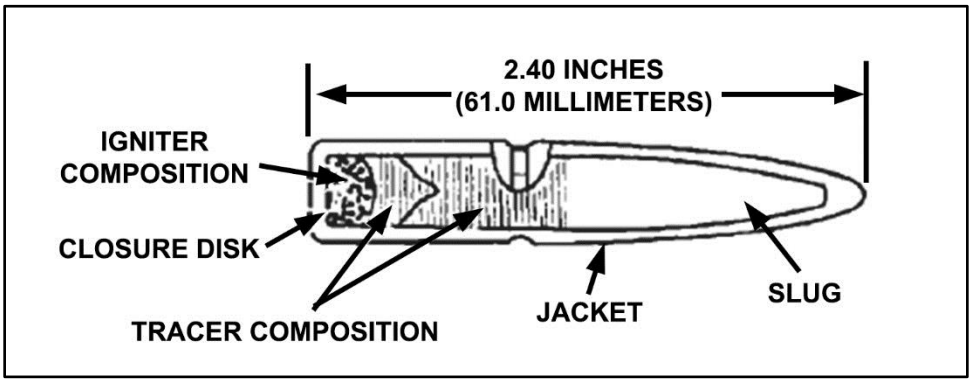


Figure A-7. Ball with tracer cartridge

ARMOR-PIERCING INCENDIARY (API)

A-18. The armor-piercing incendiary cartridge (see figure A-8) combines the functions of the M2 armor piercing bullet and the incendiary bullet, and is used against flammable targets and light-armored or unarmored targets, concrete shelters, and similar bullet-resisting targets.

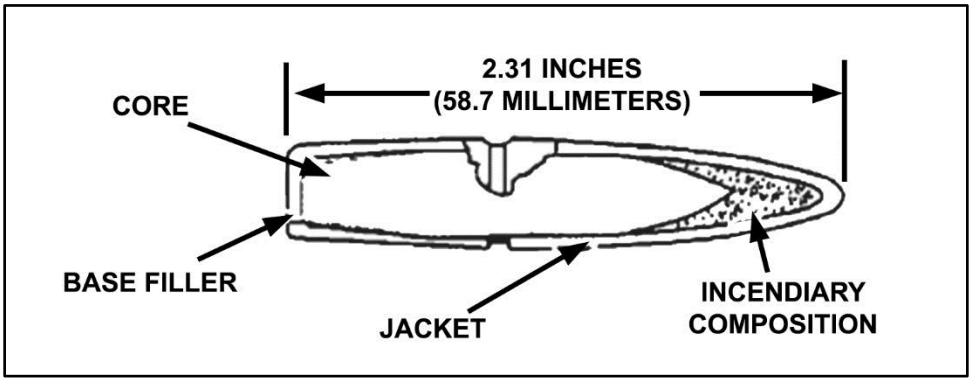


Figure A-8. Armor-piercing incendiary cartridge

PLASTIC PRACTICE BALL

A-19. The plastic practice ball cartridge (see figure A-9), also commonly referred to as short range training ammunition is intended for scaled range training purposes. It has a maximum range of 500 meters allowing higher capacity of training on smaller ranges. While using the M2-series HMG with the M3 recoil adapter, caliber .50 SRTA has an accuracy match to the M33 or M17 at 150 meters, making this cartridge ideal for training with the M2-series, both on a vehicular or ground mount, and off the tripod.

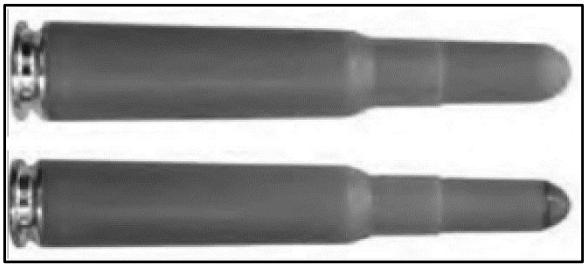


Figure A-9. Plastic practice ball cartridge

BLANK

A-20. The blank cartridge (figure A-10) is distinguished by the absence of a bullet or projectile. It is used for simulated fire and in training maneuvers. These rounds consist of a roll crimp (knurl) or cannelure on the body of the case, which holds a paper wad in place instead of a projectile. Newer cartridges have rosette crimp.

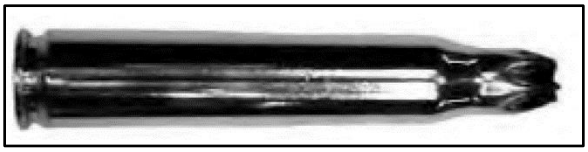


Figure A-10. Blank cartridge

DUMMY

A-21. The dummy cartridge (see figure A-11) is used for practice in loading weapons and simulated firing to detect errors in employment skills when firing weapons. This round is completely inert and consists only of an empty cartridge case and ball bullet. Cartridge identification is by means of holes through the side of the case or longitudinal corrugations in the case and by the empty primer pocket.

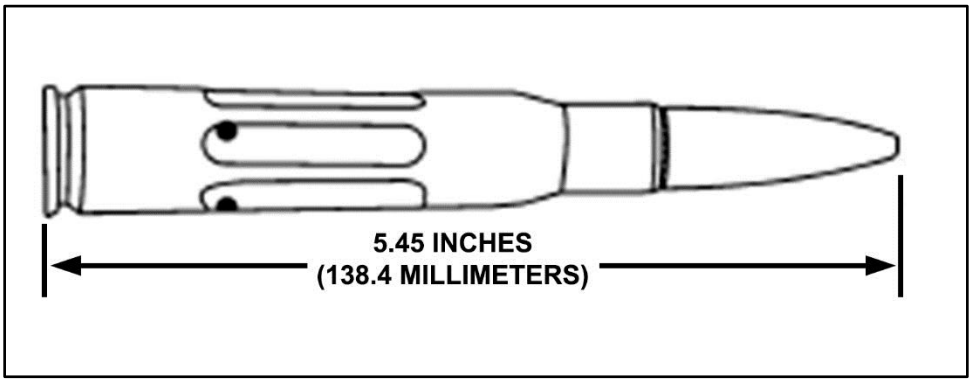


Figure A-11. Dummy cartridge

COLORS, MARKINGS, AND SYMBOLS

A-22. Small arms ammunition is identifiable by color coding specification per type and intended use. Table A-2 identifies the color code specifications that are applied to the tip of .50 caliber ammunition.

A-23. Markings stenciled or stamped on munitions or their containers include all information needed for complete identification.

A-24. Packaging and containers for small arms ammunition are clearly marked with standard NATO symbols identifying the contents of the package by type of ammunition, primary use, and packaging information. The most common NATO symbols are described according to standardization agreements (known as STANAGs) (see table A-1).

A-25. Small arms ammunition (less than 20 mm) is not color-coded under MIL-STD-709D. Marking standards for small arms ammunition are outlined in the following publications, which describe the color coding system for small arms projectiles. The bullet tips are painted a distinctive color as a ready means of identification for the user. Table A-1 describes the general color codes for all types of caliber .50 small arms ammunition. These publications describe the color coding system for small arms projectiles. The bullet tips are painted a distinctive color as a ready means of identification for the user. (See TM 9-1305-201-20&P.) Table A-1 describes the general color codes for all types of .50 caliber small arms ammunition:

Table A-1. Small arms color codes and package marking

Ammunition Type	Ammunition Color Coding	Package Marking
Ball	No Color	
Armor Piercing	Amber or Red Sabot	
Armor Piercing Incendiary	Silver Tip	
Armor Piercing Incendiary	Green Tip with Aluminum Color Annulus	
Armor Piercing Incendiary with Tracer	Silver with Red Tip	
Armor Piercing Incendiary with Dim Tracer	Lavender Tip with Gray Annulus	
Tracer	Red or Brown Tip	
Dummy	Perforated Cartridge	None
Blank	Crimped or Capped End	

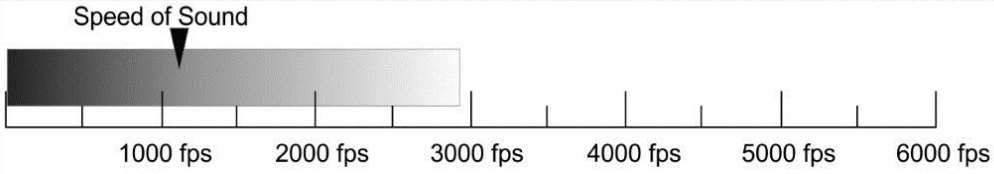
CALIBER .50 AMMUNITION

A-26. Tables A-2 through A-12, pages A-8 through A-18, show specifications for the eleven most commonly used caliber .50 training and combat rounds. Some have more than one Department of Defense identification code (known as DODIC). All are provided for ease of resourcing.

Table A-2. Caliber .50, M33, ball

DODIC	A552	A557	
Model:	M33		
Type:	Ball		
Weight:	1762 grain		
Length:	138.4 mm	5.449 in	
Color Code:		Bronze Tip	
Markings:			
Case			
Type:	Center Fire	**Description:**	.50 Caliber
Propellant			
Type:	WC 860	Double Base	Nitrocellulose,
Weight:	235 gr	0.54 oz	Nitroglycerine
Primer			
Type:	Center Fire, Percussion		
Bullet			
Type:	Ball, lead free slug (or core)		
Design:	Copper full metal jacket boattail with mild steel core.		
Weight:	660 gr	1.51 oz	
Length:	58.7 mm	2.311 in	
Tracer:	none		
Characteristics			
Chamber Pressure:	3792 bars	55,000 psi	
Velocity:	887 mps	2910 fps	2.59 mach
Kinetic Energy (Ek)	16,824 J	12,412 ft lb f	

Velocity to Speed of Sound



Special Features

The cartridge is used primarily for training. It can also be used to defeat enemy personnel, equipment, and light armored targets.

Legend

Ek	Kinetic energy	mm	millimeter
fps	feet per second	mod	model
ft lb f	foot pound force	mps	meters per second
gr	grains(s)	oz	ounce(s)
in	inch(es)	psi	pounds per square inch
J	Joules		

Table A-3. Caliber .50, M17, tracer

DODIC	A571	A557
Model:	M17	
Type:	Ball	
Weight:	1732 grain	
Length:	138.4 mm	5.449 in
Color Code:		Red or brown tip
Markings:		

Case			
Type:	Center Fire	**Description:**	.50 Caliber

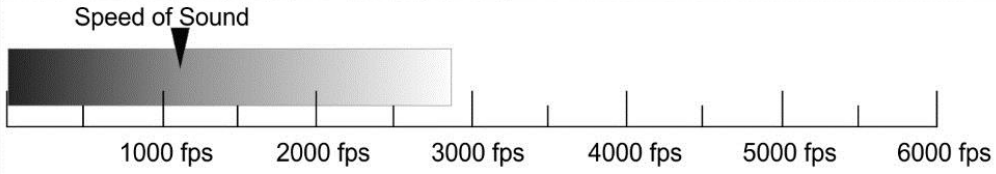
Propellant			
Type:	IMR 5010	Double Base	Nitrocellulose,
Weight:	225 gr	0.51 oz	Nitroglycerine

Primer	
Type:	Center Fire, Percussion

Bullet		
Type:	Tracer	
Design:	Lead alloy core in copper alloy jacket with incendiary compound fill in a hollow base.	
Weight:	618 gr	1.41 oz
Length:	61 mm	2.402 in
Tracer:	R256	

Characteristics			
Chamber Pressure:	3723 bars	54,000 psi	
Velocity:	872 mps	2860 fps	2.54 mach
Kinetic Energy (Ek)	15,225 J	11,226 ft lb f	

Velocity to Speed of Sound



Special Features

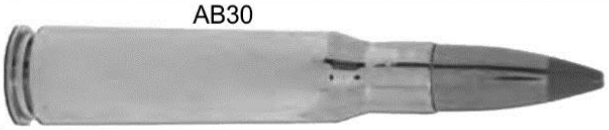
The cartridge tracer permits visual observation of the bullet's in-flight path or trajectory from 91 to 1460 meters. The cartridge is used primarily for training. It can also be used to defeat enemy personnel, equipment, and light armored targets.

Legend

Ek	Kinetic energy	mm	millimeter
fps	feet per second	mod	model
ft lb f	foot pound force	mps	meters per second
gr	grains(s)	oz	ounce(s)
in	inch(es)	psi	pounds per square inch
J	Joules		

Table A-4. Caliber .50, M8, API

DODIC	A531	AB30	
Model:	M8		
Type:	API		
Weight:	1764 grain		
Length:	138.4 mm	5.449 in	
Color Code:		**Silver Tip**	
Markings:			



Case			
Type:	Center Fire	**Description:**	.50 Caliber

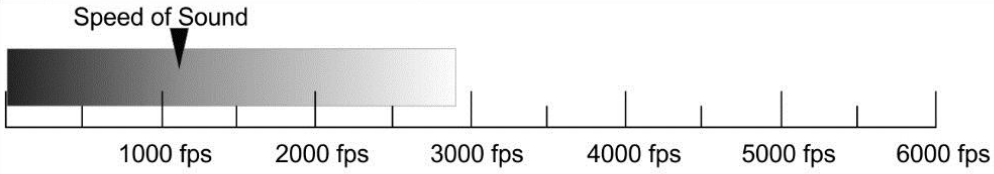
Propellant			
Type:	WC 860	Double Base	Nitrocellulose,
Weight:	233 gr	0.53 oz	Nitroglycerine

Primer	
Type:	Center Fire, Percussion

Bullet			
Type:	Armor-piercing incendiary (API)		
Design:	Manganese molybdenum steel core, an incendiary point filler composition, and a lead antimony base seal.		
Weight:	622.5 gr	1.42 oz	
Length:	58.7 mm	2.311 in	
Tracer:	none		

Characteristics			
Chamber Pressure:	4068 bars	59,000 psi	
Velocity:	887 mps	2910 fps	2.59 mach
Kinetic Energy (Ek)	15,868 J	11,707 ft lb f	

Velocity to Speed of Sound



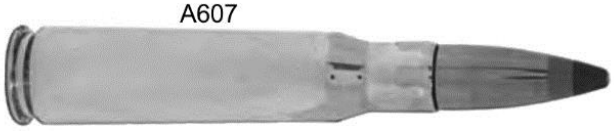
Special Features

It is used against flammable targets and light armored or unarmored targets, concrete shelters, and similar bullet-resistant targets. The cartridge perforates armor plate 2.2 centimeters thick at 91 meters (7/8th inch at 100 yards).

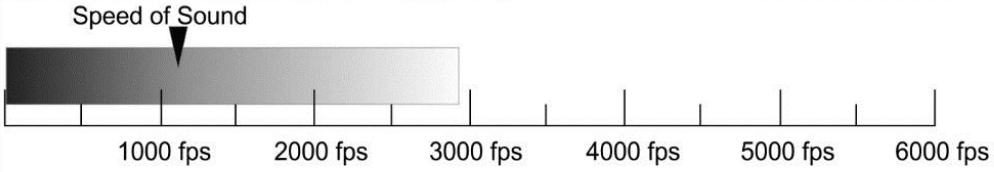
Legend

API	armor-piercing, incendiary	J	Joules
Ek	Kinetic energy	mm	millimeter
fps	feet per second	mod	model
ft lb f	foot pound force	mps	meters per second
gr	grains(s)	oz	ounce(s)
in	inch(es)	psi	pounds per square inch

Table A-5. Caliber .50, M20, API-T

DODIC	A542	A607	
Model:	M20		
Type:	API-T		
Weight:	1718 grain	5.449 in	
Length:	138.4 mm		
Color Code:	Red tip with silver annulus		
Markings:			
Case			
Type:	Center Fire	**Description:**	.50 Caliber
Propellant			
Type:	IMR 5010	Double Base	Nitrocellulose,
Weight:	230 gr	0.53 oz	Nitroglycerine
Primer			
Type:	Center Fire, Percussion		
Bullet			
Type:	Armor-piercing, incendiary with tracer (API-T)		
Design:	Maganese molybdenum steel core, a point filler of incendiary composition, and a lead antimony base seal.		
Weight:	619 gr	1.41 oz	
Length:	58.7 mm	2.311 in	
Tracer:	R256		
Characteristics			
Chamber Pressure:	3792 bars	55,000 psi	
Velocity:	887 mps	2910 fps	2.59 mach
Kinetic Energy (Ek)	15,779 J	11,641 ft lb f	

Velocity to Speed of Sound



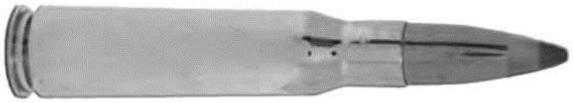
Special Features

The cartridge is used against flammable targets and light armored or unarmored targets. The cartridge perforates armor plate 2.2 centimeters thick at 91 meters (7/8 inch at 100 yards). The tracer permits visual observation of the bullet's in-flight path with a visible trace of 91 to 1460 meters (100 to 1600 yards).

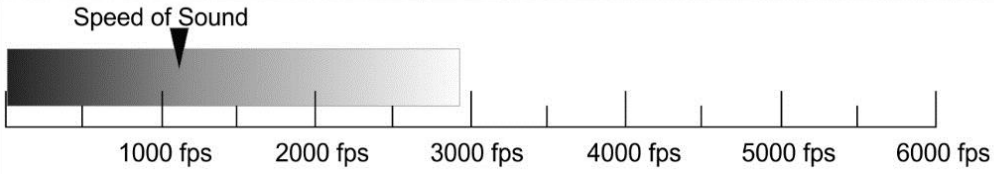
Legend

API	armor-piercing, incendiary	J	Joules
Ek	Kinetic energy	mm	millimeter
fps	feet per second	mod	model
ft lb f	foot pound force	mps	meters per second
gr	grains(s)	oz	ounce(s)
in	inch(es)	psi	pounds per square inch

Table A-6. MK 211 MOD 0, API

DODIC	A608	A607	A606
Model:	MK211 Mod 0		
Type:	API		
Weight:	1765 grain		
Length:	138.4 mm	5.449 in	
Color Code:	Green bullet tip with aluminum color annulus		
Markings:			
Case			
Type:	Center Fire	**Description:**	.50 Caliber
Propellant			
Type:	WC 860 MR 5010	Double Base	Nitrocellulose,
Weight:	233 gr	0.53 oz	Nitroglycerine
Primer			
Type:	Center Fire, Percussion		
Bullet			
Type:	Armor-piercing, incendiary (API)		
Design:	Projectile consists of a brass jacket surrounding a steel body and tungsten core with incendiary and high-explosive charges.		
Weight:	671 gr	1.53 oz	
Length:	58.6486 mm	2.309 in	
Tracer:	none		
Characteristics			
Chamber Pressure:	3792 bars	55,000 psi	
Velocity:	886.968 mps	2910 fps	2.59 mach
Kinetic Energy (Ek)	17,104 J	12,619 ft lb f	

Velocity to Speed of Sound



Special Features

The cartridge provides improved penetration performance against enemy personnel and light armored targets. The MK211 can perforate armor plate 2.2 centimeters thick at 91 meters.

Legend

API	armor-piercing, incendiary	J	Joules
Ek	Kinetic energy	mm	millimeter
fps	feet per second	mod	model
ft lb f	foot pound force	mps	meters per second
gr	grains(s)	oz	ounce(s)
in	inch(es)	psi	pounds per square inch

Table A-7. Caliber .50, MK 257, API-DT

DODIC	AA42	AA50	AB30
Model:	MK257		
Type:	API-DT		
Weight:	870 grain		
Length:	138.4 mm		
Color Code:	Lavender tip and gray annulus		
Markings:			

Case			
Type:	Center Fire	**Description:**	.50 Caliber

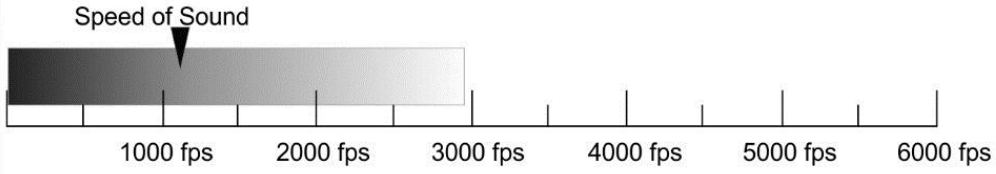
Propellant			
Type:	WC 857	Double Base	Nitrocellulose,
Weight:	230 gr	0.53 oz	Nitroglycerine

Primer	
Type:	Center Fire, Percussion

Bullet			
Type:	Armor-piercing, incendiary-dim tracer (API-DT)		
Design:	Copper jacket, incendiary, and dim tracer composition.		
Weight:	619 gr	1.41 oz	
Length:	56.896 mm	2.24 in	
Tracer:	R 440		

Characteristics			
Chamber Pressure:	4482 bars	65,000 psi	
Velocity:	887 mps	2910 fps	2.59 mach
Kinetic Energy (Ek)	15,779 J	11,641 ft lb f	

Velocity to Speed of Sound



Special Features

The cartridge combines the functions of the armor-piercing and incendiary bullets. It is used against light armored or unarmored targets, concrete shelters, and similar bullet-resistant targets. It will perforate armor plate 2.2 centimeters thick at 91 meters. This cartridge has a dim tracer, which reduces the potential of weapon location during night fire, and is only visible with the use of night vision devices. The tracer is visible between 91 and 1460 meters.

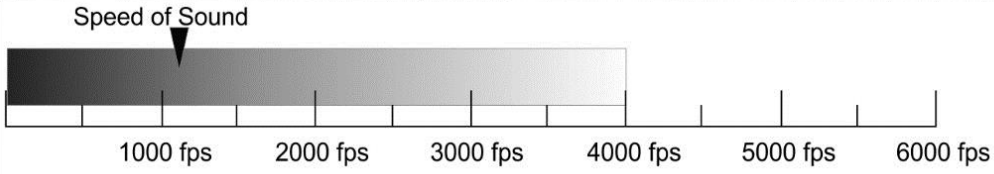
Legend

Ek	Kinetic energy	mm	millimeter
fps	feet per second	mod	model
ft lb f	foot pound force	mps	meters per second
gr	grains(s)	oz	ounce(s)
in	inch(es)	psi	pounds per square inch
J	Joules	SLAP-T	saboted light armor penetrator-tracer

Table A-8. Caliber .50, M903, SLAP

DODIC	A518	A519	
Model:	M903		
Type:	SLAP		
Weight:	1466 grain	5.449 in	
Length:	138.4 mm		
Color Code:	Amber sabot		
Markings:			
Case			
Type:	Center Fire	**Description:**	.50 Caliber
Propellant			
Type:	IMR 5010	Double Base	Nitrocellulose,
Weight:	275 gr	0.63 oz	Nitroglycerine
Primer			
Type:	Center Fire, Percussion		
Bullet			
Type:	Saboted light armor penetrator (SLAP)		
Design:	Saboted tungsten alloy penetrator.		
Weight:	355 gr	0.81 oz	
Length:	45.9232 mm	1.808 in	
Tracer:	none		
Characteristics			
Chamber Pressure:	3792 bars	55,000 psi	
Velocity:	1219 mps	4000 fps	3.56 mach
Kinetic Energy (Ek)	17,092 J	12,614 ft lb f	

Velocity to Speed of Sound



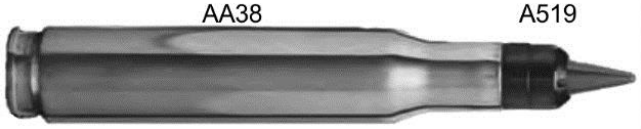
Special Features

The tungsten alloy penetrator is sabot launched at a much higher velocity than standard rounds. The sabot releases the projectile on exiting the muzzle.

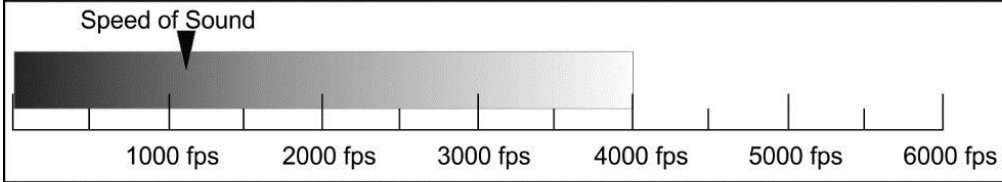
Legend

E_k	Kinetic energy	mm	millimeter
fps	feet per second	mod	model
ft lb f	foot pound force	mps	meters per second
gr	grains(s)	oz	ounce(s)
in	inch(es)	psi	pounds per square inch
J	Joules	SLAP	saboted light armor penetrator

Table A-9. Caliber .50, M962 SLAP-T

DODIC	A518	AA38	A519
Model:	M962		
Type:	SLAP-T		
Weight:	1466 grain	5.449 in	
Length:	138.4 mm		
Color Code:	Red sabot		
Markings:			
Case			
Type:	Center Fire	**Description:**	.50 Caliber
Propellant			
Type:	WC 856	Double Base	Nitrocellulose,
Weight:	282 gr	0.64 oz	Nitroglycerine
Primer			
Type:	Center Fire, Percussion		
Bullet			
Type:	Saboted light armor penetrator-tracer (SLAP-T)		
Design:	Saboted tungsten alloy penetrator.		
Weight:	350 gr	0.8 oz	
Length:	49.3776 mm	1.944 in	
Tracer:	R543		
Characteristics			
Chamber Pressure:	3792 bars	55,000 psi	
Velocity:	1219 mps	4000 fps	3.56 mach
Kinetic Energy (Ek)	16,851 J	12,437 ft lb f	

Velocity to Speed of Sound



Special Features

The tungsten alloy penetrator is sabot launched at a much higher velocity than standard rounds. The sabot releases the projectile on exiting the muzzle. The cartridge tracer permits visual observation of the bullet's in-flight path or trajectory to the point of impact or tracer burn-out.

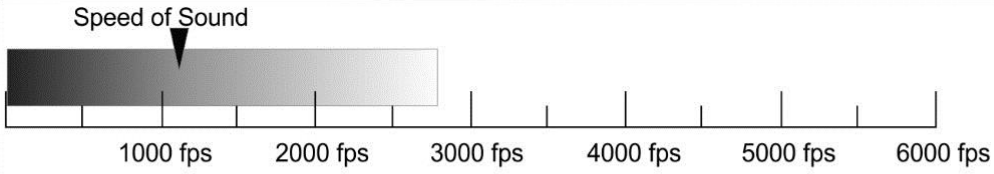
Legend

Ek	Kinetic energy	mm	millimeter
fps	feet per second	mod	model
ft lb f	foot pound force	mps	meters per second
gr	grains(s)	oz	ounce(s)
in	inch(es)	psi	pounds per square inch
J	Joules	SLAP-T	saboted light armor penetrator-tracer

Table A-10. Caliber .50, M858, SRTA

DODIC	A603	A602	
Model:	M858		
Type:	SRTA		
Weight:	460 grain	5.2 in	
Length:	132.08 mm		
Color Code:	Blue bullet and case		
Markings:			
Case			
Type:	Center Fire	**Description:**	.50 Caliber
Propellant			
Type:	10B101	Double Base	Nitrocellulose,
Weight:	49 gr	0.11 oz	Nitroglycerine
Primer			
Type:	Center Fire, Percussion		
Bullet			
Type:	Ball, plastic practice		
Design:	High-density polyethylene plastic.		
Weight:	52.47 gr	0.12 oz	
Length:	32.26 mm	1.27 in	
Tracer:	none		
Characteristics			
Chamber Pressure:	1182 bars	26,100 psi	
Velocity:	850 mps	2790 fps	2.48 mach
Kinetic Energy (Ek)	1228 J	907 ft lb f	

Velocity to Speed of Sound



Special Features

The cartridge is used for scaled range training purposes. The cartridge is identified by the blue bullet and case, which are molded into one piece of high-density polyethylene plastic. It has a maximum range of 700 meters. The M858 is used with the M3 recoil amplifier.

Legend

Ek	Kinetic energy	mm	millimeter
fps	feet per second	mod	model
ft lb f	foot pound force	mps	meters per second
gr	grains(s)	oz	ounce(s)
in	inch(es)	psi	pounds per square inch
J	Joules	SRTA	short range training ammunition

Table A-11. Caliber .50, M860, SRTA

DODIC	A595
Model:	M860
Type:	SRTA
Weight:	460 grain
Length:	132.08 mm
Color Code:	Red bullet tip and blue bullet and case
Markings:	

Case

Type:	Center Fire	**Description:**	.50 Caliber

Propellant

Type:	10B101	Double Base	Nitrocellulose,
Weight:	49 gr	0.11 oz	Nitroglycerine

Primer

Type:	Center Fire, Percussion

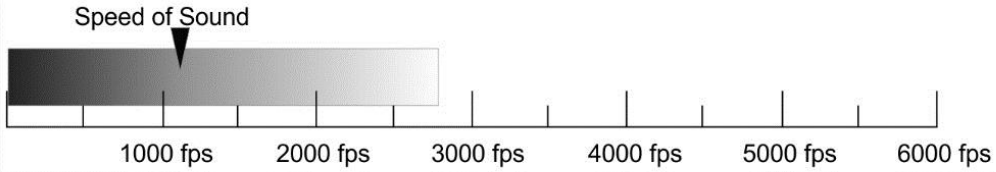
Bullet

Type:	Tracer, plastic practice	
Design:	High-density polyethylene plastic.	
Weight:	66.3591 gr	0.15 oz
Length:	32.26 mm	1.27 in
Tracer:	DAG9591254/4	

Characteristics

Chamber Pressure:	1800 bars	26,100 psi	
Velocity:	850 mps	2790 fps	2.48 mach
Kinetic Energy (Ek)	1553 J	1147 ft lb f	

Velocity to Speed of Sound



Special Features

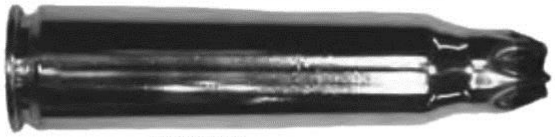
The cartridge tracer is used for scaled range training. It permits visual observation of the bullet's in-flight path or trajectory to the point of impact. The cartridge is used with the M858 plastic practice ball cartridge. The maximum range is 700 meters. The trace is visual from 20 to 150 meters. It is used with the M3 recoil amplifier.

Legend

Ek	Kinetic energy	mm	millimeter
fps	feet per second	mod	model
ft lb f	foot pound force	mps	meters per second
gr	grains(s)	oz	ounce(s)
in	inch(es)	psi	pounds per square inch
J	Joules	SRTA	short range training ammunition

Table A-12. Caliber .50, M1A1, blank

DODIC	A559		
Model:	M1A1		
Type:	Blank		
Weight:	915 grain		
Length:	99.3 mm		
Color Code:	Rosette crimp at the mouth		
Markings:			



Case			
Type:	Center Fire	**Description:**	.50 Caliber

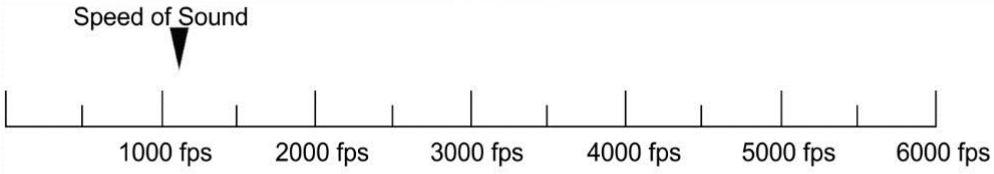
Propellant			
Type:	Dupont Hi Skor 700X	Double Base	Nitrocellulose, Nitroglycerine
Weight:	42 gr	0.1 oz	

Primer	
Type:	Center Fire, Percussion

Bullet		
Type:	Blank	
Design:	This cartridge does not contain a bullet.	
Weight:	NA	
Length:	NA	0
Tracer:	NA	

Characteristics			
Chamber Pressure:	0 bars	psi	
Velocity:	0 mps	fps	0 mach
Kinetic Energy (Ek)	0 J	0 ft lb f	

Velocity to Speed of Sound



Special Features

The cartridge simulates firing in training exercises. The cartridge is identified by the absence of a bullet. Unlike the M1, the M1A1 has a rosette crimp at the mouth. The M1A1 cartridge is used with the M19 blank ammunition firing attachment.

Legend

Ek	Kinetic energy	mm	millimeter
fps	feet per second	mod	model
ft lb f	foot pound force	NA	not applicable
gr	grains(s)	oz	ounce(s)
in	inch(es)	psi	pounds per square inch
J	Joules		

Appendix B
Ballistics

Ballistics is the science of the processes that occur from the time a firearm is fired to the time when the bullet impacts its target. Soldiers must be familiar with the principles of ballistics as they are critical in understanding how the projectiles function, perform during flight, and the actions of the bullet when it strikes the intended target. The profession of arms requires Soldiers to understand their weapons, how they operate, their functioning, and their employment.

BALLISTIC CATEGORIES

B-1. The flight path of a bullet includes three stages: the travel down the barrel, the path through the air to the target, and the actions the bullet takes upon impact with the target. These stages are defined in separate categories of ballistics; internal, external, and terminal ballistics.

INTERNAL BALLISTICS

B-2. This is the study of the propulsion of a projectile. Internal ballistics begin from the time the firing pin strikes the primer to the time the bullet leaves the muzzle. Once the primer is struck, the priming charge ignites the propellant. The expanding gases caused by the burning propellant create pressures that push the bullet down the barrel. The bullet engages the lands and grooves (rifling) imparting a spin on the bullet that facilitates stabilization of the projectile during flight. Internal ballistics ends at shot exit, where the bullet leaves the muzzle.

B-3. Several key terms are used when discussing the physical actions of internal ballistics, which are listed below:

- Bore. The interior portion of the barrel forward of the chamber.
- Chamber. The part of the barrel that accepts the ammunition for firing.
- Grain. A unit of measurement of either a bullet or a projectile. A pound contains 7000 grains, and an ounce contains 437.5 grains.
- Pressure. The force developed by the expanding gasses generated by the combustion (burning) of the propellant. Pressure is measured in pounds per square inch (psi).
- Shoulder. The area of the chamber that contains the shoulder, which forces the cartridge and projectile into the entrance of the bore at the throat of the barrel.
- Muzzle. The end of the barrel.
- Throat. The entrance to the barrel from the chamber, where the projectile is introduced to the lands and grooves in the barrel.

EXTERNAL BALLISTICS

B-4. This is the study of the physical actions and effects of gravity, drag, and wind along the projectile's flight to the target. It includes only those general physical actions that cause the greatest change to the flight of a projectile (see figure B-1, page B-2). External ballistics begins at shot exit and continues through the moment the projectile strikes the target.

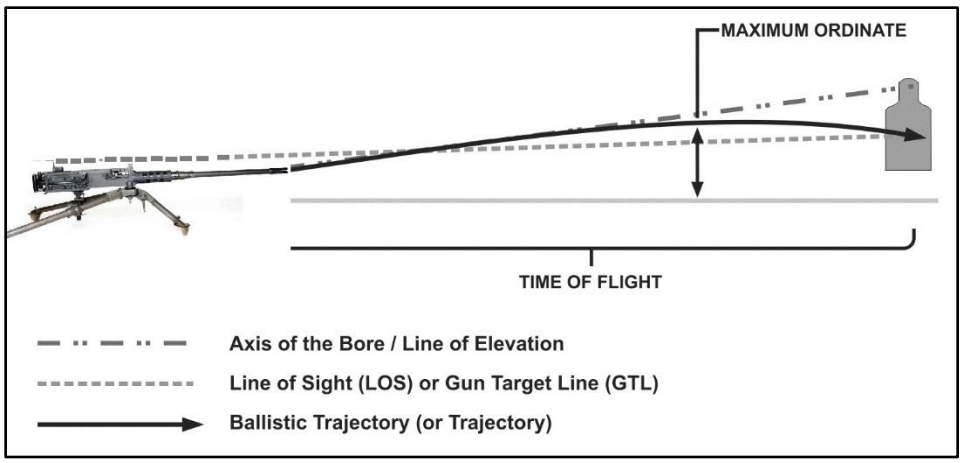


Figure B-1. External ballistic terms

B-5. The following terms and definitions are used to describe the actions or reactions of the projectile during flight. This terminology is standard when dealing with any weapon or weapon system, regardless of caliber:

- Axis of the bore (line of bore). The line passing through the center of the bore or barrel.
- Line of sight (LOS) or gun-target line. A straight line between the sights or optics and the target. This is never the same as the axis of the bore. The LOS is what the Soldier sees through the sights and can be shown by drawing an imaginary line from the gunner's eye through the rear and front sights out to infinity. The LOS is synonymous with the gun-target line when viewing the relationship of the sights to a target.
- Line of elevation. The angle represented from the ground to the axis of the bore.
- Ballistic trajectory. The path of a projectile when influenced only by external forces, such as gravity and atmospheric friction.
- Maximum ordinate. The maximum height the projectile will travel above the line of sight on its path to the point of impact.
- Time of flight. The time taken for a specific projectile to reach a given distance after firing.
- Jump. Vertical jump in an upward and rearward direction caused by recoil. Typically, it is the angle, measured in mils, between the line of departure and the line of elevation.
- Line of departure. The line the projectile is on at shot exit.
- Muzzle. The end of the barrel.
- Muzzle velocity or velocity. The velocity of the projectile measured at shot exit. Muzzle velocity decreases over time due to air resistance. For small arms ammunition, velocity (V) is represented in feet per second (f/s).
- Twist rate. The rotation of the projectile within the barrel of a rifled weapon based on the distance to complete one revolution. The twist rate relates to the ability to gyroscopically spin-stabilize a projectile on rifled barrels, improving its aerodynamic stability and accuracy. The twist rate of the M2-series weapon is a right hand, one revolution in every 15 inches of barrel length (or R 1:15 inches).
- Shot exit. The moment the projectile clears the muzzle of the barrel, where the bullet is not supported by the barrel.
- Oscillation. The movement of the projectile in a circular pattern around its axis during flight.
- Drift. The lateral movement of a projectile during its flight caused by its rotation or spin.
- Yaw. A deviation from stable flight by oscillation. This can be caused by crosswind or destabilization when the projectile enters or exits a transonic stage.
- Grain (gr). A unit of measurement of either a bullet or a propellant charge. There are 7000 grains in a pound, or 437.5 grains per ounce.

- Pressure. The force developed by the expanding gases generated by the combustion (burning) of the propellant. For small arms, pressure is measured in pounds per square inch (psi).
- Gravity. The constant pressure of the earth on a projectile at a rate of about 9.8 meters per second squared, regardless of the projectile's weight, shape or velocity. Commonly referred to as bullet drop, gravity causes the projectile to drop from the line of departure. Soldiers must understand the effects of gravity on the projectile when zeroing as well as how it applies to determining the appropriate hold-off at ranges beyond the zero distance, unless the gunner accurately determines the range to target and applies the range to the rear leaf sight.
- Drag (air resistance). The friction that slows the projectile down while moving through the air. Drag begins immediately upon the projectile exiting the barrel (shot exit). It slows the projectile's velocity over time, and is most pronounced at extended ranges. Each round has a ballistic coefficient that is a measurement of the projectile's ability to minimize the effects of air resistance (drag) during flight.
- Trajectory. The path of flight that the projectile takes upon shot exit over time. For the purposes of this manual, the trajectory ends at the point of impact.
- Wind. The factor with the greatest variable effect on ballistic trajectories. The effects of wind on a projectile are most noticeable in three key areas between half and two-thirds the distance to the target:
  - Time (T) – the amount of time the projectile is exposed to the wind along the trajectory. The greater the range to target, the greater time the projectile is exposed to the wind's effects.
  - Direction – the direction of the wind in relation to the axis of the bore. This determines the direction of drift of the projectile that should be compensated.
  - Velocity (V*)* – the speed of the wind during the projectile's trajectory to the target. Variables in the overall wind velocity affecting a change to the ballistic trajectory include sustained rate of the wind and gust spikes in velocity.

TERMINAL BALLISTICS

B-6. Terminal ballistics is the science of the actions of a projectile from the time it strikes an object until it comes to rest (called terminal rest). This includes the terminal effects that take place against the target.

- Kinetic energy. A unit of measurement of the delivered force of a projectile. Kinetic energy is the delivered energy that a projectile possesses due to its mass and velocity at the time of impact. Kinetic energy is directly related to the penetration capability of a projectile against the target.
- Penetration. The ability or act of a projectile to enter a target's mass based on its delivered kinetic energy. When a projectile strikes a target, the level of penetration into the target is termed the impact depth. The impact depth is the distance from the point of impact to the moment the projectile stops at its terminal resting place. Ultimately, the projectile stops when it has transferred its momentum to an equal mass of the medium (or arresting medium).

B-7. Against any target, penetration is the most important terminal ballistic consideration. Soldiers must be aware of the penetration capabilities of their ammunition against their target, and the most probable results of the terminal ballistics.

FIRING TABLES

B-8. Firing tables are booklets of ammunition firing data recorded from multiple firing occasions in controlled environments. Sophisticated devices are used to detect, identify, and record the path of a particular ammunition after it has been fired. The aerodynamic, meteorological, and physical characteristics, and the time of flight data are employed as inputs to computing ballistic coefficient or to produce final values for each ammunition found within the firing table. Firing tables are extremely useful for tactical planning and during live fire training.

B-9. Tabular firing tables consist of four different tables (listed below). Each table offers information pertaining to specific areas. Because a gunner is not expected to have the equipment necessary to detect and measure nonstandard conditions, ammunition temperature, or air density, only table A, Basic Data, will be discussed. For specific ballistic data, reference the ammunition type's appropriate tabular firing table. Firing

tables can be obtained by submitting an application to the U.S. Army Armament Research, Development, and Engineering Center (ARDEC).

- Table A, Basic Data. A compilation of the basic data required for the tank fire control solution.
- Table B, Effect on Range. Range effects due to nonstandard conditions of muzzle velocity, range wind and air density.
- Table C, Effect on Muzzle Velocity Due to a Change in Ammunition Temperature. The change in muzzle velocity produced by variations in ammunition temperature.
- Table D, Effects on Air Density Due to a Change in Altitude. Standard air density for the altitude of the firing unit.

B-10. Ballistic information. Firing table ballistic information is listed in columns. Table A for the M8 armor piercing incendiary ammunition has 11 columns, numbered 1-11 in order from left to right. Each column is described below.

- Column 1, Range. The distance measured from the gun muzzle to a target at the level point under standard conditions.
- Column 2, Superelev. The gun angle in the vertical plane above the line of sight required to reach the range listed in column 1. The super elevation is equal to the quadrant elevation when the height of the gun and the target are the same.
- Column 3, DR/DSE. The adjustment in range for a one-mil change in the angle of superelevation listed in column 2.
- Column 4, DH/DR. Change in the height of the trajectory corresponding to an increase of 100 meters to the range listed in column 1, with the appropriate change in the angle of superelevation.
- Column 5, Drift. When projectiles are spun for stabilization purposes by gun tubes with right handed twist of rifling, the drift of the projectile is to the right of the vertical plane of fire. Drift is the angular displacement a projectile will incur when it is spun. Gun tubes whose rifling has a right twist cause projectiles to drift right of the vertical plane of fire.
- Column 6, Time of Flight. The projectile travel time, under standard conditions, from the muzzle to the level point at the range listed in column 1.
- Column 7, 10 kph CW DEFL. The effect of wind deflection due to a 10 kilometer per hour crosswind.
- Column 8, Max Ord. The maximum height of the trajectory above the gun muzzle, fired under standard conditions, to the range in column 1.
- Column 9, Rg to Max Ord. The distance in the horizontal plane measured from the gun muzzle to the point perpendicular to the maximum ordinate listed in column 8.
- Column 10, Angle of Fall. The least angle measured clockwise from the horizontal to a line tangent to the trajectory at the level point.
- Column 11, Remaining Velocity. The speed of the projectile at the level point.

DETERMINE DISTANCE TO AND HEIGHT OF MAX ORDINATE

B-11. When searching for information pertaining to questions regarding ballistics contained in a firing table, the minimum information must be known: ammunition, range, and column. For example, height and range to the maximum ordinate when firing at a range of 500 meters. The Soldier must select the firing table based upon the type of ammunition. Second the Soldier uses column 1 to find the correct range to target. Finally the Soldier would use the information corresponding to information located in columns 8 and 9 in order to find the information, and this depicts the max ordinate of M8 ammunition when firing at 500 meters (see figure B-2).

1	2	3	4	5	6	7	8	9	10	11
RANGE	SUPER-ELEV	DR/DSE	DH/DR	DRIFT	TIME OF FLIGHT	10 KPH CW DEFL	MAX ORD	RANGE TO MAX ORD	ANGLE OF FALL	REMAINING VELOCITY
m	mils	m/mils	m/100m	mils	sec	mils	m	m	mils	m/s
0	0.00	152	0.0	0.0	0.00	0.0	0.0	0	0	899
100	0.64	142	0.1	0.0	0.11	0.1	0.0	51	1	850
200	1.33	132	0.1	0.0	0.24	0.2	0.1	103	1	803
300	2.08	123	0.2	0.0	0.36	0.3	0.2	156	2	758
400	2.89	113	0.3	0.1	0.50	0.4	0.3	210	3	714
500	3.77	105	0.4	0.1	0.64	0.5	0.5	265	5	762

LEGEND

CW – crosswind; defl – deflection; DH– change in height; DR – change in range; DSE – change in superelevation; elev – elevation; KPH – kilometers per hour; m – meter(s); m/s – meters per second; max – maximum; ord – ordinate; sec – second(s)

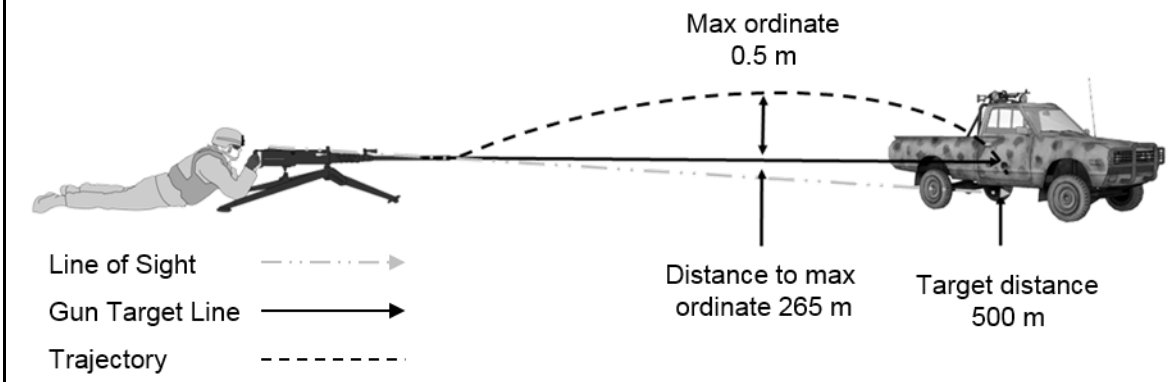


Figure B-2. Firing table data with max ordinate, example

DETERMINE EFFECT OF CROSSWIND

B-12. Firing tables are useful when determining the effects a crosswind has on a bullet. Crosswind is measured in kilometers per hour (abbreviated kph) and the deflection is measured in mils. The firing tables base wind measurement is 10 kph. To determine deflection measurements for other crosswind speeds simply multiply the number listed in column 7 by a number relative to a different wind speed. If using miles per hour to measure wind a conversion is necessary. To convert miles per hour to convert to miles per hour to kilometers per hour multiply by 1.6. To convert the deflection from mils to meters use the mil relation formula to determine distance in meters. For example, in a 20 kph crosswind, the Soldier must multiply the number in column 7 by 2. Figure B-3, page B-6, shows how this wind would affect the effects of a 20 kph crosswind when the weapon is fired at a target 1000 meters away.

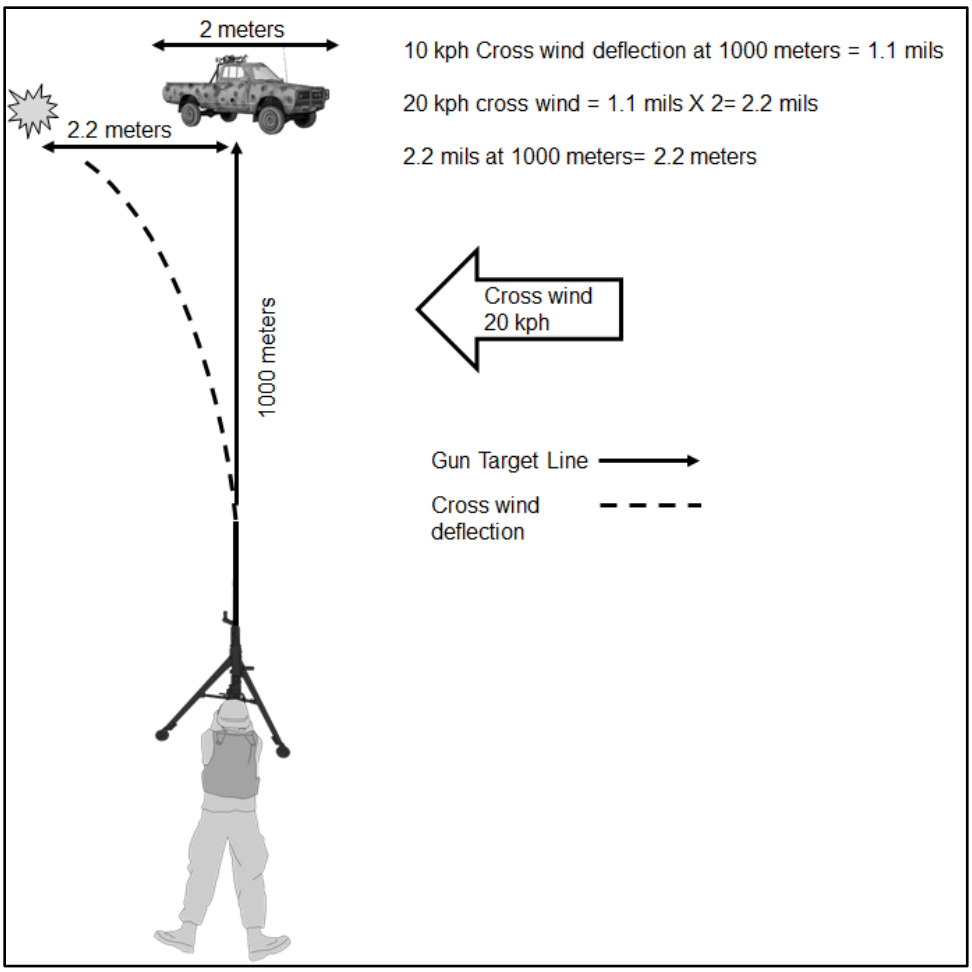


Figure B-3. Crosswind example

DETERMINE CHANGE IN RANGE FOR A CHANGE IN SUPER ELEVATION

B-13. Tabular firing tables can be used to determine a change in range for a change in super elevation. Data listed in column 3 represent the change in range of a projectile after a one mil change in super elevation has been applied. Range increases as more superelevation is applied to the weapon system. This information is extremely useful and important for gunners and leaders to understand. By studying information in column 3, leaders can adjust a gunner's fire by simply having a Soldier add one mil of super elevation to the gun using the T&E. Additionally, understanding this column will help gunners and leaders understand the limitations of the weapon, ammunition, and equipment in terms of plunging fire.

Example. An initial burst was fired using M8 API at 1000 meters and the rounds landed short of a target located at 1068 meters. By adding one mil of superelevation the next burst impacts the target (see figure B-4).

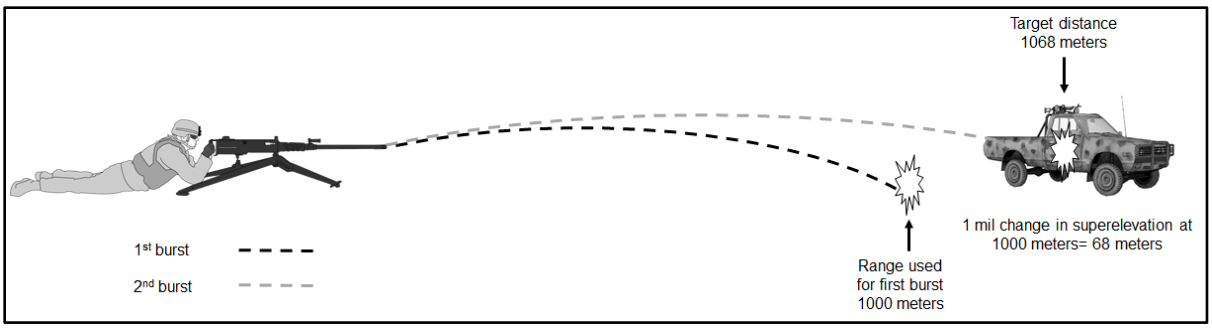


Figure B-4. Change in range example

ACTIONS AFTER THE TRIGGER PRESS

B-14. As the trigger is pressed down, it pivots on the trigger pin, so that the trigger cam on the inside of the backplate engages and raises the rear end of the trigger lever. This pivots on the trigger lever pin assembly, causing the front end of the trigger lever to press down on the top of the sear stud. The sear is forced down until the hooked notch of the firing pin extension is disengaged from the sear notch. The firing pin spring drives the firing pin and firing pin extension forward. Then, the striker of the firing pin hits the primer of the cartridge. Once the trigger is pressed, the ballistic actions begin. Although not all ammunition and weapons operate in the same manner, the list below describes the general events that occur on the M2-series weapons when the trigger is pressed.

- The primer is crushed, pushing the primer composition through the paper disk, and on to the anvil, detonating the primer composition.
- The burning primer composition is focused evenly through the primer cup vent hole, igniting the propellant.
- The propellant burns evenly within the cartridge case.
- The cartridge case wall expands from the pressure of the burning propellant, firmly locking the case to the chamber walls.
- The expanded cartridge case, held firmly in place by the chamber walls and the face of the bolt provide rear obturation, keeping the burning propellant and created expanding gasses in front of the cartridge case.
- The projectile is forced by the expanding gasses firmly into the lands and grooves at the throat of the bore, causing engraving.
- Engraving causes the scoring of the softer outer jacket of the projectile with the lands and grooves of the bore. This allows the projectile to spin at the twist rate of the lands and grooves, and provides a forward obturation seal. The forward obturation keeps the expanding gasses behind the projectile in order to push it down the length of the barrel.
- As the propellant continues to burn, the gasses created continue to seek the path of least resistance. As the cartridge case is firmly seated and the projectile is moveable, the gas continues to exert its force on the projectile.
- As the end of the projectile leaves the muzzle, it is no longer supported by the barrel itself. Shot exits.
- Upon shot exit, most of the expanding and burning gasses move outward and around the projectile, causing the muzzle flash.
- At shot exit, the projectile achieves its maximum muzzle velocity. From shot exit until the projectile impacts an object, the projectile loses velocity at a steady rate due to air resistance.
- As the round travels along its trajectory, the bullet drops consistently by the effects of gravity.
- As the actual line of departure is an elevated angle from the line of sight, the projectile appears to rise and then descend. This rise and fall of the projectile is the trajectory.

- The round achieves the highest point of its trajectory typically over half way to the target, depending on the range to target. The high point is called the round's maximum ordinate or max ord.
- From the maximum ordinate, the projectile descends into the target.
- The round strikes the target at the point of impact, which, depending on the firing event, may or may not be the desired point of impact, and is seldom the point of aim.
- Once the projectile strikes a target or object, it delivers its kinetic energy (force) at the point of impact.

TERMINAL BALLISTICS BEGIN

B-15. Once terminal ballistics begin, no bullets follow the same path or function. Generally speaking, each projectile penetrates objects where the delivered energy (mass times velocity squared, divided by 2) is greater than the mass, density, and area of the target at the point of the delivered force. Other factors, such as the angle of attack, yaw, and oscillation, and other physical considerations are not included in this ballistic discussion.

$$\text{Delivered energy} = \frac{(\text{Mass} \times \text{Velocity})^2}{2}$$

MOMENTUM

B-16. Kinetic energy projectiles use momentum (high velocity plus mass) together to penetrate their target. Kinetic energy direct-fire projectiles include ball and tracer, armor-piercing, and armor-piercing incendiary rounds.

B-17. Armor-piercing and armor-piercing incendiary rounds penetrate armor plate and other types of homogeneous steel. Armor-piercing projectiles have a special jacket encasing a hard core or penetrating rod. They are highly accurate when fired at an angle very close to the perpendicular of the target. Incendiary projectiles are used principally to penetrate a target and ignite its contents. They are used effectively against fuel supplies and storage areas.

STRUCTURE PENETRATION

B-18. The .50 caliber round penetrates best at 800 meters. For hard targets, obliquity and range affect the penetration of the .50 caliber round. Both armor-piercing and ball ammunition penetrates 14 inches of sand or 28 inches of packed earth at 200 meters if the round impacts perpendicular to the target.

B-19. The M2A1 can be fired accurately from the tripod using the single-shot mode. This is the most efficient method for producing a loophole. Automatic fire in three- to five-round bursts in a U-shaped pattern is more effective in producing a breach.

B-20. The round can penetrate common urban barriers, except a 55-gallon drum filled with sand, a car engine block, or a sewer cover. Continued and concentrated fire can breach most urban walls, except for the reinforcing bars in concrete or dense natural stone walls. Ball ammunition and armor-piercing rounds produce almost the same results, but are more likely to ricochet to the sides and rearward back at the gunner (called spit back).

Note. Soldiers must wear the appropriate level of personal protective equipment when conducting tactical and collective tasks, particularly at ranges under 50 meters.

B-21. Table B-1 shows the type and level of thickness required to protect from ball, armor-piercing, and armor-piercing incendiary ammunition.

Table B-1. Level of thickness required for protection

	Concrete Thickness (Inches)	*Wythes of Nominal 4-Inch Thick Brick*	*Layers of Nominal 8 to 10-Inch Thick E-Glass, Ballistic Grade [3]*	*Layers of Nominal 8 to 10-Inch Thick Sandbags*	*8-Inch Thick Hollow CMU*	*8-Inch Thick Grout-Filled CMU*	*4-Inch Thick Brick/ 2-Inches of Air/ 8-Inch Hollow CMU*	*Sand and Steel Plates[4]*
.50 Cal M2 and M33 Ball	12 (100 M)	6 (100 M)	12 (Muzzle Velocity)	3 (100 M)	Fails (19 M)	Fails* (100 M)	Fails* (100 M)	—
.50 Cal AP M2 and API-T M20	18 (200 M)	—	14 (Muzzle Velocity)	3 (200 M)	Fails (19 M)	Fails* (200 M)	Fails* (200 M)	10 Inches of Sand + 0.8 Inches of Milled Steel

Notes.

Table adapted from Graphic Training Aid 90-01-011, *Joint Forward Operations Base (JFOB) Protection Handbook* (6th Edition), and revised with additional information provided by the United States Army Engineer Research and Development Center. Table data is based on single shots. Multiple shots in or near the same area may penetrate. A dash indicates no data.

1 All thicknesses are in inches. All ranges are in meters.

2 North Atlantic Treaty Organization small arms projectile.

3 National stock number 9340-01-533-3758.

4 Other sand-filled containers of equal thickness can be used. Data is for dry sand. For wet sand, use twice the indicated thickness.

**Inferred from other data.*

LEGEND

AP – armor piercing; API – armor-piercing incendiary; API-T – armor-piercing incendiary-tracer; Cal – caliber; CMU – concrete masonry unit; in – inch; m – meter; mm – millimeter

MISCELLANEOUS DATA

B-22. Table B-2 shows the maximum penetration in inches for an armor-piercing cartridge fired from the 45-inch barrel (muzzle velocity, 2935 feet per second), which in some cases may enhance the leader's selection of targets to engage.

Table B-2. Maximum penetration for armor-piercing cartridge

Material	*Inches at—*		
	200 meters	*600 meters*	*1,500 meters*
Armor plate (homogeneous)	1.0	.7	.3
Armor plate (face-hardened)	.9	.5	.2
Sand (100 pounds dry weight/cubic feet)	14.0	12.0	6.0
Clay (100 pounds dry weight/cubic feet)	28.0	27.0	21.0

B-23. Table B-3 shows the maximum penetration in inches for a ball cartridge fired from the 45-inch barrel (muzzle velocity, 2935 feet per second).

Table B-3. Maximum penetration for ball cartridge

Material	*Inches at—*		
	200 meters	*600 meters*	*1,500 meters*
Sand (100 pounds dry weight/cubic feet)	14.0	12.0	6.0
Clay (100 pounds dry weight/cubic feet)	28.0	27.0	21.0
Concrete	2.0	1.0	1.0

SOFT TISSUE PENETRATION

B-24. A gunshot wound, or ballistic trauma, is a form of physical damage sustained from the entry of a projectile. The degree of tissue disruption caused by a projectile is related to the size of the cavities created by the projectile as it passes through the target's tissue. When striking a personnel target, there are two types of cavities created by the projectile; permanent and temporary wound cavities.

Permanent Wound Cavity

B-25. The permanent cavity refers specifically to the physical hole left in the tissues of soft targets by the pass-through of a projectile. It is the total volume of tissue crushed or destroyed along the path of the projectile within the soft target.

B-26. Depending on the soft tissue composition and density, the tissues are either elastic or rigid. Elastic organs stretch when penetrated, leaving a smaller wound cavity. Organs that contain dense tissue, water, or blood are rigid, and can shatter from the force of the projectile. When a rigid organ shatters from a penetrating bullet, it causes massive blood loss within a larger permanent wound cavity. Although typically fatal, striking these organs may not immediately incapacitate the target.

Temporary Wound Cavity

B-27. The temporary wound cavity is an area that surrounds the permanent wound cavity. It is created by soft, elastic tissues as the projectile passes through the tissue at greater than 2000 feet per second. The tissue around the permanent cavity is propelled outward (stretched) in an almost explosive manner from the path of the bullet. This forms a temporary recess or cavity 10 to 12 times the bullet's diameter.

B-28. Tissue such as muscle, some organs, and blood vessels are very elastic and can be stretched by the temporary cavity with little or no damage and have a tendency to absorb the projectile's energy. The temporary cavity created will slowly reduce in size over time, although typically not returning completely to the original position or location.

Note. Projectiles that do not exceed 2000 feet per second velocity on impact provide insufficient force to cause a temporary cavity capable of incapacitating a threat.

B-29. The extent of the cavitation (the bullet's creation of the permanent and temporary cavities) is related to the characteristics of the projectile. Once inside the target, the projectile's purpose is to destroy soft tissues with fragmentation. The ball ammunition is designed to not flatten or expand on impact, which would decrease velocity and delivered energy:

- Kinetic energy. The delivered mass at a given velocity. Higher delivered kinetic energy produces greater penetration and tissue damage.
- Yaw. Any yaw at the point of impact increases the projectile's surface area that strikes the target, decreasing kinetic energy, but increasing the penetration and cavity size.

- Deformation. The physical changes of the projectile's original shape and design due to the impact of the target. This increases the projectile's surface area and the size of the cavity created after penetration.
- Fragmentation. The fracturing of a projectile into multiple pieces or sub-projectiles. The multiple paths of the fragmented sub-projectiles are unpredictable in size, velocity, and direction. The bullet jacket, and for some types of projectiles, the lead core, fracture creating small, jagged, sharp edged pieces that are propelled outward with the temporary cavity. Fragments can sever tissue, causing large, seemingly explosive-type damage. Bone fragments caused by the bullet's strike can have the same effect.
- Tumbling. The inadvertent end-over-end rotation of the projectile. As a projectile tumbles as it strikes the target, the bullet travels through the tissues with a larger diameter. This causes a more severe permanent cavity as it passes through the soft tissue. A tumbling projectile can change direction erratically within the body due to its velocity and tendency to strike dense material with a larger surface area.

Incapacitation

B-30. Incapacitation with direct fire is the act of ballistically depriving a target of the ability, strength, or capability to continue its tactical mission. To assist in achieving the highest probability of incapacitation with a single shot, the projectile is designed with the ability to tumble, ricochet, or fragment after impact.

B-31. The projectile or its fragments then must hit a vital, blood-bearing organ or the central nervous system to effectively incapacitate the threat. The projectile's limited fragmentation potential after entry maximizes the soft tissue damage and increases the potential for rapid incapacitation.

Lethal Zones

B-32. The Soldier's primary point of aim at any target by default is center base of visible mass. This allows for a tolerance that includes the greatest margin of error with the highest probability of a first round hit. Combat conditions may require more precise fires at partially exposed targets or targets that require immediate incapacitation.

B-33. Ideally, the point of aim is anywhere within a primary switch area. This point will maximize the possibility of striking major organs and vessels, rendering a clean, one-shot kill (see figure B-5, page B-12).

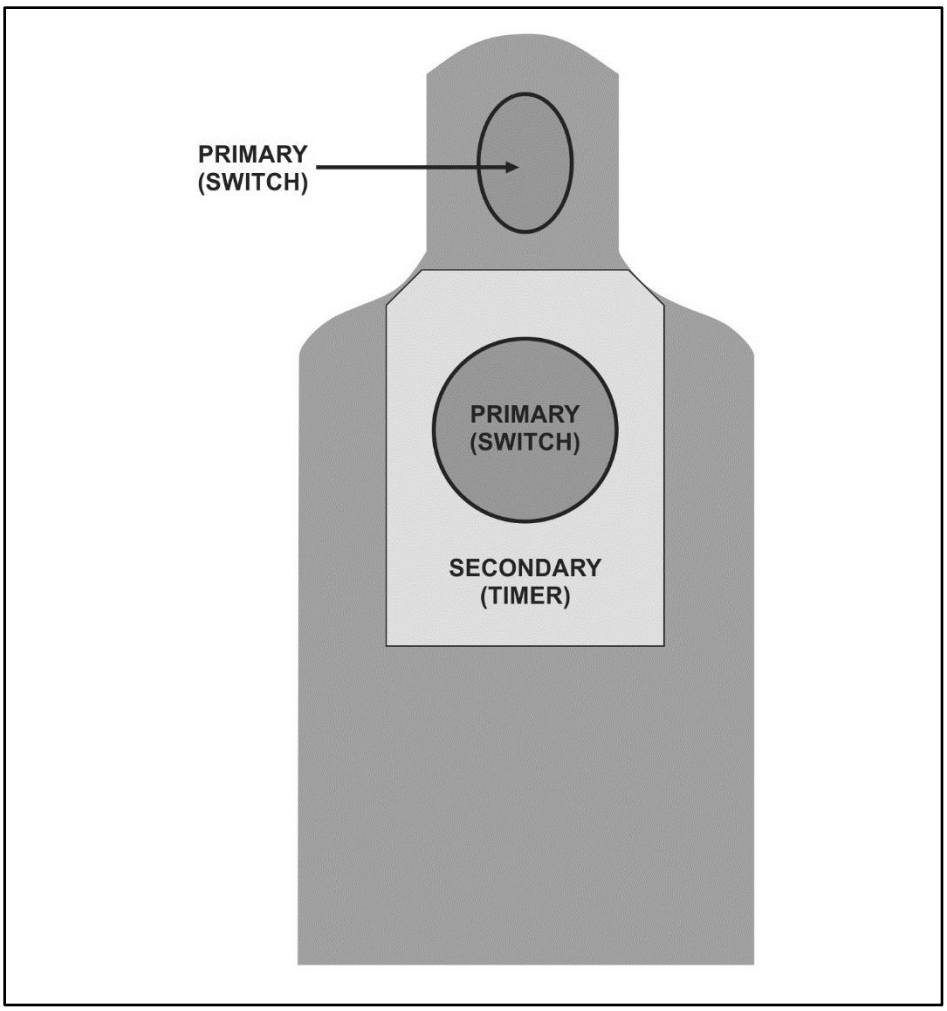


Figure B-5. Lethal zone

B-34. Shots to the head should be weighed with caution. The head is the most frequently moved body part and are the most difficult to hit with precision. Shots to other exposed body parts, such as the pelvic area, should be considered for the shot.

B-35. Shots to the pelvic area are used when the target is not completely visible or when the target is wearing body armor that prevents the Soldier from engaging the primary zone. This area is rich in large blood vessels and a shot here has a good possibility of impeding enemy movement by destroying the pelvic or hitting the lower spine.

- Circuitry shots (switches).
- Hydraulic shots (timers).

Circuitry Shots (Switches)

B-36. Circuitry shots, or switches, are strikes to a target that deliver its immediate incapacitation. Immediate incapacitation is the sudden physical or mental inability to initiate or complete any physical task. To accomplish this, the central nervous system must be destroyed by hitting the brain or spinal column. All bodily functions and voluntary actions cease when the brain is destroyed and if the spinal column is broken, all functions cease below the break.

Hydraulic Shots (Timer)

B-37. Hydraulic shots, or timers, are impacts on a target where immediate incapacitation is not guaranteed. These types of ballistic trauma are termed timers as that after the strike of the bullet, the damage caused requires time for the threat to have sufficient blood loss to render it incapacitated. Hydraulic shots, although ultimately lethal, allow for the threat to function in a reduced capacity for a period of time.

B-38. For hydraulic shots to eliminate the threat, they must cause a 40 percent loss of blood within the circulatory system. If the shots do not disrupt that flow at a rapid pace, the target will be able to continue its mission. Once two liters of blood are lost, the target will transition into hypovolemic shock and become incapacitated.

This page intentionally left blank.

Appendix C

Machine Gun Theory

Whether organic to the unit or attached, machine guns provide the heavy volume of close and continuous fire needed to achieve fire superiority. They are the Infantry platoon's most effective weapons against a dismounted enemy force. These formidable weapons can engage enemy targets beyond the capability of individual weapons with controlled and accurate fire. This appendix addresses the capabilities, limitations, and engagement techniques of fire common to machine guns.

COMBAT TECHNIQUES OF FIRE

C-1. Technique of fire is the method of delivering and controlling fire. Each member of the machine gun crew must be trained in standard methods of applying fire, either as a crewmember or a gunner, and must perform their assigned task automatically and effectively. The simplest and most effective technique of delivering fire with the machine gun mounted on its ground or vehicular mount is direct laying, aligning the sights of the gun on the target and firing. At times, techniques of fire other than direct laying are more appropriate and effective. When delivering overhead fire or fire from position defilade, the gunner must use the appropriate technique.

C-2. Before the machine gun can be employed to the best advantage using any firing technique, certain engagement techniques must be understood and applied. These include:

- Characteristics of fire.
- Classes of fire.
- Fire control.
- Target types and methods of engagement.
- Overhead fire.
- Methods of laying the gun.
- Firing from position defilade.
- Final protective fires.

CHARACTERISTICS OF FIRE

C-3. The gunner's knowledge of their machine gun is not complete until they learn something of the action and effect of the projectiles when fired. This section discusses various characteristics of machine gun fire, including trajectory, cone of fire, and the beaten zone.

TRAJECTORY

C-4. The trajectory is the curved path of the projectile in its flight from the muzzle of the weapon to its impact. The major factors that influence the trajectory are the velocity of the round, gravity, rotation of the round, and resistance of the air. The farther the round travels, the greater the curve of the trajectory. The highest point of the trajectory is called the maximum ordinate. This is a point about two-thirds of the distance from the gun to the target. The maximum ordinate increases as the range increases (see figure C-1, page C-2).

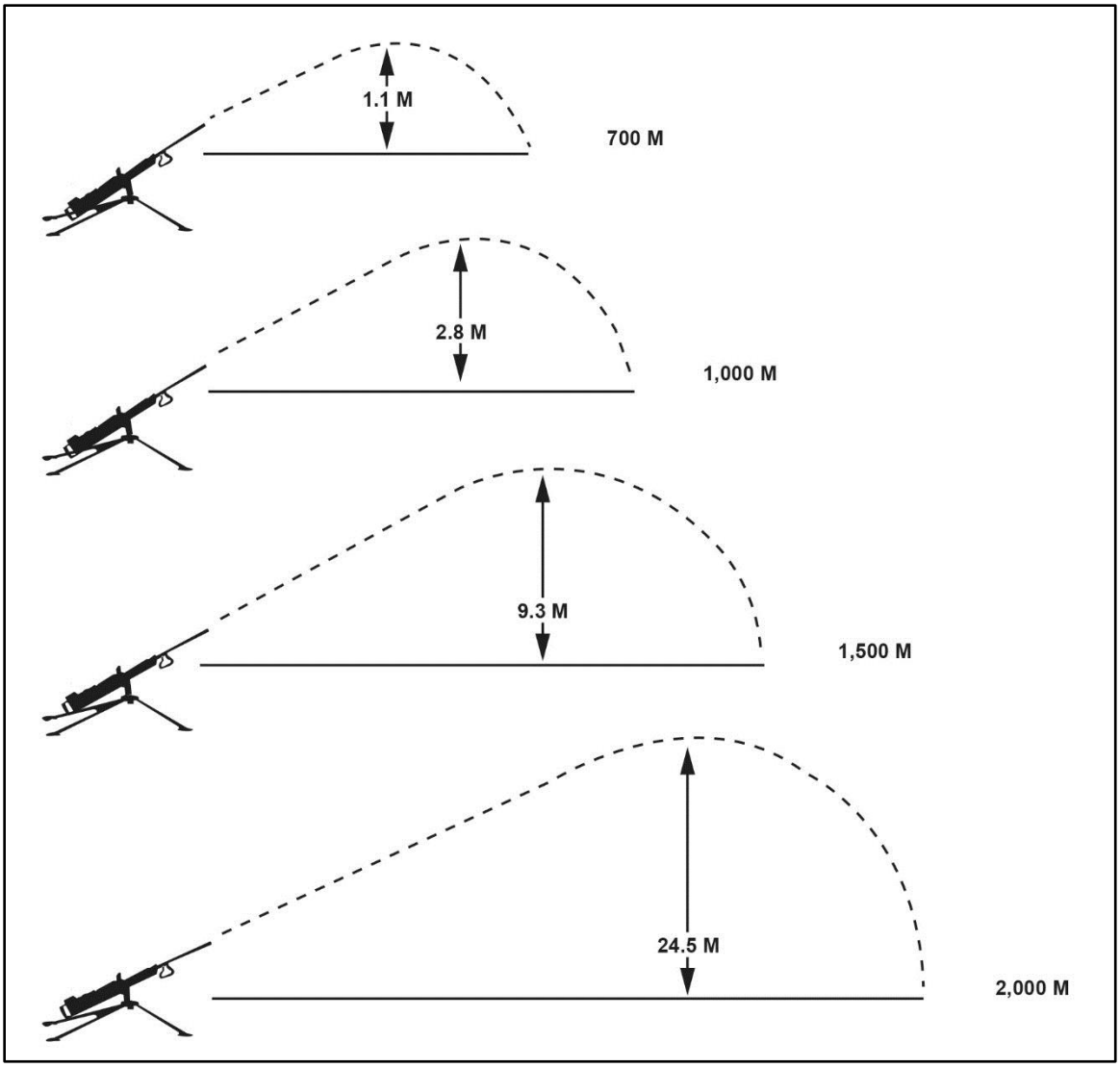


Figure C-1. Maximum ordinates at key ranges

CONE OF FIRE

C-5. When the weapon is fired automatically in bursts, the vibrations of the gun and mount, variations in ammunition, and atmospheric conditions cause the rounds to follow slightly different trajectories. This group of trajectories formed by a single burst is called the cone of fire (see figure C-2).

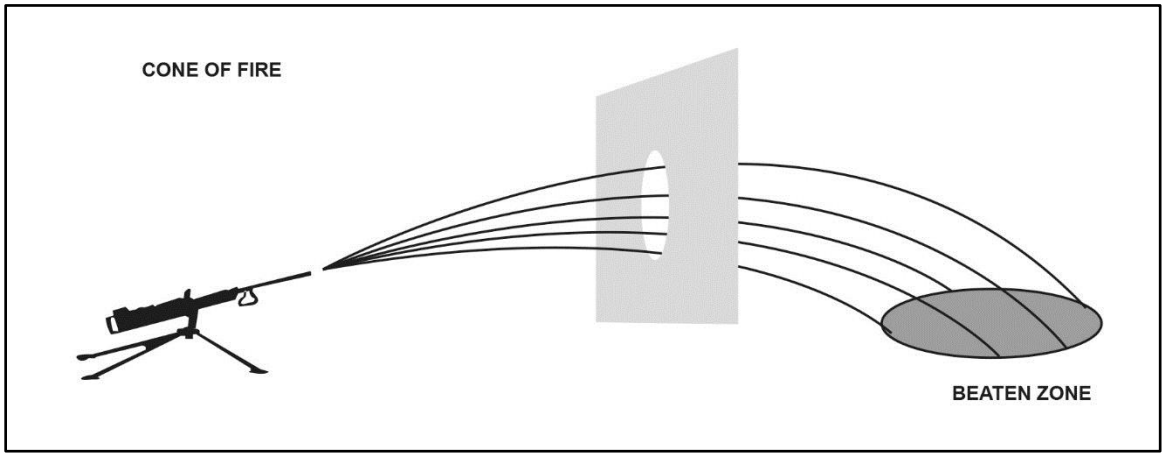


Figure C-2. Cone of fire

BEATEN ZONE

C-6. The beaten zone is an elliptical pattern formed by the cone of fire as it strikes the ground. The beaten zone varies in size due to several factors to include: the weapon, mount, tripod, atmospheric conditions, and stability.

- Effect of range. As the range to the target increases, the beaten zone becomes shorter and wider.
- Effect of terrain. The length of the beaten zone for any given range varies according to the slope of the ground. On rising ground, the beaten zone becomes shorter but remains the same width. On ground that slopes away from the gun, the beaten zone becomes longer but remains the same width.

CLASSES OF FIRE

C-7. Each of the classes of fire have unique uses and benefits. Knowing these enables the Soldier to choose which will work best in a situation. The three classes of fire are as follows:

- Respect to the ground.
- Respect to the target.
- Respect to the gun.

RESPECT TO THE GROUND

C-8. The class of fire with respect to the ground are plunging fire and grazing fire (see figure C-3). Machine gun fire is classified with respect to the ground, the target, and the gun. The classes of fire with respect to the ground are plunging fire and grazing fire.

- Plunging fire. With plunging fire, the angle of fall of the rounds (with reference to the slope of the ground) confines the danger space to the beaten zone, and the length of the beaten zone is materially shortened. Plunging fire is obtained when firing from high ground to low ground, when firing from low ground to high ground, and when firing at long ranges.
- Grazing fire. With grazing fire, the center of the cone of fire remains within 1 meter above the ground. When firing over level or uniformly sloping terrain, the maximum extent of grazing fire obtainable is about 700 meters.

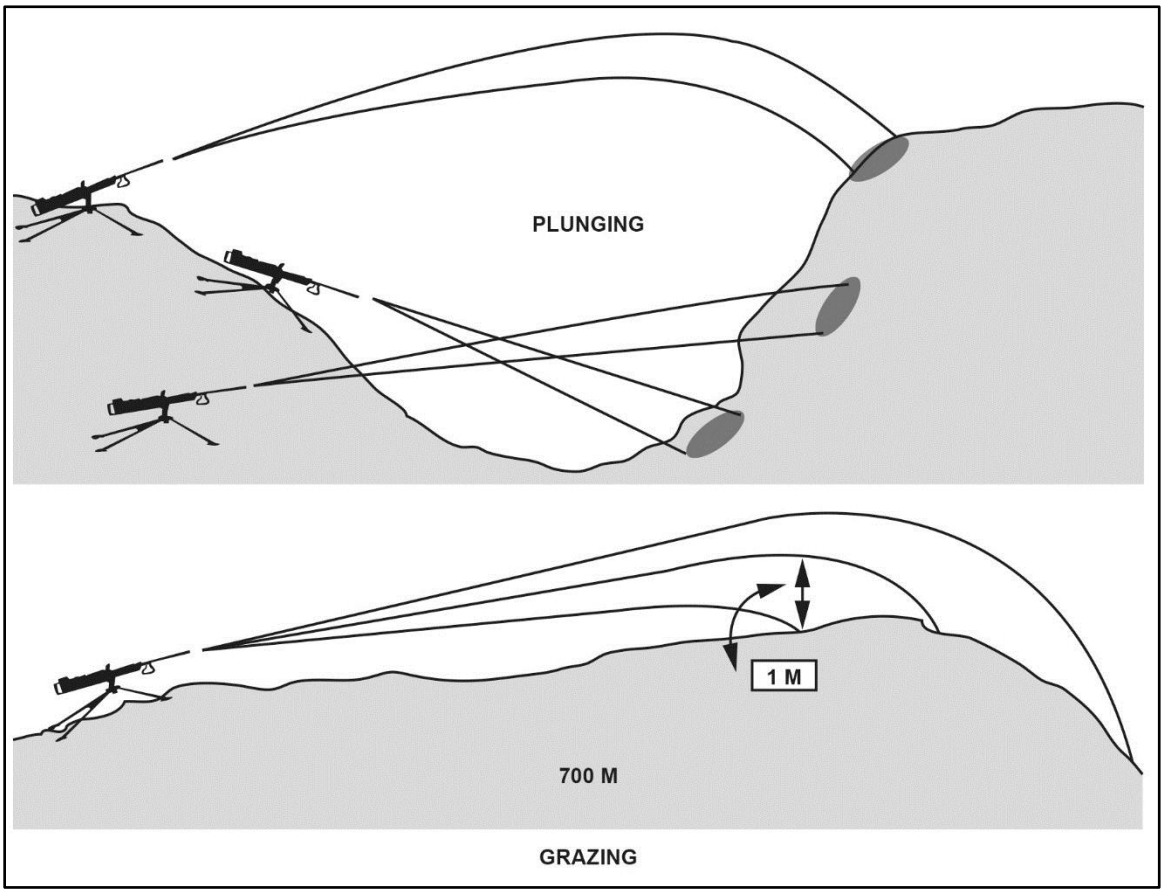


Figure C-3. Classes of fire with respect to the ground

RESPECT TO THE TARGET

C-9. Class of fire with respect to the target include frontal, flanking, oblique, and enfilade (figure C-4):

- Frontal. The long axis of the beaten zone is at a right angle to the long axis of the target.
- Flanking. This is delivered against the flank of a target.
- Oblique. The long axis of the beaten zone is at an angle (not a right angle) to the long axis of the target.
- Enfilade. The long axis of the beaten zone coincides or nearly coincides with the long axis of the target. This class of fire is either frontal or flanking. It is the most desirable class of fire with respect to the target because it makes maximum use of the beaten zone.

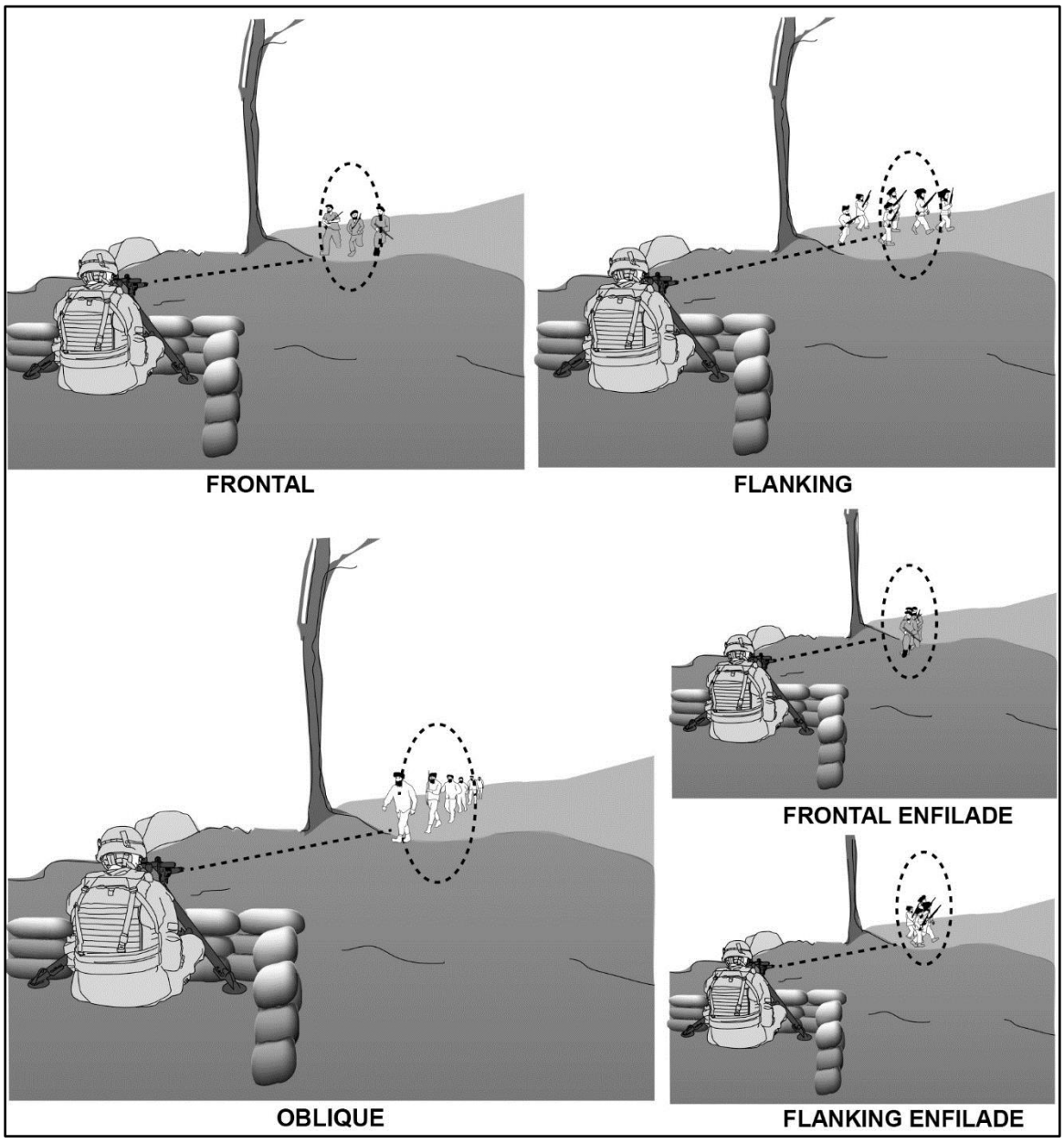


Figure C-4. Classes of fire with respect to the target

RESPECT TO GUN

C-10. Class of fire with respect to the gun include fixed, traversing, searching, traversing and searching, swinging, and free gun (see figure C-5).

- Fixed fire. Delivered on a point target with little or no manipulation needed. After the initial burst, the gunners will follow any change or movement of the target without command.
- Traversing fire. Distributed against a wide target requiring successive changes in the direction of the gun. When engaging a wide target requiring traversing fire, the gunner should select successive aiming points throughout the target area. These aiming points should be close enough together to ensure adequate target coverage; however, they need not be so close as to be wasteful of ammunition by concentrating a heavy volume of fire in a small area. Two clicks on the traversing handwheel after each burst ensure coverage (2 clicks = 2 mils = constant width of beaten zone).
- Searching fire. Delivered against a deep target or a target that has depth, requiring changes in elevation of the gun. The amount of elevation change depends upon the range and the slope of the ground.
- Traversing and searching fire. Delivered both in width and depth by changes in direction and elevation. It is employed against a target whose long axis is oblique to the direction of the fire.
- Swinging traverse. Employed against targets that require major changes in direction but little or no change in elevation. Targets may be dense, wide, in close formations moving slowly toward or away from the gun, or they may be vehicles or mounted troops moving across the front. The traversing slide lock lever is loosened enough to permit the gunner to swing the gun laterally.
- Free gun. Delivered against moving targets that must be rapidly engaged with fast changes in both direction and elevation. Examples are aerial targets, vehicles, mounted troops, or infantry in relatively close formations moving rapidly toward or away from the gun position. To fire free gun on the M3 tripod mount, remove the T&E mechanism from the receiver and traversing bar and put it down. When firing swinging traverse and free gun, the weapon is normally fired at the cyclic rate of fire, which is more than 450 rounds per minute. Free gun fire uses a lot of ammunition. It has no beaten zone, because each round seeks its own area of impact.

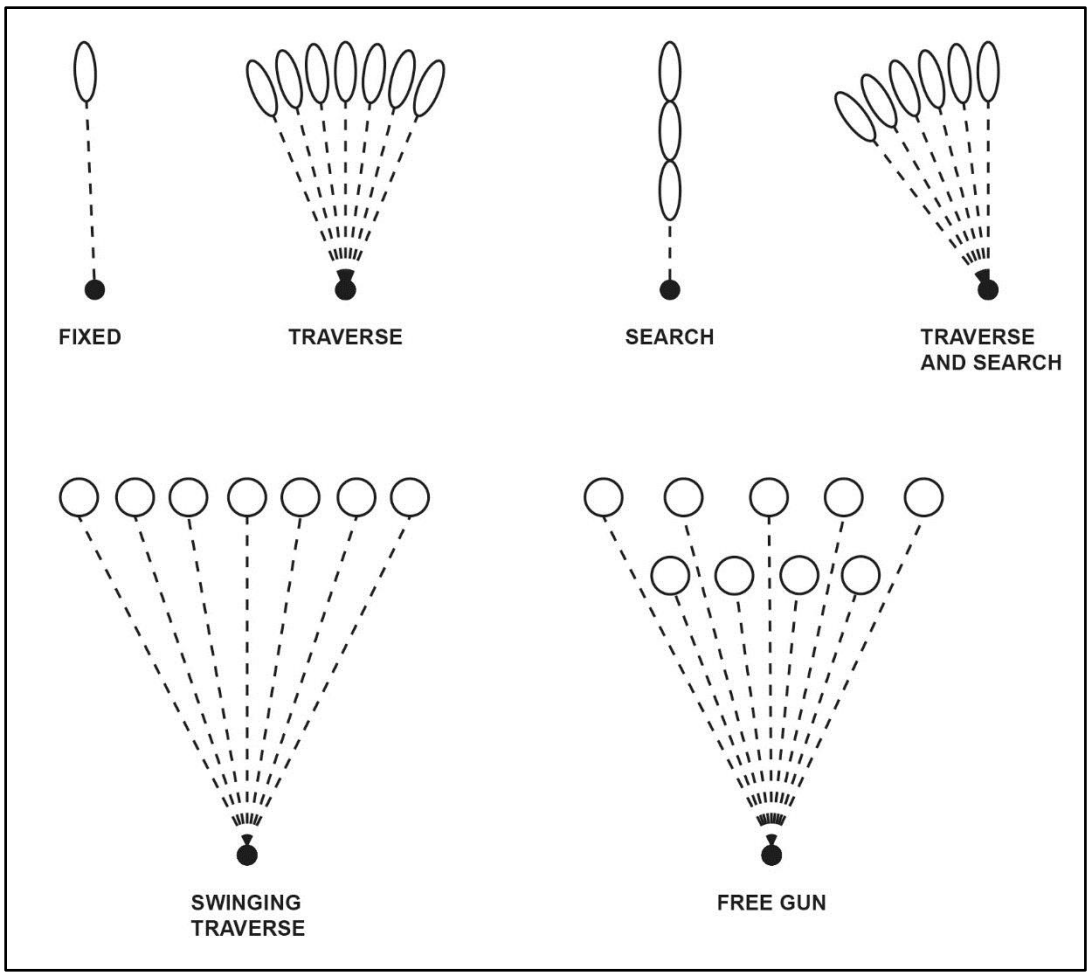


Figure C-5. Classes of fire with respect to the gun

FIRE CONTROL

C-11. Fire control of machine guns includes all operations connected with the preparation and actual application of effective fire on a target. It implies the ability of the leader to open fire at the instant they desire, to adjust the fire of the gun(s) on the target, to regulate the rate of fire, to shift from one target to another, and to cease firing. The ability to exercise proper fire control depends primarily on the discipline and the proper training of the crew. Failure to exercise fire control results in danger to friendly troops, loss of surprise, premature disclosure of positions, application of fire on unimportant targets, loss of time in adjusting fire, and waste of ammunition.

CONTROL METHODS

C-12. Of the several methods of controlling machine gun fire, the noise of battle will limit the use of some. Therefore, the leader must select the method or combination of methods that will best accomplish their purpose. The chain of fire control begins with the leader. The leader is responsible for both the technical and tactical employment of the gun and the training of the crew. The leader is responsible for passing on to the crewmembers all instructions and orders from their next higher leader regarding the situation and mission. The leader assigns sectors of fire and firing positions, designates targets to engage, adjusts fire, and ensures effective coverage of the targets.

- Oral. Oral control is effective unless the leader is too far away from the gun crew(s), or the noise of battle makes it impossible for the gun crew(s) to hear them.

- Hand and arm signals. Using hand and arm signals is an effective method when the gun crew(s) can see the leader. All crewmembers must understand the standard arm-and-hand signals used to control machine gun fire. (Refer to TC 3-21.60 *Visual Signals* for more information).
- Prearranged signals. Prearranged signals are either visual or sound signals such as pyrotechnics or blasts on a whistle. These signals should be included in the units' SOPs and must be clearly understood by all crewmembers.
- Personal contact. In many situations, the leader must move to individual crewmembers to issue orders. This method is used more than any other by small-unit leaders. The leader must use maximum cover and concealment to keep from disclosing the gun crew's position.
- Standing operating procedures. Standing operating procedures cover actions the gun crews perform without command because they were developed and practiced during the training. Their application eliminates many commands and simplifies the leader's job of fire control.

POINT TARGETS

C-13. Point targets are targets that require the use of a single aiming point. Enemy bunkers, weapon emplacements, vehicles, small groups of soldiers, and aerial targets, such as helicopters or descending paratroopers, are examples of point targets. A point target is engaged with fixed fire. If the target moves after the initial burst, the gun crew(s) keeps fire on the target by following its movement with the gun(s).

LINEAR TARGETS

C-14. Linear targets have sufficient width to require traversing fire and no more depth than can be effectively covered by the beaten zone. Linear targets are engaged with traversing fire. Targets presented to the machine gunners during combat consist, in most cases, of enemy soldiers in various formations. This requires distribution and concentration of fire. These targets have width and depth, and the application of machine gun fire is designed to completely cover the area in which the enemy is known or suspected to be. These targets may be easy to see or may be indistinct and difficult to locate.

C-15. When machine gun fire is under direct control of a leader, they designate the midpoint and flanks or ends of a target unless they are obvious to the gun crew(s). When a target other than a point target is engaged by two gunners, it is always divided. Each gunner applies their fire to that portion of the target corresponding to their position with relation to the other gun. Normally, each gunner engages one-half of the target; however, gunners must be prepared to engage the entire target if necessary. Gunners continue to fire on the target until it is neutralized or until another signal is received from the leader.

NUMBERED POSITIONS

C-16. The gunner's positions (including vehicle mounted) should be numbered so each gunner will know which portion of a target they should engage. It should be emphasized that the positions are numbered—not the guns or gunners. To ensure that gunners react quickly and properly when they detect a target or when a target is designated by the leader, standard methods of applying fire to the various type targets are taught. These methods are the same for ground and vehicular-mounted guns.

Two Guns, Normal Division

C-17. When the target is divided at the midpoint; the right gun engages the right half of the target, and the gun on the left engages the left half of the target. The point of initial lay and adjustment for both guns is at the midpoint of the target. After adjusting on the midpoint, the right gun traverses the right half of the target, to include one aiming point beyond the last visible target flank, and returns to the midpoint.

Two Guns, Special Division

C-18. If one portion of the target presents a greater threat than another, the target can be divided so fire is concentrated on that portion presenting the greatest threat. The special division of the target is accomplished by a subsequent fire command after firing begins. The gunners initially lay at the midpoint, regardless of the special division to be made, thus avoiding confusion.

One Gun

C-19. A single gunner must engage the entire width of a linear target. The point of the initial lay and adjustment is on the midpoint, or that portion of the target presenting the greatest threat. The gunner traverses to either flank and then covers the remainder of the target (see figure C-6).

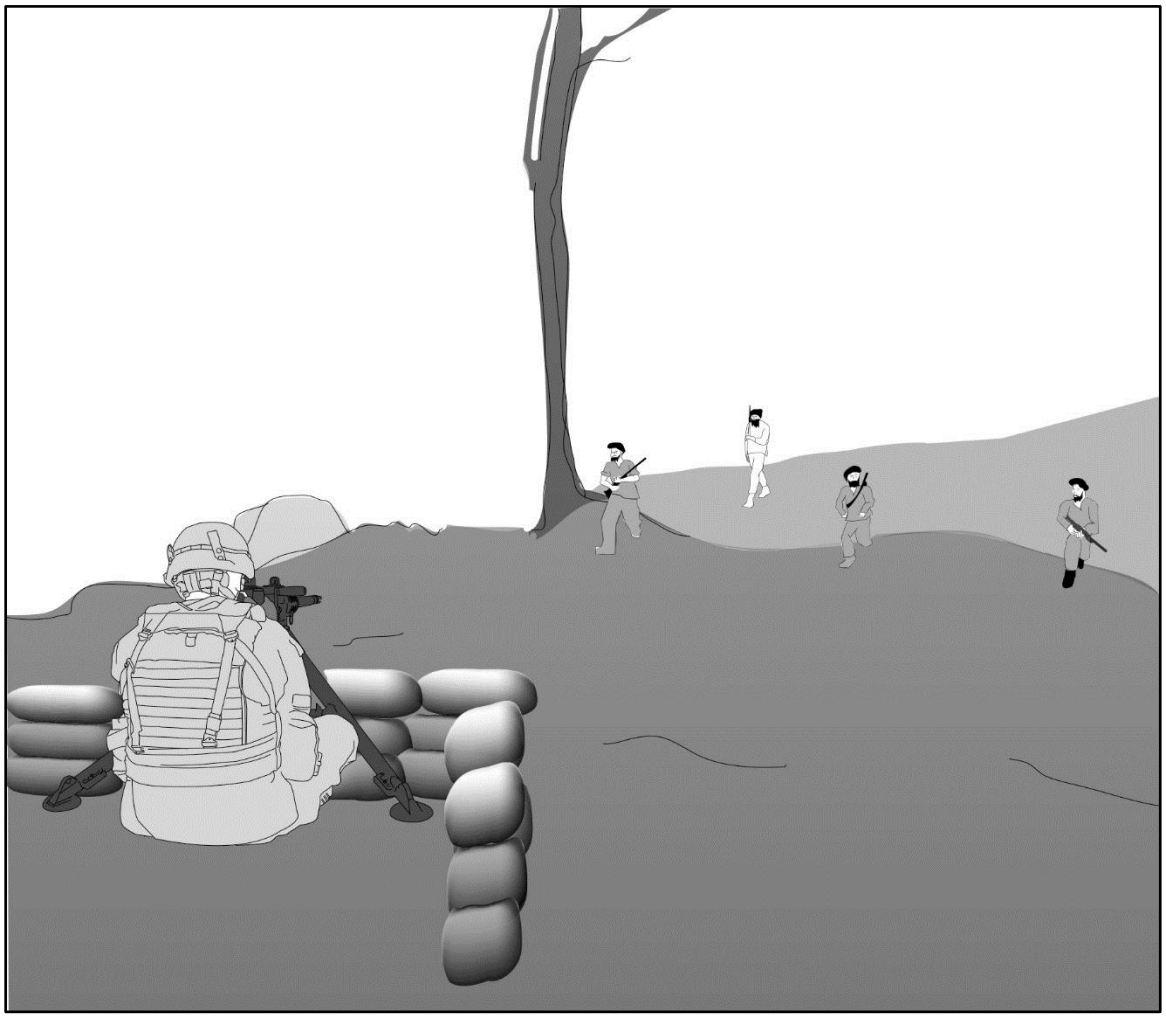


Figure C-6. Linear target and one gun

LINEAR TARGETS WITH DEPTH

C-20. Linear targets with depth are targets that have sufficient width to require traversing fire and depth that cannot be covered by the beaten zone. A combined change in direction and elevation (traversing and searching fire) is required to maintain effective fire on these targets (see figure C-7). When range is announced, the range to the midpoint is given.

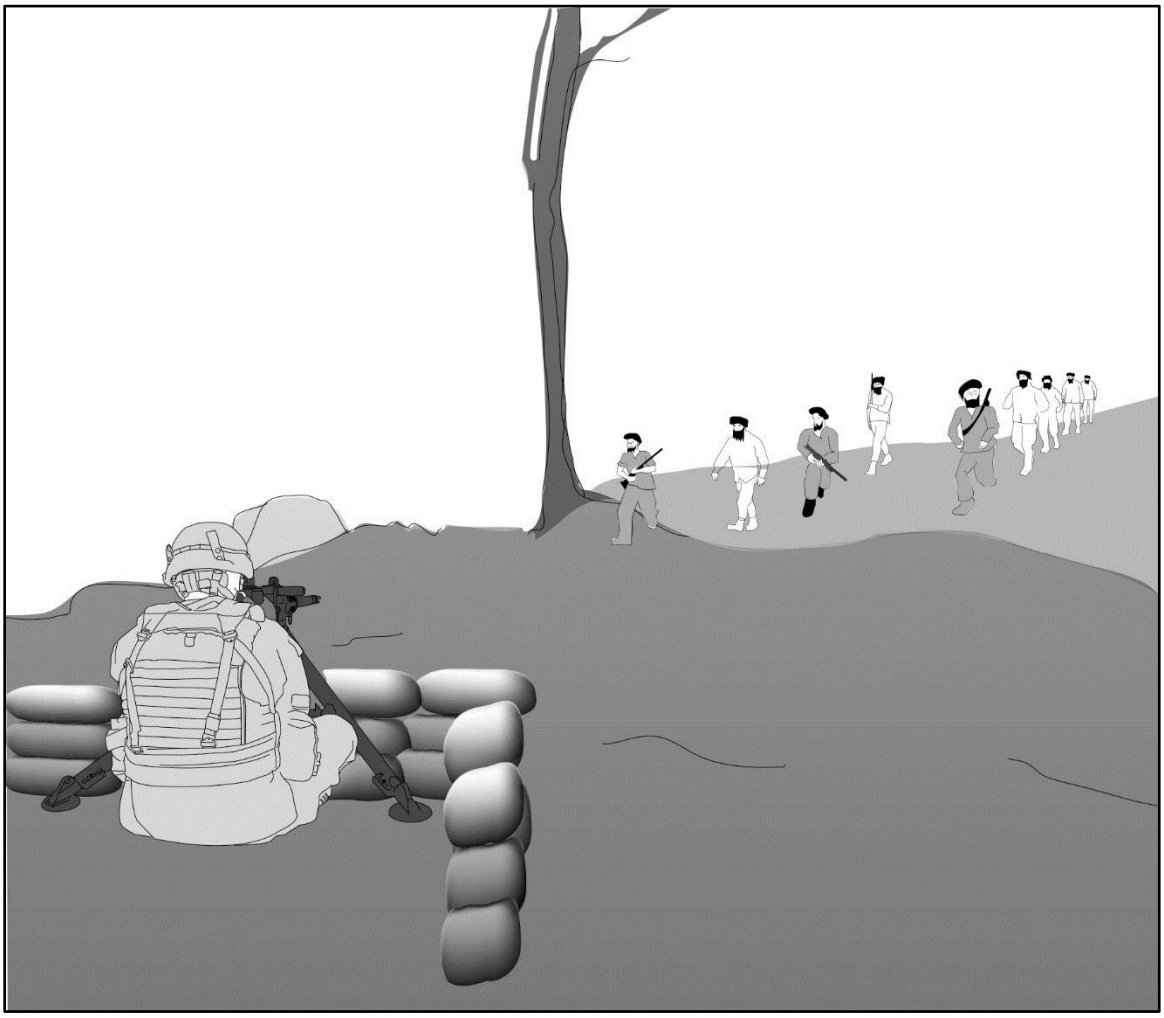


Figure C-7. Linear target with depth

Two Guns

C-21. The method of division, the point of initial lay and adjustment, and the extent of manipulation for both guns are the same as prescribed for linear targets. The gunners, however, apply enough search between each burst to ensure the center of the beaten zone is maintained at the center base of the target (see figure C-8).

One Gun

C-22. A single gunner initially lays and adjusts on the midpoint of a linear target with depth unless some other portion of the target presents a greater threat. The gunner traverses and searches to the near flank, then covers the entire target area (figure C-8).

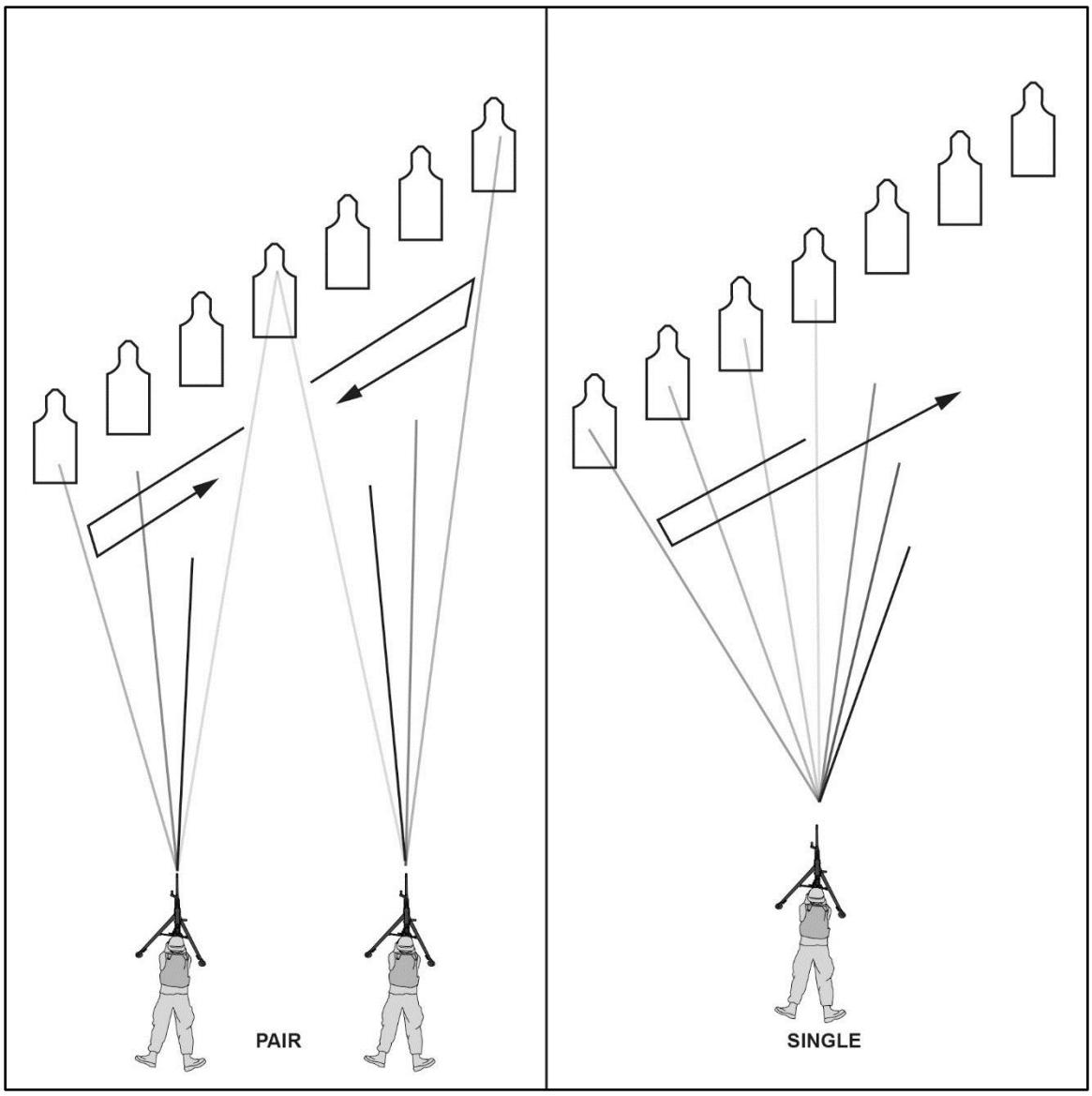


Figure C-8. Engagement of linear targets with depth

DEEP TARGETS

C-23. Deep targets have depth but very little width, and can be effectively covered by searching fire (see figure C-9). When the range is announced, it is given to the midpoint of the target.

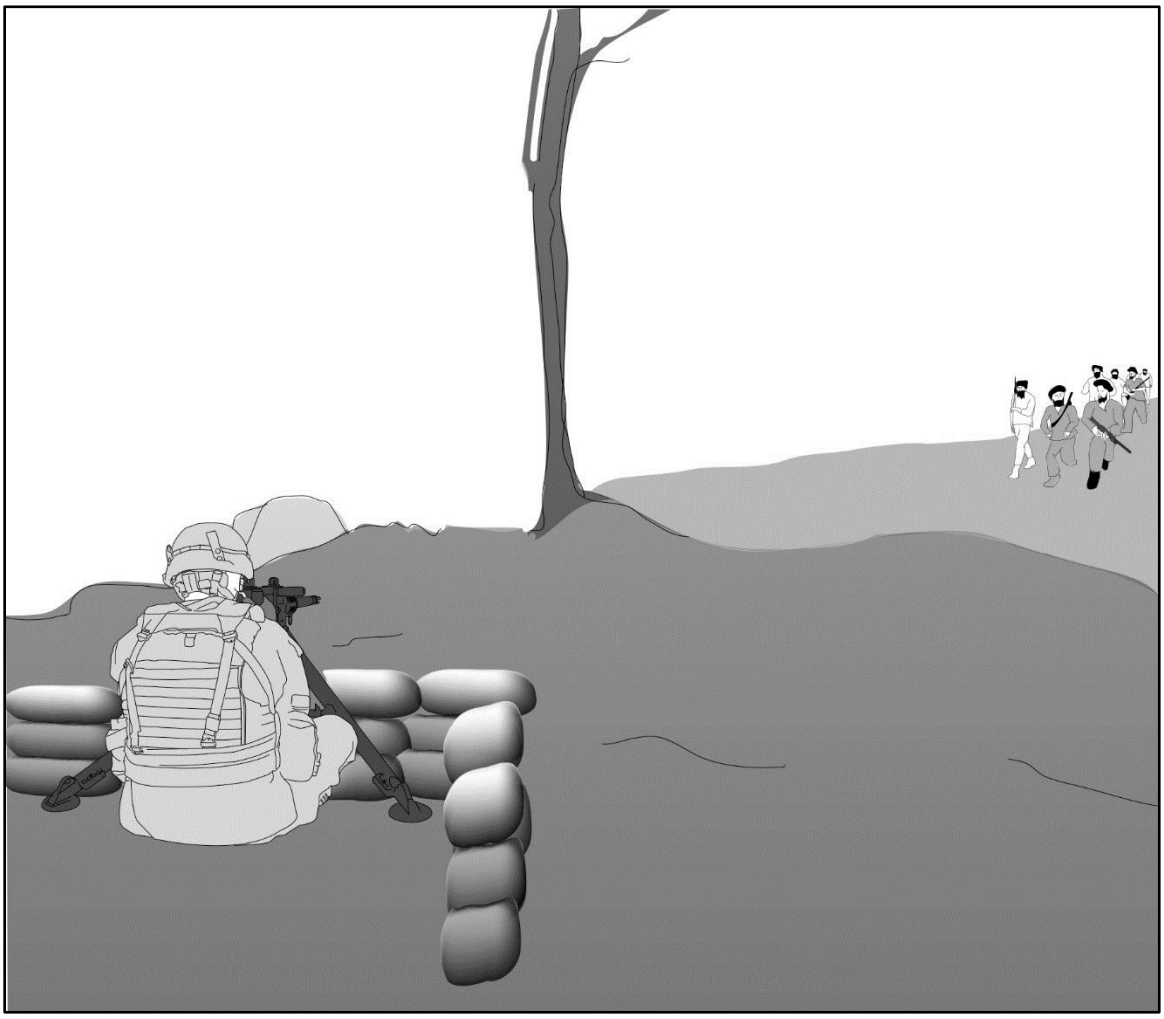


Figure C-9. Deep target

Two Guns

C-24. The point of initial lay of both guns is on the midpoint, which is also the point of division. Since enfilade fire is delivered, it is not necessary to adjust on the midpoint of the target because the long axis of the beaten zone will compensate for missing the midpoint. However, should the gunner's beaten zone fall outside the lateral confines of the target, the gunners must adjust fires into the target area. After the initial bursts, the right gun searches to the near end of the target, and the left gun searches to the far end of the target. Each gunner then reverses the direction of search and returns to the midpoint (see figure C-10).

One Gun

C-25. A single gunner initially lays and fires at the midpoint of a deep target, unless another portion of the target presents a greater threat. The gunner immediately searches to the near end, then covers the entire target (see figure C-10).

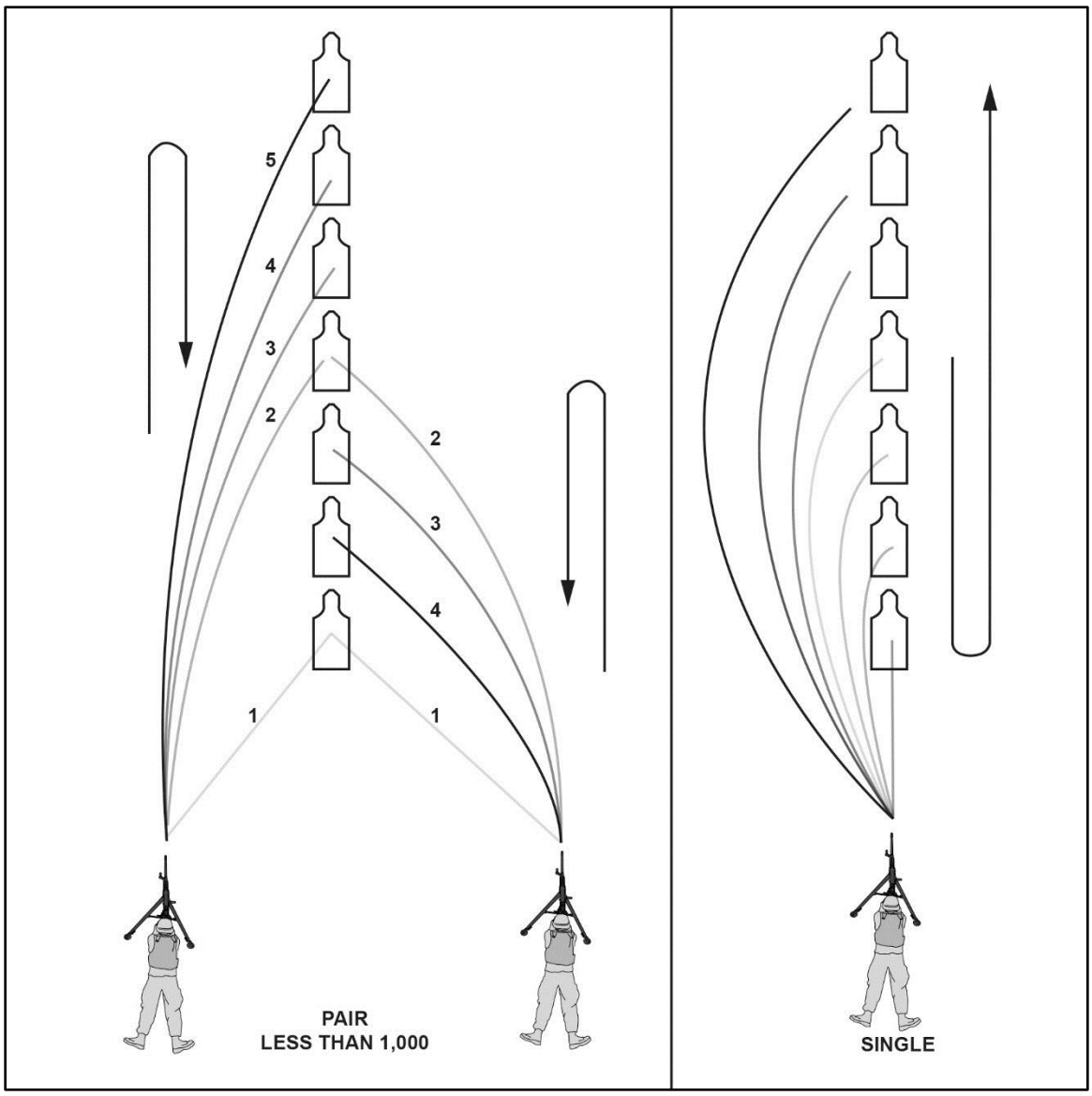


Figure C-10. Engagement of deep targets

AREA TARGETS

C-26. Area targets have considerable width and depth, and they require extensive traversing and searching fires. This type target exists when the enemy is known to be in a certain area, but their exact location is not known. A hilltop is a typical area target. The leader designates an area target by indicating to the gun crew(s) the width and depth of the target.

Two Guns

C-27. The target is divided at the center of mass; the right gun fires on the right half and the left gun fires on the left half. The point of initial lay and adjustment for both guns is on the center of mass. After adjusting on the center of mass, fire is distributed by determining the size of the beaten zones and applying direction and elevation changes that cause the most effective coverage of the target area. Both guns traverse and search their respective halves to the flanks, then return to the midpoint (see figure C-11, page C-14).

One Gun

C-28. A single gunner engages an area target by laying and adjusting on the center of mass, traversing and searching to either flank, then reversing the direction and traversing and searching to the other flank (see figure C-11).

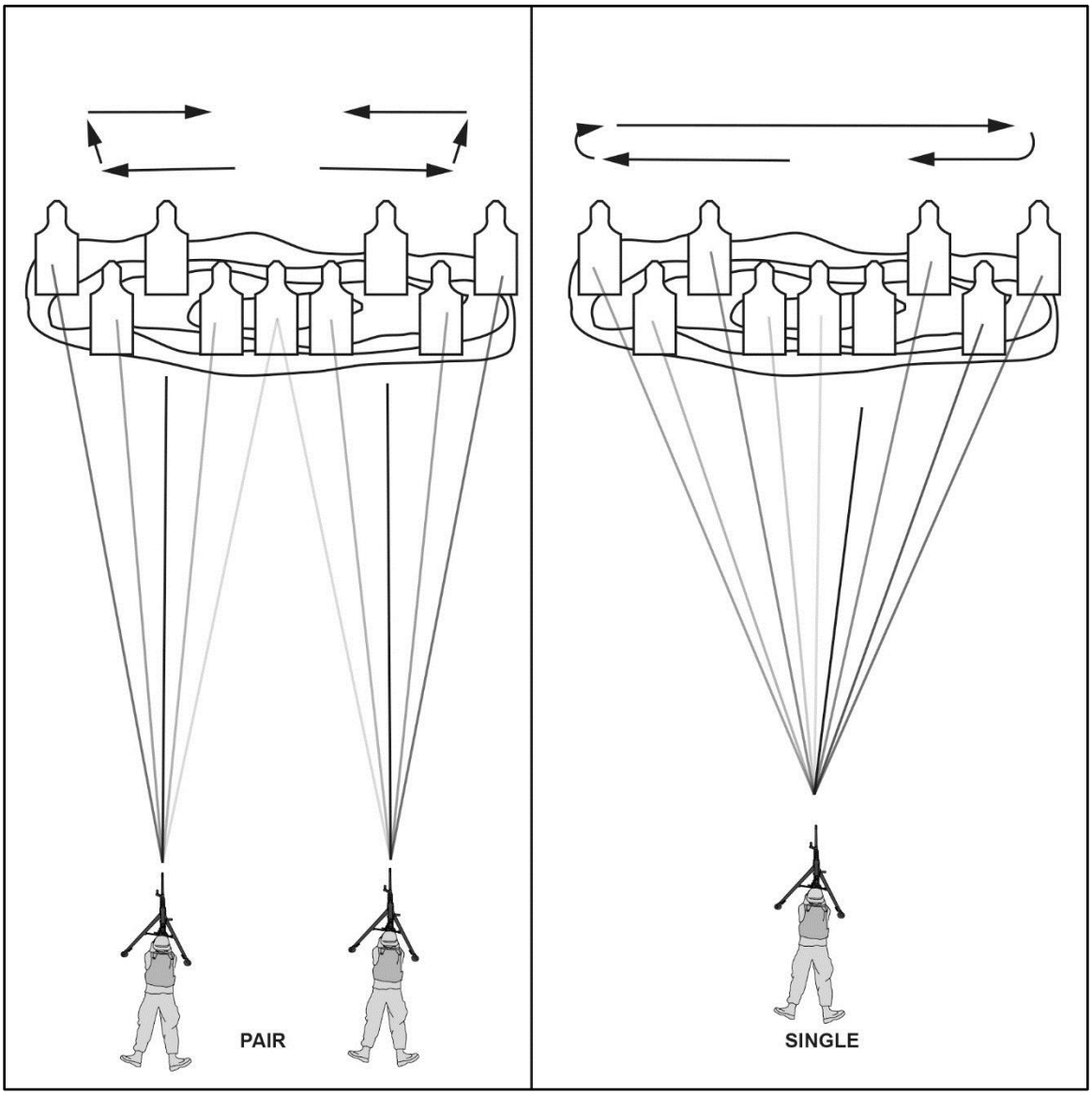


Figure C-11. Engagement of area targets (objective)

Note. After the target is engaged in either formation, the target configuration will change. The gunner must be trained to compensate for this change and still place effective fire on the target.

OVERHEAD FIRE

C-29. Overhead fire is fire delivered over the heads of friendly troops. A machine gun on a tripod is capable of delivering this type of fire because of the small and uniform dispersion of the cone of fire. In the attack, the use of overhead fire permits the machine gun to support the advance of rifle units. Sectors of fire allow the trainers to plan safe training while still incorporating the combat realities of overhead fires.

MINIMUM CLEARANCE

C-30. The center of the cone of fire must clear the heads of the friendly troops by a prescribed distance (see figure C-12). This distance, known as minimum clearance, is found by adding together the following elements:

- The height of a standing man, taken as 1.8 meters.
- Half the vertical dimension of the 100 percent cone of fire at the range to the troops.
- A margin of safety equal to the vertical distance that extends a 5-mil angle at the gun or 3 meters, whichever is greater.
- An additional allowance to compensate for a 15 percent error in range determination.

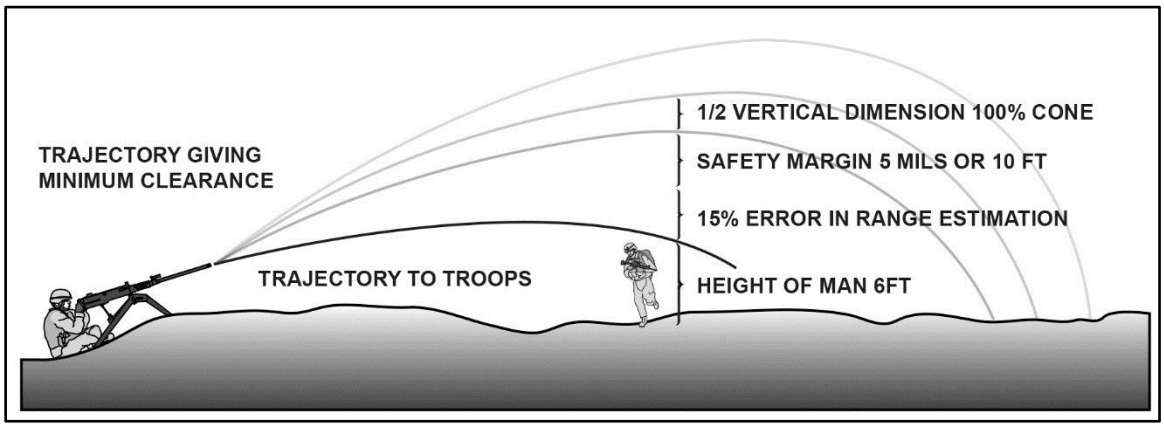


Figure C-12. Components of minimum clearance

C-31. To obtain this minimum clearance, the gun is elevated so that the center of the cone of fire is raised from the feet of the friendly troops to maintain clearance above their head. The amount of this elevation change is known as the safety angle.

C-32. When the gun is fired from the tripod with the required safety angle, the center of impact determines the shortest range at which fire can be delivered over the heads of friendly troops. The range from the gun to the point of strike is called the corresponding range.

C-33. When the ground is level or uniformly sloping between the gun and the target, the corresponding range for the safety angle used is obtained by converting the angle of elevation expressed in mils into range.

CONDITIONS

C-34. Overhead fire is used only when the following conditions have been met:

- The safety limit has been determined and has been identified on the ground.
- The gun mount is firmly seated.
- Friendly troops have been notified, if at all possible, that fire is to be delivered over them.
- The rate of fire does not exceed 40 rounds per minute.
- The gun barrel is not badly worn. This condition is indicated by excessive muzzle blast.

UNEVEN TERRAIN

C-35. Level or uniformly sloping ground is seldom found in the field, which limits the use of firing tables and corresponding ranges in determining the limit of troop safety. In lieu of firing tables, a rule of thumb has been devised to give the gunner a simple method of checking for troop safety.

C-36. The gunner's rule can be applied when the friendly troops are at least 350 meters in front of the gun position, and the range to the target is 850 meters or less (see figure C-13).

1. Lay the gun on the target with the correct sight setting to hit the target.
2. Without disturbing the lay of the gun, set the rear sight at a range of 1600 meters.
3. Look through the sights and notice where the new line of aim strikes the ground. This is the limit of troop safety. When the feet of the friendly troops reach this point, the gunner must lift or shift fire.

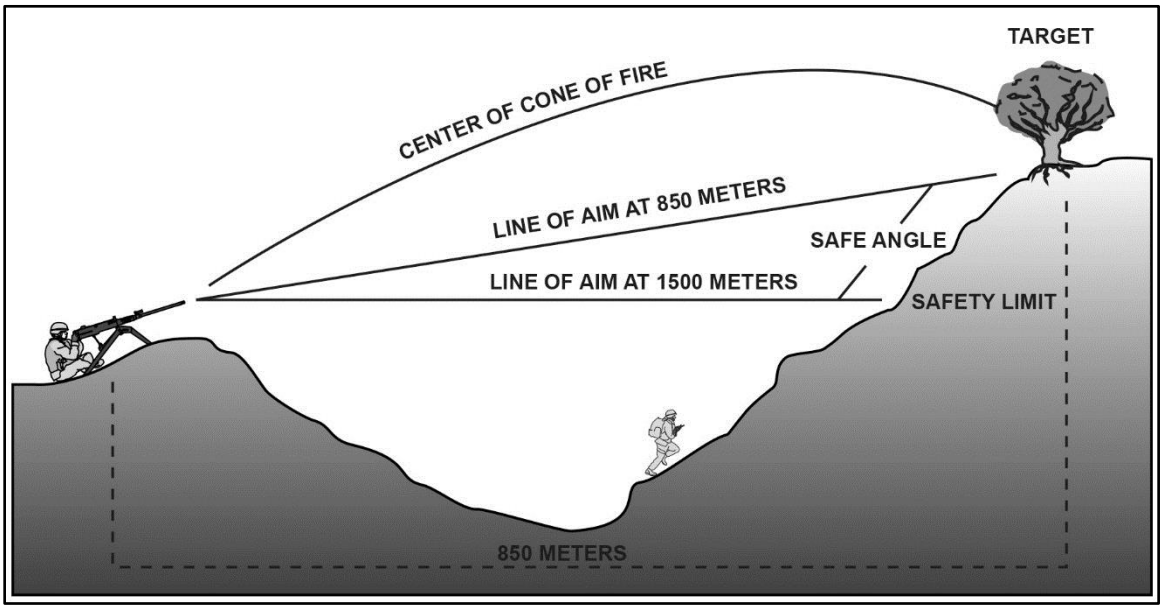


Figure C-13. Application of gunner's rule

RANGE EXCEEDS 850 METERS

C-37. When the range to the target is greater than 850 meters, overhead fire should be delivered only in an emergency. Then it should only be delivered out to a range where the gunner can see either the tracers or the strike of the bullets. In this situation, the leader's rule applies (see figure C-14). The platoon or section leader uses the leader's rule (listed below) only when the target is greater than 850 meters:

1. Select a point on the ground where it is believed friendly troops can advance with safety.
2. Determine the range to this point by the most accurate means available. Lay the gun on the target with the correct sight setting to hit the target. Without disturbing the lay of the gun, set the rear sight to 1600 meters, or the range to the target plus 500 meters, whichever is greater. Under no conditions should the sight setting be less than 1500 meters.
3. Note the point where the new line of aim strikes the ground, and—
   - If it strikes at the selected point, that point marks the limit of safety.
   - If it strikes short of the selected point, it is safe for troops to advance to the point where the line of aim strikes the ground and to an unknown point beyond. If it is desired to fire after friendly troops advance farther than the point where the line of aim strikes the ground, this farther point is determined by testing new selected points until the line of aim and the selected point coincide.
   - If it clears the selected point, it is safe for the troops to advance to the selected point and to an unknown point beyond. If it is desired to have troops advance beyond the selected point, this farther point must be determined by testing new selected points until the line of aim and the selected point coincide. This point marks the line of safety.

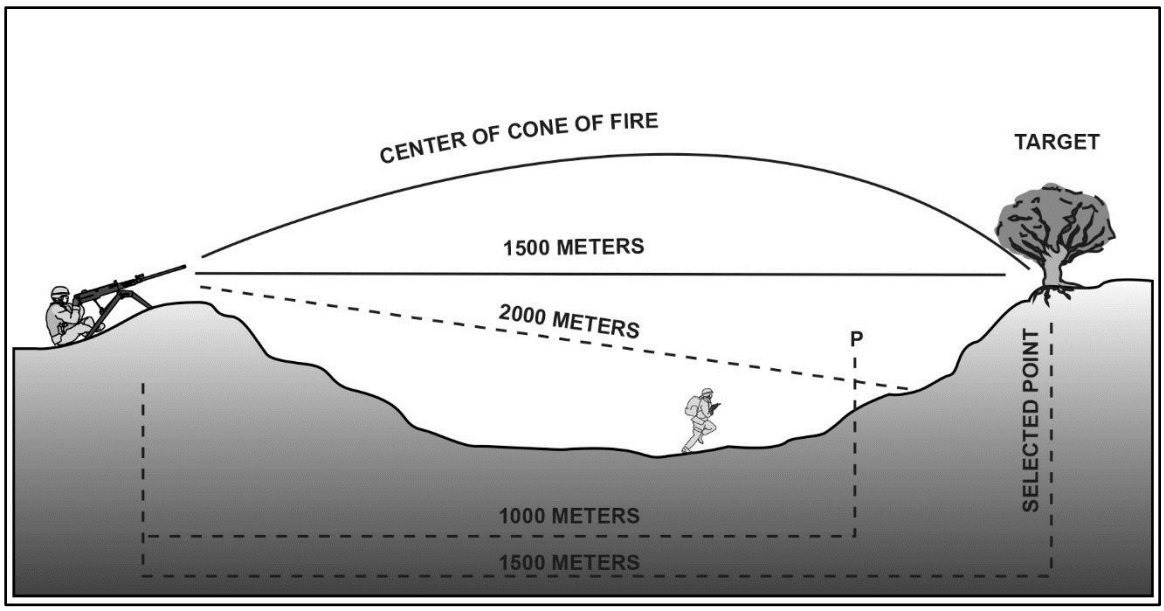


Figure C-14. Application of leader's rule

PRECAUTIONS

C-38. The following safety precautions must be observed in delivering overhead fire:

- Firmly emplace the tripod mount.
- Use depression stops to prevent the muzzle of the gun from accidentally being lowered below the safety limit.
- Do not deliver overhead fire through trees.
- Inform commanders of friendly troops when fire is to be delivered over their heads.
- Ensure that all members of the gun crew(s) are aware of the safety limit.
- Do not deliver overhead fire if the range from the gun to the target is less than 350 meters or more than 850 meters.
- Do not use a barrel that has excessive muzzle blast or that is otherwise determined to be badly worn.
- Do not lay machine guns so their fires will cross at any point over the heads of friendly troops.

DEFILADE POSITIONS

C-39. For maximum effectiveness, the machine gun must be employed using the technique of direct lay; however, at times defilade positions may be desirable.

FULL DEFILADE

C-40. A machine gun is in full defilade when the gun and its crew are hidden from enemy ground observation by a land mass such as the crest of a hill. The position may be on the reverse side of the crest or the forward slope of the next higher ground (see figure C-15, page C-18). The gun must fire up and over the hill. Fire must be observed and adjusted by a crewmember who can observe the target from a position on a flank or to the rear of the gun (on higher ground). A full defilade position allows little opportunity to engage new targets.

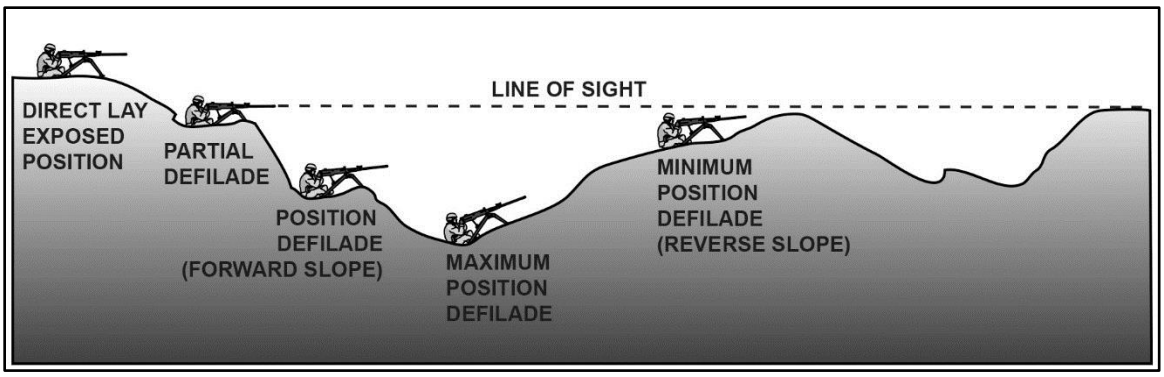


Figure C-15. Minimum and maximum position defilade, partial defilade, and direct lay areas

PARTIAL DEFILADE

C-41. A machine gun is in partial defilade when a mask (usually the crest of a hill) provides the gun and gunner with some protection from enemy direct fire, but the gunner is able to engage the target using direct laying techniques. The gun is far enough up the slope so that the gunner can see the target through the sights but the lower portion of their body and lower portion of the gun are protected by the mask. Partial defilade positions are desirable when a fire mission cannot be accomplished from a full defilade position.

Advantages

C-42. The gun and crew have cover and concealment from direct fire weapons. The crew has some freedom of movement in the vicinity of the gun position, and control and supply are facilitated. The characteristic smoke and flash of the gun are partially concealed from observation.

Disadvantages

C-43. Rapidly moving ground targets are not easily engaged because adjustment of fire must be made through an observer. Targets close to the mask usually cannot be engaged, and it is difficult to secure grazing fire for a final protective line.

POSITION SELECTION

C-44. The fire unit leader selects the location of the gun position. To select a position in partial defilade, the fire unit leader moves up the reverse side of the slope until they have the target in view above the mask when sighting at the height of the gunner's eye. To select a position in maximum defilade, the fire unit leader estimates the lowest point below the mask at which the gun can still engage the target without danger of hitting the mask.

METHODS OF LAYING THE GUN FOR DEFILADE FIRE

C-45. The essential elements in engagement of a target from a defilade position are direction, elevation, mask clearance, and adjustment of fire.

Direction

C-46. An observer places themselves on the gun-target line in a position from which they can see the gun and the target. The observer aligns the gun about by having the gunner shift the mount. The gunner then loosens the traversing slide lock lever and, as directed by the observer, moves the gun right or left until it is aligned on the target; then clamps it in that position.

C-47. A prominent landmark, visible to the gunner through their sights, is selected as an aiming point. An aiming point on the gun-target line and at an equal or greater range than the target is desirable. However, an aiming point on the mask may be used. If the aiming point is on the gun-target line, the gun is laid on the

aiming point and is thereby aligned for direction. If the aiming point is not on the gun-target line, the deflection is measured by binoculars or compass. This measured deflection is laid off with the gun.

Elevation

C-48. An aiming point visible from the gun position is selected (preferably a point at a greater range and at a higher elevation than the target) and the range to the target is determined. The leader, using binoculars, measures the vertical angle in mils from the aiming point to the base of the target. The leader then lays the gun on the aiming point with the sight set to hit the target. The leader directs the gunner to manipulate the gun through the number of mils measured. For example, in figure C-16, the range to the target is 1300 meters.

C-49. The angle read with the binoculars from the aiming point down to the base of the target is 12 mils. The sight is set at 1300 meters, the gun laid on the aiming point, and the muzzle depressed 12 mils. If the aiming point is off the gun-target line, deflection in mils may be taken with the rear sight windage screw knob if it is not over 5 mils; otherwise, the deflection must be taken up on the traversing handwheel.

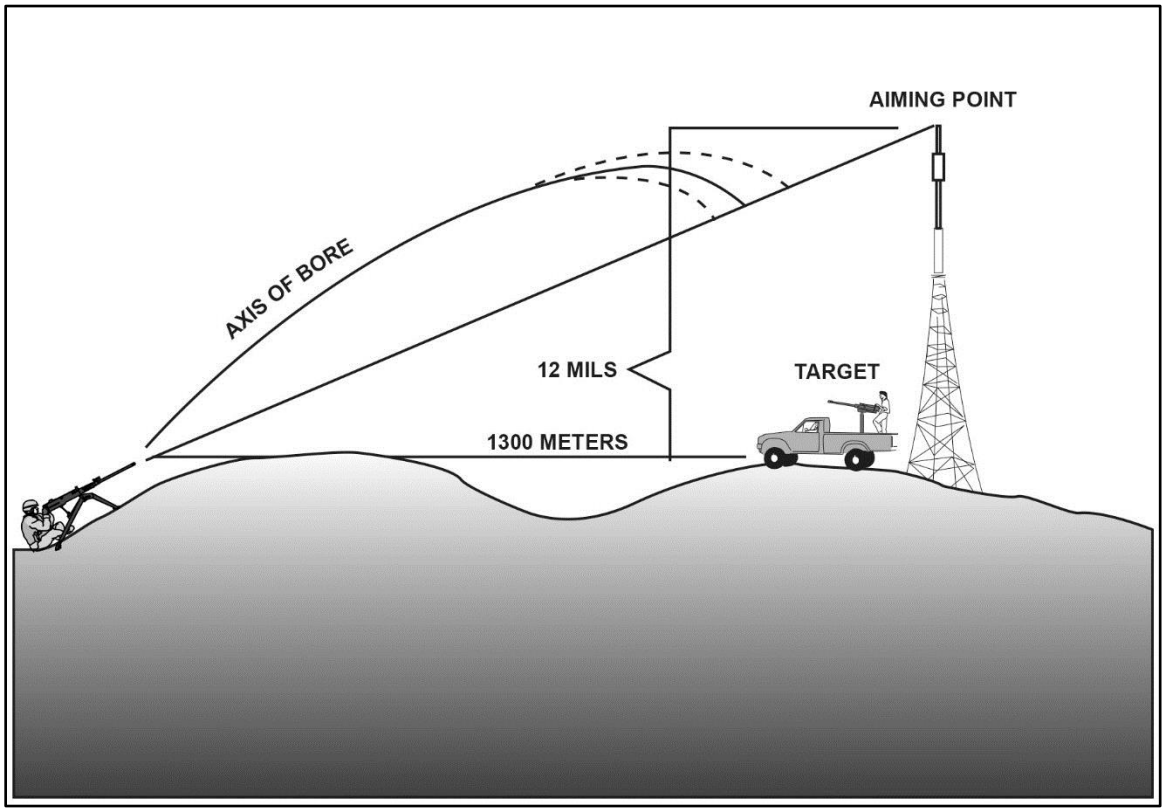


Figure C-16. Aiming point method

Mask Clearance

C-50. After the gun has been laid, determine if the entire cone of fire will clear the mask.

- Visual method. When the range to the mask is not more than 450 meters, mask clearance exists when the axis of the bore is elevated 7 mils or more above the gun-mask line. Mask clearance can be checked after the gun has been laid on the target by depressing the muzzle of the gun 2 mils and sighting along the bottom of the receiver and the barrel support. If this line of sight clears the mask, the clearance exists. Elevate 2 mils before firing.
- Firing tables method. Determine the range to the mask and obtain the corresponding angle of elevation for mask clearance from the firing tables. The range corresponding to the angle of elevation is set on the gun sight. If the line of aim through the sight clears the mask, the clearance exists.

- Fire adjustment. Under field conditions, even the most practical methods of laying the gun on the target quickly do not always result in the initial burst being on the target. For this reason, adjustment of fire on the target is essential. Creeping fire should be avoided.

FINAL PROTECTIVE FIRE (FPF)

C-51. Final protective fire (FPF) is an immediately available, prearranged barrier of fire to stop enemy movement across defensive lines or areas.

FINAL PROTECTIVE LINE (FPL)

C-52. Final protective line (FPL) are placed on a predetermined line along which grazing fire is placed to stop an enemy assault. This fire is fixed in direction and elevation; however, a few mils of search are employed during firing to compensate for irregularities in the terrain. Final protective fires are always laid in using the extreme left or right of the tripod, causing the T&E mechanism to move to the extreme left or right on the traversing bar. The FPL can be delivered in any visibility conditions. When terrain permits, FPL are assigned to machine guns along the forward line of troops as a part of the FPL of the defending unit. The signal used to call for FPL is normally prescribed in the company operation order. The authority to call for these fires may be delegated to the platoon leader of a forward rifle platoon. Final protective fires are ceased on order.

- Signals. Arm-and-hand signals, voice commands, or pyrotechnic devices may be used in calling for FPFs.
- Rates of fire. When firing FPFs, the rapid rate of fire is used unless it is obvious that a different rate is necessary to accomplish the mission. When engaging other preselected target areas, the rapid rate of fire is used until commanded to cease fire.

APPLICATION OF FIRE

C-53. To be effective, machine gun fire must be distributed over the entire target area. Improper distribution of fire results in gaps that allow the enemy to escape or use weapons against friendly positions without effective opposition.

C-54. The method of applying fire to a target is generally the same for either a single gun or a pair of guns. Direct laying is pointing the gun for direction and elevation so that the sights are aligned directly on the target. Fire is delivered in width, depth, or in a combination of the two. To distribute fire properly, the gunners must know where to aim, how to adjust their fire, and the direction to manipulate the gun. The gunner must aim, fire, and adjust on a certain point of the target. Binoculars may be used by the leader to facilitate fire adjustment.

C-55. The gunner ensures throughout their firing that the center of the beaten zone is maintained at the center base of the target for maximum effect from each burst of fire. When this is done, projectiles in the upper half of the cone of fire will pass through the target if it has height, and the projectiles in the lower half of the beaten zone may ricochet into the target (see figure C-17).

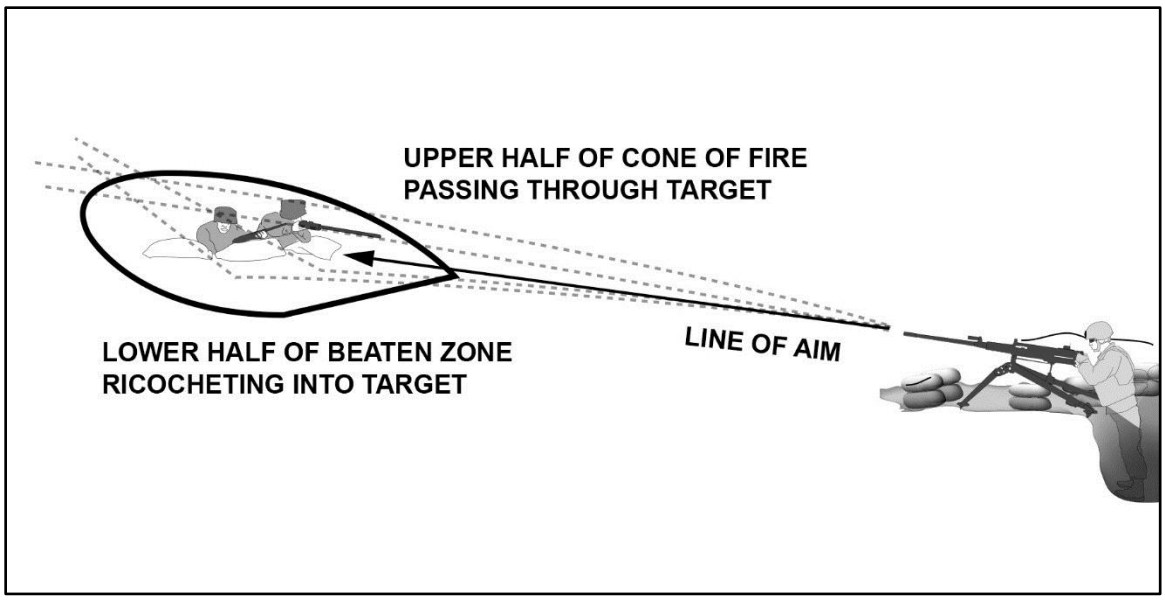


Figure C-17. Line of aim and placement of center of beaten zone on target

C-56. The gunner must move their beaten zone in a certain direction over the target. The direction depends on the type of target and whether the target is engaged with a pair of guns or a single gun. When engaging targets other than point targets with a pair of guns, the targets are divided so that fire is evenly distributed throughout the target area. Fire delivered on point targets or a specific area of other target configurations is called concentrated fire.

Adjustment of Fire

C-57. Machine gun fire is adjusted by observing the strike of the rounds, observing the flight of tracers, frequently re-laying the gun, or by a combination of these. Adjustment by observation of fire is the most important element of fire control if it is bold, aggressive, rapid, and continuous throughout the action.

C-58. The gunner is trained to observe and adjust the gun's fire without command. The gunner is trained to anticipate the action of the enemy after the initial burst, and is prepared to shift fire to cover any change in formation or movement of the target. If the gunner fails to accomplish this, the fire unit leader must promptly correct the gunner by announcing or signaling subsequent fire commands. The responsibility to adjust fire continues through the chains of command.

C-59. When subsequent fire commands are given, the gunner makes the required corrections and continues to engage the target without any further command to fire. If the gun is fired on the tripod mount, subsequent commands are given to make changes in direction, elevation, and the rate of fire. These changes are given orally as SHIFT RIGHT, SHIFT LEFT, ADD, or DROP. (Refer to FM 21-60 for arm-and-hand signals.) When making these announced changes, mils may be used to indicate the amount of desired shift; for example, SHIFT RIGHT 5 or SHIFT LEFT 7. When making changes in elevation, mils are not used, as it is normally difficult to determine just how high or low the center of the beaten zone is striking the ground in relation to the target.

C-60. When firing on the 10-meter range, the strike of the bullets is visible on the target. When firing at greater distances, the strike of the bullets on the ground may cause dust to rise, which is visible to the gunner; however, during wet weather the strike cannot always be seen. In this event, tracers will allow the gunner or crew leader to note the strike of the burst in relation to the target.

C-61. Using the mil relation, one click of the traversing handwheel or elevating handwheel moves the strike of the bullet ½ inch on the target at a range of 10 meters as follows:

- When firing on the 10-meter range, adjust by moving the shot group a required number of centimeters vertically or horizontally until the center of the group is on the aiming paster. Should the gunner's initial burst strike the target 2 centimeters to the left and 3 centimeters below the aiming paster, adjust fire by traversing right 4 clicks and elevating 6 clicks before firing again.
- When firing on field targets, adjust by moving the burst into the target. One click (mil) on the traversing handwheel will move the strike ½ meter at a range of 500 meters or 1 meter at a range of 1000 meters; however, the distance 1 click (mil) in the elevating handwheel will move the strike depends on the range to the target and the slope of the ground. The gunner determines the number of mils necessary to move the center of the strike into the target, and manipulates the gun the required number of mils. This does not require the use of sights. For example, should the gunner fire on a target at 500 meters and observe the strike 10 meters to the right of the target and short about 50 meters, they would traverse the gun to the left 20 clicks (mils) and add one or more clicks (mils), depending on the slope of the ground.
- The gunner may use the adjusted aiming point method to adjust the fire. In this method, the gunner must use the sights. The gunner selects an aiming point that will place the next burst on the target. For example, should the gunner fire on a target at 500 meters and estimate that the strike is 20 meters short and 10 meters to the right of the target, they would rapidly select an aiming point about 20 meters beyond the target and 10 meters to the left of the target, lay on that aiming point, and fire.

Antiaircraft Gunnery

C-62. The machine gun can provide units with a self-defense capability against hostile low-flying, low-performance aircraft. These guns are employed in the air defense role as part of the unit's local defense. The machine guns are not components of an integrated and coordinated air defense system. Unless otherwise directed, hostile aircraft within range of the gun (about 800 meters maximum effective range) should be engaged. The decision will be made by the commander. Typical targets are surveillance, reconnaissance, and liaison aircraft; troop carriers; helicopters; and drones.

Engagement and Employment

C-63. The mission is to impose maximum attrition upon the attacking enemy such as low-flying, low-performance aircraft. Employment of machine guns used for air defense is guided by the following defense design factors:

C-64. Defense design should produce an equally balanced defense that is effective in all directions, unless a forced route of approach exists.

- Machine guns should be sited so that the maximum number of targets can be engaged, continuous fire can be delivered, and the most likely routes of approach are covered.
- Machine guns used to defend April columns should be interspersed in the convoy, with emphasis on the lead and rear elements (see figure C-18).

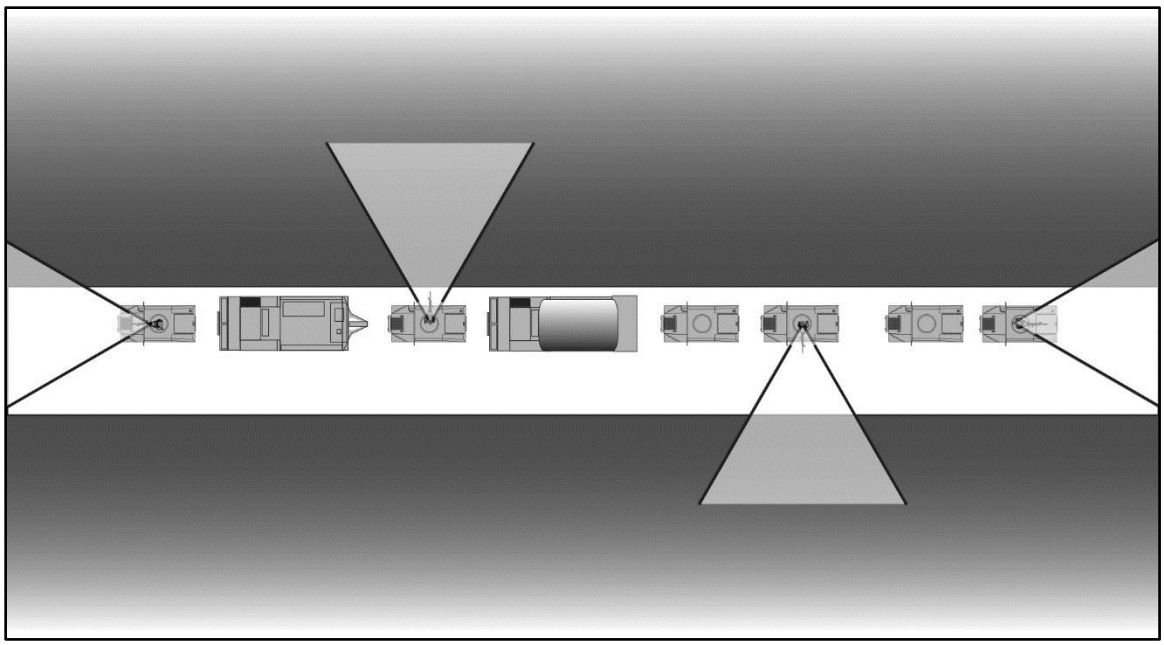


Figure C-18. April column with four machine guns

Target Selection and Engagement Control

C-65. These actions depend upon visual means. The sites selected for the guns must provide maximum observation and unobstructed sectors of fire. Units furnished machine guns in sufficient numbers should site them within mutual support distances of 90 to 360 meters. Each gun is assigned a primary and secondary sector of fire. Weapon crews maintain constant vigilance in their primary sectors of fire, regardless of the sector in which the guns are actually engaged.

AMMUNITION PLANNING

C-66. Leaders must carefully plan the rates of fire to be employed by machine guns as they relate to the mission and amount of ammunition available. The weapons squad leader must understand fully the mission the amount of available ammunition and application of machine gun fire needed to support fully all vital events of the mission. Planning ensures the guns do not run out of ammunition.

C-67. A mounted platoon or squad might have access to enough machine gun ammunition to support the guns throughout its operation. A dismounted platoon or squad with limited resupply capabilities has to plan for only the basic load to be available. In either case, leaders must take into account vital events the guns must support during the mission. They must plan the rate of machine gun fire needed to support the vital events, and amount of ammunition needed for scheduled rates of fire.

C-68. The leader must make an estimate of the total amount of ammunition needed to support all the machine guns. The leader then must adjust the amount of ammunition used for each event to ensure enough ammunition is available for all phases of the operation.

LIMITED VISIBILITY CONDITIONS

C-69. The machine gun is provided with a stable tripod mount, M3, and a traversing and elevating mechanism. By manipulating the T&E mechanism, gun crews can record target data during good visibility and engage the same targets in poor visibility. This section provides guidance on machine gun firing techniques and terms used during limited visibility, which includes darkness, smoke, fog, rain, or snow.

DIFFICULTIES

C-70. Crewmembers encounter difficulties while defending during limited visibility, which preclude the use of many of the daylight techniques of engaging targets. To overcome these difficulties, special techniques must be developed for engaging targets and delivering preplanned fires by the use of range cards.

- During limited visibility, the machine gunner's sector of responsibility cannot be observed in-depth; therefore, targets are difficult or impossible to detect.
- Visibility may be so limited that the leader cannot control the fires of their guns by selecting and directing fire on targets as they would during good visibility. Oral commands are not dependable, arm-and-hand signals may not be seen, and personal contact with the gunner is difficult.
- At night, machine gunners have a tendency to fire indiscriminately at noises and suspected enemy locations.

TERMINOLOGY

C-71. The following terms must be familiar to machine gun crews for them to complete their missions in poor visibility:

- Sector of fire. An area (to be covered by fire) assigned to an individual or unit. Machine guns are normally assigned two sectors of fire, a primary and a secondary sector.
- Final protective line. A predetermined line along which grazing fire is placed to stop an enemy assault. The FPL is fixed as to direction and elevation; however, a few mils of search are employed during firing to compensate for irregularities in the terrain. The FPL can be delivered regardless of visibility conditions. The FPL is always the inner limit of the primary sector, which is assigned close to the forward line of own troops. When terrain permits, FPLs are assigned to machine guns along the FLOT as a part of the final protective fires of the defending unit.
- Principal direction of fire. A priority direction of fire that marks a specific area assigned to a weapon. This area may extend from the gun position to the maximum effective range of the weapon, and therefore is not fixed for elevation. Visible targets appearing in the PDF take priority over targets that may appear elsewhere in the sector. A PDF may be assigned to cover an area that provides good fields of fire, is a likely avenue of foot approach, or mutually supports an adjacent unit.
- Sector of graze. A wedge-shaped area formed by assigned sector limits that afford grazing fire (1 meter high, maximum) from the muzzle of the weapon to the first major break in the terrain. The sector of graze is fired using swinging traverse in the primary sector of fire. It can be fired in the secondary sector with field expedients by freeing the T&E mechanism and using the mount as a pivot. A sector of graze can be delivered regardless of the condition of visibility.
- Area of graze. An area, other than the sector of graze, within a sector of fire that is covered by grazing fire. Grazing fire need not be continuous from the muzzle of the weapon to the area over which grazing fire is desired.

TARGET ENGAGEMENT

C-72. A gunner's ability to detect and identify targets during limited visibility will vary, depending upon the amount of natural and artificial light and the types and numbers of sensors used. All tracer ammunition allows a gunner to more effectively engage visible targets during limited visibility; it should be used when possible. Gunners must be trained to fire low initially and adjust up when engaging targets during limited visibility. This helps them overcome the tendency to fire high during these conditions. The types of point targets machine gunners will be concerned with during limited visibility, particularly at night, are enemy automatic weapons and assaulting enemy personnel.

C-73. Point targets, such as automatic weapons, may be identified during limited visibility by their muzzle flashes. To effectively engage these targets, fire should be delivered in a heavy volume and adjusted by observing the tracer stream.

C-74. During the final stage of an enemy assault, machine guns normally fire at personnel on an FPL; they may be assigned a PDF. Both are considered as final protective fires and should be planned for and

coordinated as such. If individual enemy soldiers are observed near the gun position, they must be neutralized by someone other than the machine gunner (by the other crewmembers or by security forces of the supported unit). The FPFs are fired according to the order or SOP, and the machine gunner is not allowed to stop firing them except in accordance with those orders or SOP.

FIRE CONTROL

C-75. During limited visibility, the leader cannot direct the fires of their guns as effectively as with good visibility. Consequently, initiative is required of the gunners. When targets within their sectors become visible to gunners, they must engage such targets without command and continue to fire until the targets have been neutralized. Gun crews engage targets only when they can identify them, unless otherwise ordered. For example, if one gunner detects a target and engages it, the other gunners will observe the area in which fire is being placed. They will add their fire only if they can identify the target or are ordered to place fire in the area.

PREPLANNED FIRES

C-76. In addition to engaging appropriate visible targets, the gunner must be able to deliver preplanned fires during limited visibility. These fires are used to cover target areas of tactical significance (such as routes, avenues of approach, anticipated enemy supporting weapons positions, and probable enemy assault positions) and to establish sectors of graze and final protective lines. For maximum effect in all preplanned target areas, grazing fire should be obtained when possible.

C-77. The machine gunner sets the rear sights at 700 meters; selects a point on the ground, which they determine to be at a range of about 700 meters; and lays, fires, and adjusts on this point. If the gunner cannot obtain 700 meters of grazing fire because of a major break in the ground at a range of less than 700 meters, they place the range to the break on their sight and lays, fires, and adjusts at that point.

- Determine the extent of grazing fire on the final protective line. The extent of grazing fire on the FPL is determined using the techniques described above. Any intermediate breaks in the terrain along this line that cannot be covered by grazing fire from a gun firing along the line are considered dead spaces.
- Determine the extent of grazing fire in the sector of graze. The ranges to the extent of grazing fire in a sector of graze are determined by observing the terrain and by observing the tracer stream from behind or from a flank of the gun position. Normally, the extent of grazing fire within this area will be much less than on an FPL and will form an irregular pattern.
- Determine the amount of grazing fire in an area of graze. The same procedures used in paragraph C-8 are used in determining the extent of grazing fire in an area of graze. The ranges to areas of grazing fire are determined by observing the flight of tracer ammunition from behind or from the flank of the gun position. The gunner determines the lateral extent of areas of graze by selecting and engaging successive aiming points in the area believed to afford grazing fire, using the same range setting as when determining the range to the extent of grazing fire.

CBRN CONSIDERATIONS

C-78. During this phase of training, the gunner is introduced to firing the machine gun while in MOPP, keeping in mind that engagement of some targets in MOPP is a qualification requirement. Firing weapons is only part of the overall CBRN training. Soldiers must first be familiar with the CBRN equipment, its use, and proper wear before they progress to learning the techniques of MOPP firing. Although there is no different technique required to fire the machine gun, there are certain engagement techniques that may be slightly impaired.

IMMEDIATE ACTION

C-79. Under normal conditions, a gunner should be able to clear a stoppage in two to four seconds; however, under full MOPP, this may take a few seconds longer. Dry-fire practice under these conditions is necessary to reduce time and streamline actions. When practicing with the hood/mask and gloves, care must be taken not to snag or damage the gloves or dislodge the hood/mask during movement. Trainers should apply

immediate action to a variety of stoppages during dry fire until the gunners are able to instinctively do it without compromising their CBRN environment.

TARGET DETECTION

C-80. Techniques and principles of target detection and target acquisition remain valid during CBRN conditions, but considerations must be made for limiting factors imposed by MOPP equipment. For example, vision is limited to what can be seen through the mask's lens/faceplate. Peripheral vision is severely restricted. The lens/faceplate may be scratched or partly fogged, further restricting vision. Gunners requiring corrective lenses must be issued insert lenses before training. Scanning movements may be restricted by the hood/mask. Any of these factors could adversely affect the gunner's ability to quickly and accurately detect targets. Extra skill practice should be conducted.

EFFICIENT PERFORMANCE

C-81. The trainer must keep in mind that although movements are slowed, tasks take longer, and function checks, loading, unloading, and cleaning are affected by MOPP. The gunner must avoid damaging MOPP gear, risking exposure to lethal agents. Due to the great difference between not being in MOPP and MOPP4, gunners must be trained in all aspects of operation and maintenance of the weapon while practicing at the highest MOPP level. Only through repeated training and practice can the Soldier be expected to perform all tasks efficiently.

Appendix D
Drills

Appendix D describes and provides the various drills for the M2 machine gun, and their purposes. The drill structure is designed to reinforce the most common actions in a logical sequence that all Soldiers need to routinely execute with their assigned equipment during training and combat.

These drills are used during Table III of the integrated weapons training strategy, as well as during routine maintenance, concurrent training, and during deployments. The drills found within this appendix are used to build and maintain skills needed to achieve proficiency and mastery of the weapon, and are to be ingrained into daily use with the weapon.

Note. The drills described in this appendix apply only to the M2A1 and M205 tripod. If the unit is drilling with the M2 HB or M3 tripod, they must modify the steps to conform to that weapon and tripod's TM.

BUILDING CONFIDENCE

D-1. Each drill is designed to develop confidence in the equipment and Soldier actions during training and combat operations. As they are reinforced through repetition, they become second nature to the Soldier, providing smooth, consistent employment during normal and unusual conditions. The drills provided are designed to build the Soldier's proficiency with the following principles:

- Mindset. Perform tasks quickly and effectively under stress.
- Efficiency. Ensure the drills require the least amount of movement or steps to complete correctly. Make every step count.
- Individual tactics. Ensure the drills are directly linked to employment in combat.
- Flexibility. Provide drills that are not rigid in execution.

MINDSET

D-2. Continuous combat is inherently stressful. It exhausts Soldiers and causes physiological changes that reduce their ability to perform tasks as quickly or effectively as necessary. The Soldier's ability to function under stress is the key to winning battles, since, without the Soldier, weapons and tactics are useless. Individual and unit military effectiveness depend on the Soldier's ability to think clearly, accurately, quickly, all with initiative, motivation, physical strength, and endurance.

D-3. The impact of physiological changes caused by the stress of combat escalates or de-escalates based on the degree of stimulation, causing Soldiers to attain different levels of awareness as events occur in the continually transitioning operational area around them. Maintaining a tactical mindset involves understanding one's level of awareness and transitioning between the levels of awareness as the situation requires escalation or de-escalation.

Note. Stress can be countered using the principles associated with Soldier resilience and performance enhancement. The Comprehensive Soldier and Family Fitness (known as CSF2) is designed to increase a Soldier's ability and willingness to perform an assigned task or mission and enhance their performance by assessing and training mental resilience, physical resilience, and performance enhancement techniques and skills. This initiative introduces many resources used to train Soldiers on skills to counter stress. For more information about CSF2, see http://csf2.army.mil/.

EFFICIENCY

D-4. Efficiency is the minimization of time or resources to produce a desired outcome. Efficient movements are naturally faster than movements with excess or wasteful actions.

D-5. By reducing the amount of effort, mental, or physical, a movement becomes repeatable and the effect predictable. This allows the Soldier to focus on the tactics while still maintaining the ability to produce accurate and precise fires.

INDIVIDUAL TACTICS

D-6. Individual tactics are actions independent of unit standard operating procedures (SOPs) or situations. They maximize the Soldier's chance of survival and victory in a small arms, direct fire battle. Examples of individual tactics include use of cover and standoff, and the manipulation of time and space between a Soldier and the enemy.

FLEXIBILITY

D-7. These techniques are not prescriptive; multiple techniques can be used to achieve the same goal. In fact, there is no single way to use a machine gun; different types of enemies and scenarios require different techniques. However, the techniques presented are efficient and proven techniques for conducting various machine gun-related tasks. Should other techniques be selected, they should meet the following criteria:

Reliability Under Conditions of Stress

D-8. Techniques should be designed for reliability when it counts; during combat. The technique should produce the intended results without fail, under any conditions and while wearing mission-essential equipment. It should also be tested under as high stress conditions as allowed in training.

Repeatability Under Conditions of Stress

D-9. As combat is a stressor, a Soldier's body responds much as it does to any other stressful stimulus; physiological changes begin to occur, igniting a variable scale of controllable and uncontrollable responses based on the degree of stimulation. The technique should support or exploit the body's natural reaction to life-threatening stress.

Efficiency in Motion

D-10. The technique should be designed to create the greatest degree of efficiency of motion. It should contain only necessary movement. Excessive or unnecessary movement in a fighting technique costs time to execute. In a violent encounter, time can mean the difference between life and death. Consider the speed at which violent encounters occur; an unarmed person can cover a distance of 20 feet in about 1 second. Efficiency decreases the time necessary to complete a task, which enhances the Soldier's safety.

Development of Natural Responses through Repetition

D-11. When practiced correctly and in sufficient volume, the technique should build reflexive reactions that a Soldier applies in response to a set of conditions. Only with correct practice will a Soldier create the muscle

memory necessary to serve them under conditions of dire stress. The goal is to create automaticity, the ability to perform an action without thinking through the steps associated with the action.

Leverage Overmatch Capabilities

D-12. Engagements can occur from 0 to 1800 meters. Fast and efficient movements of the machine gun allow more time to stabilize the weapon, refine the aim, and control the shot required to deliver precise fires. This rapidly moves the unit toward the goal of fire superiority and gains/maintains the initiative. Speed should be developed throughout the training cycle and maintained during operations.

D-13. As distance between the Soldier and a threat decreases, so does the time to engage with well-place lethal fires. As distance increases, the Soldier gains time to refine their aim and conduct manipulations.

CONDUCT DRILLS

D-14. To build the skills necessary to master the functional elements of the shot process, certain tasks are integrated into drills. These drills are designed specifically to capture the routine, critical tasks or actions Soldiers must perform fluently and as a second nature to achieve a high level of proficiency.

D-15. Drills focus on the Soldier's ability to apply specific weapons manipulation techniques to engage a threat correctly, overcome malfunctions of the weapon or system, and execute common tasks smoothly and confidently.

WEAPON CHECK

D-16. The weapon check is a visual inspection of the weapon by the Soldier. Upon the command "Weapon Check" the Soldier will perform a weapon check to verify:

- Weapon is clear.
- Head space and timing (M2 HB only, M2A1 head space and timing must be checked by unit armorer prior to issue.)
- Weapon serial number.
- Aiming device(s) serial number.
- Attachment points of all aiming devices, equipment, and accessories.
- Functions check.
- Proper location of all attachments on the adaptive rail system.
- Zero information.

D-17. The weapon check is initiated when first receiving the weapon from the arms room or storage facility. This includes when recovering the weapon when they are secured at a grounded location.

D-18. Units may add tasks to this task as necessary. Units may direct Soldiers to execute this drill at any time to support the unit's mission.

EQUIPMENT CHECK

D-19. The equipment check drill is a precombat (PCC) check that ensures the Soldier's aiming devices, equipment, and accessories are prepared. Upon the command "Equipment Check" the Soldier will verify:

- Batteries.
- Secured correctly.
- Equipment does not interfere with operation of the weapon.
- Basic load of ammunition is stowed properly.

PLACE WEAPON INTO ACTION

D-20. The place weapon into action drill exercises the Soldier's ability to deploy the weapon into action on demand. The team will emplace the weapon's tripod, mount the weapon, and attach the T&E.

D-21. The ammunition bearer will be responsible for establishing the tripod and assisting in mounting the receiver. The gunner will bring up the receiver and with the help of the ammunition bearer mount the receiver to the tripod. The assistant gunner will install the barrel while the gunner positions the recoiling parts and verifies the proper installation of the barrel. The drill ends after the gunner conducts the safety functions check for preparation for firing for the M2A1 or headspace and timing have been completed on the M2. Upon the command "Place Weapon Into Action" the team will perform the following steps:

Step 1: Release front leg cam handle (see figure D-1) to unlocked position.

Figure D-1. Release front leg cam handle

Step 2: Place front leg (see figure D-2) in deployed position and lock front leg cam handle.

Figure D-2. Place front leg in the deployed position

Step 3: Position tripod in upright position and pull traverse and elevation (T&E) quick release pin (see figure D-3, item 1) on the elevation mounting bracket (figure D-3, item 2). Pull the traverse handle to the stowed position (figure D-3, item 3) to release T&E assembly from right rear leg stowage lugs.

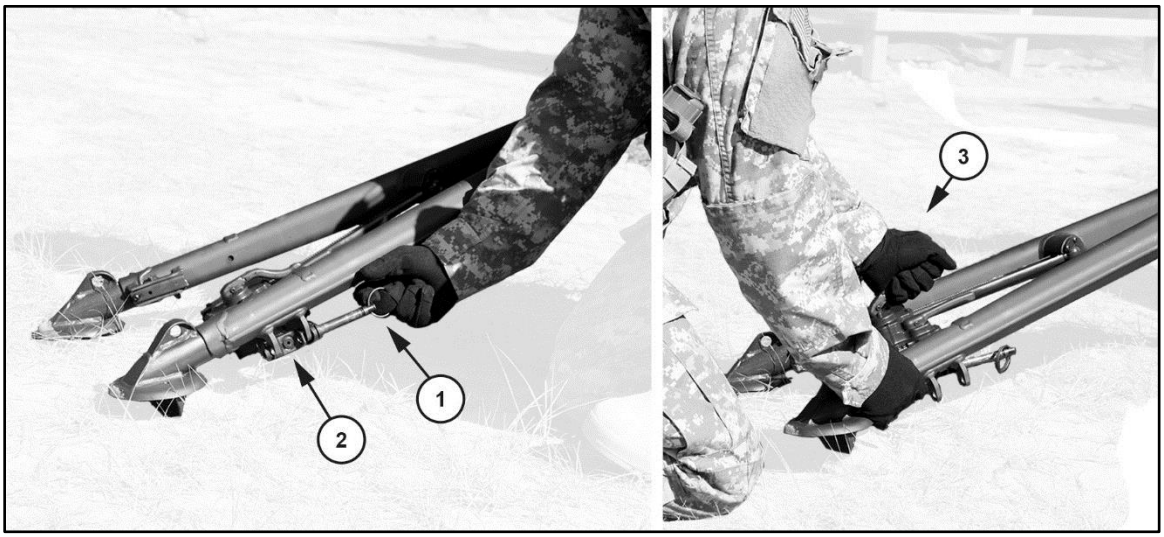


Figure D-3. Remove T&E from mounting bracket

Step 4: Spread rear legs into deployed position (see figure D-4).

Figure D-4. Spread rear tripod legs

Step 5: Pull traverse handle and rotate the handle 180°.

Step 6: Pull or depress traverse handle to slide the T&E assembly towards the center of the traverse bar and remove from left rear leg stowage lug.

Step 7: Locate the traverse bar index notch (see figure D-5, item 1), rotate T&E assembly to align the traverse bar index notch with dowel pin (figure D-5, item 2), then engage index notch onto dowel pin (D-5, item 3).

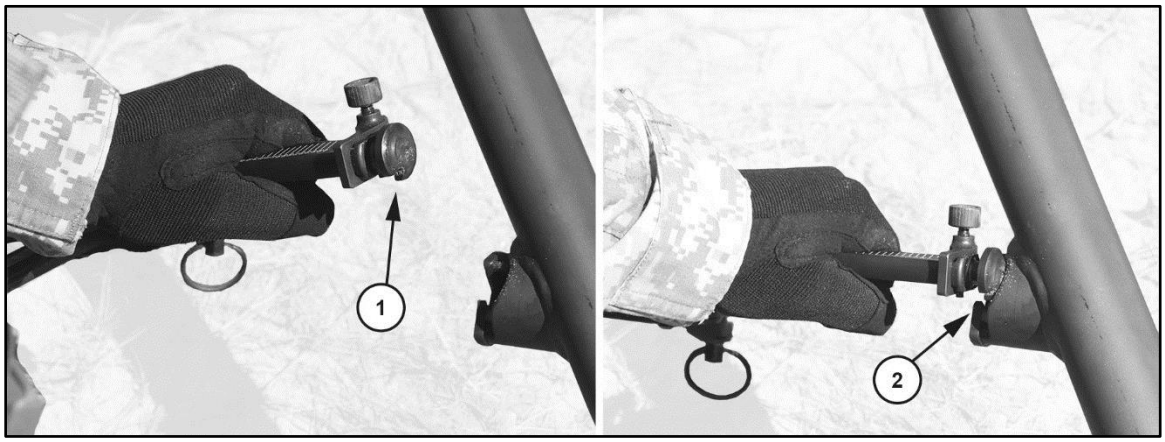


Figure D-5. Align the traverse bar index notch with dowel pin

Step 8: Press down on traverse bar while rotating elevation bar away from pintle socket until traverse bar drops into place as shown in figure D-6.

Figure D-6. Lock traverse bar

Step 9: Depress right leg latch (see figure D-7, item 1), extend right lower leg (figure D-7, item 2) and slide to desired position, release latch, and pull right lower leg until locked into position. Repeat process for left leg (figure D-7, item 3).

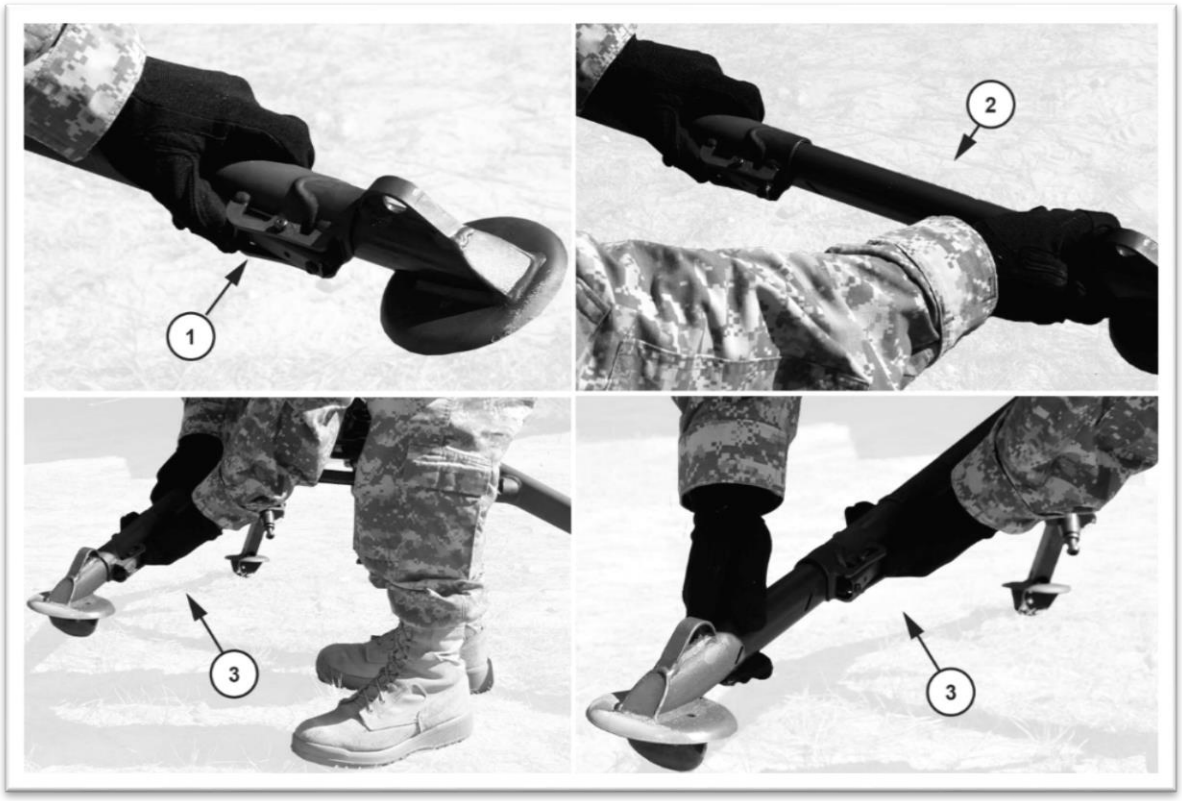


Figure D-7. Extend tripod legs

Step 10: Pull pintle quick release pin (see figure D-8, item 1) on pintle assembly to open position then remove pintle assembly from front leg.

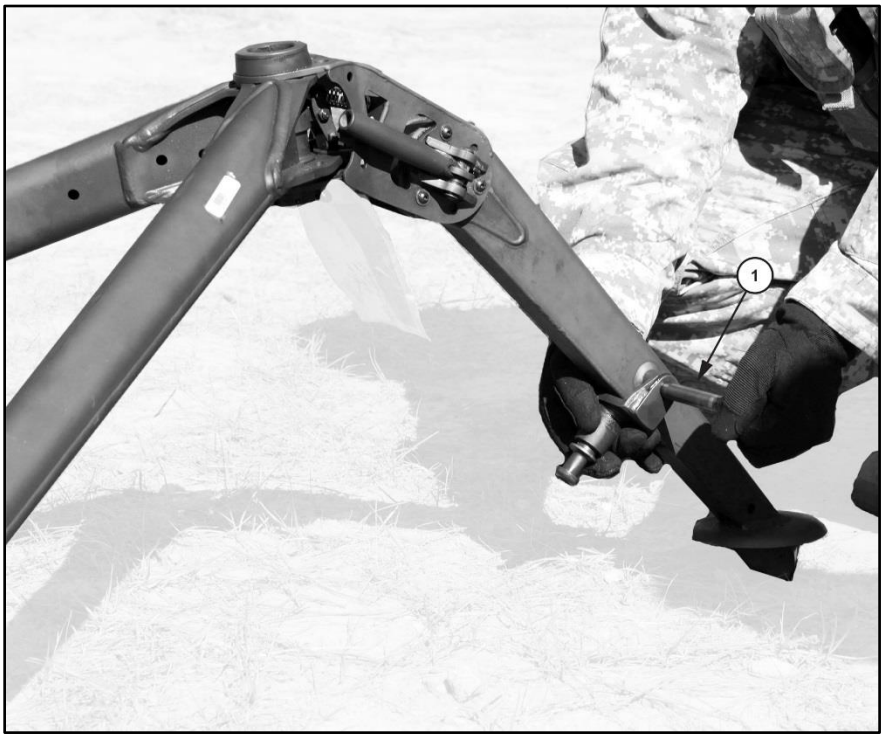


Figure D-8. Remove pintle from front leg

Step 11: Align pintle assembly with front mounting point on weapon system and push pintle quick release pin until secured (see figure D-9).

Figure D-9. Install pintle onto front mounting point

Step 12: Align pintle assembly with socket on tri-head assembly, then push pintle assembly down into socket until weapon is fully seated (see figure D-10).

Note. When installing pintle ensure quick release pins are located on the left side.

Figure D-10. Seat pintle onto tripod

Step 13: Align rear mounting point of the weapon to the elevation bracket assembly and push the T&E quick release pin into secured position (see figure D-11). Ensure both quick release pins are located on the left side of the receiver.

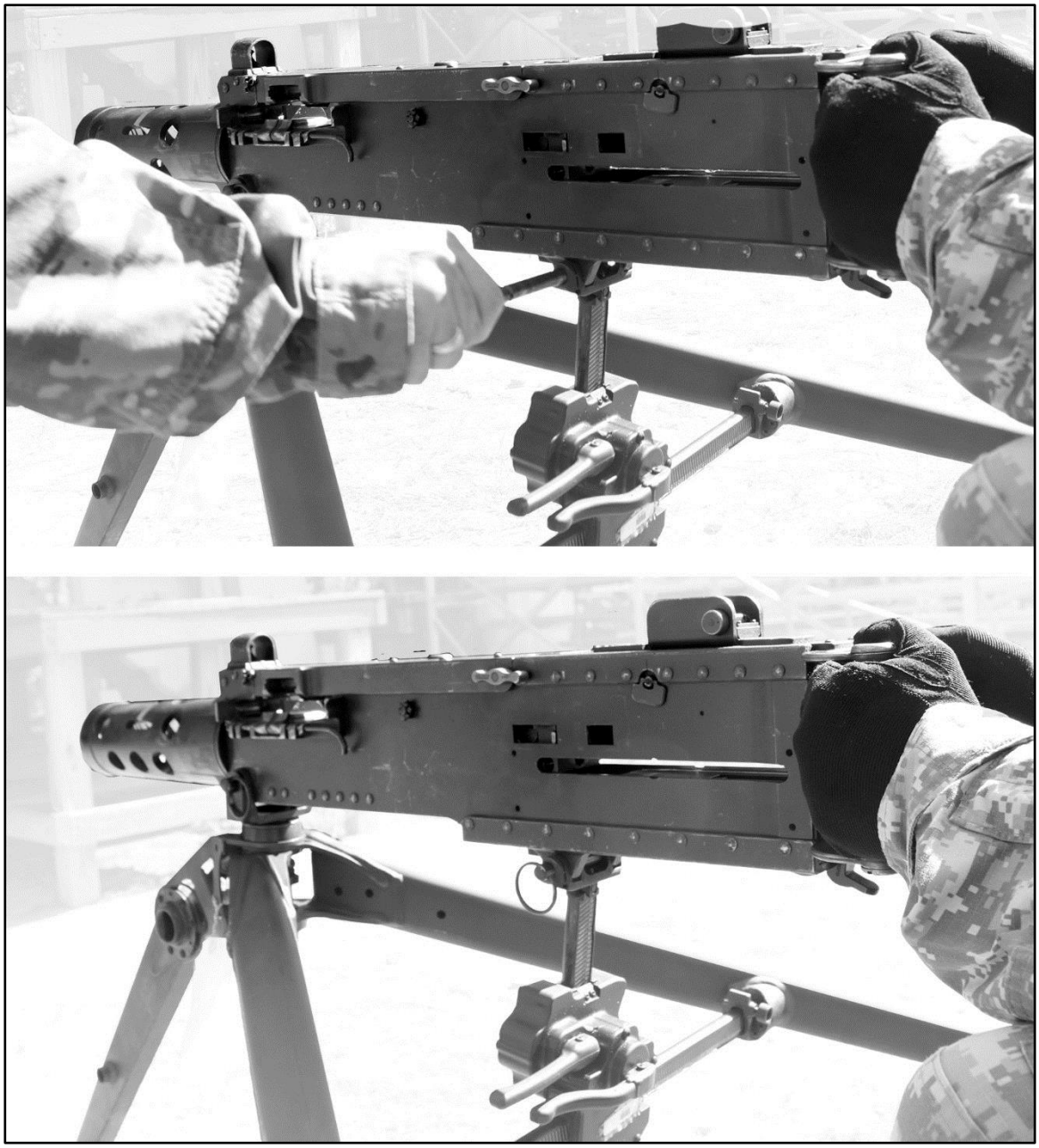


Figure D-11. Mount elevation bracket onto rear mounting point of weapon

Step 14: Raise cover assembly (see figure D-12, item 1) all the way up. Grasp retracting slide handle (figure D-12, item 2) and retract bolt to align barrel locking lug (figure D-12, item 3) with the 3/8-inch hole in the right side of the receiver while inserting the barrel.

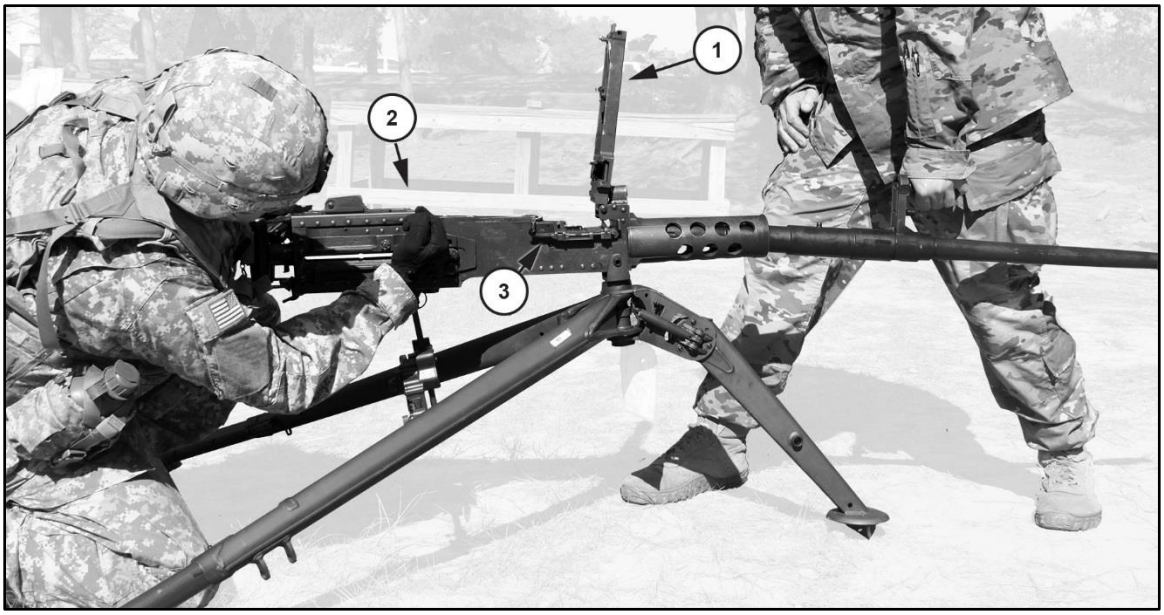


Figure D-12. Position recoiling parts in preparation for barrel installation

Step 15: Insert barrel (figure D-13, item 1) into barrel support (figure D-13, item 2) until barrel alignment pin (figure D-13, item 3) engages camming slot (figure D-13, item 4). Rotate barrel clockwise and secure barrel alignment pin in retention slot (figure D-13, item 5). For M2 HB proceed to drill D for barrel installation and headspace and timing procedures.

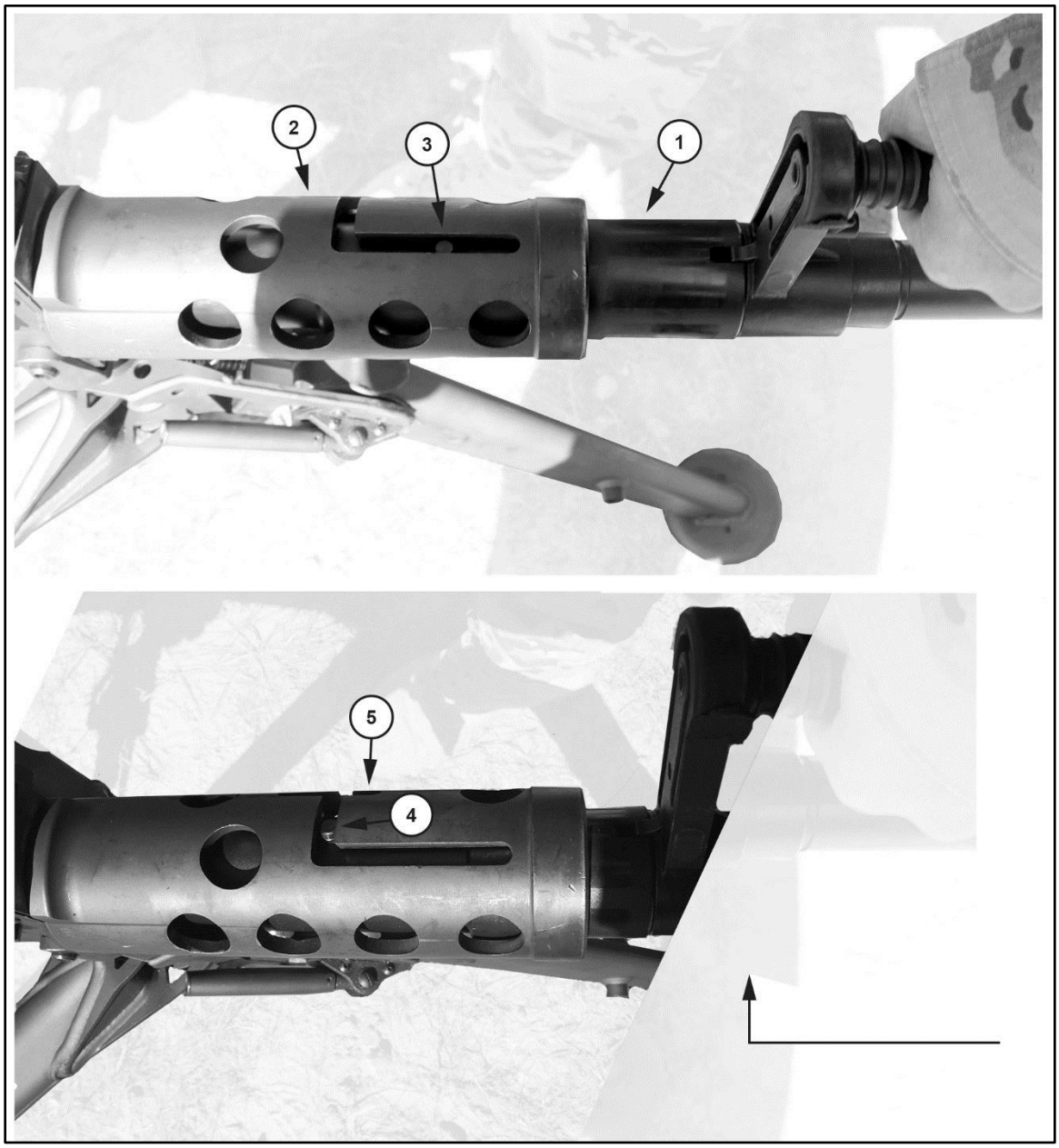


Figure D-13. Install barrel

Step 16: Inspect the barrel and barrel extension to ensure end of barrel protrudes beyond the barrel extension threads (figure D-14, item 1).

Figure D-14. Inspect barrel and barrel extension

Step 17: Release retracting slide handle and allow bolt to go forward, then place weapon on automatic fire (see figure D-15).

Figure D-15. Place weapon on automatic fire

Step 18: Pull the charging handle to ensure that the barrel moves back and forth freely (see figure D-16).

Figure D-16. Charge weapon to ensure barrel moves freely

Step 19: Place trigger block to S (safe) position. Unlock bolt latch release (see figure D-17) (rotate clockwise) and place the weapon on single shot.

Figure D-17. Place weapon on safe and single shot mode

Step 20: Charge weapon. Holding handle, depress bolt latch release and slowly return bolt forward. Press trigger. Weapon should not fire. Place trigger block to F (fire) position. Press trigger. Firing pin should release. If weapon fails safety/function check, notify field maintenance.

HEADSPACE AND TIMING

D-22. During the headspace and timing drill, the gunner remains behind the weapon system with responsibility for its safe operation, positioning of the recoiling parts, removal and installation of the backplate, and adjustment of the timing nut. The assistant gunner is responsible for installation and adjustment of the barrel, and the installation and removal of the head space and timing gage. Upon the command "Headspace and Timing" the Soldier will follow the steps for headspace and timing listed below.

Note: Headspace is the distance between the face of the bolt and the shoulder surface in chamber of the barrel. Timing is the adjustment of the gun so that firing takes place when the recoiling parts are in the correct position for firing. Because the cartridge is held by the T-slot of the bolt, headspace with the machine gun is measured as the distance between the rear of the barrel and the face of the bolt. This occurs when the recoiling parts are forward and there is a positive contact between the breech lock recess in the bolt and the lock in the barrel extensions. Headspace and timing gages must be calibrated at least every 360 days according to TB 750-25. Contact the TMDE support coordinator.

WARNING

Ensure gun is clear of ammunition before starting maintenance procedures. Headspace and timing must be adjusted before firing weapon, after assembling weapon, and after replacing barrel. Improper headspace and timing can cause malfunctions, damage to gun, and injury to personnel. Weapon will explode if this step is not followed. Ensure retracting slide handle is retracted while inserting barrel. Installing the barrel without retracting the charging handle to view square on the barrel extension through the 3/8 inch hole on right side of receiver will cause malfunction, damage to the gun, and injury to personnel.

Step 1: Raise top cover all the way up.

Step 2: Grasp retracting slide handle and retract bolt to align barrel locking spring lug with the 3/8 inch hole in the right side of receiver while inserting barrel.

Note. Ensure no obstructions are located in the barrel assembly before installing.

Step 3: Holding bolt in this position, screw the barrel fully into the barrel extension.

Step 4: With bolt still retracted, unscrew barrel two notches (clicks). Release retracting slide handle and allow bolt to go forward.

WARNING

Check barrel to ensure it is locked with the bolt in the forward position. Attempt to turn barrel in either direction; barrel should not turn. If barrel does turn, stop here, do not attempt to fire the gun. Notify field maintenance.

Step 5: In single shot mode, pull bolt to rear with retracting slide handle and hold. This charges the weapon (withdraws firing pin into bolt). Otherwise headspace gage will not fit and could cause damage to the firing pin.

Step 6: Hold retracting slide handle, push the bolt latch release, and slowly return bolt forward (do not slam). Do not fire the weapon.

Note. Do not insert any objects such as coins and feeler gages between the barrel extension and trunnion block while retracting the bolt to verify or adjust headspace. Placing an object between the barrel extension and trunnion can cause excessive headspace adjustment.

Step 7: Remove slack in the bolt and barrel extension by retracting the retracting slide handle until the barrel extension begins to separate (but not more than 1/16 inch) from the trunnion block.

Note. Ensure GO/NO GO gage does not have any broken, bent, rusted, or pitted areas or other forms of mutilation that could affect dimensional tolerances.

When the charging handle is retracted a rearward pressure is placed on the bolt, breech lock, and barrel extension, removing slack or clearance between these parts, and all three parts move as one. It is at this point the distance between the bolt face and the end of the barrel reflects a correct headspace.

Step 8: While maintaining 1/16 inch separation, raise cartridge extractor and attempt to insert the GO end of the GO/NO GO headspace gage in the T-slot between the face of the bolt and the rear of barrel all the way to the ring, then attempt to insert the NO GO end of the GO/NO GO headspace gage.

Step 9: If GO end of headspace gage enters freely all the way to the ring and NO GO end does not enter, headspace is correct. Proceed to adjust timing. If GO end of headspace gage does not enter T-slot freely, headspace is too tight. Proceed to Step 10. If NO GO end of headspace gage enters, headspace is too loose. Proceed to step 11.

Step 10: If GO end of headspace gage will not enter T-slot, retract bolt to view the barrel locking spring lug in center of 3/8 inch hole on right side of receiver. Unscrew barrel one notch (click). Repeat steps 8 and 9. If necessary, repeat steps 8 through 10 until GO end of headspace gage enters and NO GO end of headspace gage does not enter.

CAUTION

Do not unscrew barrel more than a total of five notches (clicks) beyond the first setting of two clicks for a total of seven. If this condition occurs, turn in machine gun to field maintenance for inspection.

Step 11: If NO GO end of headspace gage enters T-slot, retract bolt to view the barrel locking spring lug in center of 3/8 inch hole on right side of receiver. Screw barrel in one notch (click). Repeat steps 8 and 9. If necessary, repeat steps 8, 9 and 11 until NO GO end of headspace gage

does not enter and GO end of headspace gage enters. If the barrel is completely screwed into the barrel extension and the NO GO end of headspace gage enters T-slot, do not attempt to fire the weapon. Notify field maintenance.

CAUTION

After obtaining proper headspace, recheck positive locking action of barrel by attempting to screw barrel in or out with bolt in forward position. Do not fire machine gun if barrel can be screwed in or out.

Note: Timing nut must be completely loosened before timing adjustment is started. Ensure proper headspace before adjusting timing.

Step 12: Pull bolt to rear with retracting slide handle to cock machine gun; while holding handle, depress the bolt latch release and slowly return bolt forward. Do not press trigger.

Step 13: Place trigger block on F (fire) position.

WARNING

Never charge gun when backplate is off and do not stand directly behind gun while removing backplate because spring may be under high tension. Failure to comply can cause death or injury to personnel.

Step 14: Remove backplate assembly.

Step 15: Screw timing adjustment nut all the way down (to the left). Nut should not be hard to turn.

WARNING

Failure to reinstall the backplate may lead to inconsistent timing adjustment and weapon stoppage or explosion. Failure to comply may cause death or injury to personnel.

Note. Do not attempt to fire the gun by pushing up on the trigger bar with the backplate assembly removed.

Step 16: Reinstall backplate assembly. Grasp retracting slide handle and retract bolt just enough to insert FIRE gage with beveled edge against barrel notches between barrel extension and trunnion block. Release retracting slide handle slowly. Attempt to fire gun by depressing trigger. Gun should not fire.

Step 17: Remove fire gage, then backplate assembly. Screw timing adjustment nut, up (to the right) one click. Reinstall backplate assembly, and reinsert FIRE gage. Attempt to fire by depressing trigger. Repeat step 17 until gun fires and then proceed to step 18.

Step 18: Remove fire gage then backplate assembly and turn timing adjustment nut two more clicks up (to the right). Do not turn the timing adjustment nut any more.

Step 19: Reinstall backplate.

Step 20: Pull retracting slide handle to rear to charge machine gun.

Step 21: Depress bolt latch release and slowly ease bolt forward with retracting slide handle.

Step 22: Grasp retracting slide handle and retract bolt just enough to insert NO FIRE gage with beveled edge against barrel notches between barrel extension and trunnion block. Release retracting slide handle slowly.

Step 23: Depress trigger; gun should not fire.

Note. If machine gun does fire, it has early timing. Re-adjust timing or notify field maintenance.

Step 24: Retract bolt just enough to remove NO FIRE gage and insert FIRE gage with beveled edge against barrel notches between barrel extension and trunnion block. Release retracting slide handle slowly.

Step 25: Depress trigger; machine gun should fire. Timing is now complete.

Note. If machine gun does not fire, it has late timing. Re- adjust timing or notify field maintenance.

Step 26: Repeat steps 20 through 25 with both FIRE and NO FIRE gages two more times to ensure that adjustment is correct.

Step 27: Remove FIRE gage.

LOAD AND BARREL CHANGE

D-23. The load and barrel change drill is predominantly an administrative loading and barrel change function. This allows the Soldier to develop reliable loading and barrel changing techniques. If using an M2 HB, headspace and timing must be checked, Soldiers must perform head space and timing when changing barrels. M2A1 will not need to perform the head space and timing portion of this drill. The load and barrel change can be performed together or separately.

D-24. During this drill, the gunner remains behind the weapon system with responsibility for its safe operation. The assistant gunner is responsible for positioning the ammunition, and the removal and installation of the barrel. Upon the command "Load and Barrel Change" the Soldier will perform the following steps:

Step 1: Ensure weapon is on safe with cover closed. Insert the double loop end of ammunition (see figure D-18, item 1) into the feed-way until first cartridge is held by belt-holding pawls (figure D-18, item 2).

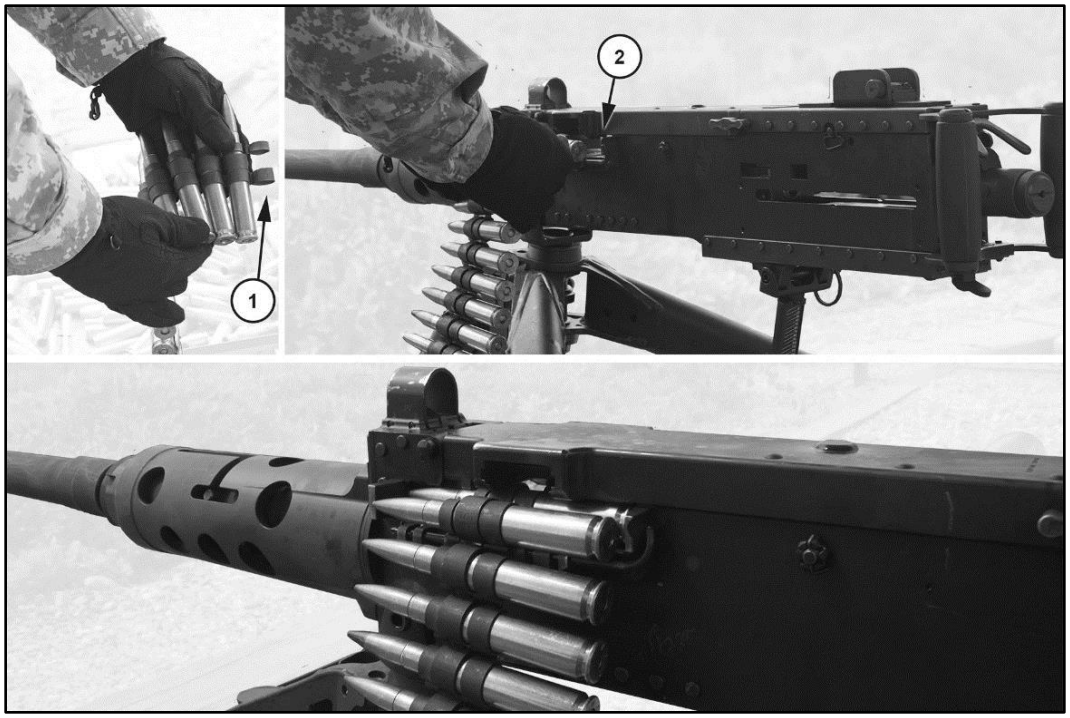


Figure D-18. Load ammunition

Step 2: Pull retracting charging handle rearward, retracting the bolt all the way to the rear. Place the charging handle forward if the weapon is in single shot.

Step 3: Release the handle if weapon is in the automatic mode. Press bolt release latch to allow bolt to cycle forward. This half-loads the machine gun. Repeat step 2 and 3 to fully load weapon. For full automatic fire, lock down bolt latch with buffer tube sleeve.

D-25. The barrel should be changed as frequently as needed or as the tactical situation permits. Table D-1 shows the frequency of barrel changes based upon rate of fire. When conducting this drill without ammunition the leader announces barrel change. This initiates the next part of the drill. Barrel changes should coincide with reloading drill.

Table D-1. Barrel change frequency

Machine Gun	Rate of Fire			Frequency of Barrel Change
	Rounds per minute	Burst	Interval	
M2/M2A1 Sustained:	< 40	6 – 9 Rounds	10 – 15 Seconds	End of the firing day / barrel damaged
Rapid:	> 40	6 – 9 Rounds	5 – 10 Seconds	One hour / barrel damaged
Cyclic:	450 – 600	Continuous	Continuous	200 rounds / barrel damaged

Step 4: Place the weapon in a safe direction and place the weapon on safe and on single-shot mode.

Step 5: Look away from the cover in a safe direction, and away from the weapon. Then raise feed tray cover. Lift the cartridge extractor and remove the ammunition belt from the feed way (see figure D-19). Close the cover.

Figure D-19. Remove ammunition

Step 6: Pull and lock the bolt to the rear, leaving the retracting slide handle to the rear. Open the cover. The gunner must ensure gun is clear by visually inspecting the chamber and T-slot for rounds. In darkness, feel the chamber and T-slot to ensure they are clear (see figure D-20).

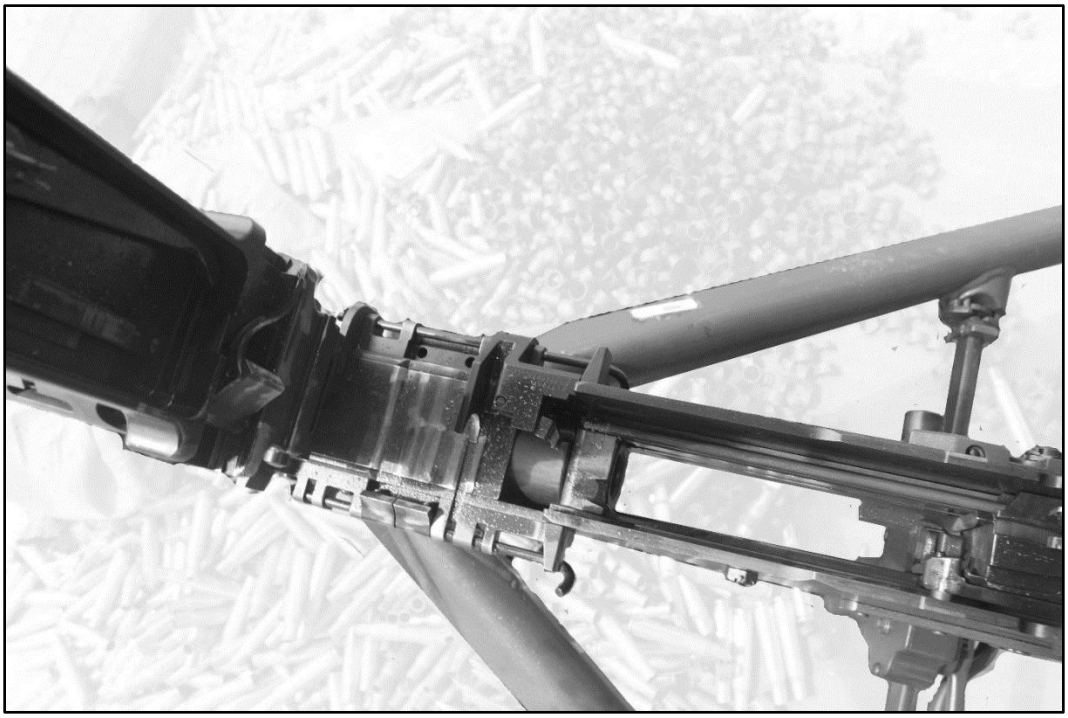


Figure D-20. Clear chamber and T-slot

Step 7: Press the bolt latch release and ease the bolt forward with retracting slide handle.

Step 8: Grasp retracting slide handle and retract bolt to align barrel locking lug with the 3/8-inch hole in right side of receiver while the assistant gunner removes the hot barrel and replaces it with the cool barrel. Soldier's using the M2 HB must perform head space and timing.

FIGHT DOWN

D-26. The fight down drill builds the Soldier's understanding of how to move effectively and efficiently between firing postures and positions. The fight down drill trains the actions taken to move the weapon system and adjust the tripod into the lower firing configurations. The drill also exposes the gunner to the different firing positions and allows them to remember the settings of the tripod that optimizes a stable firing positon.

D-27. The drill starts at seated, or if a fighting position is available, the standing position. Upon the command "Fight Down", the team executes the announced movement technique and the next lower position announced by the leader. The fight down drill exercises the following positions:

- Standing.
- Sitting.
- Prone.

D-28. Each position should be executed a minimum of three times. To execute this drill with the standing position, the gun needs to be emplaced into a fighting position. Leaders use weapon and T&E manipulation with the fight down drill.

FIGHT UP

D-29. The fight up drill builds the Soldier's understanding of how to move effectively and efficiently between firing postures and positions. The drill trains the actions taken to move the weapon system and adjust the tripod into the higher firing configurations. The drill exposes the gunner to the different firing positions and allows them to remember the settings of the tripod that optimizes a stable firing positon.

D-30. The fight up drill starts at a prone fighting position and, upon the command "Fight Up", the team executes the announced movement technique and the next higher position announced by the leader. The drill exercises the following positions:

- Prone.
- Sitting.
- Standing.

D-31. Each position should be executed a minimum of three times. To execute this drill with the standing position, the gun is emplaced into a fighting position. Leaders use the fight up drill with the fight down drill.

D-32. Leaders may increase the tempo of the drill, increasing the speed the Soldier needs to assume the next directed position. After the minimum three iterations are completed between the fight down drill and the fight up drill, the leader may switch between fight down and fight up at any time, at varying tempos.

RELOAD

D-33. This drill is executed when the Soldier is wearing complete load-bearing equipment. It provides exercises to assure fast, reliable reloading through repetition at all firing positions or postures.

D-34. The Soldier should perform this drill from each of the following positions a minimum of seven times:

- Standing.
- Sitting.
- Prone.

D-35. To reinforce training as needed, leaders may include other drills while directing reload drill. Upon the command "Reload" the Soldier performs the following steps:

Step 1: Ensure weapon is on SAFE with cover closed, insert the double loop end of ammunition into the feed-way until first cartridge is held by belt holding pawls.

Step 2: Pull retracting charging handle rearward, retracting the bolt all the way to the rear. If machine gun is in single shot mode place charging handle into the forward position.

Step 3: Press bolt release latch to allow bolt to cycle forward. If the weapon is to remain on automatic, this is not necessary as the bolt will automatically return to the fully forward position. This half-loads the machine gun. Repeat step 2 and 3 to fully load weapon.

CLEAR MALFUNCTION

D-36. The clear malfunction drill develops the skills necessary to clear common malfunctions on a machine gun in a rapid manner, while maintaining muzzle and situational awareness. Soldiers should perform clearing a malfunction based on the commands from their leader.

D-37. This drill should be executed five times. Once complete, leaders should incorporate this drill with other drills to ensure the Soldier can execute the tasks at all positions fluently. Upon the command "Clear Malfunction" the Soldier will perform the following steps:

Step 1: Pull retracting slide handle rearward.

Step 2: Observe if rounds are feeding and fired case is ejected, release retracting slide handle.

Step 3: Try to fire.

Step 4: If weapon does not fire and the barrel is hot enough to cause a cook-off (100 rounds per minute), place the bolt in the forward position and place the weapon in single shot mode. Follow the procedures listed in TM 9-1005-213-10.

UNLOAD AND SHOW CLEAR

D-38. The unload and show clear drill is predominantly an administrative unloading function, and allows the Soldier to develop reliable clearing techniques. The drill should be executed in tandem with head space and timing and load drills.

D-39. The unload and show clear drill can be executed without ammunition in the weapon. Leaders may opt to use dummy ammunition. In garrison environments, leaders should use the drill on demand to reinforce the Soldier's skills and attention to detail. Upon the command "Unload and Show Clear" the Soldier performs the following steps:

Step 1: Place the weapon in a safe direction and place the weapon on safe and on single shot mode.

Step 2: Look away from the cover in a safe direction, and away from the weapon. Then raise feed tray cover. Lift the cartridge extractor and remove the ammunition belt from the feed way. Close the cover.

Step 3: Pull and lock the bolt to the rear, leaving the retracting slide handle to the rear. Open the cover. The gunner must ensure gun is clear by visually inspecting the chamber and T-slot for rounds (in darkness the gunner must feel the chamber and T-slot to ensure they are clear).

Step 4: Press the bolt latch release and ease the bolt forward with retracting slide handle.

SUPPORTING TASKS

D-40. The weapon and T&E manipulation and range card tasks may be performed during drills or when placing the weapon into operation. They are primarily used in defensive operations.

WEAPON AND T&E MANIPULATION

D-41. This series of exercises train how to lay the gun in deflection and elevation, estimate and apply range, and apply the appropriate firing techniques. Soldiers progress through increasingly difficult scenarios utilizing the T&E and the free gun techniques. Soldiers also practice applying range to the rear leaf sight during these drills. Soldiers must demonstrate proficiency in these skills prior to live fire. Leaders should focus on the skills listed below.

- Range determination. Leaders should use the methods discussed in TC 3-20.31-4, and programs such as ROC-V to develop the gunner's skills in acquiring, Identifying, and determining the approximate range to the target. Exercises in this skill will enable the gunner to become proficient in the skills of identifying enemy at various ranges and conditions and applying the appropriate range on the rear leaf sight or AN/PAS-13, heavy weapon thermal sight.

- Sight alignment and range setting. Leaders select and announce point target aiming points and a range. The gunner manipulates the T&E aligning the sights of the weapon onto the proper aim point, and applies the announced range onto the rear leaf sight or AN/PAS-13, heavy weapon thermal sight.
- Traverse. The leader selects and announces target aiming points on a horizontal plane and instructs the gunner to engage with flanking fire. Traversing fire is distributed against a wide target requiring successive changes in the direction of the gun. When engaging a wide target requiring traversing fire, the gunner should select successive aiming points throughout the target area. These aiming points should be close enough together to ensure adequate target coverage; however, they need not be so close as to be wasteful of ammunition by concentrating a heavy volume of fire in a small area. Two clicks on the traverse lever or traversing handwheel after each burst ensure coverage. The Soldier estimates and applies the appropriate range, aligns the sights, and properly distributes fire.
- Search. The leader selects and announces target aiming points on a vertical plane and instructs the gunner to engage with frontal fire. Searching fire is delivered against a deep target or a target that has depth, requiring changes in elevation of the gun. The amount of elevation change depends upon the range and the slope of the ground. The Soldier estimates and applies the appropriate range, aligns the sights, and properly distributes fire.
- Search and traverse. The leader selects and announces target aiming points on an oblique target and instructs the gunner to engage with a combination of the skills previously learned. Traversing and searching fire is delivered both in width and depth by changes in direction and elevation. It is employed against a target whose long axis is oblique to the direction of the fire. The Soldier estimates and applies the appropriate range, aligns the sights, and properly distributes fire.
- Preplanned targets. The leader selects and records various targets or locations according to the weapons elevation and traverse bar. Without disturbing the lay of the tripod, the leader resets the T&E to zero. The leader has the Soldier assume a good fighting position, and then tells them to apply the appropriate target coordinates onto the T&E. Leaders then verify the readings are correct and continue the exercise. The exercise can also be performed by the Soldier selecting and recording preplanned targets and the leader then verifying.
- Multiple target scenarios and priority of threat. The leader uses visual aids such as mockups, pictures, or targets that represent the three threat levels for enemy targets. After the Soldier has demonstrated the ability to discern most dangerous, dangerous, and least dangerous the leader progresses into multiple target scenarios of targets with different threat levels and targets with the same threat level. The Soldier then announces the threat level of each target and their priority.

RANGE CARD

D-42. A range card is a sketch or diagram of the terrain that a weapon is assigned to cover by fire. It shows possible target areas and terrain features plotted in relation to a firing position. The information on a range card is used for planning and controlling fire, for rapidly detecting and engaging targets, and for orienting replacement personnel or units. DA Form 5517, *Standard Range Card*, should be used to record the information. Follow the procedures outlined in TC 3-21.75 for the automatic weapon range card.

D-43. The range card should be executed each time the weapon system has been established. The leader will verify the information on the range card, and then instruct the gunner and assistant gunner to place the weapon on a series of targets and aim points based upon the elevation and deflection information recorded on the range card.

RANGE CARD SECTIONS

D-44. Normally, each machine gunner prepares range cards for their fighting position. The gunner prepares one for each primary, alternate, and supplementary position designated in the defense and for any static position when enemy contact is possible; for example, a position in an assembly area.

D-45. Each range card contains, as a minimum, the following information:

- The symbol for the weapon covering the sector.
- The azimuth (degrees) and distances (meters) of the firing position from an easily recognizable terrain feature. (This serves as an easy reference to locate the firing position.) If there is no easily recognizable terrain feature, an eight digit grid coordinate may be used.
- The boundaries of the area assigned to be covered by observation and fire.
- Areas where targets are likely to appear (engagement areas) and the range, azimuth, and elevation to them from the firing position.
- Dead space (areas that cannot be observed or covered by fire).
- The direction of magnetic north when the range card is properly oriented.
- Identification data to include unit designation (no higher than company), time and date of preparation, and firing position (primary, alternate, or supplementary).

D-46. The following steps are taken to prepare a range card:

Step 1: Draw the symbol for the machine gun in the lower center of the range card.

Step 2: Show the sector of fire by drawing solid lines from the weapon symbol to the left and right limits. Sketch any easily recognizable terrain features that can be used to identify the sector. In the data section, indicate the magnetic azimuth and the range to the far limits of the sectors of fire.

Note. The left and right limits are labeled 1 and 2, respectively, in the sector sketch and a circle is drawn around each number. The left and right limits should be the first items drawn and labeled in the sector sketch and the data section of the range card. (The azimuth and range are not placed on the solid lines for left or right limit.

Step 3: Place target reference points at the location designated by the platoon leader or unit SOP, and at any other locations where a target is likely to appear. Number each TRP and likely target locations in the sketch section of the range card.

Step 4: Draw a maximum engagement line across the sector of fire for the machine gun. This line shows the maximum range at which a target can be effectively engaged.

Step 5: Show dead space or areas where targets cannot be engaged with direct fire by drawing diagonal lines across the areas and writing the words DEAD SPACE.

Step 6: Draw a magnetic north arrow on the range card to orient it with the terrain. Then add identification data—unit designation (no higher than company level), time and date of preparation, and type of position (primary, alternate, or supplementary).

Step 7: Enter the information for the weapon reference point in the remarks block on the range card.

This page intentionally left blank.

Appendix E

Zeroing

Zeroing a weapon is not a training exercise, nor is it a combat skills event. Zeroing is a maintenance procedure that is done to place the weapon in operation, based on the Soldier's skill and capabilities, the tactical scenario, the aiming device, and the ammunition. Its purpose is to achieve the desired relationship between the line of sight and the trajectory of the round at a known distance. Zeroing ensures the Soldier, weapon, aiming device, and ammunition perform as expected at a specific range to target with the least amount of induced errors.

For Soldiers to achieve a high level of accuracy and precision, they must zero their aiming device to their weapon correctly. First, they achieve a consistent group, then align the mean point of impact to the appropriate point of aim.

Soldiers zero using the specific process described in this appendix. The process is designed to be time-efficient and will produce the most accurate zero possible. They use the technical manuals that came with their weapon and equipment to complete the zeroing task.

The zero process includes mechanical zero, laser borelight, 10-meter grouping and zeroing, and field zero at 500 meters.

Note. Although wind and gravity have the greatest effect on the projectile's trajectory, air density and elevation must also be considered.

BATTLESIGHT ZERO

E-1. The term battlesight zero means the combination of sight settings and trajectory that greatly reduces or eliminates the need for precise range estimation, further eliminating sight adjustment, holdover or hold-under for the most likely engagements. The battlesight zero is the default sight setting for a weapon, ammunition, and aiming device combination. The battlesight for the M2 machine gun is fixed at 750 yards.

E-2. An appropriate battlesight zero allows the gunner to accurately engage targets out to a set distance without an adjusted aiming point. For aiming devices that are not designed to be adjusted in combat, or do not have a bullet drop compensator, the selection of the appropriate battlesight zero distance is critical.

ZEROING PROCESS

E-3. A specific process should be followed when zeroing. The process is time-efficient and produces the most accurate zero possible. The zero process includes a 10-meter laser borelight and zero and field zero (battlesight zero).

Note. Although wind and gravity have the greatest effect on the projectile's trajectory, air density and elevation must be taken into consideration also.

TEN-METER LASER BORELIGHT AND ZERO

E-4. The borelight is an eye-safe laser that is used to boresight optics, and aiming lasers. Currently there is no data for borelighting the iron sights. The borelight assists the first shot group hitting the 500-meter zeroing target when field zeroing the heavy weapon thermal sight, AN/TVS-5, AN/PEQ-2A, AN/PEQ-15, or AN/PEQ-15A to the weapon. Using the borelight will save range time and require less rounds for the zeroing process. Borelighting is done with a borelight, which is centered in the bore of the weapon, and with an offset target placed 10 meters from the muzzle of the weapon (for more information on borelighting refer to TM 9-5860-226-13&P.)

10-METER GROUPING AND ZEROING

E-5. Setting the zero for the 10-meter range allows the gunner to learn basic traverse and search techniques with the M2 machine gun while using the standard machine gun target. Just like with other weapons, the gunner must set the sight on the M2 at an initial start point (see figure E-1).

REAR SIGHT

E-6. Set the rear sight at 1000.

ELEVATION

E-7. Raise the rear sight by lifting straight up until it snaps into the upright position. Adjust the range scale to 1,000 yards by rotating the elevation screw knob in the necessary direction. (Clockwise moves the scale up; counterclockwise moves the scale down.)

WINDAGE

E-8. Rotate the windage knob until the zero index mark on the base rear sight is aligned with the index mark on the top of the receiver. (Clockwise moves the windage scale to the left; counterclockwise moves it to the right.)

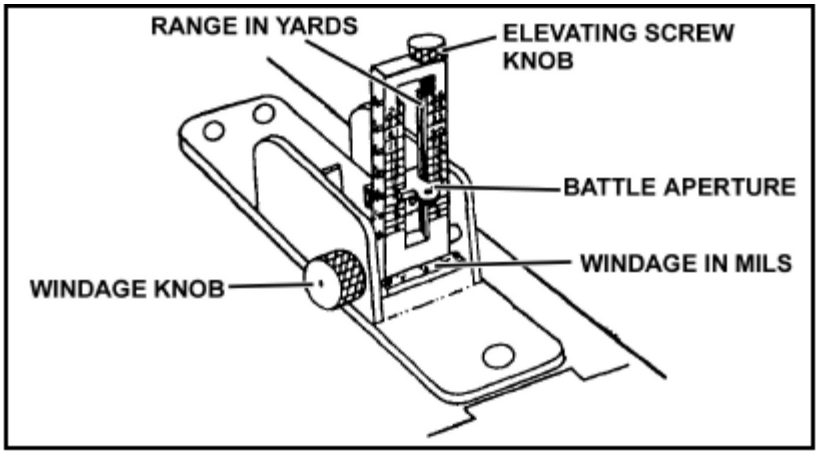


Figure E-1. Rear sight setting for 10-meter zero

PROPER SIGHT PICTURE

E-9. Obtain the proper sight picture by looking through the zero aperture and centering the front sight blade in it. Once the sight alignment is obtained, place this combination on the center base of the selected target (see figure E-2).

Figure E-2. 10-meter zero sight picture

THREE-ROUND GROUP

E-10. Fire three single rounds loaded individually at the center base of the aiming points on the basic machine gun marksmanship target. Fires the three rounds without adjusting the sights. The shot group must be in a 4-centimeter (or less) circle to establish the center of the group in relation to the center base of the aiming paster.

GRID SQUARE OVERLAY

E-11. For a more accurate adjustment, move downrange and place the grid square overlay over pasters 1 and 2. Align the overlay with the pasters and squares.

E-12. The gunner counts the number of squares it will take to move the shot group to the aiming paster.

E-13. Upon completion, return to the firing line to make corrections to the weapon. Figure E-3 shows a zero group size on which adjustments can be made and a group that is too loose for adjustments. If a group is too loose, check the position and group.

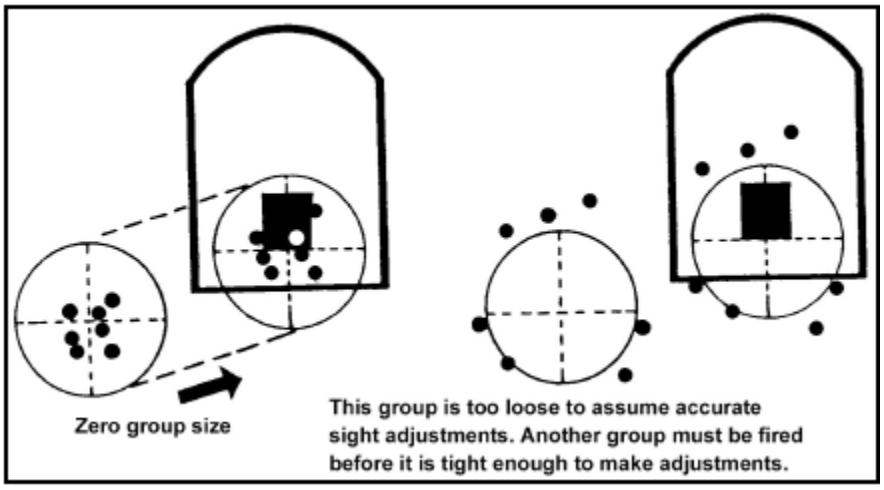


Figure E-3. 10-meter zero group size

Note. Large shot groups are usually caused by incorrect position and grip. Incorrect sight alignment, sight picture, or zero usually causes small shot groups outside of the scoring space.

E-14. If the center of the group is to the left or right of the black aiming paster, must correct for windage.

E-15. If the center of the shot group is above or below of the black aiming paster, correct for elevation.

Confirmation

E-16. Fires another three-shot group (loaded singly) after correcting for windage and elevation. If the center of the group is still off the aiming point, adjust farther until the group centers on the point of aim.

Recording of Zero

E-17. There is no reason to record the 10-meter zero, because it applies only to firing at the 10-meter basic machine gun target.

FIELD ZERO

E-18. When preparing to field zero, the Soldier ensures that the M2 is mounted securely on the tripod, the T&E mechanism is working properly, and finally, the Soldier knows the distance to the zero target. The only difference in initial sight setting for field zero is range setting on the scale.

E-19. The gunner must also remember that the range scale on the M2 is indicated in yards. Therefore, to get as close to the target as possible, the gunner may have to convert the meters to the target into yards they can set the range on the rear sight. Conversion of meters to yards is accomplished by multiplying the number of meters by 1.094. For example, 600 meters x 1.094 = 656.4 yards; the gunner would set their range scale at 650 yards.

E-20. All machine guns should be zeroed at actual range using a target between 100 and 700 meters. For the M2HB machine gun, a range of 500 meters is recommended. The field zero or combat zero obtains the gunners battlesight zero and must be recorded.

E-21. To field zero on the M2, the Soldier performs a series of steps:

ESTABLISH ZERO

E-22. To establish a proper field zero, the Soldier must complete each of the following steps carefully:

Step 1: Raise leaf sight. Raise the rear leaf sight until it snaps into the upright position (figure E-4). Rub chalk into the indentions.

Step 2: Set the elevation. Turn the elevation screw knob until the elevation line aligns with the desired elevation mark.

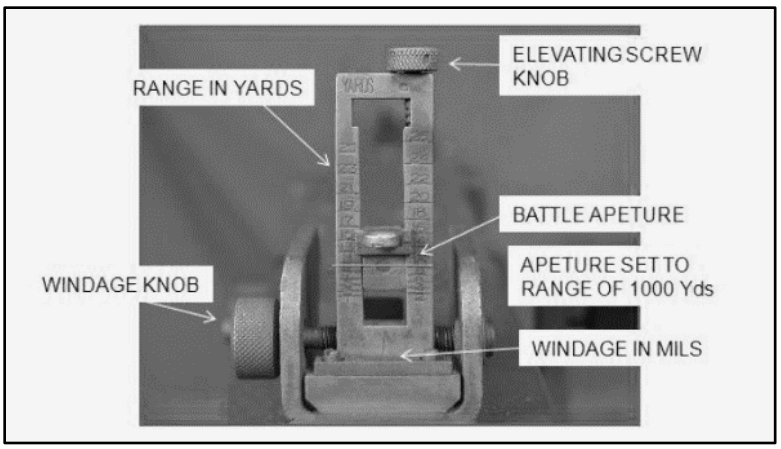


Figure E-4. Rear sight setting for field zero

Step 3: Set the windage. Turn the windage knob until the zero index mark on base of the rear sight aligns with the index mark on the top of the receiver (figure E-5).

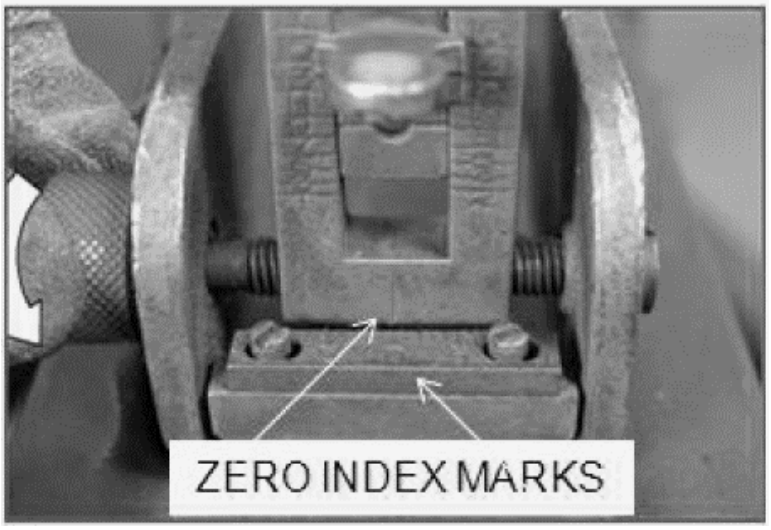


Figure E-5. Windage zero

Step 4: Select the firing mode. Verify the M2 machine gun is in single shot mode.

Step 5: Establish a firing position. Establish a stable firing position.

Step 6: Align the sight. Align the sight with the base of the target by manipulating the T&E mechanism ensuring to take the slack out of the T&E.

Step 7: Establish the zero. With a good sight picture fire a single shot at the center base of the target and observe the location of the strike of the round. If the round strikes the target, fire two more rounds then proceed to confirm zero. If the round misses the target, proceed to adjust the sight.

All adjustments are made based upon the observed impact of the rounds in relation to the target's location. The width of the front sight post can be used to help determine the amount of adjustments necessary. The width of the front sight post is 2 mm. At 500 meters, it equals 1 meter or the width of two E-type silhouettes (figure E-6, page E-6). The assistant gunner helps the gunner locate the strike of the round. If the gunner has binoculars etched with mils, the assistant gunner can provide specific mil corrections.

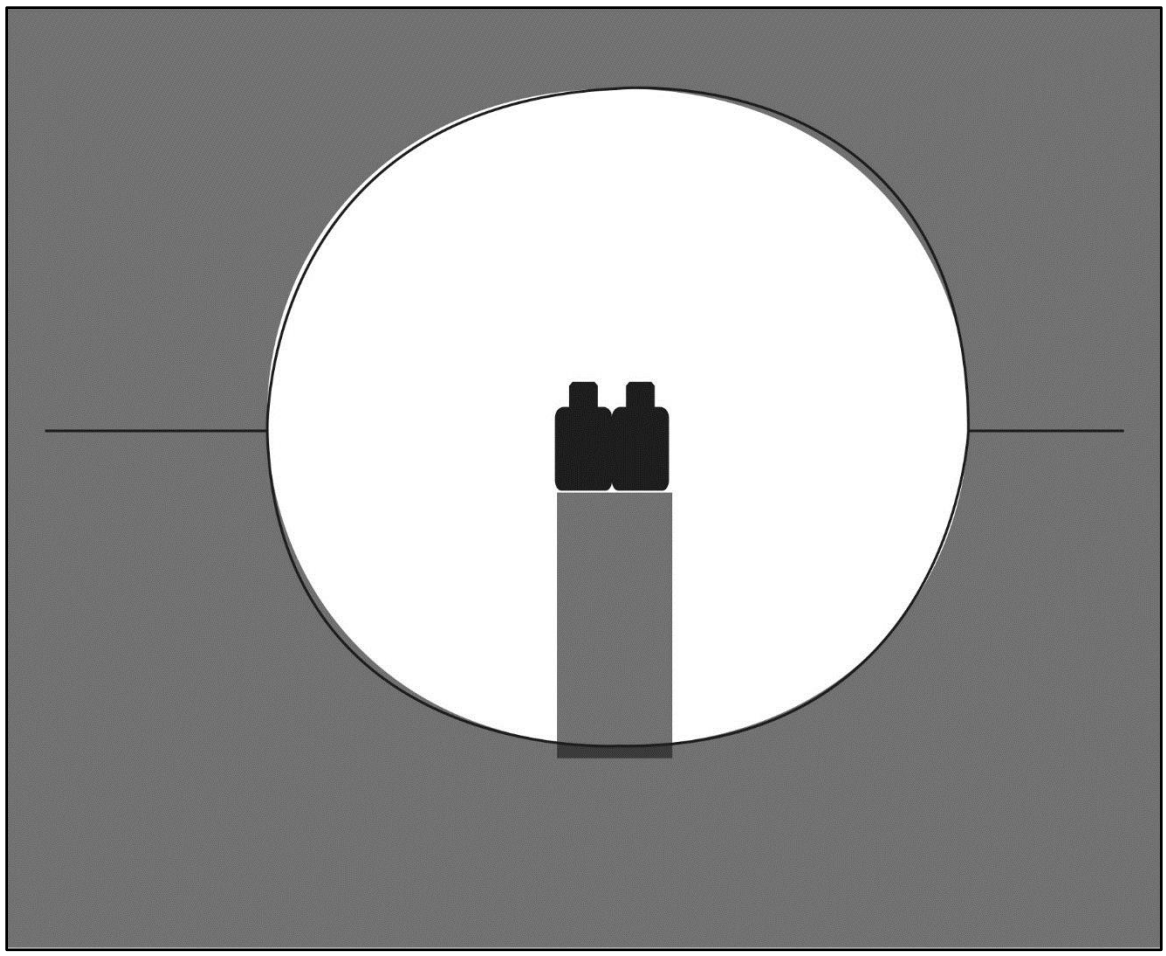


Figure E-6. Sight alignment of double E-type silhouettes at 500 meters

Step 8: Elevation adjustment. If the rounds strike short of the target, adjust the elevation knob on the rear sight up the amount necessary to bring the strike of the round onto target.

If the round was observed as over adjust the elevation knob on the rear sight down the necessary amount to bring the strike of the round onto target. When satisfied with adjustments proceed to step 9 for azimuth adjustments. If azimuth adjustments are unnecessary return to step 1 establish the zero.

Step 9. Azimuth adjustment. If the round strikes to the left or right of the target, turn the windage knob on the rear sight the necessary amount to bring the impact of the rounds onto target. Adjust the rear sight in the opposite direction of the rounds impact. When satisfied with adjustments return to step 1 establish the zero.

Step 10: Confirm zero. Ensure the M2 HB machine gun is in automatic mode. Aim at the center base of the target. Fire a five to seven round burst at the center base of the target. Observe where the burst strikes. If the burst misses the target then return to sight adjustment. If the burst hits the target, then the M2 HB machine gun is zeroed.

Step 11: Record Zero. Record the elevation (range) adjustments by the number of turns up or down. For example, if the sight had to be moved up a total of two turns to achieve a zero then record the zero as UP 2 Turns. To fire at a given range, go to that range, then turn the knob up an additional two turns. Record the windage by unscrewing the windage bar, aligning the zero marks, and then tighten the windage bar.

MARK THE SHOT GROUP

E-23. Shot groups should be marked using different colored markers, if possible, so the gunner can track their progress while conducting 10 meter ranges. Figure E-7 shows a technique for marking shot groups on a zero target. This technique allows the gunner and coach to track their progress throughout the zeroing phase.

E-24. All sight adjustments are from the center of the group, called the mean point of impact (MPI), and not from the location of a single shot. A single shot that is outside of the rest of the group should not be counted in the group for sight adjustment purposes.

Note. Figure E-7 shows the color variations in shades of gray.

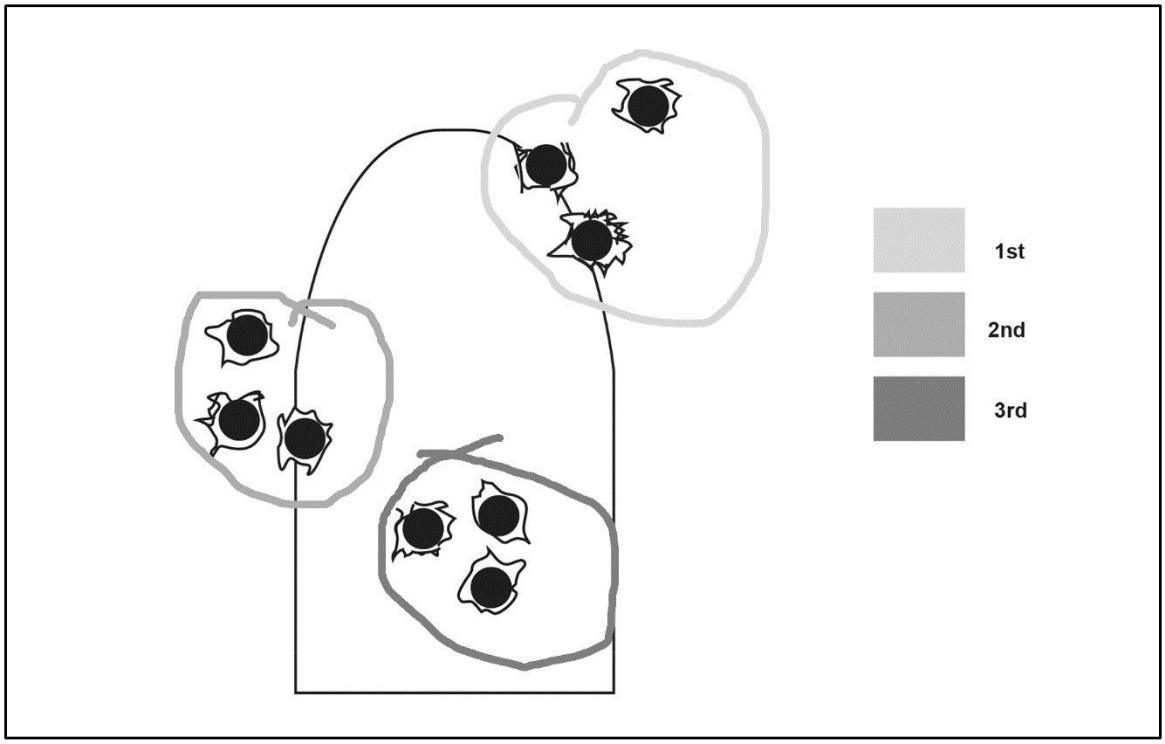


Figure E-7. Marking shot groups

E-25. The gunner fires and marks their first shot group with a colored marker. The color of the first group is noted by placing a line with that marker next to the 1 on the right side of the zero target. Groups are fired and marked until the gunner has completed the zeroing process.

E-26. Each sight adjustment is annotated in the same color as the group that was just fired.

COACHING

E-27. Coaching is the process of having another Soldier observe the gunner during the firing process to look for shooting errors that the gunner themselves may not consciously know they are making.

TYPES OF COACHES

E-28. Firing a machine gun properly requires the consistent and proper application of the elements of employment. It is about doing the right thing, the same way, every shot. The small arms trainer is also the validation point for any questions during employment training. In most cases, once group training is completed, it will be the gunner's responsibility to realize and correct their own firing errors, but this process can be made easier through the use of a coach.

E-29. Two types of coaches exist, the experienced coach and the peer coach. Although each should execute coaching the same way, experienced coaches have a more thorough understanding of employment and should have more knowledge and practice in firing than the Soldiers they are coaching. Knowledge and skill does not necessarily come with rank therefore Soldiers serving as experienced coaches should be carefully selected for their demonstrated firing ability and their ability to convey information to gunners of varying experience levels.

EXPERIENCED COACHES

E-30. Experienced coaches are generally in shorter supply throughout the Army and are generally outnumbered by less skilled gunners. This lack of experienced coaches usually leads to one experienced coach watching multiple gunners dependent upon the table or period of employment being fired. It often helps the experienced coach to make notes of errors they observe in gunners and discuss them after firing that group. It is often difficult for the coach to remember the errors that they observe in every gunner.

PEER COACHES

E-31. Using a peer coach, although generally not as effective as using an experienced coach, is still a very useful technique. The advantage of using a peer coach is two-fold: a peer coach may use their limited knowledge of employment to observe the gunner when an experienced coach is unavailable or occupied with another gunner. A peer coach can either talk the gunner through the shooting errors they have observed, or bring any observed shooting errors to the attention of the experienced coach. The other advantage of using a peer coach is that the peer coach themselves, through the act of coaching, may be able to learn from the mistakes they observe before making the mistakes themselves. Many people learn better when they are coaching others than when they are simply told to do something.

Note. Peer coaches can be limited by their level of training.

E-32. Except for aiming, the coach can observe most of the important aspects of the elements of employment. To determine the unobservable errors of shooting the coach and the gunner must have an open dialog and there must be a relaxed environment for learning. The gunner cannot be hesitant to ask questions of the coach and the coach must not become a stressor during firing. The coach must have the ability to safely move around the gunner to properly observe. There is no one ideal coaching position. The following section will discuss the elements of shooting and how best to observe them as a coach.

STABILIZE

E-33. For the coach to observe how stable the gunner is, they may have to move to different sides of the gunner. To observe the gunner's nonfiring elbow (to ensure it makes contact with the ground), the coach will need to be on the gunner's nonfiring side. The coach should look for all the other aspects of good positions as outlined in chapter 6 of this publication. The coach should also observe the total amount of weapon movement on recoil. A good stable position will have minimal movement under recoil.

AIMING

E-34. Determining the aspects of the gunner's aiming (sight picture, sight alignment, point of focus) requires dialogue between the gunner and the coach. Often, a gunner will not realize their aiming errors until they discover them on their own. A method a coach has to observe aiming errors is to use a locally produced aiming bar to determine where the gunner is aiming on the target, where the gunner is focusing during firing (which should be on the front sight), and where the front sight was at the moment of firing in relation to the rear sight aperture and the point of aim on the target. The technique of having the gunner call their shots should also be used. The technique involves calling the point on the target where the sights were located at the moment of firing and matching the point called with the impact locations on the target. Calling the shot helps the gunner learn to focus on the front sight during the entire firing process.

E-35. When optics are used, the gunner can tell the coach where they were holding. This is of particular importance with the heavy weapon thermal sight. Coaches must ensure the corresponding aim point is used when zeroing at range.

CONTROL

E-36. The ideal position to observe trigger press is from the nonfiring side because the coach will have a better view of the press, thumb position on the trigger, and grip of firing and nonfiring hand. The coach can look from behind the gunner to observe the barrel for lateral movement due to slack in the T&E.

COACHING FACTORS

E-37. All firing happens at the weapon. This means that the coach should focus solely on the gunner during firing and not on what is happening down range. A coach cannot know what errors the gunner made only by observing the bullet's impact on the target. The coach must watch the gunner during firing to determine errors, and then use the impacts to confirm their assumptions.

E-38. For a coach to properly observe all aspects of firing, they must be able to observe the gunner safely from both sides and the back. There is no prescribed coaching position. Coaching requires a relaxed atmosphere with open communication between the gunner and the coach.

SHOT GROUP ANALYSIS

E-39. Whether firing on a 10-meter range or conducting field zero, this requires the gunner to correlate the shots on paper or at the target location, while picturing how the shots looked when fired. Accurate analysis of the shot group requires more than just looking at holes in paper. Observing the gunner is more important than trying to analyze the target. All firing takes place at the weapon. The holes in the paper, the splash of the round, and the tracer are show where the barrel was pointed. To analyze the shots, groups, or bursts, they must ask the gunner about each to see what caused the placement of the shots.

E-40. For example, a gunner who fires a tight group, except for one flyer (a shot that hits well outside the group), should have observed the outlying shot while firing. The gunner would discount this shot when marking their group. If a coach analyzes the group, the gunner reports the poor shot to the coach. (See figure E-8, page E-10.)

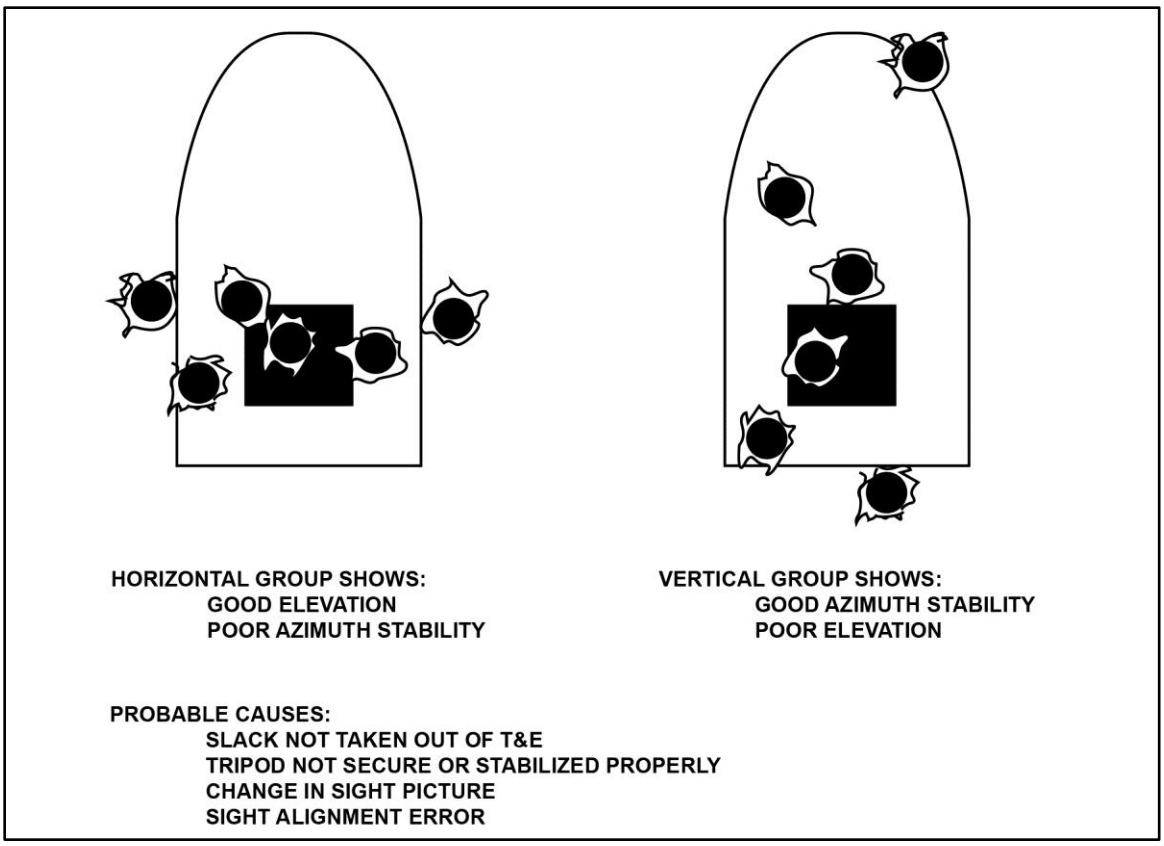


Figure E-8. Horizontal and vertical diagnostic shots

E-41. New or stressed gunners are likely to make unintentional mental adjustments in addition to the mechanical adjustments. This will affect follow-on groups. Experienced gunners rely on zeroing to align the sights to the point of impact. They are less likely than new gunners to adjust their sight placement after firing. Ideally, a coach or employment instructor marks shot groups for the less experienced gunners, and then simply tells the Soldiers what mechanical changes to make to their weapons. This works better than allowing new gunners to mark their own groups.

E-42. For best results, the coach must observe the gunner before analyzing the target. Stringing bullets vertically might not indicate a breathing issue, nor does stringing bullets horizontally indicate a problem with trigger press (figure E-8). Coaches must learn to identify gunners' errors while the gunners are firing, and then use the impact points for confirmation only. Several firing errors can cause certain misplacements of impacts. The coach has to realize that bullets only go where the barrel is pointed. The coach must therefore determine what happened that caused the barrel to point in those directions, and those causes can be many.

E-43. The key to proper coaching is becoming a shooting *detective*. The coach needs to observe the gunner, question the gunner, look at the evidence down range, question the gunner again, make assumptions based on the evidence, and then act on those assumptions. The coach and gunner must have a free and open dialog in a relaxed atmosphere. Remember, if a Soldier learns to shoot poorly, that Soldier will only be able to shoot poorly.

DISPLACEMENT OF SHOTS WITHIN A GROUP (FLYERS)

E-44. The ability of the weapon to shoot groups varies depending on the number of rounds fired through the barrel over its lifetime. The average expected group size is 4 centimeters at 10 meters; some guns may shoot slightly larger than this. If a gunner is firing groups larger than normal group size, a known skilled gunner should fire a group with the gunner's weapon. If that gunner can fire groups of the normal size, the issue is the original gunner. If the skilled gunner also cannot fire within the accepted group size, the issue is probably the gun or barrel.

E-45. When looking at groups where there are one to two shots away from the group body (one shot away for a three round group, one or two shots away for a five round group), the coach must look objectively at the overall consistency of group placement. A bad shot or group might not indicate a poor grasp of the elements. Every gunner has a bad shot now and again. Some gunners even have a bad group now and again. Coaches need to use their experience to determine whether the cause of a bad shot or group is skill or chance. If the coach decides the gunner lacks a clear grasp of the elements, then the coach must take steps to get the gunner to the end state. The coach can ignore the bad shot or group and have the gunner reshoot, hoping the new group matches previous shot groups. Or, the coach might decide to pull the gunner off the line and review the basic elements. Contrary to popular belief, having a gunner shoot over and over again in one sitting, until the gunner gets it right, is not highly effective.

BULLETS DISPERSED LATERALLY ON TARGET

E-46. An unstable position can cause the weapon to move laterally, making the bullets disperse laterally by barrel movement caused of the barrel due to an unstable position. Additional reasons for this could include—

- The gunner may be slightly misaligning the sights to the left and right.
- The gunner may have the sights aligned properly, but have trouble keeping the target perfectly centered on the tip of the front sight.
- The gunner's eyes may be closing at the moment of firing.
- The gunner may be flinching.

BULLETS DISPERSED VERTICALLY ON TARGET

E-47. Bullets could be displaced vertically by—

- The gunner may be vertically misaligning the front sight in the rear sight aperture. This can happen if the gunner watches the target instead of the front sight.
- The gunner is having trouble seeing the target and keeping the tip of the front sight exactly centered vertically on the target.

Note. The coach may consider using a larger target or a nonstandard aiming point such as a 5-inch circle. Many gunners find it easier to find the center of a circle than a man-shaped target.

- The gunner lacks good support, which causes the gunner to adjust position every shot and settle with the sights slightly misaligned.
- The gunner flinches or closes the eyes at the moment of firing.
- The gunner fails to pull the slack out of the T&E during sight alignment or during firing, reducing the stability of the position.

LARGE GROUPS

E-48. The most common cause of large groups is slack in the T&E. Another cause is looking at the target instead of the front sight. This causes the gunner to place the front sight at the center base of the target, without regard for its location in the rear sight aperture. A small misalignment of the sights causes a large displacement of shots downrange.

GOOD GROUPS THAT CHANGE POSITION ON THE TARGET

E-49. When the gunner has good groups, but they are located at different positions on the target, any of several reasons there can be a number of reasons. These include the following:

- May be caused by the gunner properly aligning sights during firing but picking up a different point of aim on the target each time.
- May be caused by the gunner settling into a position with the front sight on target but the sights misaligned. The gunner maintains the incorrect sight picture throughout the group but aligns the sights incorrectly and in a different manner during the next group. Tell the gunner to focus on the front sight and have them check natural point of aim before each group.

This page intentionally left blank.

Appendix F

Qualification

Appendix F covers basic marksmanship training and qualification for the ground-mounted M2 machine gun. The basic marksmanship course of fire relies on ranges with remote control pop-up targets. If these ranges are unavailable, commanders modify the course of fire to meet local conditions. For example, if a range with hard targets, such as hulls, is the only range available for M2 fire, the commander selects targets at ranges that most closely match those listed herein and on Firing Tables I through IV.

Note. Soldiers with mounted caliber .50 machine guns should check the appropriate weapon manual for practice and qualification.

TEN-METER PRACTICE FIRE

F-1. The purpose of 10-meter practice firing table is to develop skills in the accuracy of initial bursts on target and the proper manipulation of the T&E mechanism. Conducted properly, it trains gunners in the basic skills of zeroing, controlling the burst, traversing, and traversing and searching techniques. This paragraph discusses how to fire the 10-meter exercise on the multipurpose transition range. The basic 10-meter range works the same except the groups are divided between the firing lanes. The course fires the tripod-mounted M2. The basic machine gun target is used for all 10-meter fire and it allows four gunners to use it for practice. Table F-1 shows the four tasks that are trained in the 10-meter practice.

Table F-1. Ammunition requirements

Task 1	Twelve single rounds
Task 2	Two 7-round belts
Task 3	One 35-round belt
Task 4	One 56-round belt

TASKS

F-2. There are four tasks in the 10-meter practice fire (see figure F-1, page F-2):

Task 1—Zero

F-3. The gunner fires single shots to determine their weapon's zero for 10 meters. This task reinforces the dry-fire experience and allows the gunner to practice loading, while providing an accurate and tight shot group.

Task 2—Point Targets, Controlled-Burst Fire

F-4. Using point targets, the gunner fires bursts of five to seven rounds. This task exposes the gunner to automatic fire and the action of the weapon and at the same time introduces trigger control.

Task 3—Traverse and Search Fire

F-5. The traverse and search fire task requires the gunner to make body position changes or manipulate the T&E mechanism to engage area targets in-depth, to use controlled-burst firing, and to use a series of aiming points to disburse fire across the target.

Task 4—Traverse and Search Fire

F-6. The traverse and search fire task requires the gunner to make position changes or manipulate the T&E mechanism to engage linear targets with depth, to use controlled-burst firing, and to use a series of aiming points to disburse fire across the target.

BASIC MACHINE GUN TARGET

F-7. The basic machine gun target (NSN 6920-078-5128) is used for these exercises (see figure F-1). The following explanation of the target, including of the size of the aiming pasters and scoring spaces, will aid in zeroing the M2 and will facilitate control during firing exercises. The target has four sections, A through D. Each of these has four point targets numbered 1 through 4 (traversing), and two sets of two area targets numbered 5 through 8 (traversing and searching). Each scoring space measures 4 centimeters wide and 5 centimeters high. The black aiming pasters in some of the numbered scoring spaces measure 1 centimeter square.

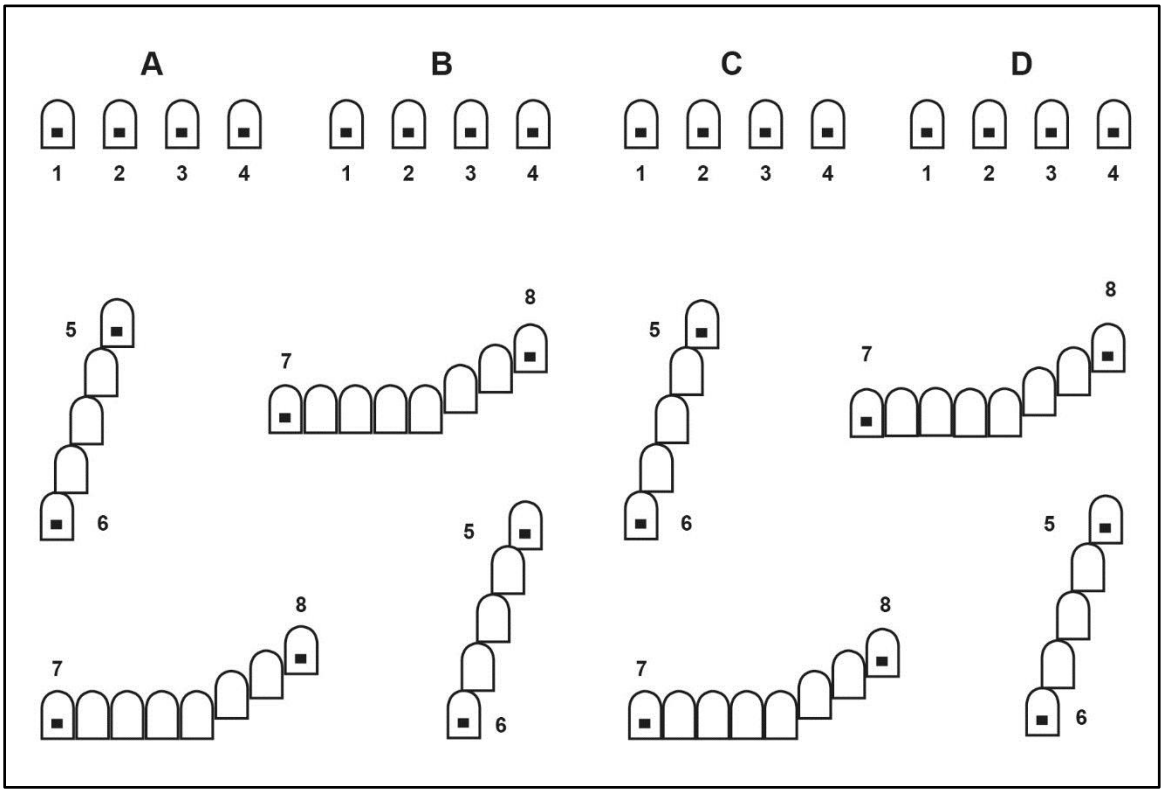


Figure F-1. Basic machine gun target

Point Targets

F-8. Point targets on the basic machine gun target are considered to be pasters 1 through 4 of section A, B, C, and D. Firing at point targets exposes the gunner to zeroing techniques and controlled-burst fire techniques. Targets 1 through 4 are also used as linear targets for qualification.

Area Targets

F-9. Area targets on the basic machine gun target are pasters 5 through 6, and 7 through 8 of sections A, B, C, and D. Target groups 5 through 6 expose the gunner to T&E manipulation when using the tripod mount. The gunner's body position changes to engage targets in-depth (elbow position changes). They cause the gunner to use a series of aiming points to disburse fire across the target when using the tripod. Target group 7 through 8 expose the gunner to position changes to engage linear targets with depth. They cause the gunner to control the burst length from the weapon, use a series of aiming points, and disburse fire across the target.

Score

F-10. Targets are analyzed and scored to determine the gunner's proficiency and to see if more training is needed in any of the engagement techniques of M2 gunnery. During firing with a properly zeroed weapon, a target is best analyzed by considering the common errors of M2 gunnery (see figure F-2).

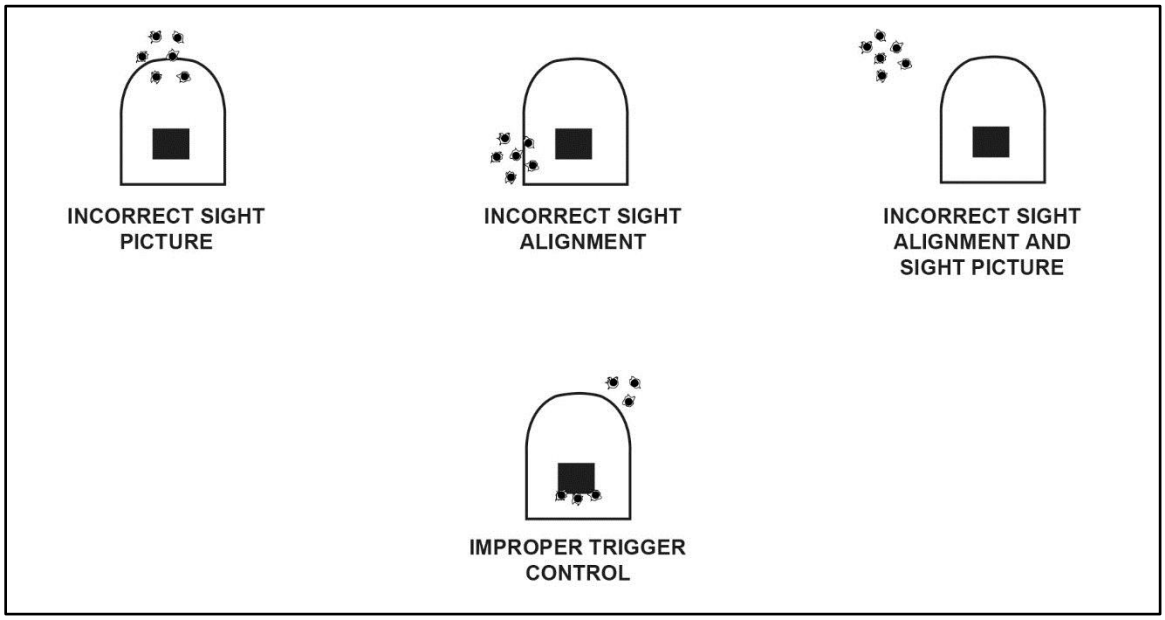


Figure F-2. Common errors found on the basic machine gun target

OBJECTIVE

F-11. The following objectives must be considered for the M2 gunner to become proficient with the machine gun:

- Obtain an accurate initial burst.
- Master the technique of controlled-burst firing.
- Traverse and search the machine gun effectively.
- Observe and adjust fire.

ORGANIZATION

F-12. The unit is organized into groups of ten. Each group is assigned a firing order number. One order becomes gunners and the other assistant gunners. The gunners and assistant gunners are assigned lanes and required to set up their guns and perform prefire checks.

AMMUNITION

F-13. The ammunition for the firing of this exercise will be broken down at the ammunition point and issued to each assistant gunner as they are assigned a firing point (see table F-2, page F-4). The total ammunition for this exercise is 117 rounds (12 for zero and 91 for practice). Issue will consist of the following rounds or belts:

POSITION

F-14. Based on the unit's METT-TC, the commander determines whether to use the prone or fighting position for the 10-meter practice.

ASSISTANT GUNNER PRACTICE

F-15. After the gunner has completed firing, the gunner and the assistant gunner exchange positions. Then the assistant gunner fires the same 10-meter practice and qualification tasks as the gunner, but at the pasters on section B.

Table F-2. 10-Meter Practice Fire

10-METER PRACTICE FIRE (Prone or Fighting Position)					
Task	**Time**	**Rounds**	**Type**	**Target**	**Type Fire**
1	No limit	12	Ball	Pasters A1 and A2	12 single rd (zero).
2	No limit	14	Ball	Pasters A3 and A4	Controlled bursts: 5- to 7-rd bursts
3	No limit	35	Ball	Pasters A5 thru A6	Traverse and search: area targets in-depth. 5- to 7-rd bursts
4	No limit	56	Ball	Pasters A7 thru A8	Traverse and search: linear targets with depth. 5- to 7-rd bursts
Note. The gunner fires pasters on section A and the assistant gunner on section B.					

FIRING SEQUENCE

F-16. Firing of the 10-meter practice is conducted in the following sequence. These procedures pertain to firing with a single gunner using section A and the assistant gunner using section B.

Note. These tasks are fired from the tripod firing position. If the gunner has difficulty in manipulating the weapon, remove them from the firing line and give them remedial training.

Task 1—Zero

F-17. If the gunner should zero their weapon in 9 rounds, they use the remaining 3 rounds to confirm their zero. If the gunner is unable to zero in 12 rounds, they are removed from the firing line for remedial training. Once the gunner and assistant gunner are in position, the tower operator instructs the team to prepare to fire by the command CONTACT. At the command CONTACT, the machine gun crew places the machine gun into action (tripod mode). The gunner prepares the rear sight for zeroing and checks the front sight. The gunner assumes a good tripod position. The tower operator instructs the gunner to prepare a single round. The following fire command is given. The gunner and assistant gunner repeat each element of the fire command as it is given:

FIRE MISSION..... (The gunner loads)
FRONT..... (The gunner focuses on the target or target area)
PASTER A1 .....(The gunner locates target)
ONE THOUSAND .....(The gunner adjusts sights and acquires the sight picture)
FIXED, ONE ROUND..... (The gunner is given the method of fire)
COMMENCE FIRING.....(The gunner fires on command from tower operator, when ready)

F-18. The gunner loads one round, obtains the proper sight picture, and gives an UP to the assistant gunner. The assistant gunner relays the READY signal to the tower operator. At the command to commence firing, the gunner engages paster A1 with three single shots when ready. The gunner moves downrange to observe, mark, and triangulate the shot group. No adjustments to the weapon will be made at this time. The tower

operator repeats the fire command and the gunner then fires three more single rounds at A1. The gunner goes downrange to observe the shot group, triangulates it, returns to the firing line, and makes necessary adjustments to their weapon. The steps above are repeated, but the gunner fires at paster A2 and adjusts their sights if necessary after each shot group is fired.

DANGER

Before any gunner goes downrange, the lane noncommissioned officer must ensure that the weapon has been properly cleared. Anyone observing any unsafe acts should immediately call a cease fire and notify range personnel.

Task 2—Controlled-Burst Fire

F-19. Using point targets, the gunner fires bursts of five to seven rounds. The tower operator instructs the gunner to prepare two seven-round belts of ammunition. When the fire command is given, the gunner and assistant gunner repeat each element as it is given:

FIRE MISSION
FRONT
PASTER A3
ONE THOUSAND
FIXED, FIVE TO SEVEN ROUNDS
AT MY COMMAND

F-20. The gunner acquires the proper sight picture and gives an UP to the assistant gunner. The assistant gunner relays the READY signal to the tower operator. The tower operator gives the command to FIRE. The gunner engages paster A3, firing five- to seven-round bursts. The gunner and assistant gunner will then move down range to observe and analyze their targets. The tower operator and gunner repeat the process but fire at paster A4.

Task 3—Traverse and Search

F-21. The gunner is required to manipulate the T&E mechanism to engage area targets in-depth. The tower operator instructs the assistant gunner to prepare a 35-round belt. When the fire command is given, the gunner and assistant gunner repeat each element as it is given:

FIRE MISSION
FRONT
PASTERS A5 THROUGH A6
ONE THOUSAND
TRAVERSE AND SEARCH, FIVE TO SEVEN ROUNDS
AT MY COMMAND

F-22. The gunner acquires the proper sight picture and gives an UP to the assistant gunner. The assistant gunner relays the READY signal to the tower operator.

F-23. The tower operator gives the command to FIRE. The gunner engages pasters A5 through A6, firing a five- to seven-round burst at each paster, using the traverse and search technique. The gunner and assistant gunner will then move down range to observe and analyze the targets.

Task 4—Traverse and Search

F-24. The gunner has to manipulate the T&E mechanism to engage linear targets with depth. The tower operator instructs the gunner to prepare a 56-round belt. When the fire command is given, the gunner and assistant gunner repeat each element as it is given:

FIRE MISSION
FRONT
PASTERS A7 THROUGH A8
ONE THOUSAND
TRAVERSE AND SEARCH, FIVE TO SEVEN ROUNDS
AT MY COMMAND

F-25. The gunner acquires the proper sight picture and gives an UP to the assistant gunner. The assistant gunner relays the READY signal to the tower operator. The tower operator gives the command to FIRE. The gunner engages pasters A7 through A8, firing five- to seven-round bursts, using the search and traverse technique. The gunner and assistant gunner move downrange to observe and analyze the targets.

FIRING TABLE I, DAY PRACTICE (MOUNTED OR DISMOUNTED, PRONE OR FIGHTING POSITION)

F-26. Day firing of the M2 machine gun teaches the gunner techniques of fire that they will use in combat situations. Within this training, the gunner is required to apply all the engagement techniques of gunnery learned in preparatory gunnery training and 10-meter firing.

F-27. Day practice consists of eight engagements: engagement one is the field zero of the machine gun, and the other engagements are a series of timed target exposures. The gunner can fire up to two five- to seven-round bursts at each target. Instructors should encourage gunners to perform immediate action if a stoppage occurs during fire. This procedure may be modified if local policies require the gunners to notify the range personnel first.

OBJECTIVES

F-28. The objectives of day fire are to—

- Field zero the M2 machine gun.
- Engage targets with the tripod- or vehicle-mounted machine gun.
- Use range estimation to determine the distance to targets.
- Apply the method of adjusted point of aim.
- Familiarize the gunner with engagements in an NBC environment.

ORGANIZATION

F-29. Organization of a unit for transition firing is conducted the same as for 10-meter firing. The day practice course is fired prior to day qualification.

AMMUNITION

F-30. The ammunition for the firing of this exercise will be broken down at the ammunition point and issued to each assistant gunner as they are assigned a firing point. The total ammunition for this exercise is 140 rounds.

STOPPAGE

F-31. If a stoppage occurs, the gunner does the following:

- If a stoppage occurs, the gunner must apply immediate action. If the stoppage is reduced, the gunner continues to fire the course as follows:
- If a stoppage occurs that cannot be reduced by immediate action, the gunner raises their hand and awaits assistance.

- Once the stoppage is reduced, the gunner completes firing beginning with the next task.
- If a stoppage is caused by an error on the part of the gunner, additional time is not permitted. The gunner receives the score they earned before the stoppage occurred.
- If it is necessary to replace the machine gun, the gunner must zero the new weapon. The gunner can fire the exercise again.
- Gunners who cannot fire a task or cannot complete firing in the time allowed (due to malfunctions) can finish the exercise in an alibi run after all other gunners complete firing. They fire only those tasks they failed to engage due to the malfunctions.

POSITION

F-32. The commander, based on their unit's METT-TC, determines whether the mounted or dismounted prone or the fighting position is used for the 10-meter practice.

ENGAGEMENTS

F-33. Firing Table I is conducted in accordance with table F-3 below. It is recorded on DA Form 7448, *M2 Caliber .50 Heavy Barrel Machine Gun Firing Table I, Day Practice Scorecard (Mounted or Dismounted, Prone or Fighting Position)*. Each gun has a gunner and an assistant gunner. The gunner can fire up to two, five- to seven-round bursts at each target. If the gunner hits the target with the first burst, they do not fire at that target with a second burst. Once the gunner completes Firing Table I, they switch with the assistant gunner and the engagements are repeated. (DA Form 7448 is available at the Army Publishing Directorate, http://armypubs.army.mil.)

Table F-3. Firing Table I, Day Practice

FIRING TABLE I, DAY PRACTICE (Mounted or Dismounted, Prone or Fighting Position)					
Engagement	**Time (Minutes)**	**Rounds**	**Target**	**Range**	**Type Fire**
Zero	No limit	14	Double E	500	Fixed, single shot, three round shot groups (field zero)
2	1.5	14	Double E	1100	Fixed, 5- to 7-round burst
3	1.5	14	Double E	1500	Fixed, 5- to 7-round burst
4	1.5	14	Double E	600	Fixed, 5- to 7-round burst
5	1.5	14	Double E	800	Fixed, CBRN, 5- to 7-round burst
6	1.5	14	Single E	400	Fixed, CBRN, 5- to 7-round burst
7	2.5	28	Double E Double E	1100 600	Fixed, 5- to 7-round burst
8	2.5	28	Double E Double E	800 1500	Fixed, 5- to 7-round burst

FIRING SEQUENCE

F-34. Firing Table I will be conducted in the following manner. These procedures pertain to firing with the gunner using section A and the assistant gunner using section B of the scorecard (see figure F-3, page F-10).

Note. If the gunner has difficulty in manipulating the weapon, remove them from the firing line and give them remedial training.

Engagement 1, Field Zero: 500-Meter, Double E-Type Silhouette

F-35. Once the gunner and assistant gunner are in position, the tower operator instructs the team to prepare to fire by the command, CONTACT. At the command CONTACT, the machine gun crew places the machine gun into action. The following fire command is given. The gunner and assistant gunner repeat each element of the fire command as it is given:

FIRE MISSION ..... (The gunner loads.)
FRONT ..... (The gunner focuses on the target or target area.)
TROOPS
FIVE HUNDRED .....(The gunner adjusts sights and acquires the sight picture.)
FIXED, ONE ROUND ..... (The gunner is given the method of fire.)
COMMENCE FIRING.... (The gunner fires when ready after this command from the tower operator.)

F-36. The assistant gunner loads the 14-round belt of ammunition and the gunner fires three rounds in the single shot setting mode at the 500-meter, Double E-type silhouette. If the gunner hits the target, they confirm their zero by firing at the same target with a second burst in the automatic setting. If the gunner misses:

F-37. If the impact is over the target, the gunner has probably fired with an incorrect sight picture (too high on the target). The gunner relays the gun on the original point of aim and then fires again. If the gunner again fails to zero with a proper sight picture, they should make necessary adjustments to the sights according to zeroing procedures. The gunner observes the beaten zone and adjusts the sights. After adjusting, the gunner relays on the center base of the target and fires another three rounds in the single shot setting. The gunner can also use the adjusted aiming point method of fire adjustment. If the gunner hits the target, they confirm their zero by firing at the same target with the remaining ammunition in the automatic setting.

Note. If the gunner is unable to zero within 14 rounds, they are removed from the firing line and given remedial training.

Engagement 2 through Engagement 8: Single and Multiple Engagements

F-38. Engagements 2 through 8 are initiated by a single fire command. The gunner loads the gun, observes their lane, and fires as the targets appear. If the gunner hits the target with the first burst, they wait and fire at the next target. If the gunner misses with the first burst, they should re-lay and fire a second burst. The gunner can fire up to two bursts at a single target. The assistant gunner is issued 126 rounds and loads as required. When the fire command is given as listed below, the gunner and assistant gunner repeat each element as it is given. It is only given once for engagements 2 through 8.

FIRE MISSION
FRONT
TARGET: TROOPS
FOUR HUNDRED TO FIFTEEN HUNDRED METERS
FIXED, FIVE- TO SEVEN-ROUND BURST
AT MY COMMAND

F-39. The gunner gives an UP to the assistant gunner. The assistant gunner gives the READY signal to the tower operator. The tower operator gives the command FIRE. For each engagement, the gunner scans the sector, acquires the target, sets the sights and fires one or two bursts for each target. If the gunner misses with the first burst, they make the same type of adjustments as in engagement one and fires again. After firing is completed, weapons are cleared and the gunner critiqued. The entire procedure is repeated for the second gunner.

Notes. 1. The 1100- and 1500-meter targets may be either double E-type silhouettes or stationary armor targets.

2. Engagements 5 and 6 will be conducted with the gunner wearing the individual protective mask and chemical gloves. A signal will be given to signify the gunner is under an NBC attack. The trainer must allow enough time for the soldier to don this equipment. Target exposure time will be adjusted to allow this task to take place.

Engagement 2: 1100-Meter, Double E-Type Silhouette

F-40. An 1100-meter, double E-type target is exposed for 1.5 minutes.

Engagement 3: 1500-Meter, Double E-Type Silhouette

F-41. A 1500-meter, double E-type target is exposed for 1.5 minutes.

Engagement 4: 600-Meter, Double E-Type Silhouette

F-42. A 600-meter, double E-type target is exposed for 1.5 minutes. After engagement 4, the gunner dons protective gear.

Engagement 5: 800-Meter, NBC, Double E-Type Silhouette

F-43. An 800-meter, double E-type target is exposed for 1.5 minutes.

Engagement 6: 400-Meter, NBC, Single E-Type Silhouette

F-44. A 600-meter, double E-type target is exposed for 1.5 minutes. After completing engagement 6, the gunner removes the protective gear.

Engagement 7: 1100-Meter and 600-Meter, Double E-Type Silhouettes

F-45. Both 1100- and 600-meter double E-type targets are exposed for 2.5 minutes. The gunner can fire up to two bursts at each target.

Engagement 8: 800-Meter and 1500-Meter Double E-Type Silhouettes

F-46. Both 800- and 1500-meter double E-type targets are exposed for 2.5 minutes. The gunner can fire up to two bursts at each target.

SCORING

F-47. Even though Firing Table I is practice, it is scored to provide feedback to the gunner. Use DA Form 7448 to record the scores. (Figure F-3, page F10, shows an example of a completed scorecard.)

Note. After both gunners have fired for practice, they will be assigned new lanes and issued more ammunition for record firing. If possible, the gunner should keep the same weapon they used for practice fire.

DANGER

Before any gunner changes lanes, the lane noncommissioned officer must ensure that the weapon has been properly cleared. Anyone observing any unsafe acts should immediately call a cease fire and notify range personnel.

M2 CALIBER .50 HEAVY BARREL MACHINE GUN FIRING TABLE I, DAY PRACTICE SCORECARD
(MOUNTED OR DISMOUNTED, PRONE OR FIGHTING POSITION)
For use of this form, see TC 3-22.50; the proponent agency is TRADOC.

1a. LAST NAME	1b. FIRST NAME	1c. MI	2. RANK
DOE	JOHN	A	PFC

3. DATE *(YYYYMMDD)*	4. UNIT	5. RANGE	6. LANE
20170401	2/29TH INF	RUTH	4

7a. ENGAGEMENT	7b. STANDARDS	7c. AMMO	7d. TIME *(Minutes)*	7e. RANGE *(Meters)*	7f. GO	7g. NO GO
ZERO	1 BURST HIT	14	NA	500	NA	NA
2	1 BURST HIT	14	1.5	1,100 (±200)	☒	☐
3	1 BURST HIT	14	1.5	1,500 (±200)	☒	☐
4	1 BURST HIT	14	1.5	600 (±100)	☒	☐
5 (NBC)	1 BURST HIT	14	1.5	800 (±100)	☒	☐
6 (NBC)	1 BURST HIT	14	1.5	400	☒	☐
8. MULTIPLE TARGETS						
7	1 BURST HIT	28	2.5	1,100 (±200)	☒	☐
	1 BURST HIT			600 (±100)	☒	☐
8	1 BURST HIT	28	2.5	800 (±100)	☒	☐
	1 BURST HIT			1,500 (±200)	☒	☐

9. SCORING *(Check one)*

EXPERT - 9 ☒ SHARPSHOOTER - 8 ☐

MARKSMAN - 6 ☐ UNQUALIFIED - 5 OR BELOW ☐

10. GUNNER'S SIGNATURE

John Doe

11a. GRADER'S PRINTED OR TYPED NAME	11b. GRADER'S SIGNATURE
SSG ISAAC M. SOLDIER	I. M. Soldier

DA FORM 7448, APR 2017 PREVIOUS EDITIONS ARE OBSOLETE. APD LC v1.00ES

Figure F-3. Completed DA Form 7448, example

FIRING TABLE II, DAY QUALIFICATION (MOUNTED OR DISMOUNTED, PRONE OR FIGHTING POSITION)

F-48. Day qualification is conducted and fired the same as the day practice.

OBJECTIVES

F-49. The objective of day fire qualification is to test the gunner's knowledge of machine gun fire and the skills they learned during the 10 meter and practice live fire. It also provides additional live-fire experience for the gunner.

ENGAGEMENTS

F-50. Firing Table II is conducted in accordance with table F-4 below. Each gun has a gunner and an assistant gunner. The gunner can fire up to two, five- to seven-round bursts at each target. If the gunner hits the target with the first burst, they do not fire at that target with a second burst. Once the gunner completes Firing Table II, they switch with the assistant gunner and the engagements are repeated.

SCORING

F-51. Firing Table II is recorded on DA Form 7449, M2 Caliber .50 Heavy Barrel Machine Gun Firing Table II, Day Qualification Scorecard (Mounted or Dismounted, Prone or Fighting Position). The maximum possible score is nine target hits (GOs) and the minimum qualifying score is six target hits (GOs). The gunner must qualify in both the day and the night qualification tables to receive an overall qualification. Use DA Form 7449 to record the scores. Figure F-4, page F-12, shows an example completed scorecard. (DA Form 7449 is available at the Army Publishing Directorate, http://armypubs.army.mil.)

Table F-4. Firing Table II, Day Qualification

FIRING TABLE II, DAY QUALIFICATION (Mounted or Dismounted, Prone or Fighting Position)					
Engagement	**Time (Minutes)**	**Rounds**	**Target**	**Range**	**Type Fire**
Zero	No limit	14	Double E	500	Fixed, single shot, three round shot groups (field zero)
2	1.5	14	Double E	1100	Fixed, 5- to 7-round burst
3	1.5	14	Double E	1500	Fixed, 5- to 7-round burst
4	1.5	14	Double E	600	Fixed, 5- to 7-round burst
5	1.5	14	Double E	800	Fixed, CBRN, 5- to 7-round burst
6	1.5	14	Single E	400	Fixed, CBRN, 5- to 7-round burst
7	2.5	28	Double E Double E	1100 600	Fixed, 5- to 7-round burst
8	2.5	28	Double E Double E	800 1500	Fixed, 5- to 7-round burst

M2 CALIBER .50 HEAVY BARREL MACHINE GUN FIRING TABLE II, DAY QUALIFICATION SCORECARD (MOUNTED OR DISMOUNTED, PRONE OR FIGHTING POSITION)

For use of this form, see TC 3-22.50; the proponent agency is TRADOC.

1a. LAST NAME	1b. FIRST NAME	1c. MI	2. RANK
DOE	JOHN	A	PVT

3. DATE *(YYYYMMDD)*	4. UNIT	5. RANGE	6. LANE
20170401	2/29TH INF	RUTH	4

7a. ENGAGEMENT	7b. STANDARDS	7c. AMMO	7d. TIME *(Minutes)*	7e. RANGE *(Meters)*	7f. GO	7g. NO GO
ZERO	1 BURST HIT	14	NA	500	NA	NA
2	1 BURST HIT	14	1	1,100 (±200)	☐	☒
3	1 BURST HIT	14	1	1,500 (±200)	☒	☐
4	1 BURST HIT	14	1	600 (±100)	☒	☐
5 (NBC)	1 BURST HIT	14	1	800 (±100)	☒	☐
6 (NBC)	1 BURST HIT	14	1	400	☒	☐
8. MULTIPLE TARGETS						
7	1 BURST HIT	28	2	1,100 (±200)	☒	☐
	1 BURST HIT			600 (±100)	☒	☐
8	1 BURST HIT	28	2	800 (±100)	☒	☐
	1 BURST HIT			1,500 (±200)	☒	☐

9. **SCORING** ***(Check one)***

EXPERT - 9 ☐ SHARPSHOOTER - 8 ☒

MARKSMAN - 6 ☐ UNQUALIFIED - 5 OR BELOW ☐

10. GUNNER'S SIGNATURE: John Doe

11a. GRADER'S PRINTED OR TYPED NAME	11b. GRADER'S SIGNATURE
SSG ISAAC M. SOLDIER	I. M. Soldier

DA FORM 7449, APR 2017 PREVIOUS EDITIONS ARE OBSOLETE. APD LC v1.00ES

Figure F-4. Completed DA Form 7449, example.

FIRING TABLE III, NIGHT PRACTICE (MOUNTED OR DISMOUNTED, PRONE OR FIGHTING POSITION)

F-52. Night or limited visibility firing requires the Soldier to apply the techniques of gunner marksmanship while using night sights. This training instills confidence in the machine gunner. Each Soldier learns how to engage targets using a night sight, and learns how to fire in NBC conditions. Finally, they learn to detect and engage a series of targets at various ranges with the vision device. Night firing exercises can be conducted during daylight with the AN/TVS-5 when the daylight cover is used. Firing Table III is conducted according to table F-5 (see below). It is recorded on DA Form 7450, *M2 Caliber .50 Heavy Barrel Machine Gun Firing Tables III(A) and III(B), Night Practice Scorecards (Mounted or Dismounted, Prone or Fighting Position)*. (This form is available at the Army Publishing Directorate, http://armypubs.army.mil.)

USE OF FIRING TABLE III(A) OR (B)

F-53. Firing Table III has two sections. Gunners fire one, not both.

Firing Table III(A)

F-54. Firing Table III(A) is used when the M2 is mounted with the TWS or the AN/TVS-5 with the third generation tube.

Firing Table III(B)

F-55. Firing Table III(B) is used when the M2 is mounted with the AN/TVS-5 without the third generation tube. Due to the decreased range of this night vision sight, Firing Table III(B) does not include a 1500-meter target.

Table F-5. Firing Table III, Night Practice

FIRING TABLE III, NIGHT PRACTICE (Mounted or Dismounted, Prone or Fighting Position)						
Engagement	Time (Minutes)	Rounds	Target	Range		Type Fire
				A	B	
Zero	No Limit	14	Double E	500	500	Fixed, single shot, three round shot groups (field zero)
2	1.5	14	Double E	1100	1100	Fixed, 5- to 7-round burst
3	1.5	14	Double E	1500	800	Fixed, 5- to 7-round burst
4	1.5	14	Double E	800	800	Fixed, 5- to 7-round burst
5	1.5	14	Double E	600	600	Fixed, NBC, 5- to 7-round burst
6	1.5	14	Single E	400	400	Fixed, NBC, 5- to 7-round burst
7	2.5	28	Double E Double E	1100 600	1100 600	Fixed, 5- to 7-round burst
8	2.5	28	Double E Double E	800 1500	800 600	Fixed, 5- to 7-round burst

TIME AND AMMUNITION

F-56. Single targets are exposed for 1.5 minutes and multiple targets are exposed for 2.5 minutes. Firing Table III uses 140 rounds.

STOPPAGE

F-57. If a stoppage occurs, the gunner must apply immediate action. If the stoppage is reduced, the gunner continues to fire the course.

F-58. If a stoppage occurs that cannot be reduced by immediate action, the gunner raises their hand and awaits assistance.

F-59. Once the stoppage is reduced, the gunner completes firing beginning with the next task.

F-60. If a stoppage is caused by an error on the part of the gunner, additional time is not permitted. The gunner receives the score they earned before the stoppage occurred.

F-61. If it is necessary to replace the machine gun, the gunner must zero the new weapon. The gunner can fire the exercise again.

F-62. Gunners who cannot fire a task or cannot complete firing in the time allowed (due to malfunctions) can finish the exercise in an alibi run after all other gunners complete firing. They fire only those tasks they failed to engage due to the malfunction.

POSITION

F-63. Based on their unit's METT-TC, the commander determines whether the practice and qualification will be conducted from the dismounted or mounted platform.

CONDITIONS

F-64. Firing Table III (table F-5) is used for engaging targets out to 1500 meters for the upgraded AN/TVS-5 night vision sight and the AN/PAS-13B (V) 3 heavy weapon thermal sight, and 1100 meters for the non-improved AN/TVS-5 night vision sight. If visibility is limited because of a lack of ambient light, commanders may use field-expedient means to identify targets. Commanders may also have to substitute targets if the far targets cannot be seen with the sights.

FIRE CONTROL

F-65. Controlling M2 firing and ensuring that gunners fire at targets within their lane is more difficult during limited visibility. The range officer in charge may consider the following methods to reduce gunner confusion.

- Have gunners fire on every other lane.
- Expose the targets one at a time prior to firing.

ADJUSTMENT OF FIRE AND THE USE OF TRACER

F-66. Gunners will probably not see the impact of the rounds if they miss the target. They have to use the tracer to sense the location of the burst's impact and use the adjusted point of aim method to bring the next burst onto the target.

FIRING SEQUENCE

F-67. Firing Table III is conducted in the same manner as the day practice. Ranges for the section B targets are in parenthesis. After firing is completed, weapons will be cleared and the gunner critiqued. The entire procedure is repeated for the second gunner.

Engagement 1, Field Zero, 500-Meter, Double E-Type Silhouette

F-68. Once the gunner and assistant gunner are in position, the tower operator instructs the team to prepare to fire by the command CONTACT. At the command CONTACT, the machine gun crew places the machine gun into action. The following fire command is given. The gunner and assistant gunner repeat each element of the fire command as it is given:

FIRE MISSION .....(The gunner loads.)
FRONT ..... (The gunner focuses on the target or target area.)
TROOPS
FIVE HUNDRED .....(The gunner adjusts sights and acquires the sight picture.)
FIXED, SINGLE ROUND ..... (The gunner is given the method of fire.)
COMMENCE FIRING.... (The gunner fires when ready after this command from the tower operator.)

F-69. The assistant gunner loads the 14-round belt of ammunition and the gunner fires three rounds in the single shot setting mode at the 500-meter, double E-type silhouette. If the gunner hits the target, they confirm their zero by firing at the same target with a second burst in the automatic setting. If the gunner misses:

F-70. The gunner uses the tracer and observed impact to sense the location of the mean point of impact and adjusts their point of aim. The gunner fires another three rounds in the single shot setting mode and makes subsequent adjustments as necessary. If the gunner hits the target, they confirm their zero by firing at the same target with the remaining ammunition in the automatic setting.

Note. If the gunner is unable to zero within 14 rounds, they are removed from the firing line and given remedial training.

Engagements 2 through 8, Single and Multiple Engagements

F-71. Engagements 2 through 8 are initiated by a single fire command. The gunner loads the gun, observes their lane, and fires as the targets appear. If the gunner hits the target with the first burst, they wait to fire at the next target. If the gunner missed with the first burst, they should re-lay and fire a second burst. The gunner can fire up to two bursts at a single target. The assistant gunner is issued 126 rounds and loads them as required. When the fire command is given, the gunner and assistant gunner repeat each element as it is given (it is only given once for engagements 2 through 8):

FIRE MISSION
FRONT
TARGET: TROOPS
FOUR HUNDRED TO FIFTEEN HUNDRED ..... (ELEVEN HUNDRED) METERS
FIXED, FIVE- TO SEVEN-ROUND BURST
AT MY COMMAND

F-72. The gunner gives an UP to the assistant gunner. The assistant gunner gives the READY signal to the tower operator. The tower operator gives the command FIRE. For each engagement, the gunner scans the sector, acquires the target, estimates the range, adjusts their point of aim, and fires one or two bursts for each target. If the gunner misses with the first burst, they make the same type of adjustments as in engagement one and fire again.

Notes. 1. The 1100- and 1500-meter targets may be either double E-type silhouettes or stationary armor targets.

2. Engagements 5 and 6 are conducted with the gunner wearing the individual protective mask and chemical gloves. A signal will be given to signify the gunner is under an NBC attack. The trainer must allow enough time for the soldier to don this equipment. Target exposure time will be adjusted to allow this task to take place.

Engagement 2: 1100-Meter, Double E-Type Silhouette

F-73. An 1100-meter, double E-type target is exposed for 1.5 minutes.

Engagement 3: 1500 (800)-Meter, Double E-Type Silhouette

F-74. A 1500 (800)-meter, double E-type target is exposed for 1.5 minutes.

Engagement 4: 800-Meter, Double E-Type

F-75. A 600-meter, double E-type target is exposed for 1.5 minutes. After engagement 4, the gunner dons protective gear.

Engagement 5: 600-Meter, NBC, Double E-Type Silhouette

F-76. An 800-meter, double E-type target is exposed for 1.5 minutes.

Engagement 6: 400-Meter, NBC, Single E-Type Silhouette

F-77. A 600-meter, double E-type target is exposed for 1.5 minutes. After completing engagement 6 the gunner removes the protective gear.

Engagement 7: 1100-Meter and 600-Meter, Double E-Type Silhouettes

F-78. Both 1100- and 600-meter double E-type targets are exposed for 2.5 minutes. The gunner can fire up to two bursts at each target.

Engagement 8: 800-Meter and 1500 (600)-Meter Double E-Type Silhouettes

F-79. Both 800- and 1500 (600)-meter double E-type targets are exposed for 2.5 minutes. The gunner can fire up to two bursts at each target.

SCORING

F-80. Even though Firing Table III is practice, it is scored to provide feedback to the gunner. Use DA Form 7450 to record the scores. (Figure F-5, page F-17, shows an example of a completed scorecard.)

M2 CALIBER .50 HEAVY BARREL MACHINE GUN FIRING TABLES III(A) AND III(B), NIGHT PRACTICE SCORECARDS
(MOUNTED OR DISMOUNTED, PRONE OR FIGHTING POSITION)
For use of this form, see TC 3-22.50; the proponent agency is TRADOC.

NAME	RANK
DOE, JOHN, A.	PVT

TABLE III (A). NIGHT PRACTICE SCORECARD
Note: Use this table if the M2 has the TWS, or if it has an AN/TVS-5 that has been upgraded with the third-generation tube.

RANGE	UNIT	LANE	DATE *(YYYYMMDD)*
RUTH	2/29TH INF	4	20170401

ENGAGEMENT	STANDARDS	AMMO	TIME *(Minutes)*	RANGE *(Meters)*	GO	NO GO
ZERO	1 BURST HIT	14	NA	500	NA	NA
2	1 BURST HIT	14	1.5	1,100 (±200)	X	
3	1 BURST HIT	14	1.5	1,500 (±200)	X	
4	1 BURST HIT	14	1.5	800 (±100)		X
5 (NBC)	1 BURST HIT	14	1.5	600 (±100)	X	
6 (NBC)	1 BURST HIT	14	1.5	400	X	
	MULTIPLE TARGETS					
7	1 BURST HIT	28	2.5	1,100 (±200)	X	
	1 BURST HIT			600 (±100)	X	
8	1 BURST HIT	28	2.5	800 (±100)	X	
	1 BURST HIT			1,500 (±200)	X	

SCORING			GUNNER'S SIGNATURE
EXPERT	9		John Doe
SHARPSHOOTER	8	X	GRADER'S PRINTED OR TYPED NAME
MARKSMAN	6		SSG ISAAC M. SOLDIER
UNQUALIFIED	5 or less		GRADER'S SIGNATURE I. M. Soldier

TABLE III (B). NIGHT PRACTICE SCORECARD
NOTE: Use this table if the M2 has an AN/TVS-5 that has not been upgraded.

RANGE	UNIT	LANE	DATE *(YYYYMMDD)*
RUTH	2/29TH INF	4	20170401

ENGAGEMENT	STANDARDS	AMMO	TIME *(Minutes)*	RANGE *(Meters)*	GO	NO GO
ZERO	1 BURST HIT	14	NA	500	NA	NA
2	1 BURST HIT	14	1.5	1,100 (±200)	X	
3	1 BURST HIT	14	1.5	800 (±100)	X	
4	1 BURST HIT	14	1.5	800 (±100)	X	
5 (NBC)	1 BURST HIT	14	1.5	600 (±100)	X	
6 (NBC)	1 BURST HIT	14	1.5	400	X	
	MULTIPLE TARGETS					
7	1 BURST HIT	28	2.5	1,100 (±200)	X	
	1 BURST HIT			600 (±100)	X	
8	1 BURST HIT	28	2.5	800 (±100)	X	
	1 BURST HIT			600 (±100)	X	

SCORING			GUNNER'S SIGNATURE
EXPERT	9	X	John Doe
SHARPSHOOTER	8		GRADER'S PRINTED OR TYPED NAME
MARKSMAN	6		SSG ISAAC M. SOLDIER
UNQUALIFIED	5 or less		GRADER'S SIGNATURE I. M. Soldier

DA FORM 7450, APR 2017 PREVIOUS EDITIONS ARE OBSOLETE. APD LC v1.00ES

Figure F-5. Completed DA Form 7450, example

Note. After both gunners have fired for practice, they will be assigned new lanes and issued more ammunition for record firing. The gunner should keep the same weapon they used for practice fire. The only change in the above procedures will be in step (c); here, the gunner will be scored along with the critique. If the gunner is unable to meet standard, they are removed from the firing line, given remedial training, and re-fired.

DANGER

Before any gunner changes lanes, the lane noncommissioned officer must ensure that the weapon has been properly cleared. Anyone observing any unsafe acts should immediately call a cease fire and notify range personnel.

FIRING TABLE IV, NIGHT QUALIFICATION (MOUNTED OR DISMOUNTED, PRONE OR FIGHTING POSITION)

F-81. Night qualification is conducted and fired the same as the night practice.

OBJECTIVES

F-82. The objective of night fire qualification is to test the gunner's knowledge of machine gun fire and of the skills gained during 10-meter and practice live fire. It also provides additional live-fire experience for the gunner.

SCORING

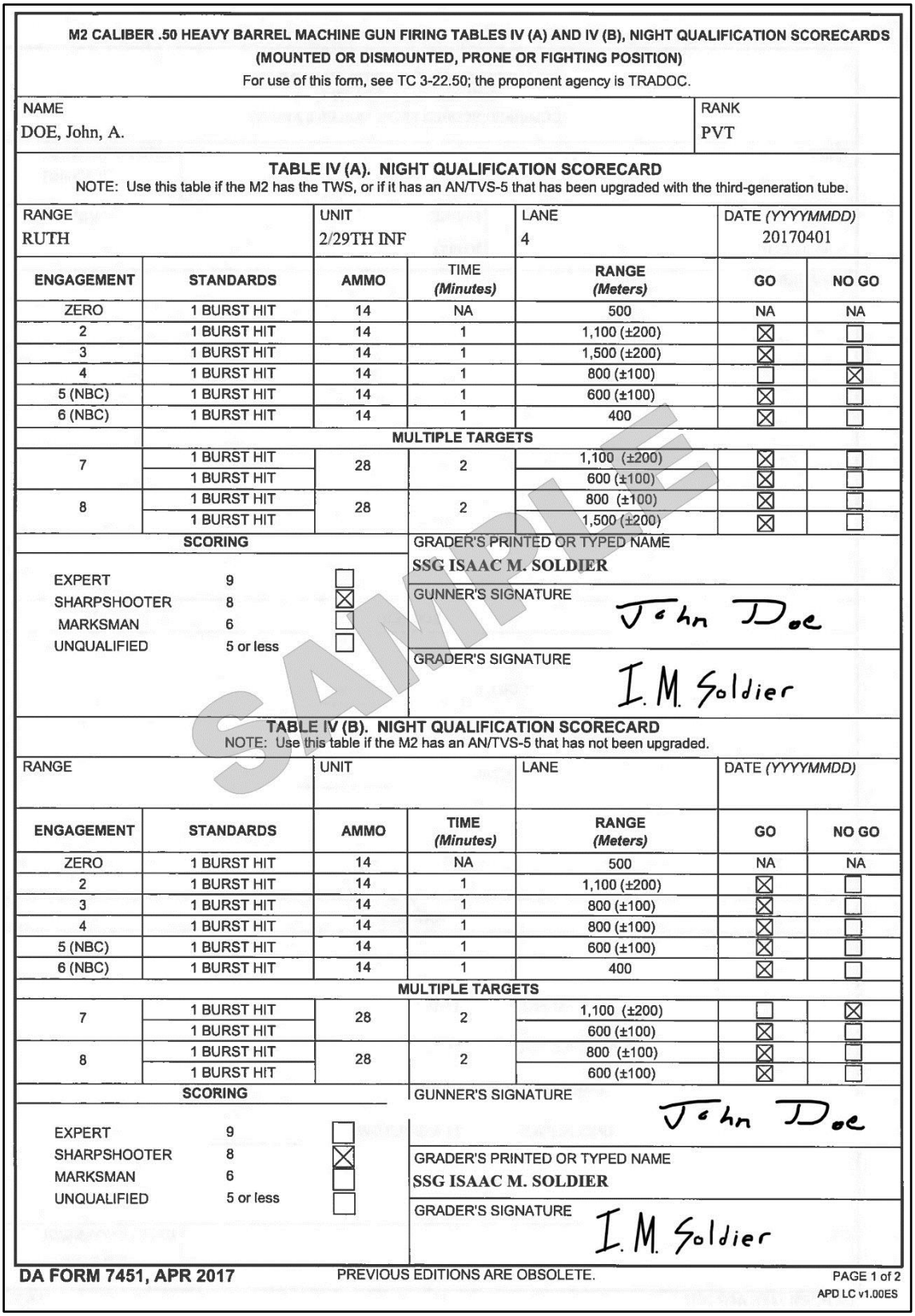
F-83. The maximum possible score is nine target hits (GOs) and the minimum qualifying score is six target hits (GOs). The gunner must qualify in both the day and the night qualification to receive an overall qualification. Use DA Form 7451, *M2 Caliber .50 Heavy Barrel Machine Gun Firing Table IV(A) and IV(B), Night Qualification Scorecards (Mounted or Dismounted, Prone or Fighting Position)* to record the scores. (Figure F-6, page F-20 and Figure F-7, page F-22, show a completed scorecard.) (This form is available at the Army Publishing Directorate, http://armypubs.army.mil.)

ENGAGEMENTS

F-84. Firing Table IV is conducted the same as night practice and in accordance with table F-6 below. It is recorded on DA Form 7451. Each gun has a gunner and an assistant gunner. The gunner can fire up to two, five- to seven-round bursts at each target. If the gunner hits the target with the first burst, they do not fire at that target with a second burst. Once the gunner completes Firing Table IV, they switch with the assistant gunner and the engagements are repeated.

Table F-6. Firing Table IV, Night Qualification

FIRING TABLE IV, NIGHT QUALIFICATION (Mounted or Dismounted, Prone or Fighting Position)						
Engagement	Time (Minutes)	Rounds	Target	Range		Type Fire
				A	B	
Zero	No Limit	14	Double E	500	500	Fixed, single shot, three round shot groups (field zero)
2	1.5	14	Double E	1100	1100	Fixed, 5- to 7-round burst
3	1.5	14	Double E	1500	800	Fixed, 5- to 7-round burst
4	1.5	14	Double E	800	800	Fixed, 5- to 7-round burst
5	1.5	14	Double E	600	600	Fixed, NBC, 5- to 7-round burst
6	1.5	14	Single E	400	400	Fixed, NBC, 5- to 7-round burst
7	2.5	28	Double E Double E	1100 600	1100 600	Fixed, 5- to 7-round burst
8	2.5	28	Double E Double E	800 1500	800 600	Fixed, 5- to 7-round burst



M2 CALIBER .50 HEAVY BARREL MACHINE GUN FIRING TABLES IV (A) AND IV (B), NIGHT QUALIFICATION SCORECARDS
(MOUNTED OR DISMOUNTED, PRONE OR FIGHTING POSITION)
For use of this form, see TC 3-22.50; the proponent agency is TRADOC.

NAME	RANK
DOE, John, A.	PVT

TABLE IV (A). NIGHT QUALIFICATION SCORECARD
NOTE: Use this table if the M2 has the TWS, or if it has an AN/TVS-5 that has been upgraded with the third-generation tube.

RANGE	UNIT	LANE	DATE *(YYYYMMDD)*
RUTH	2/29TH INF	4	20170401

ENGAGEMENT	STANDARDS	AMMO	TIME *(Minutes)*	RANGE *(Meters)*	GO	NO GO
ZERO	1 BURST HIT	14	NA	500	NA	NA
2	1 BURST HIT	14	1	1,100 (±200)	☒	☐
3	1 BURST HIT	14	1	1,500 (±200)	☒	☐
4	1 BURST HIT	14	1	800 (±100)	☐	☒
5 (NBC)	1 BURST HIT	14	1	600 (±100)	☒	☐
6 (NBC)	1 BURST HIT	14	1	400	☒	☐
	MULTIPLE TARGETS					
7	1 BURST HIT	28	2	1,100 (±200)	☒	☐
	1 BURST HIT			600 (±100)	☒	☐
8	1 BURST HIT	28	2	800 (±100)	☒	☐
	1 BURST HIT			1,500 (±200)	☒	☐

SCORING		
EXPERT	9	☐
SHARPSHOOTER	8	☒
MARKSMAN	6	☐
UNQUALIFIED	5 or less	☐

GRADER'S PRINTED OR TYPED NAME: SSG ISAAC M. SOLDIER
GUNNER'S SIGNATURE: John Doe
GRADER'S SIGNATURE: I. M. Soldier

TABLE IV (B). NIGHT QUALIFICATION SCORECARD
NOTE: Use this table if the M2 has an AN/TVS-5 that has not been upgraded.

RANGE	UNIT	LANE	DATE *(YYYYMMDD)*

ENGAGEMENT	STANDARDS	AMMO	TIME *(Minutes)*	RANGE *(Meters)*	GO	NO GO
ZERO	1 BURST HIT	14	NA	500	NA	NA
2	1 BURST HIT	14	1	1,100 (±200)	☒	☐
3	1 BURST HIT	14	1	800 (±100)	☒	☐
4	1 BURST HIT	14	1	800 (±100)	☒	☐
5 (NBC)	1 BURST HIT	14	1	600 (±100)	☒	☐
6 (NBC)	1 BURST HIT	14	1	400	☒	☐
	MULTIPLE TARGETS					
7	1 BURST HIT	28	2	1,100 (±200)	☐	☒
	1 BURST HIT			600 (±100)	☒	☐
8	1 BURST HIT	28	2	800 (±100)	☒	☐
	1 BURST HIT			600 (±100)	☒	☐

SCORING		
EXPERT	9	☐
SHARPSHOOTER	8	☒
MARKSMAN	6	☐
UNQUALIFIED	5 or less	☐

GUNNER'S SIGNATURE: John Doe
GRADER'S PRINTED OR TYPED NAME: SSG ISAAC M. SOLDIER
GRADER'S SIGNATURE: I. M. Soldier

SAMPLE

DA FORM 7451, APR 2017 PREVIOUS EDITIONS ARE OBSOLETE. PAGE 1 of 2
APD LC v1.00ES

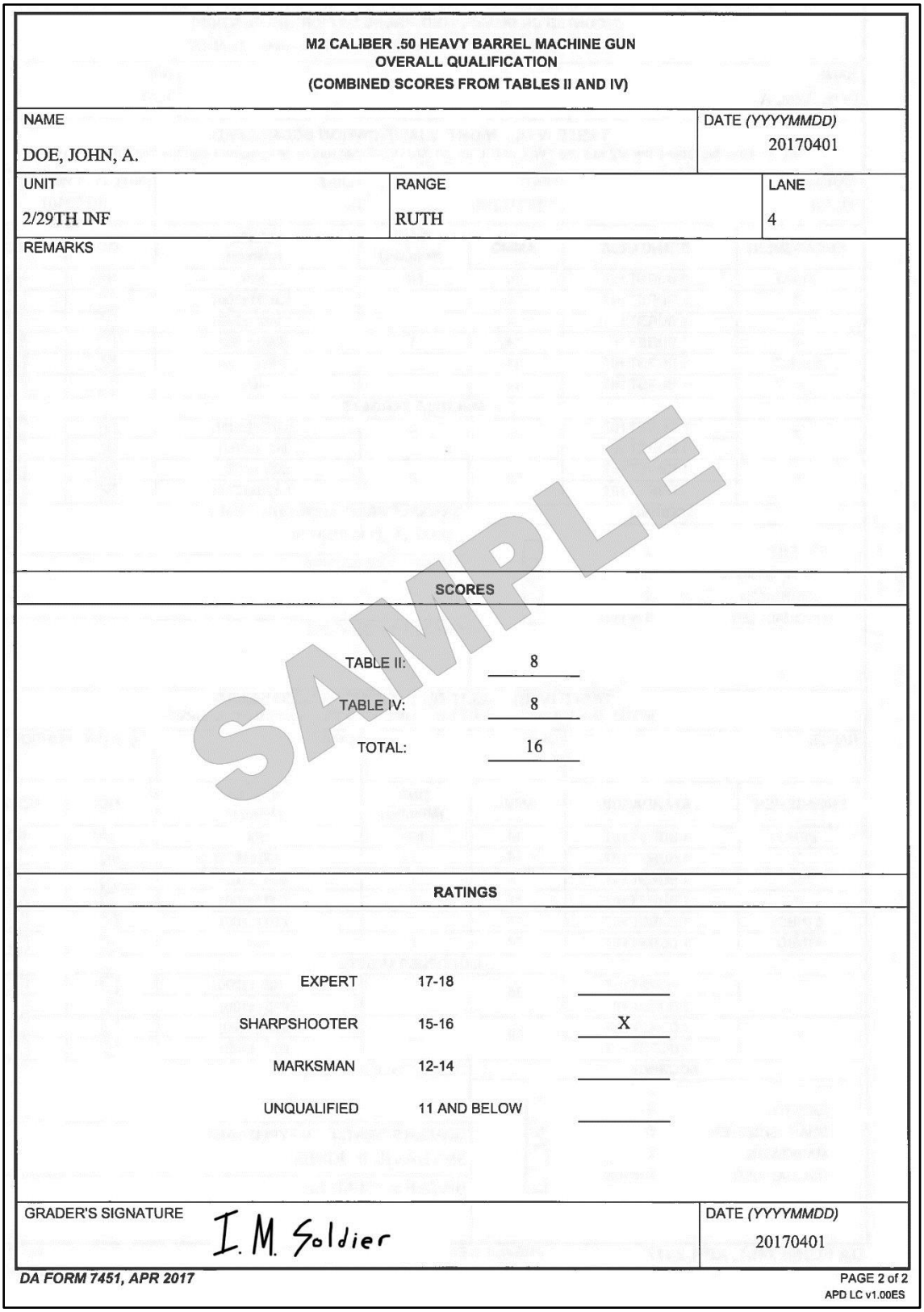
Figure F-6. Completed DA Form 7451 (front), example

QUALIFICATION STANDARDS

F-85. The day and night qualification tables (Firing Tables II and IV) are scored separately. Overall M2 qualification is determined by two criteria: the gunner must qualify on both the day and the night firing tables; and the rating is based on the cumulative score. The maximum possible points to qualify are 18 and the minimum are 12. A gunner is unqualified if they fail to receive six or more GOs, or target hits, on either the day or night qualification. The overall ratings are scored as follows:

RATINGS
Expert 17 to 18
Sharpshooter 16 to 15
Marksman 12 to 14
Unqualified 11 or fewer

***Note*.** Use the back of DA Form 7451 to record the overall score for Firing Tables II and IV.



M2 CALIBER .50 HEAVY BARREL MACHINE GUN
OVERALL QUALIFICATION
(COMBINED SCORES FROM TABLES II AND IV)

NAME	DATE *(YYYYMMDD)*
DOE, JOHN, A.	20170401

UNIT	RANGE	LANE
2/29TH INF	RUTH	4

REMARKS

SAMPLE

SCORES

TABLE II:	8
TABLE IV:	8
TOTAL:	16

RATINGS

EXPERT	17-18	
SHARPSHOOTER	15-16	X
MARKSMAN	12-14	
UNQUALIFIED	11 AND BELOW	

GRADER'S SIGNATURE	DATE *(YYYYMMDD)*
I. M. Soldier	20170401

DA FORM 7451, APR 2017

PAGE 2 of 2
APD LC v1.00ES

Figure F-7. Completed DA Form 7451 (back), example

Glossary

SECTION I – ACRONYMS AND ABBREVIATIONS

ATPIAL	advanced target pointer illuminator aiming light
CBRN	chemical, biological, radiological, and nuclear
DA	Department of the Army
DBAL-A2	dual beam aiming laser-advanced 2
DODIC	Department of Defense identification code
HB	heavy barrel
I2	image intensifier
LCD	liquid crystal display
METT-TC	mission, enemy, terrain and weather, troops and support available--time available and civil considerations (Army)
MIL-STD	military standard
MOPP	mission-oriented protective posture
mph	mile(s) per hour
NATO	North Atlantic Treaty Organization
SLAP	saboted light armor penetrator
SOP	standard operating procedure
SRTA	short range training ammunition
T&E	traversing and elevating mechanism
TC	training circular
TM	technical manual
TWS	thermal weapon sight
WTS	weapon thermal sights

This page intentionally left blank.

References

All URLs accessed on 20 April 2017.

REQUIRED PUBLICATIONS

ADRP 1-02, *Terms and Military Symbols*, 16 November 2016.

DOD Dictionary of Military and Associated Terms, February 2017.

RELATED PUBLICATIONS

These documents contain relevant supplemental information.

JOINT PUBLICATIONS

Most joint publications are available online at: http://www.dtic.mil/doctrine/new_pubs/jointpub.htm

ARMY PUBLICATIONS

Most Army doctrinal publications and regulations are available at: http://armypubs.army.mil.

Military Standards are available online at http://quicksearch.dal.mil.

Technical manuals are available online at https://www.logsa.army.mil/.

Other publications are available on the Central Army Registry on the Army Training Network, https://atiam.train.army.mil.

ATP 3-21.8, *Infantry Platoon and Squad*, 12 April 2016.

FM 27-10, *The Law of Land Warfare*, 18 July 1956.

Graphic Training Aid, 9-01-011

MIL-STD-709D, *Ammunition Color Coding*, 16 April 2009.

MIL-STD-1913, *Dimensioning of Accessory Mounting Rail for Small Arms Weapons*, 3 October 2013.

TB 750-25, *Department of the Army Technical Bulletin. Maintenance of Supplies and Equipment, Army Test, Measurement, and Diagnostic Equipment (TMDE), Calibration and Repair Support (C&RS) Program*, 1 February 2017.

TC 3-20.31-4, *Direct Fire Engagement Process (DIDEA)*, 23 July 2015.

TC 3-21.60, *Visual Signals*, 17 April 2017.

TC 3-21.75, *The Warrior Ethos and Soldier Combat Skills*, 13 August 2013.

TM 9-1005-213-10, *Technical Manual/Operator Maintenance for Machine Gun, Caliber .50: M2A1, w/Fixed Headspace and Timing, NSN 1005-01-511-1250 (EIC 4AZ) Machine Gun, Caliber .50: M2, Heavy Barrel Flexible, W/E, NSN 1005-00-322-9715 (EIC 4AG)*, 11 January 2016.

TM 9-1305-201-20&P, *Unit Maintenance Manual (Including Repair Parts and Special Tools List) for Small Arms Ammunition to 30 Millimeter Inclusive (Federal Supply Class 1305)*, 5 October 1981.

TM 9-5855-1912-13&P, *Operator and Field Maintenance Manual Including Repair Parts and Special Tools List for Dual Beam Aiming Laser-Advanced2 (DBAL-A2), AN/PEQ-15A (NSN: 5855-01-535-6166) (NSN: 5855-01-579-0062) (LIN: J03261)*, 1 September 2012.

TM 9-5855-1913-13&P, *Operator and Field Maintenance Manual Including Repair Parts and Special Tools List for the Illuminator, Integrated, Small Arms (Storm) AN/PSQ-23 TAN (NSN: 5855-577-5946 (4XG) (NSN: 5855-01-535-1905) (EIC: 4XF) (LIN: J68653*), 31 August 2012.

TM 9-5855-1914-13&P, *Operator and Field Maintenance Manual Including Repair Parts and Special Tools List for the Advanced Target Pointer Illuminator Aiming Light (ATPIAL) AN/PEQ-15 (NSN 5855-01-534-5931) (NSN 5855-01-577-7174) {TM 10470B-0I/1}*, 10 September 2012.

TM 9-5855-1915-13&P, *Operator and Field Maintenance Manual (Including Repair Parts and Special Tools List) for the Target Pointer Illuminator/Aiming Light (TPIAL) AN/PEQ-2A (NSN:*

5855-01-447-8992) (EIC: N/A) AN/PEQ-2B (5855-01-515-6904) (EIC: N/A) {TM 10470A-0I/1}, 31 August 2007.

TM 9-5860-226-13&P, *AN/PEM-1 Laser Borelight System (LSB-300-A2) (NSN 5860-01-471-2091) (EIC: N/A) and Laser Borelight System (LBS-050) (NSN 5860-01-466-2087) (EIC: N/A)*, 17 May 2013.

PRESCRIBED FORMS

Unless otherwise indicated, DA forms are available on the Army Publishing Directorate (APD) website, http://armypubs.army.mil.

DA Form 7448, *M2 Caliber .50 Heavy Barrel Machine Gun Firing Table I, Day Practice Scorecard (Mounted or Dismounted, Prone or Fighting Position)*.

DA Form 7449, *M2 Caliber .50 Heavy Barrel Machine Gun Firing Table II, Day Qualification Scorecard (Mounted or Dismounted, Prone or Fighting Position)*.

DA Form 7450, *M2 Caliber .50 Heavy Barrel Machine Gun Firing Tables III(A) and III(B), Night Practice Scorecards (Mounted or Dismounted, Prone or Fighting Position)*.

DA Form 7451, *M2 Caliber .50 Heavy Barrel Machine Gun Firing Tables IV(A) and IV(B), Night Qualification Scorecards (Mounted or Dismounted, Prone or Fighting Position)*.

REFERENCED FORMS

Unless otherwise indicated, DA forms are available on the Army Publishing Directorate (APD) website, http://armypubs.army.mil.

DA Form 2028, *Recommended Changes to Publications and Blank Forms*.

DA Form 5517, *Standard Range Card.*

Index

A

AN/PAS-13 series weapons
thermal sight. 3-22

AN/PEQ-15 advanced target
pointer, illuminator, aiming
light. 3-32

AN/PEQ-15A, dual beam
aiming laser-advanced 2.
3-37

AN/PEQ-2A target pointer,
illuminator, aiming light. 3-28

B

barrel change. D-25

C

coaching
elements of shooting. E-32
aiming. E-34
control. E-36
stabilize. E-33
two types. E-29

common aiming errors. 7-16

cook-off. 8-38

E

engagement. 7-17, 6-1

F

firing positions. 6-24

H

headspace and timing. D-22

I

iron sight. 3-16

L

load. D-23-D-24

M

machine gun
basic target. F-7
clear malfunction. 8-32
common failures. 8-29

P

perform actions
immediate. 8-33
remedial. 8-34

place weapon into action. D-20

point of aim. 7-17, 7-2

precision. 5-7

R

range card. D-43-D-44

rates of fire
cyclic. 8-23
rapid fire. 8-21
sustained fire. 8-20

T

traversing and elevating
assembly. 4-13
mechanism. 4-6

U

unload, show clear. D-39

This page intentionally left blank.

TC 3-22.50
19 May 2017

By Order of the Secretary of the Army:

MARK A. MILLEY
General, United States Army
Chief of Staff

Official:

GERALD B. O'KEEFE
Administrative Assistant to the
Secretary of the Army
1711806

DISTRIBUTION:
Active Army, Army National Guard, and United States Army Reserve: To be distributed in accordance with the initial distrubution number (IDN) 110203, requirements for TC 3-22.50.

PIN: 201602-000