Appendix A

Machine Gun Employment

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 fundamental techniques of fire common to machine guns.

SECTION I — TECHNICAL DATA AND CONSIDERATIONS

A-1. Leaders must know the technical characteristics of their assigned weapon systems and associated ammunition to maximize their killing and suppressive fires while minimizing the risk to friendly forces. Table A-1 lists machine gun specifications and technical data. Read the FMs specific to the machine guns listed in Table A-1 for complete information regarding their technical specifications.

Table A-1. Machine gun specifications.

WEAPON	M249	M240B	M2	MK 19
FIELD MANUAL	FM 3-22.68	FM 3-22.68	FM 3-22.65	FM 3-22.27
TM	9-1005-201-10	9-1005-313-10	9-1005-213-10	9-1010-230-10
DESCRIPTION	5.56-mm gas-operated automatic weapon	7.62-mm gas-operated medium machine gun	.50-caliber recoil-operated heavy machine gun	40-mm air-cooled, blowback-operated automatic grenade launcher
WEIGHT	16.41 lbs (gun with barrel) 16 lbs (tripod)	27.6 lbs (gun with barrel) 20 lbs (tripod)	128 lbs (gun with barrel and tripod)	140.6 lbs (gun with barrel and tripod)
LENGTH	104 cm	110.5 cm	156 cm	109.5 cm

Table A-1. Machine gun specifications (continued).

WEAPON	M249	M240B	M2	MK 19
SUSTAINED RATE OF FIRE **Rounds/burst** **Interval** **Minutes to barrel change**	50 RPM 6-9 rounds 4-5 seconds 10 minutes	100 RPM 6-9 rounds 4-5 seconds 10 minutes	40 RPM 6-9 rounds 10-15 seconds Change barrel end of day or if damaged	40 RPM
RAPID RATE OF FIRE **Rounds/burst** **Interval** **Minutes to barrel change**	100 RPM 6-9 rounds 2-3 seconds 2 minutes	200 RPM 10-13 rounds 2-3 seconds 2 minutes	40 RPM 6-9 rounds 5-10 seconds Change barrel end of day or if damaged	60 RPM
CYCLIC RATE OF FIRE	850 RPM in continuous burst Barrel change every 1 minute	650-950 RPM in continuous burst Barrel change every 1 minute	450-550 RPM in continuous burst	325-375 RPM in continuous burst
MAXIMUM EFFECTIVE RANGES	Bipod/point: 600 m Bipod/area: 800 m Tripod/area: 1,000 m Grazing: 600 m	Bipod/point: 600 m Tripod/point: 800 m Bipod/area: 800 m Tripod/area: 1,100 m Suppression: 1,800 m Grazing: 600 m	Point: 1,500 m (single shot) Area: 1,830 m Grazing: 700 m	Point: 1,500 m Area: 2,212 m
MAXIMUM RANGE	3,600 m	3,725 m	6,764 m	2,212 m

A-2. Machine gun fire has different effects on enemy targets depending on the type of ammunition used, the range to target, and the nature of the target. It is important that gunners and leaders understand the technical aspects of the different ammunition available to ensure the machine guns and automatic weapons are employed in accordance with their capabilities. Machine guns and automatic weapons use several different types of standard military ammunition. Soldiers should use only authorized ammunition that is manufactured to U.S. and NATO specifications.

M249 MACHINE GUN

A-3. The M249 machine gun is organic to the Infantry platoon and provides rifle squads with a light automatic weapon for employment during assault (Figure A-1). The M249 can also be used in the machine gun role in the defense or support-by-fire position. The M249 fires from the bipod, the hip, or from the underarm position. The hip and underarm positions are normally used for close-in fire during an assault when the M249 gunner is on the move and does not have time to set the gun in the bipod position. It is best used when a high rate of fire is needed immediately. Accuracy of fire is decreased when firing from either the hip or shoulder.

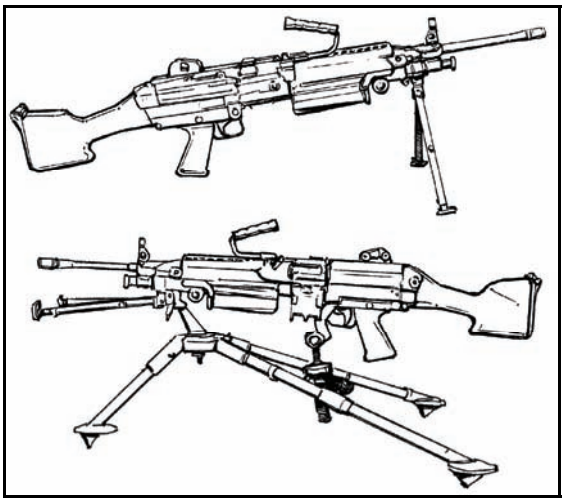

Figure A-1. M249 machine gun, bipod and tripod mounted.

A-4. Available M249 ammunition is classified as follows (Table A-2).

- **M855 5.56-mm Ball.** For use against light materials and personnel, but not vehicles.
- **M856 5.56-mm Tracer.** Generally used for adjustments after observation, incendiary effects, and signaling. When tracer rounds are fired, they are normally mixed with ball ammunition in a ratio of four ball rounds to one tracer round.
- **M193 5.56-mm Ball.** M193 ball ammunition can be fired with the M249, but accuracy is degraded. It should therefore only be used in emergency situations when M855 ball is not available.
- **M196 5.56-mm Tracer.** M196 tracer ammunition can be fired with the M249, but accuracy is degraded. It should therefore only be used in emergency situations when M856 ammunition is not available.

Table A-2. M249 ballistic data.

AVAILABLE M249 CARTRIDGES	MAXIMUM RANGE (meters)	TRACER BURNOUT (meters)	USES
Ball, M855	3,600	——	Light materials, personnel
Tracer, M856	3,600	900	Observation and adjustment of fire, incendiary effects, signaling

M240B MACHINE GUN

A-5. The M240B is organic to the Infantry platoon. Two machine guns and crews are found in the weapons squad (Figure A-2). The M240B can be fired in the assault mode in emergencies, but is normally fired from the bipod or tripod platform. It can also be vehicle mounted. The platoon leader (through his weapons squad leader) employs his M240B machine guns with a rifle squad to provide long range, accurate, sustained fires against dismounted infantry, apertures in fortifications, buildings, and lightly-armored vehicles. The M240B also provides a high volume of short-range fire in self defense against aircraft. Machine gunners use point, traversing, searching, or searching and traversing fire to kill or suppress targets.

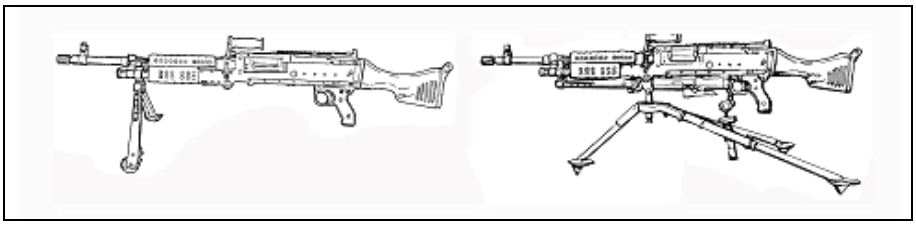

Figure A-2. M240B machine gun, bipod and tripod mounted.

A-6. Available M240B machine gun ammunition is classified as follows (Table A-3).

- **M80 7.62-mm Ball.** For use against light materials and personnel.
- **M61 7.62-mm Armor Piercing.** For use against lightly-armored targets.
- **M62 7.62-mm Tracer.** For observation of fire, incendiary effects, signaling, and for training. When tracer rounds are fired, they are normally mixed with ball ammunition in a ratio of four ball rounds to one tracer round.

Table A-3. M240B ballistic data.

AVAILABLE M240B CARTRIDGES	MAXIMUM RANGE (meters)	TRACER BURNOUT (meters)	USES
Ball, M80	3,725	——	Light materials, personnel
Armor Piercing, M61	3,725	——	Lightly-armored targets
Tracer, M62	3,725	900	Observation and adjustment of fire, incendiary effects, signaling

MK 19 40-MM MACHINE GUN, MOD 3

A-7. The MK 19 is not organic to the weapons company, not the Infantry platoon, but because there are many times when Infantrymen use it, it is described in this appendix. The MK 19 supports the Soldier in both the offense and defense. It gives the unit the capability of laying down a heavy volume of close, accurate, and continuous fire (Figure A-3). The MK 19 can also—

- Protect motor movements, assembly areas, and supply trains in a bivouac.
- Defend against hovering rotary aircraft.
- Destroy lightly-armored vehicles.
- Fire on enemy prepared positions.
- Provide high volumes of fire into an engagement area (EA).
- Cover obstacles.
- Provide indirect fires from defilade positions.

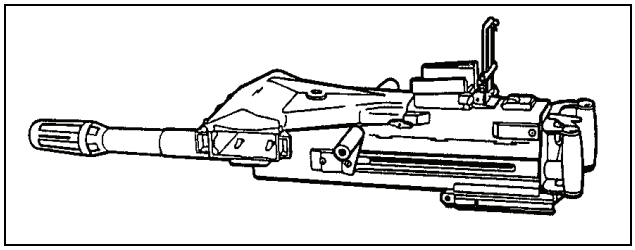

Figure A-3. MK 19, 40-mm grenade machine gun, MOD 3.

A-8. The MK 19 is normally vehicle mounted on a pedestal, ring, or weapon platform, but can also be fired from the M3 tripod. It fires high explosive (HE) and high explosive, dual purpose (HEDP) rounds. The HE round is effective against unarmored vehicles and personnel.

A-9. Available MK 19 machine gun ammunition is classified as follows (Table A-4).

- **M430 40-mm HEDP.** This is the standard round for the MK 19 and comes packed in either 48- or 32- round ammunition containers. It can penetrate 2 inches of steel armor at zero-degree obliquity and inflict casualties out to 15 meters from impact. It arms within 18 to 30 meters of the gun muzzle.
- **M383 40-mm HE.** Comes packed in a 48-round container. It has a wound radius of 15 meters, but lacks the armor piercing capabilities of the HEDP round. It arms 18 to 36 meters from the muzzle.

Table A-4. MK 19 ballistic data.

AVAILABLE MK 19 CARTRIDGES	MAXIMUM RANGE (meters)	PENETRATION/ CASUALTY RADIUS	USES
HEDP, M430	2,212	2-inch armor/ 15-meter casualty radius	Lightly-armored targets, light material targets, personnel.
HE, M383	2,212	15-meter casualty radius	Unarmored vehicles, light material targets, personnel

M2 .50 CALIBER MACHINE GUN

A-10. The M2 .50 caliber machine gun is not organic to the Infantry platoon, but as there are many times when Infantrymen use it, it is described in this appendix (Figure A-4).

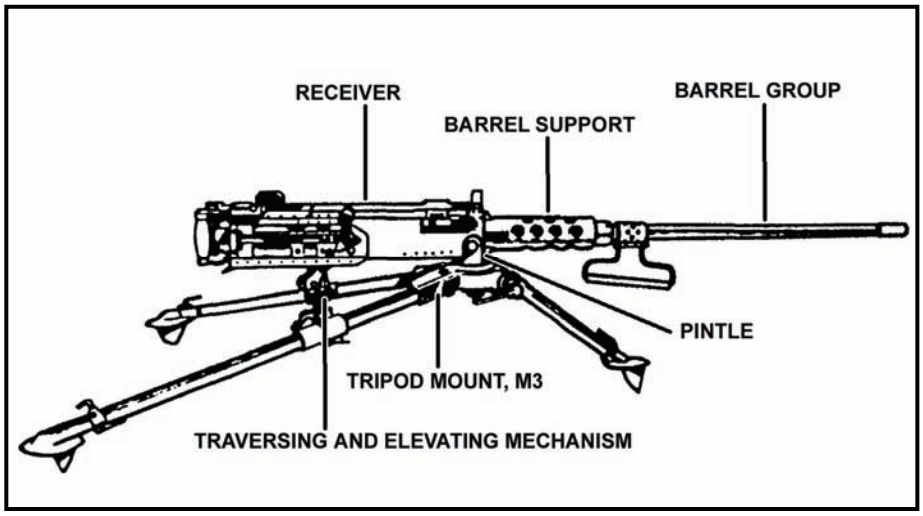

Figure A-4. M2 .50 caliber machine gun.

A-11. The available M2 .50 caliber machine gun ammunition is classified as follows (Table A-5).

- **M2 .50-Caliber Ball.** For use against enemy personnel and light material targets.
- **M1/M17 .50-Caliber Tracer.** Aids in observing fire. Secondary purposes are for incendiary effect and for signaling.
- **M1 .50-Caliber Incendiary.** For incendiary effect, especially against aircraft.

- **M2 .50-Caliber AP.** For use against armored aircraft and lightly-armored vehicles, concrete shelters, and other bullet-resisting targets.
- **M8 .50-Caliber API.** For combined armor-piercing and incendiary effect.
- **M20 .50-Caliber API Tracer.** For combined armor-piercing and incendiary effect, with the additional tracer feature.

Table A-5. M2 Ballistic data.

AVAILABLE M2 CARTRIDGES	MAXIMUM RANGE (meters)	TRACER BURNOUT (meters)	AVERAGE MUZZLE VELOCITY (feet per second)
Ball, M2	7,400	——	2,930
Tracer, M1 (with gilding metal jacket)	5,575	1,800	2,860
Tracer, M1 (with clad steel jacket)	5,450	1,800	3,030
Tracer, M17	5,450	2,450	3,030
Incendiary, M1	6,050	——	3,090
Armor-piercing, M2	7,400	——	2,930
Armor-piercing incendiary, M8	6,470	——	3,050
Armor-piercing incendiary tracer, M20	6,470	*300-1,750	3,050
* This tracer is dim at near ranges but increases in brightness as it moves farther from the gun.			

SECTION II — COMBAT TECHNIQUES OF FIRE

A-12. This section is designed to illustrate the characteristics of machine gun fire, the types of enemy targets that might be engaged, and how to successfully apply machine gun fire on those enemy targets.

A-13. Read the appropriate FM (as shown in Table A-1) for more weapon-specific information on engaging enemy targets with a particular machine gun.

CHARACTERISTICS OF FIRE

A-14. The gunner's or leader's knowledge of the machine gun is not complete until he learns about the action and effect of the projectiles when fired. The following definitions will help the leader, gunner, and automatic rifleman understand the characteristics of fire for the platoon's machine guns.

LINE OF SIGHT

A-15. Line of sight is an imaginary line drawn from the firer's eye through the sights to the point of aim.

BURST OF FIRE

A-16. A burst of fire is a number of successive rounds fired with the same elevation and point of aim when the trigger is held to the rear. The number of rounds in a burst can vary depending on the type of fire employed.

TRAJECTORY

A-17. 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 trajectory are the velocity of the round, gravity, rotation of the round, and resistance of the air. As the range to the target increases, so does the curve of trajectory (Figure A-5).

MAXIMUM ORDINATE

A-18. Maximum ordinate is the highest point above the line of sight the trajectory reaches between the muzzle of the weapon and the base of the target. It always occurs at a point about two-thirds of the distance from weapon to target and increases with range. Like trajectory, maximum ordinate increases as the range increases (Figure A-5).

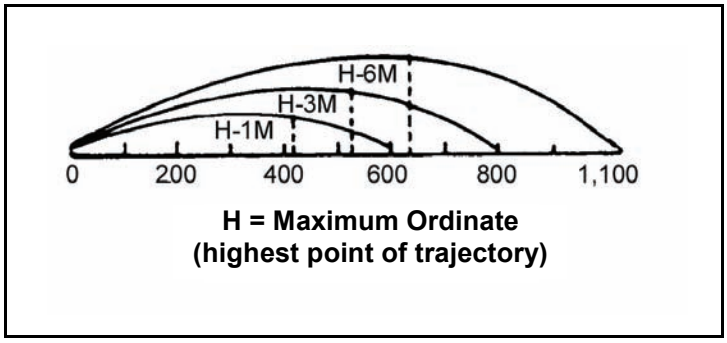

Figure A-5. Trajectory and maximum ordinate.

CONE OF FIRE

A-19. The cone of fire is the pattern formed by the different trajectories in each burst as they travel downrange. Vibration of the weapon and variations in ammunition and atmospheric conditions all contribute to the trajectories that make up the cone of fire (Figure A-6).

BEATEN ZONE

A-20. The beaten zone is the elliptical pattern formed when the rounds within the cone of fire strike the ground or target. The size and shape of the beaten zone change as a function of the range to and slope of the target, but is normally oval or cigar shaped and the density of the rounds decreases toward the edges. Gunners and automatic riflemen should engage targets to take maximum effect of the beaten zone. The simplest way to do this is to aim at the center base of the target. Most rounds will not fall over the target, and any that fall short will create ricochets into the target (Figure A-6).

Effective Beaten Zone

A-21. Because of dispersion, only that part of the beaten zone in which 85 percent of the rounds fall is considered the effective beaten zone.

Effect of Range on the Beaten Zone

A-22. As the range to the target increases, the beaten zone becomes shorter and wider. Conversely, as the range to the target decreases, the beaten zone becomes longer and narrower (Table A-6).

Effect of Slope on the Beaten Zone

A-23. The length of the beaten zone for any given range will vary 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.

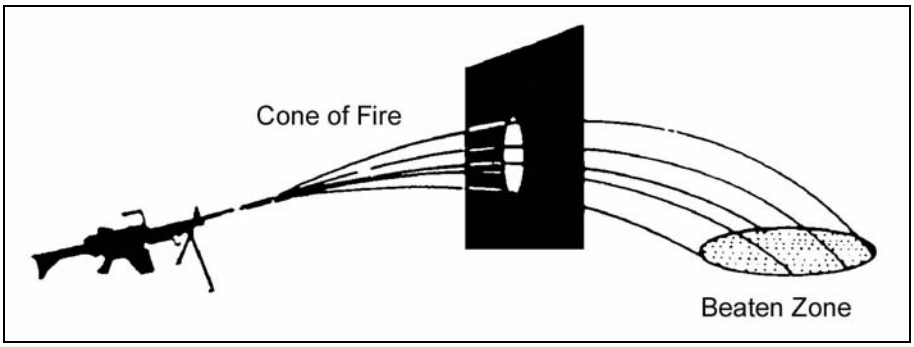

Figure A-6. Cone of fire and beaten zone.

Table A-6. Beaten zones of M240B.

M240B
Range: 500m (1m wide x 110m long)
Range: 1,000m (2m wide x 75m long)
Range: 1,500m (3m wide x 55m long)
Range: 2,000m (4m wide x 50m long)

DANGER SPACE

A-24. This is the space between the muzzle of the weapon and the target where the trajectory does not rise above 1.8 meters (the average height of a standing Soldier) that includes the beaten zone. Gunners should consider the danger space of their weapons when planning overhead fires.

SURFACE DANGER ZONE

A-25. Surface danger zones (SDZs) were developed for each weapon and are defined as the area in front, back, or side of the muzzle of the weapon that provides a danger to friendly forces when the weapon is fired. The SDZ is not just the area that comprises the cone of fire as it moves downrange. It also involves the possible impact area on both sides of the gun target line and the possible dispersion of material caused by the strike of the rounds, the possible ricochet area, and any area to the rear that is adversely affected by the effects of firing the weapon (Figure A-7).

A-26. SDZs were developed primarily for ranges and must be complied with when training, but they should also be complied with in combat when possible to minimize risk to friendly forces.

A-27. Refer to DA PAM 385-63 for a more detailed discussion of the SDZs for machine guns.

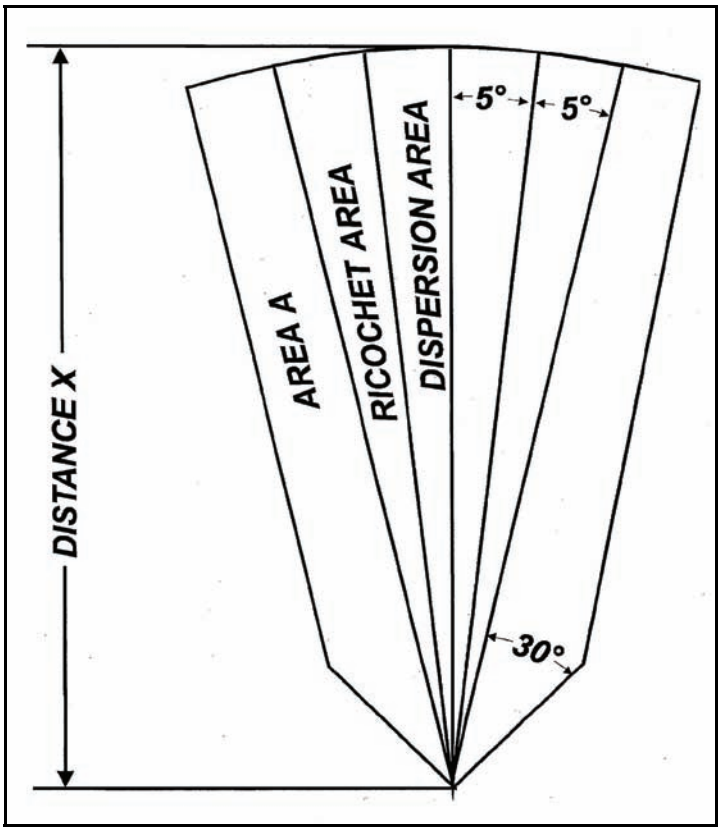

Figure A-7. Example surface danger zone for machine guns.

CLASSIFICATIONS OF AUTOMATIC WEAPONS FIRE

A-28. The U.S. Army classifies automatic weapons fires with respect to the ground, target, and weapon.

CLASSIFICATION OF FIRES WITH RESPECT TO THE GROUND

A-29. Fires with respect to the ground include grazing and plunging fire.

Dead Space

A-30. Any fold or depression in the ground that prevents a target from being engaged from a fixed position is termed *dead space*. Paragraph A-81 discusses methods of determining dead space.

Grazing Fires

A-31. Automatic weapons achieve grazing fire when the center of the cone of fire does not rise more than 1 meter above the ground. Grazing fire is employed in the final protective line (FPL) in defense and is only possible when the terrain is level or uniformly sloping. Any dead space encountered along the FPL must be covered by indirect fire, such as from an M203. When firing over level or uniformly sloping terrain, the machine gun M240B and M249 can attain a maximum of 600 meters of grazing fire. The M2 can attain a maximum of 700 meters. Paragraphs A-78 and A-79 discuss the FPL.

Plunging Fires

A-32. Plunging fire occurs when there is little or no danger space from the muzzle of the weapon to the beaten zone. It occurs when weapons fire at long range, when firing from high ground to low ground, when

firing into abruptly rising ground, or when firing across uneven terrain, resulting in a loss of grazing fire at any point along the trajectory (Figure A-8).

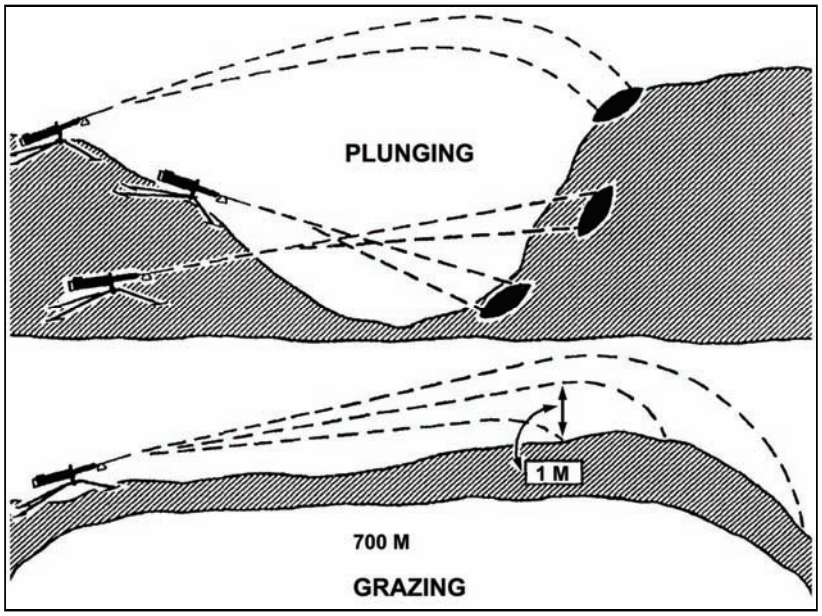

Figure A-8. Classes of fire with respect to the ground.

CLASSIFICATION OF FIRES WITH RESPECT TO THE TARGET

A-33. Fires with respect to the target include enfilade, frontal, flanking, and oblique fire (Figures A-9, A-10, and A-11). These targets are normally presented to gun teams by the enemy and must be engaged as they are presented. For instance, if the enemy presents its flank to the gun crew as it moves past their position from the left or right, the gun crew will have no choice but to employ flanking fire on the enemy.

A-34. Leaders and gunners should strive at all times to position their gun teams where they can best take advantage of the machine gun's beaten zone with respect to an enemy target. Channeling the enemy by use of terrain or obstacles so they approach a friendly machine gun position from the front in a column formation is one example. In this situation, the machine gun would employ enfilade fire on the enemy column, and the effects of the machine gun's beaten zone would be much greater than if it engaged that same enemy column from the flank.

Enfilade Fire

A-35. Enfilade fire occurs when the long axis of the beaten zone coincides or nearly coincides with the long axis of the target. It can be frontal fire on an enemy column formation or flanking fire on an enemy line formation. *This is the most desirable class of fire with respect to the target because it makes maximum use of the beaten zone.* Leaders and gunners should always strive to position the guns to the extent possible that they can engage enemy targets with enfilade fire (Figures A-9 and A-11).

Frontal Fire

A-36. Frontal fire occurs when the long axis of the beaten zone is at a right angle to the front of the target. This type of fire is highly desirable when engaging a column formation. It then becomes enfilade fire as the beaten zone coincides with the long axis of the target (Figures A-9 and A-10). Frontal fire is not as desirable when engaging a line formation because the majority of the beaten zone normally falls below or after the enemy target.

Flanking Fire

A-37. Flanking fire is delivered directly against the flank of the target. Flanking fire is highly desirable when engaging an enemy line formation. It then becomes enfilade fire as the beaten zone will coincide with the long axis of the target (Figures A-9 and A-10). Flanking fire against an enemy column formation is least desirable because the majority of the beaten zone normally falls before or after the enemy target.

Oblique Fire

A-38. Gunners and automatic riflemen achieve oblique fire when the long axis of the beaten zone is at an angle other than a right angle to the front of the target (Figures A-9 and A-11).

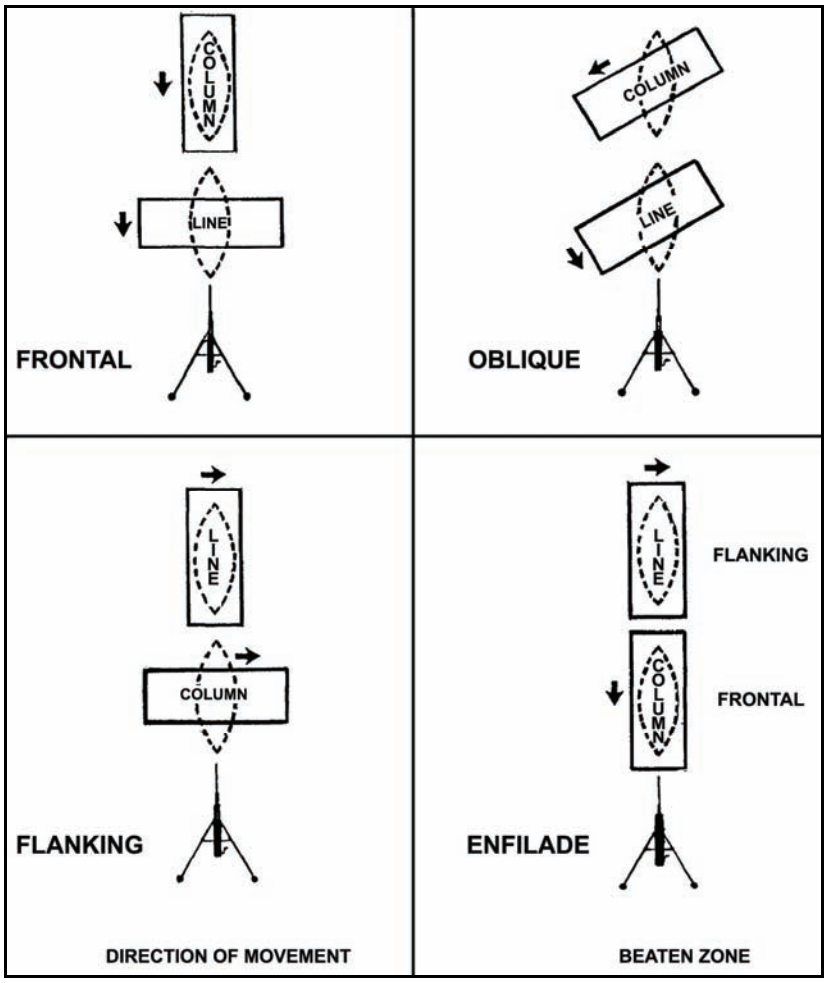

Figure A-9. Classes of fire with respect to the target.

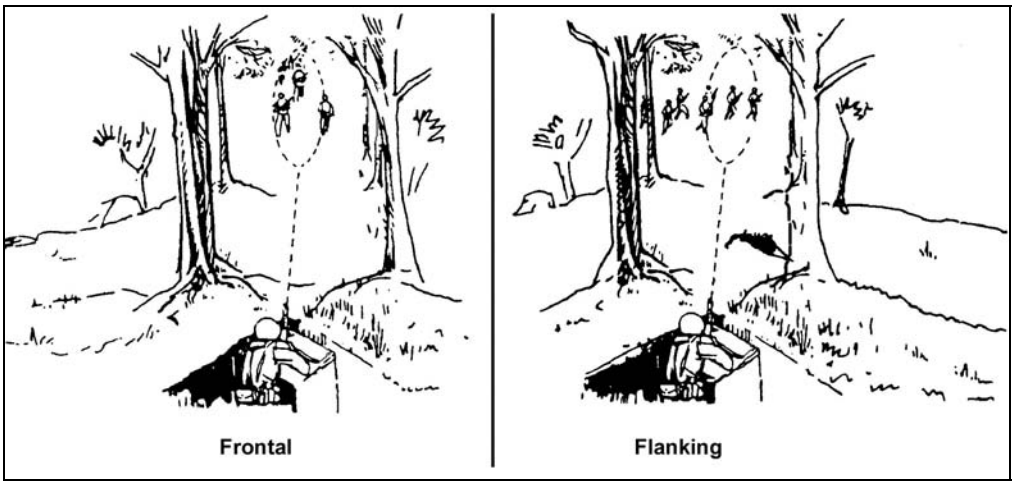

Figure A-10. Frontal fire and flanking fire.

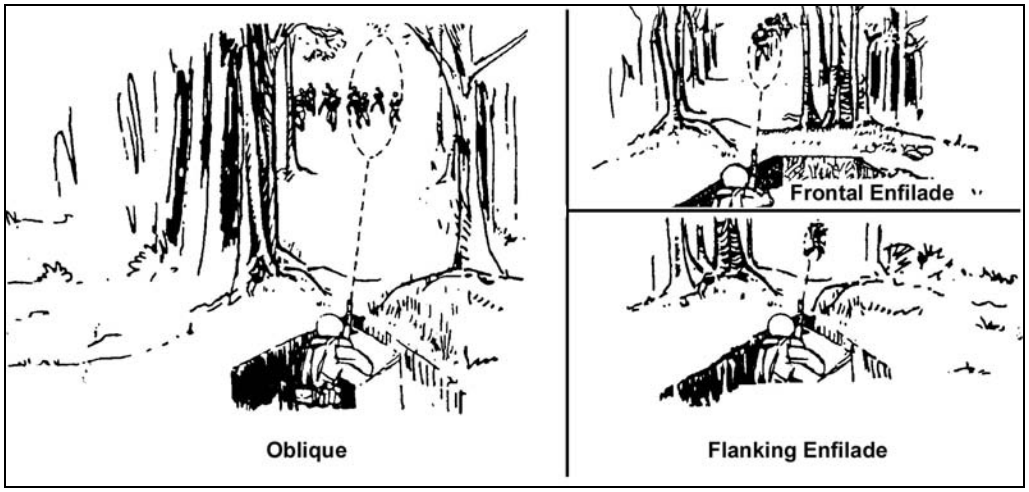

Figure A-11. Oblique fire and enfilade fire.

CLASSIFICATION OF FIRES WITH RESPECT TO THE MACHINE GUN

A-39. Fires with respect to the weapon include fixed, traversing, searching, traversing and searching, swinging traverse, and free gun fires (Figure A-12).

Fixed Fire

A-40. Fixed fire is delivered against a stationary point target when the depth and width of the beaten zone will cover the 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

A-41. Traversing disperses fires in width by successive changes in direction, but not elevation. It is delivered against a wide target with minimal depth. 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 do not need to be so close that they waste ammunition by concentrating a heavy volume of fire in a small area.

Searching Fire

A-42. Searching distributes fires in depth by successive changes in elevation. It is employed against a deep target or a target that has depth and minimal width, requiring changes in only the elevation of the gun. The amount of elevation change depends upon the range and slope of the ground.

Traversing and Searching Fire

A-43. This class of fire is a combination in which successive changes in direction *and* elevation result in the distribution of fires both in width and depth. It is employed against a target whose long axis is oblique to the direction of fire.

Swinging Traverse

A-44. Swinging traverse fire is 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 vehicles or mounted troops moving across the front. If tripod mounted, the traversing slide lock lever is loosened enough to permit the gunner to swing the gun laterally. When firing swinging traverse, the weapon is normally fired at the cyclic rate of fire. Swinging traverse consumes a lot of ammunition and does not have a beaten zone because each round seeks its own area of impact.

Free Gun

A-45. Free gun fire is 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. When firing free gun, the weapon is normally fired at the cyclic rate of fire. Free gun fire consumes a lot of ammunition and does not have a beaten zone because each round seeks its own area of impact.

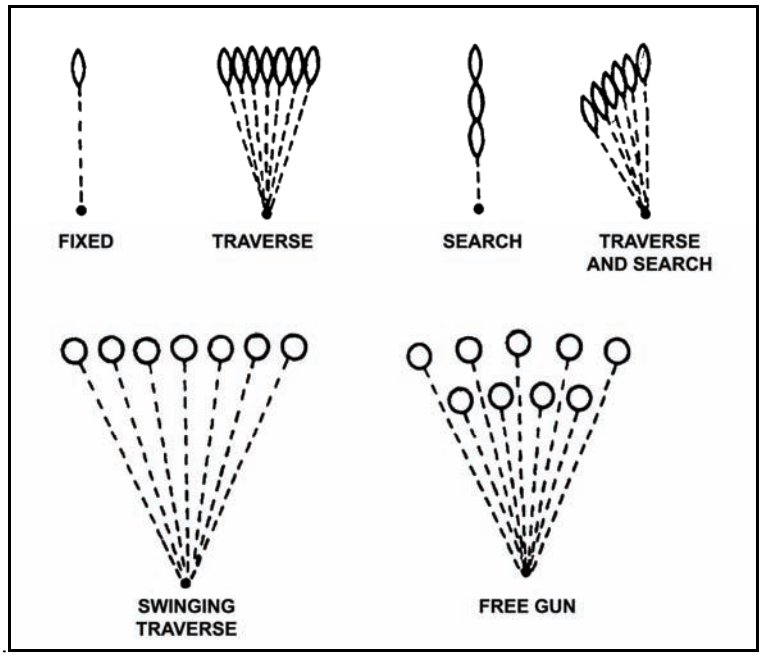

Figure A-12. Classes of fire with respect to the gun.

APPLICATION OF FIRE

A-46. Application of fire consists of the methods the gunner uses to effectively cover an enemy target area. Training these methods of applying fire can be accomplished only after the weapons squad leader and the gunners have learned how to recognize the different types of targets they may find in combat. They must

also know how to distribute and concentrate their fire, and how to maintain the proper rate of fire. Normally, the gunner is exposed to two types of targets in the squad or platoon sector: enemy soldiers, and supporting automatic weapons. Leaders must ensure that these targets have priority and that they are engaged immediately.

A-47. 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 their weapons against friendly positions without effective opposition.

A-48. The method of applying fire to a target is generally the same for either a single gun or a pair of guns. Direct lay is pointing the gun for direction and elevation so 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, 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.

SIGHT PICTURE

A-49. A correct sight picture has the target, front sight post, and rear sight aligned. The sight picture has sight alignment and placement of the aiming point on the target. The gunner aligns the front sight post in the center of the rear sight and then aligns the sights with the target. *The top of the front sight post is aligned on the center base of the target*.

BEATEN ZONE

A-50. The gunner ensures throughout his 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 (Figure A-13).

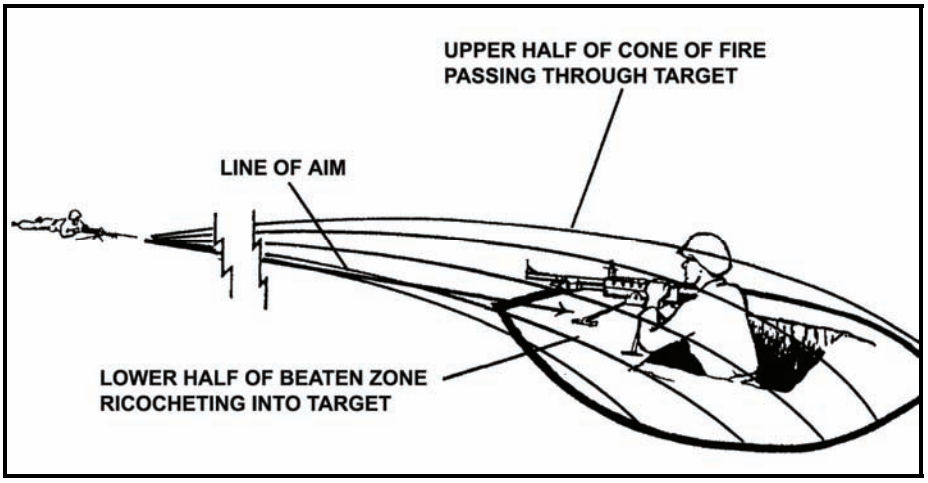

Figure A-13. Line of aim and placement of center of beaten zone on target.

A-51. The gunner must move his 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 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.

TARGET ENGAGEMENTS BY TYPES OF TARGETS

A-52. Gunners engage targets throughout their respective sectors. They must know how to effectively engage all types of targets, either individually or with other gunners.

A-53. Gunner's targets in combat are normally enemy troops in various formations or displacements, which require distribution and concentration of fire. These targets often have both 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. The size of the target, stated in terms of the number of aiming points required to engage it completely, determines its type.

A-54. When a single gunner is assigned any target he is responsible for covering the entire target.

A-55. When a pair of gunners engage an enemy target, each gunner is normally responsible for effectively covering one half of the target. The gunners must be prepared to engage the entire target should the other gun go down.

A-56. 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

A-57. 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:

- 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 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 march columns should be interspersed in the convoy, with emphasis on the lead and rear elements (Figure A-14).

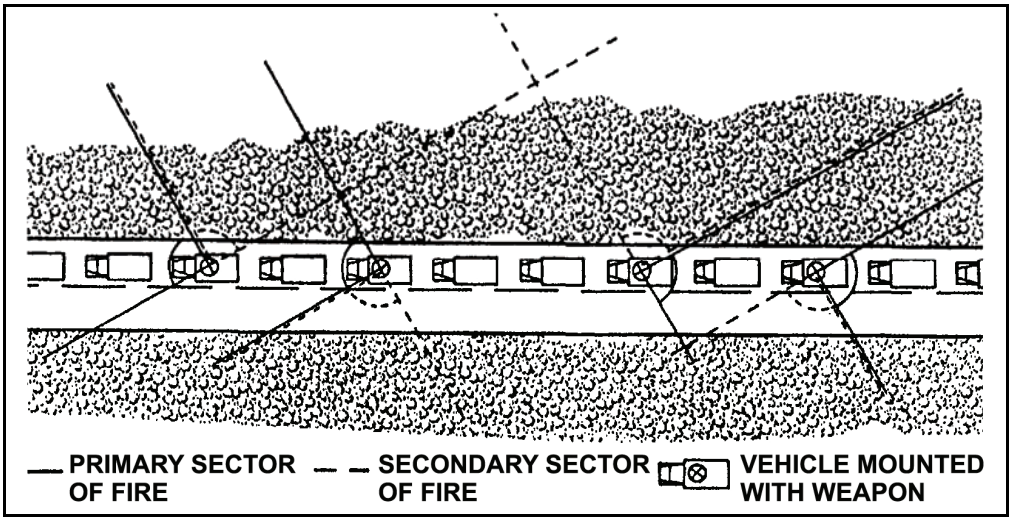

Figure A-14. March column with four machine guns.

TARGET SELECTION AND ENGAGEMENT CONTROL

A-58. 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.

DISTRIBUTION, CONCENTRATION, AND RATE OF FIRE

A-59. The size and nature of the enemy target determines how machine gun fire is applied. Automatic weapons fire in one of three rates: rapid, sustained, or cyclic. The rates of fire for each machine gun are shown in Table A-1. The situation normally dictates the rate used, but the availability of ammunition and need for barrel changes play important roles as well. The rate of fire must be controlled to adequately cover the target, but not waste ammunition or destroy the barrel.

DISTRIBUTED AND CONCENTRATED FIRE

A-60. Distributed fire is delivered in width and depth such as at an enemy formation. Concentrated fire is delivered at a point target such as an automatic weapon or an enemy fighting position.

RAPID FIRE

A-61. Rapid rate of fire places an exceptionally high volume of fire on an enemy position. 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.

SUSTAINED FIRE

A-62. Once the enemy has been suppressed, machine gunners 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.

CYCLIC RATE OF FIRE

A-63. To fire the cyclic rate, the gunner holds the trigger to the rear while the assistant gunner feeds ammunition into the weapon. This is normally only used to engage aerial targets in self-defense or to fire the final protective fire in the defense to protect the perimeter. This produces the highest volume of fire the machine gun can fire, but can permanently damage the machine gun and barrel and should be used only in case of emergency.

TARGET ENGAGEMENT DURING LIMITED VISIBILITY

A-64. Gunners have difficulty detecting and identifying targets during limited visibility. The leader's ability to control the fires of his weapons is also reduced; therefore, he may instruct the gunners to fire without command when targets present themselves.

A-65. Gunners should engage targets only when they can identify the targets, unless ordered to do otherwise. For example, if one gunner detects a target and engages it, the other gunner observes the area fired upon and adds his fire only if he can identify the target or if ordered to fire.

A-66. Tracer ammunition helps a gunner engage targets during limited visibility and should be used if possible. It is important to note that in certain circumstances the enemy will have an easy time identifying the machine gun’s position if the gunner uses tracer ammunition. The need to effectively engage targets must be balanced with the need to keep the guns safe before deciding to employ tracers. If firing unaided, gunners must be trained to fire low at first and adjust upward. This overcomes the tendency to fire high.

A-67. When two or more gunners are engaging linear targets, linear targets with depth, or deep targets, they do not engage these targets as they would when visibility is good. With limited visibility, the center and flanks of these targets may not be clearly defined. Therefore, each gunner observes his tracers and covers what he believes to be the entire target.

TECHNIQUES

A-68. Techniques of fire include assault fire; overhead fire; and fire from a defilade position. Only automatic rifles use assault fire.

ASSAULT FIRE

A-69. Automatic riflemen use assault fire when in close combat. Assault fire involves firing without the aid of sights using the hip, shoulder, and underarm positions. The underarm position is best when rapid movement is required. In all three positions, automatic riflemen adjust their fire by observing the tracer and the impact of the bullets in the target area. Additional considerations for automatic riflemen using assault fire include—

- Maintaining alignment with the rest of the assault element.
- Reloading rapidly.
- Aiming low and adjusting the aim upward toward the target.
- Distributing fires across the objective when not engaging enemy automatic weapons.

OVERHEAD FIRE

A-70. Gunners can use overhead fire when there is sufficient low ground between the machine gun and the target area for the maneuver of friendly forces. 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. Gunners must accurately estimate range to the target and establish a safety limit that is an imaginary line parallel to the target where fire would cause casualties to friendly Soldiers. Gun crews and leaders must be aware of this safety limit. Leaders must designate signals for lifting or shifting fires. Gunners should not attempt overhead fires if the terrain is level or slopes uniformly, if the barrel is badly worn, or if visibility is poor.

Gunner's Rule

A-71. 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 (Figure A-15). The rule follows:

- 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 at a range of 1,600 meters.
- 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, fire must be lifted or shifted.

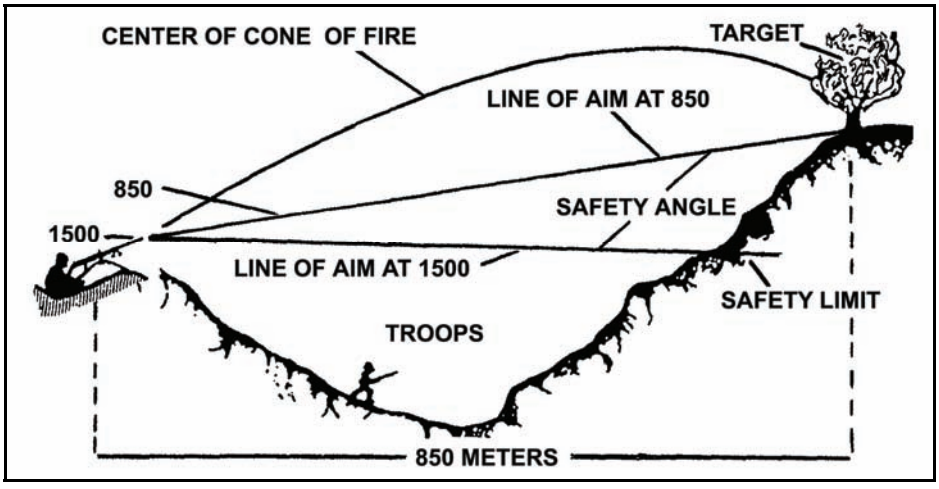

Figure A-15. Application of gunner's rule.

Leader's Rule

A-72. When the range to the target is greater than 850 meters, overhead fire should be delivered only in an emergency. Even then, fire should only extend to a range at which the tracers or strike of the bullets can be seen by the gunner. In this situation the leader's rule applies (Figure A-16). The platoon or section leader uses the leader's rule only when the target is greater than 850 meters. The rule follows:

- Select a point on the ground where it is believed friendly troops can advance with safety.
- 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 1,600 meters or the range to the target plus 500 meters, whichever is the greater of the two ranges. Under no conditions should the sight setting be less than 1,500 meters.
- Note the point where the new line of aim strikes the ground.
  - 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 fire is called for 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 advantageous 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.

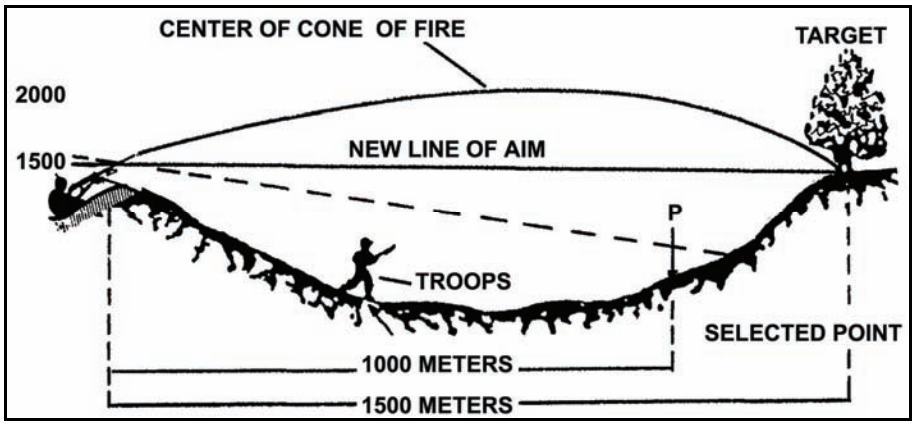

Figure A-16. Application of leader's rule.

Fire From a Defilade Position

A-73. Defilade positions protect gunners from frontal or enfilading fires (Figure A-17). Cover and concealment may not provide the gunner a view of some or all of the target area. In this instance, some other member of the platoon must observe the impact of the rounds and communicate adjustments to the gunner (Figure A-18). Gunners and leaders must consider the complexity of laying on the target. They must also take into account the gunner's inability to make rapid adjustments to engage moving targets, the ease with which targets are masked, and the difficulty in achieving grazing fires for an FPL.

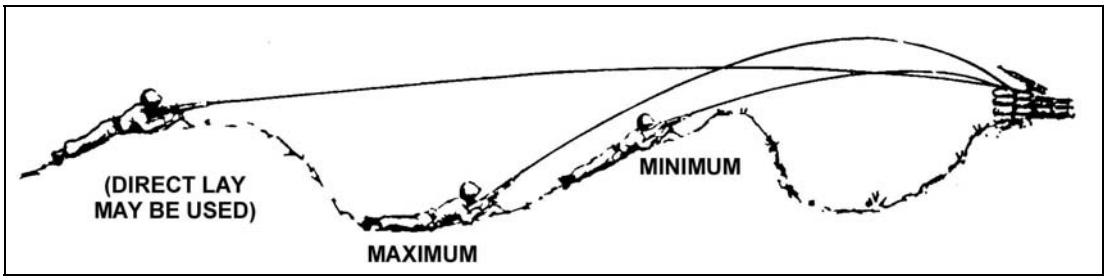

Figure A-17. Defilade positions.

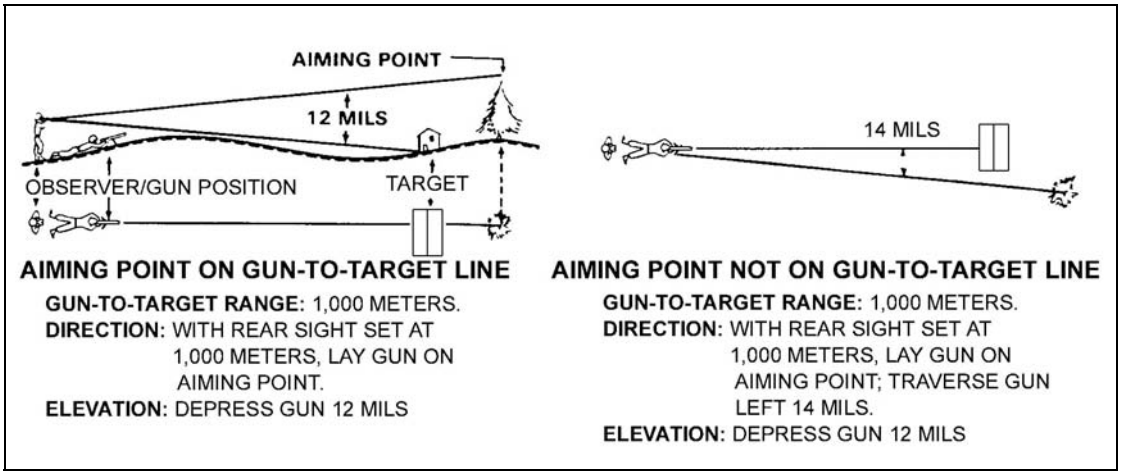

Figure A-18. Observer adjusting fire.

SECTION III — PREDETERMINED FIRES

A-74. Predetermined fires organize the battlefield for the gunners. They allow the leader and gunner to select potential targets or target areas that will most likely be engaged or that have tactical significance. This includes dismounted enemy avenues of approach, likely positions for automatic weapons, and probable enemy assault positions. The gunners do this by using sectors of fire, final protective lines, or a principal direction of fire and selected target areas. This preparation maximizes the effectiveness of the machine gun during good as well as limited visibility. It enhances fire control by reducing the time required to identify targets, determine range, and manipulate the weapon onto the target. Abbreviated fire commands and previously-recorded data enable the gunner to aim or adjust fire on the target quickly and accurately. Selected targets should be fired on in daylight whenever practical to confirm data. The range card identifies the targets and provides a record of firing data.

TERMINOLOGY

A-75. Gunners need to know several terms associated with predetermined fire.

SECTOR OF FIRE

A-76. A sector of fire is an area to be covered by fire that is assigned to an individual, a weapon, or a unit. Gunners are normally assigned a primary and a secondary sector of fire.

FINAL PROTECTIVE FIRE

A-77. A final protective fire (FPF) is an immediately-available, prearranged barrier of fire to stop enemy movement across defensive lines or areas.

FINAL PROTECTIVE LINE

A-78. An FPL is a predetermined line along which grazing fire is placed to stop an enemy assault. If an FPL is assigned, the machine gun is sighted along it except when other targets are being engaged. An FPL becomes the machine gun's part of the unit's final protective fires. An FPL is fixed in direction and elevation. However, a small shift for search must be employed to prevent the enemy from crawling under the FPL and to compensate for irregularities in the terrain or the sinking of the tripod legs into soft soil during firing. Fire must be delivered during all conditions of visibility.

A-79. A good FPL covers the maximum area with grazing fire. Grazing fire can be obtained over various types of terrain out to a maximum of 600 meters. To obtain the maximum extent of grazing fire over level or uniformly sloping terrain, the gunner sets the rear sight at 600 meters. He then selects a point on the ground that he estimates to be 600 meters from the machine gun, and he aims, fires, and adjusts on that point. To prevent enemy soldiers from crawling under grazing fire, he searches (downward) by lowering the muzzle of the weapon.

PRINCIPAL DIRECTION OF FIRE

A-80. A principal direction of fire (PDF) is assigned to a gunner to cover an area that has good fields of fire or has a likely dismounted avenue of approach. It also provides mutual support to an adjacent unit. Machine guns are sighted using the PDF if an FPL has not been assigned. If a PDF is assigned and other targets are not being engaged, machine guns remain on the PDF. A PDF has the following characteristics:

- It is used only if an FPL is not assigned; it then becomes the machine gun's part of the unit's final protective fires.
- When the target has width, direction is determined by aiming on one edge of the target area and noting the amount of traverse necessary to cover the entire target.
- The gunner is responsible for the entire wedge-shaped area from the muzzle of the weapon to the target, but elevation may be fixed for a priority portion of the target.

DEAD SPACE AND GRAZING FIRE

A-81. The extent of grazing fire and the extent of dead space may be determined in two ways. In the preferred method, the machine gun is adjusted for elevation and direction. A member of the squad then walks along the FPL while the gunner aims through the sights. In places where the Soldier's waist (midsection) falls below the gunner's point of aim, dead space exists. Arm-and-hand signals must be used to control the Soldier who is walking and to obtain an accurate account of the dead space and its location. Another method is to observe the flight of tracer ammunition from a position behind and to the flank of the weapon.

PRIMARY SECTOR OF FIRE

A-82. The primary sector of fire is assigned to the gun team to cover the most likely avenue of enemy approach from all types of defensive positions.

SECONDARY SECTOR OF FIRE

A-83. The secondary sector of fire is assigned to the gun team to cover the second most likely avenue of enemy approach. It is fired from the same gun position as the primary sector of fire.

RANGE CARD

A-84. DA Form 5517-R, *Standard Range Card*, provides a record of firing data and aids defensive fire planning.

FIELD EXPEDIENTS

A-85. When laying the machine gun for predetermined targets, the gunner can use field expedients as a means of engaging targets when other sources are not available.

BASE STAKE TECHNIQUE

A-86. A base stake is used to define sector limits and may provide the lay for the FPL or predetermined targets along a primary or secondary sector limit. This technique is effective in all visibility conditions. The gunner uses the following steps:

- Defines the sector limits by laying the gun for direction along one sector limit and by emplacing a stake along the outer edge of the folded bipod legs. Rotates the legs slightly on the receiver, so the gunner takes up the "play." Uses the same procedure for placing a stake along the opposite sector limit.
- Lays the machine gun along the FPL by moving the muzzle of the machine gun to a sector limit. Adjusts for elevation by driving a stake into the ground so the top of the stake is under the gas cylinder extension. This allows a few mils of depression to cover irregularities in the terrain.
- Lays the machine gun to engage other targets within a sector limit. Done in a primary sector by using the procedure described previously, except he keeps the elevation fixed.

NOTCHED-STAKE OR TREE-CROTCH TECHNIQUE

A-87. The gunner uses the notched-stake or tree-crotch technique with the bipod mount to engage predetermined targets within a sector or to define sector limits. This technique is effective during all conditions of visibility and requires little additional material. The gunner uses the following steps:

- Drives either a notched stake or tree crotch into the ground where selected targets are anticipated. Places the stock of the machine gun in the nest of the stake or crotch and adjusts the weapon to hit the selected targets and to define his sector limits.
- Digs shallow, curved trenches or grooves for the bipod feet. (These trenches allow for rotation of the bipod feet as the gunner moves the stock from one crotch or stake to another.)

HORIZONTAL LOG OR BOARD TECHNIQUE

A-88. This technique is used with the bipod or tripod mount to mark sector limits and engage wide targets. It is good for all visibility conditions and is best suited for flat, level terrain. The gunner uses the following steps.

Bipod-Mounted Machine Gun

A-89. Using a bipod-mounted machine gun, the gunner places a log or board beneath the stock of the weapon so the stock can slide across it freely. He digs shallow, curved trenches or grooves for the bipod feet to allow rotation of the feet as he moves the stock along the log or board. (The gunner may mark the sector limits by notching or placing stops on the log or board. The gunner uses the bipod firing position and grip.)

Tripod-Mounted Machine Gun

A-90. Using a tripod-mounted machine gun, the gunner places a log or board beneath the barrel, positioning it so the barrel, when resting on the log or board, is at the proper elevation to obtain grazing fire. When appropriate, he marks the sector limits as described for the bipod in the preceding paragraph. (This technique is used only if a T&E mechanism is not available.)

SECTION IV — FIRE CONTROL

A-91. Fire control includes all actions of the leader and Soldiers in planning, preparing, and applying fire on a target. The leader selects and designates targets. He also designates the midpoint and flanks or ends of a target, unless they are obvious to the gunner. The gunner fires at the instant desired. He then adjusts fire, regulates the rate of fire, shifts from one target to another, and ceases fire. When firing, the gunner should continue to fire until the target is neutralized or until signaled to do otherwise by the leader.

A-92. Predetermined targets, including the FPL or PDF, are engaged on order or by SOP. The signal for calling for these fires is normally stated in the defense order. Control these predetermined targets by using arm-and-hand signals, voice commands, or pyrotechnic devices. Gunners fire the FPL or PDF at the sustained rate of fire unless the situation calls for a higher rate. When engaging other predetermined targets, the sustained rate of fire is also used unless a different rate is ordered.

METHODS OF FIRE CONTROL

A-93. The noise and confusion of battle may limit the use of some of these methods. Therefore, the leader must select a method or combination of methods that will accomplish the mission.

ORAL

A-94. The oral fire control method can be effective, but sometimes the leader may be too far away from the gunner, or the noise of the battle may make it impossible for him to hear. The primary means of the oral fire control method is the issuance of a fire command.

ARM-AND-HAND SIGNALS

A-95. Arm-and-hand signals are an effective fire control method when the gunner can see the leader. All gunners must know the standard arm-and-hand signals. The leader gets the gunner's attention and then points to the target. When the gunner returns the READY signal, the leader commands FIRE.

PREARRANGED SIGNALS

A-96. Prearranged signals are either visual or sound signals such as casualty-producing devices (rifle or claymore), pyrotechnics, whistle blasts, or tracers. These signals should be included in SOPs. If the leader wants to shift fire at a certain time, he gives a prearranged signal such as smoke or pyrotechnics. Upon seeing the signal, the gunner shifts his fire to a prearranged point.

PERSONAL CONTACT

A-97. In many situations, the leader must issue orders directly to individual Soldiers. Personal contact is used more than any other method by Infantry leaders. The leader must use maximum cover and concealment to keep from disclosing the position or himself.

RANGE CARDS

A-98. When using the range card method of fire control, the leader must ensure all range cards are current and accurate. Once this is accomplished, the leader may designate certain targets for certain weapons with the use of limiting stakes or with fire commands. He should also designate no-fire zones or restricted fire areas to others. The key factor in this method of fire control is that gunners must be well disciplined and pay attention to detail.

STANDING OPERATING PROCEDURES

A-99. SOPs are actions to be executed without command that are developed during the training of the squads. Their use eliminates many commands and simplifies the leader's fire control. SOPs for certain actions and commands can be developed to make gunners more effective. Some examples follow:

- **Observation.** The gunners continuously observe their sectors.
- **Fire.** Gunners open fire without command on appropriate targets that appear within their sectors.
- **Check.** While firing, the gunners periodically check with the leader for instructions.
- **Return Fire.** The gunners return enemy fire without order, concentrating on enemy automatic weapons.
- **Shift Fire.** Gunners shift their fires without command when more dangerous targets appear.
- **Rate of Fire.** When gunners engage a target, they initially fire at the rate necessary to gain and maintain fire superiority.
- **Mutual Support.** When two or more gunners are engaging the same target and one stops firing, the other increases the rate of fire and covers the entire target. When only one gunner is required to engage a target and the leader has alerted two or more, the gunner not firing aims on the target and follows the movements of the target. He does this to fire instantly in case the other machine gun malfunctions or ceases fire before the target has been eliminated.

FIRE COMMANDS

A-100. A fire command is given to deliver effective fire on a target quickly and without confusion. When the leader decides to engage a target that is not obvious to the squad, he must provide them with the information they need to effectively engage the target. He must alert the Soldiers; give a target direction, description, and range; name the method of fire; and give the command to fire. There are initial fire commands and subsequent fire commands.

A-101. It is essential that the commands delivered by the weapons squad leader are understood and echoed by the assistant gunner/gun team leader and the gunner. Table A-7 provides an example of the weapons squad fire commands and actions used by the weapons squad leader (WSL), assistant gunner (AG)/gun team leader (GTL), and gunner.

Table A-7. Example weapons squad fire commands and actions.

ACTION	WSL COMMANDS	AG/GTL COMMANDS AND ACTIONS	GUNNER ACTIONS	GUNNER RESPONSES
WSL or GTL identifies target within gun team's sector	"Light-skinned truck, 3 o'clock, 400 m, on my laser."	"Light-skinned truck, 3 o'clock, 400 m, on my laser." "Once on TGT engage."	Gunner looks for laser and identifies target. Gunner traverses and gets on target. Gunner engages target with correct rate of fire.	"TGT identified." "TGT acquired."
Gun team (or weapons SQD) go to bipod	"Gun 1-Bipod."	Repeats "Gun 1-Bipod" and identifies location for gun.	Gets down beside AG/GTL.	"Gun 1 up" once ready to fire.
Gun team go to tripod	"Gun 1-Tripod."	Repeats "Gun 1-Tripod" and lays down tripod (if not done) and prepares to lock gun on tripod.	Gunner picks up gun and places into tripod. He gets AG/GTL to lock it in. Once locked in, the AG/GTL collapses bipod legs.	"Gun 1 up" once ready to fire.
Barrel change	NA	"Gun 1 prepare for barrel change." "Gun 1 barrel change."	Fires one more burst. Waits for barrel change.	Repeats AG/GTL command. Once done, "Gun 1 up."
Displace gun	"Gun 1 out of action, prepare to move."	"Gun 1 out of action, prepare to move." Breaks down barrel bag, prepares to move.	Gunner takes gun off tripod, continues to orient towards target on bipod, and prepares to move.	"Gun 1, ready to move."
WSL identifies sector of fire for gun team(s) Day-marks w/tracer Night-marks with PEQ/tracer	"Gun 1, left, center, right sectors on my mark. Do you identify?" (Always marks left to right.)	Using binoculars identifies sectors and states, "Gun 1 identifies." Adjusts gunner onto target.	Gunner makes necessary adjustments, tells AG/GTL whether he identifies or not. Engages or makes further adjustments.	"Sector identified" to AG/GTL once he identifies.

Table A-7. Example weapons squad fire commands and actions (continued).

ACTION	WSL COMMANDS	AG/GTL COMMANDS AND ACTIONS	GUNNER ACTIONS	GUNNER RESPONSES
WSL or AG/GTL gives or adjusts rate of fire	"Gun 1, sustained __ seconds, engage."	Echoes command, starts count. Tells gunner to fire. Keeps count between bursts and ensures gun does not fire out of turn.	Gunner echoes command, also counts and fires when AG/GTL gives command to fire.	Echoes rate of fire "Sustained __ seconds."
WSL changes gun team(s) sector of fire or shift fire	"Gun 1, shift fire, target # (or) right/left sector." Marks sector same as above.	Echoes command to shift; identifies new target/sector. Adjusts gunner, alerts WSL once the gunner has shifted.	Gunner echoes command, makes necessary adjustment, acquires new target. Confirms with AG/GTL that all is OK. Engages new sector when told.	Echoes command with AG/GTL. "Shift fire to TGT #__." Once identified, "Sector/target identified."
Talking the gun teams (ensuring one gun fires during the other gun's interval and visa versa).	WSL gives gun teams the rate of fire. (As long as they are keeping correct interval, they should "talk" themselves.)	Repeats rate of fire and maintains proper count, telling gunner when to fire. Adjusts rate of fire off of lead gun.	Repeats rate of fire command, keeps own count. Fires when told to fire. Adjusts rate of fire off of lead gun.	"Sustained __ seconds."
Lift fire	"Lift fire, lift fire, lift fire." Or "Gun 1, lift fire."	Repeats command to gunner, ensures gunner lifts fire.	Repeats command. Ceases all fire onto the objective. Maintains overwatch and scans objective until told to reengage or go out of action.	Echoes "lift fire."
Round count	If need to know round count, prompt "Gun 1, round count."	AG/GTL continuously links rounds and gives WSL round count every 100. "Gun 1, 200 rounds."	Gunner echoes round count to ensure it is heard.	"Gun 1, 200 rounds."
"Watch and shoot" or "Traverse and search"	"Gun 1, watch and shoot." "Gun 1, traverse and search."	Repeats command, searches objective for targets of opportunity within sector.	Repeats command, searches objective for targets of opportunity in sector. Confirms target with AG/GTL before engaging.	"Gun 1, watch and shoot." "Gun 1, traverse and search."

INITIAL FIRE COMMANDS

A-102. Initial fire commands are given to adjust onto the target, change the rate of fire after a fire mission is in progress, interrupt fire, or terminate the alert.

ELEMENTS

A-103. Fire commands for all direct-fire weapons follow a pattern that includes similar elements. There are six elements in the fire command for the machine gun: alert; direction; description; range; method of fire; and command to open fire. The gunners repeat each element of fire command as it is given.

Alert

A-104. This element prepares the gunners for further instructions. The leader may alert both gunners in the squad and may have only one fire, depending upon the situation. To alert and have both gunners fire, the leader announces FIRE MISSION. If he desires to alert both gunners but have only one fire, he announces GUN NUMBER ONE, FIRE MISSION. In all cases, upon receiving the alert, the gunners load their machine guns and place them on FIRE.

Direction

A-105. This element indicates the general direction to the target and may be given in one or a combination of the following methods.

Oral

A-106. The leader orally gives the direction to the target in relation to the position of the gunner (for example, FRONT, LEFT FRONT, RIGHT FRONT).

Pointing

A-107. The leader designates a small or obscure target by pointing with his finger or aiming with a weapon. When he points with his finger, a Soldier standing behind him should be able to look over his shoulder and sight along his arm and index finger to locate the target. When aiming his weapon at a target, a Soldier looking through the sights should be able to see the target. Leaders may also use lasers in conjunction with night vision devices to designate a target to the gunner.

Tracer Ammunition

A-108. Tracer ammunition is a quick and sure method of designating a target that is not clearly visible. When using this method, the leader should first give the general direction to direct the gunner's attention to the target area. To prevent the loss of surprise when using tracer ammunition, the leader does not fire until he has given all elements of the fire command except the command to fire. The leader may fire his individual weapon. The firing of the tracer(s) then becomes the last element of the fire command, and it is the signal to open fire.

NOTE: Soldiers must be aware that with the night vision device, temporary blindness ("white out") may occur when firing tracer ammunition at night or when exposed to other external light sources. Lens covers may reduce this effect.

Reference Points

A-109. Another way to designate obscure targets is to use easy-to-recognize reference points. All leaders and gunners must know terrain features and the terminology used to describe them (see FM 3-25.26, *Map Reading and Land Navigation*). When using a reference point, the word "reference" precedes its description. This is done to avoid confusion. The general direction to the reference point should be given.

Description

A-110. The target description creates a picture of the target in the minds of the gunners. To properly apply their fire, the Soldiers must know the type of target they are to engage. The leader should describe it briefly. If the target is obvious, no description is necessary.

Range

A-111. The leader always announces the estimated range to the target. The range is given, so the gunner knows how far to look for the target and what range setting to put on the rear sight. Range is announced in meters. However, since the meter is the standard unit of range measurement, the word "meters" is not used. With machine guns, the range is determined and announced to the nearest hundred or thousand (for example, THREE HUNDRED, or ONE THOUSAND).

Method of Fire

A-112. This element includes manipulation and rate of fire. Manipulation dictates the class of fire with respect to the weapon. It is announced as FIXED, TRAVERSE, SEARCH, or TRAVERSE AND SEARCH. Rate controls the volume of fire (sustained, rapid, and cyclic). Normally, the gunner uses the sustained rate of fire. The rate of fire is omitted from the fire command. The method of fire for the machine gun is usually 3- to 5-round bursts (M249) and 6- to 9-round bursts (M60/M240B).

Command to Open Fire

A-113. When fire is to be withheld so surprise fire can be delivered on a target or to ensure that both gunners open fire at the same time, the leader may preface the command to commence firing with AT MY COMMAND or AT MY SIGNAL. When the gunners are ready to engage the target, they report READY to the leader. The leader then gives the command FIRE at the specific time desired. If immediate fire is required, the command FIRE is given without pause and the gunners fire as soon as they are ready.

SUBSEQUENT FIRE COMMANDS

A-114. Subsequent fire commands are used to make adjustments in direction and elevation, to change rates of fire after a fire mission is in progress, to interrupt fires, or to terminate the alert. If the gunner fails to properly engage a target, the leader must promptly correct him by announcing or signaling the desired changes. When these changes are given, the gunner makes the corrections and resumes firing without further command.

A-115. Adjustments in direction and elevation with the machine gun are always given in meters; one finger is used to indicate 1 meter and so on. Adjustment for direction is given first. For example: RIGHT ONE ZERO METERS or LEFT FIVE METERS. Adjustment for elevation is given next. For example: ADD FIVE METERS or DROP ONE FIVE METERS. These changes may be given orally or with arm-and-hand signals.

- Changes in the rate of fire are given orally or by arm-and-hand signals.
- To interrupt firing, the leader announces CEASE FIRE, or he signals to cease fire. The gunners remain on the alert. They resume firing when given the command FIRE.
- To terminate the alert, the leader announces CEASE FIRE, END OF MISSION.

DOUBTFUL ELEMENTS AND CORRECTIONS

A-116. When the gunner is in doubt about any element of the fire command, he replies, SAY AGAIN RANGE, TARGET. The leader then announces THE COMMAND WAS, repeats the element in question, and continues with the fire command.

A-117. When the leader makes an error in the initial fire command, he corrects it by announcing CORRECTION, and then gives the corrected element. When the leader makes an error in the subsequent fire command, he may correct it by announcing CORRECTION. He then repeats the entire subsequent fire command.

ABBREVIATED FIRE COMMANDS

A-118. Fire commands do not need not be complete to be effective. In combat, the leader gives only the elements necessary to place fire on a target quickly and without confusion. During training, however, he should use all of the elements to get gunners in the habit of thinking and reacting properly when a target is to be engaged. After the gunner's initial training in fire commands, he should be taught to react to abbreviated fire commands, using one of the following methods.

Oral

A-119. The leader may want to place the fire of one machine gun on an enemy machine gun and quickly tells the gunner to fire on that gun.

Hand-and-Arm Signals

A-120. Battlefield noise and the distance between the gunner and the leader often make it necessary to use arm-and-hand signals to control fire (Figure A-19). When an action or movement is to be executed by only one of the gunners, a preliminary signal is given to that gunner only. The following are commonly used signals for fire control:

- **Ready.** The gunner indicates that he is ready to fire by yelling UP or having the assistant gunner raise his hand above his head toward the leader.
- **Commence Firing or Change Rate of Firing.** The leader brings his hand (palm down) to the front of his body about waist level, and moves it horizontally in front of his body. To signal an increase in the rate of fire, he increases the speed of the hand movement. To signal slower fire, he decreases the speed of the hand movement.
- **Change Direction or Elevation.** The leader extends his arm and hand in the new direction and indicates the amount of change necessary by the number of fingers extended. The fingers must be spread so the gunner can easily see the number of fingers extended. Each finger indicates 1 meter of change for the weapon. If the desired change is more than 5 meters, the leader extends his hand the number of times necessary to indicate the total amount of change. For example, *right nine* would be indicated by extending the hand once with five fingers showing and a second time with four fingers showing for a total of nine fingers.
- **Interrupt or Cease Firing.** The leader raises his arm and hand (palm outward) in front of his forehead and brings it downward sharply.
- **Other Signals.** The leader can devise other signals to control his weapons. A detailed description of arm-and-hand signals is given in FM 21-60.

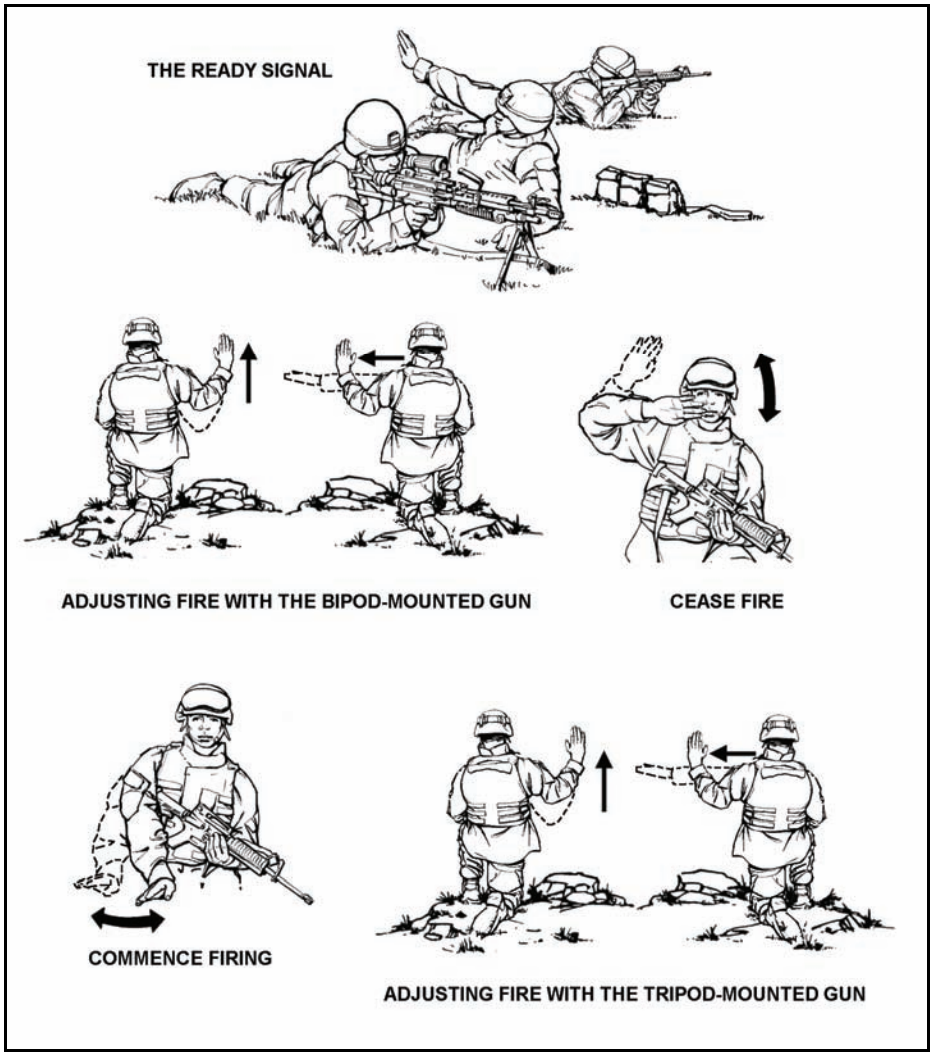

Figure A-19. Hand-and-arm signals.

SECTION V — MACHINE GUN USE

A-121. Despite their post-Civil War development, modern machine guns did not exhibit their full potential in battle until World War I. Although the machine gun has changed, the role of the machine gun and machine gunner has not. The mission of machine guns in battle is to deliver fires when and where the leader wants them in both the offense and defense. Machine guns rarely, if ever, have independent missions. Instead, they provide their unit with accurate, heavy fires to accomplish the mission.

TACTICAL ORGANIZATION OF THE MACHINE GUN

A-122. The accomplishment of the platoon's mission demands efficient and effective machine gun crews. Leaders consider the mission and organize machine guns to deliver firepower and fire support to any area or point needed to accomplish the assigned mission.

A-123. Infantry platoons will normally have an organic weapons squad that consists of a weapons squad leader and two gun teams. Depending on the unit's organization or the platoon's mission, there could be additional machine gun teams attached or organic to the platoon.

A-124. The weapons squad consists of a weapons squad leader and machine gun teams. Each machine gun team has a gunner, assistant gunner, and ammunition bearer. In some units the senior member of the gun team is the gunner. In other units the assistant gunner is the senior gun team member who also serves as the gun team leader. Table A-8 illustrates equipment carried by the weapons squad. Table A-9 illustrates the duty positions within the weapons squad and gives possible duty descriptions and responsibilities. The tables serve to show possible position and equipment use only. Individual unit SOPs and available equipment dictate the exact role each weapons squad member plays within his squad.

Table A-8. Example weapons squad equipment by position.

	Weapons Squad Leader	Assistant Gunner/ Gun Team Leader	Gunner	Ammunition Bearer
Weapon	M4 (w/ 7 mags*)	M4 (w/ 7 mags*)	M240B (50-100 rounds)	M4 (w/ 7 mags)
Day Optic	ACOG	ACOG	M145	M68/ACOG
Laser	PEQ-2	PEQ-2	PEQ-2	PAQ-4/PEQ-2
Additional Equipment	3x magnifier**	3x magnifier** Spare barrel(s)***	3x magnifier**	Tripod T&E
M240 Ammunition	100 rounds	300 rounds	100 rounds	300 rounds
Miscellaneous	Whistle Pen gun flare** Other shift signals** VS-17 panel Binoculars****	M9 pistol Cleaning kit Binoculars****	M9 pistol Cleaning kit CLP for 72 hours*****	NA
*WSL and AG/GTL load tracer rounds (4:1 mix) in magazines for marking targets.				
**3x magnifier, flares, and shift signals are readily accessible at all times.				
***Spare barrel(s) marked by relative age with ¼ pieces of green tape on carrying handle. Oldest barrel=2 parallel strips Second newest barrel=1 strip Newest barrel=no tape				
****Binoculars carried in the assault pack or in suitable pouch on vest (mission dependent).				
*****Gunners always carry enough CLP for 72 hours of operations.				

Table A-9. Example weapons squad duty positions and responsibilities.

Weapons Squad Leader	Senior squad leader within the platoon. Responsible for all training and employment of the machine guns. The WSL's knowledge, experience, and tactical proficiency influence the effectiveness of the squad.
Assistant Gunner/ Gun Team Leader	AG/GTL is a team leader with the responsibilities of a fire team leader.
	GTL is responsible for his team members and all the gun equipment.
	GTL and his team will be tactically proficient and knowledgeable on this FM and applicable FMs and TMs that apply to the machine gun.
	GTL assists the WSL on the best way to employ the M240B.
	GTL enforces field discipline while the gun team is employed.
	GTL leads by example in all areas. He sets the example in all things.
	GTL assists the WSL in all areas. He advises him of any problems either tactical or administrative.
	AG is responsible for all action concerning the gun.
	AG/GTL calls the ammunition bearer if ammunition is needed or actively seeks it out if the ammunition bearer is not available. Constantly updates the WSL on the round count and serviceability of the M240B.
	When the gun is firing, AG/GTL spots rounds and makes corrections to the gunner's fire. Also watches for friendly troops to the flanks of the target area or between the gun and the target.
	If the gunner is hit by fire, AG/GTL immediately assumes the roll of the gunner.
	AG/GTL is always prepared to change the gun's barrel (spare barrel is always out when the gun is firing). Ensures the hot barrel is not placed on live ammunition or directly on the ground when it comes out of the gun.
Machine Gunner	If second in the gun team's chain of command, he is always fully capable of taking the GTL position.
	Primary responsibility is to the gun. Focused on its cleanliness and proper function. Immediately reports any abnormalities to the GTL or WSL.
	If necessary for gunner to carry M240B ammunition, carries it in on his back so the AG/GTL can access it without stopping the fire of the gun.
	Always carries the necessary tools for the gun to be properly cleaned, along with a sufficient amount of oil for the gun's proper function.
Ammunition Bearer	The AB is the rifleman/equipment bearer for the gun team.
	Normally the newest member of the gun team. Must quickly learn everything he can, exert maximum effort at all times, and attempt to outdo his gun team members in every situation.
	Follows the gunner without hesitation. During movement moves to the right side of the gunner and no more than one 3-5 meters rush away from the gun.
	During firing, pulls rear security and if the gunner comes under enemy fire, provides immediate suppression while the gun moves into new position.
	Responsible for the tripod and T&E mechanism. They must always be clean and ready for combat. Responsible for replacing them, if necessary.

SECURITY

A-125. Security includes all command measures to protect against surprise, observation, and annoyance by the enemy. The principal security measures against ground forces include employment of security patrols and detachments covering the front flanks and rear of the unit's most vulnerable areas. The composition and strength of these detachments depends on the size of the main body, its mission, and the nature of the opposition expected. The presence of machine guns with security detachments augments their firepower to effectively delay, attack, and defend, by virtue of their inherent firepower.

A-126. The potential of air and any potential ground attacks on the unit demands every possible precaution for maximum security while on the move. Where this situation exists, the machine gun crew must be thoroughly trained in the hasty delivery of antiaircraft fire and of counterfires against enemy ground forces.

The distribution of the machine guns in the formation is critical. The machine gun crew is constantly on the alert, particularly at halts, ready to deliver fire as soon as possible. If the leader expects a halt to exceed a brief period, he carefully chooses machine gun positions to avoid unduly tiring the machine gun crew. If he expects the halt to extend for a long period, he can have the machine gun crew take up positions in support of the unit. The crew covers the direction from which he expects enemy activity as well as the direction from which the unit came. The leader selects positions that permit the delivery of fire in the most probable direction of enemy attack, such as valleys, draws, ridges, and spurs. He chooses positions that offer obstructed fire from any potential enemy locations.

MACHINE GUNS IN THE OFFENSE

A-127. Successful offensive operations result from the employment of fire and movement. Each is essential and greatly depends upon the other. Without the support of covering fires, maneuvering in the presence of enemy fire can result in disastrous losses. Covering fires, especially those that provide fire superiority, allow maneuvering in the offense. However, fire superiority alone rarely wins battles. The primary objective of the offense is to advance, occupy, and hold the enemy position.

MACHINE GUN AS A BASE OF FIRE

A-128. Machine gun fire from a support-by-fire (SBF) position must be the minimum possible to keep the enemy from returning effective fire. Ammunition must be conserved so the guns do not run out of ammunition.

A-129. The weapon squad leader positions and controls the fires of all machine guns in the element. Machine gun targets include key enemy weapons or groups of enemy targets either on the objective or attempting to reinforce or counterattack. In terms of engagement ranges, machine guns in the base-of-fire element may find themselves firing at targets within a range of 800 meters. The nature of the terrain, desire to achieve some standoff, and the other factors of METT-TC prompt the leader to the correct tactical positioning of the base-of-fire element.

A-130. The machine gun delivers an accurate, high-volume rate of lethal fire on fairly large areas in a brief time. When accurately placed on the enemy position, machine gun fires secure the essential element of fire superiority for the duration of the firing. Troops advancing in the attack should take full advantage of this period to maneuver to a favorable position from where they can facilitate the last push against the enemy. In addition to creating enemy casualties, machine gun fire destroys the enemy's confidence and neutralizes his ability to successfully engage the friendly maneuver element.

A-131. There are distinct phases of rates of fire employed by the base of fire element:

- Initial heavy volume (rapid rate) to gain fire superiority.
- Slower rate to conserve ammunition (sustained rate) while still preventing effective return fire as the assault moves forward.
- Increased rate as the assault nears the objective.
- Lift and shift to targets of opportunity.

A-132. All vocal commands from the leaders to change the rates of fire are accompanied simultaneously by hand-and-arm signals.

A-133. Machine guns in the SBF role should be set in and assigned a primary and alternate sector of fire as well as a primary and alternate position.

A-134. Machine guns are suppressive fire weapons used to suppress known and suspected enemy positions. Therefore, gunners cannot be allowed to empty all of their ammunition into one bunker simply because that is all they can identify at the time.

A-135. The SBF position, not the assault element, is responsible for ensuring there is no masking of fires. The assault element might have to mask the SBF line because they have no choice on how to move. It is the SBF gunner’s job to continually shift fires, or move gun teams or the weapons squad to support the assault and prevent any masking.

A-136. Shift and shut down the weapon squad gun teams one at a time, not all at once. M203 and mortar or other indirect fire can be used to suppress while the machine guns are moved to where they can shoot.

A-137. Leaders must take into account the SDZ of the machine guns when planning and executing the lift and or shift of the SBF guns. The effectiveness of the enemy on the objective will play a large role in how much risk should be taken with respect to the lifting or shifting of fires.

A-138. Once the SBF line is masked by the assault element, fires are shifted and or lifted to prevent enemy withdrawal or reinforcement.

MACHINE GUN WITH THE MANEUVER ELEMENT

A-139. Under certain terrain conditions, and for proper control, machine guns may join the maneuver or assault unit. When this is the case, they are assigned a cover fire zone or sector.

A-140. The machine guns seldom accompany the maneuver element. The gun's primary mission is to provide covering fire. The machine guns are only employed with the maneuver element when the area or zone of action assigned to the assault or company is too narrow to permit proper control of the guns. The machine guns are then moved with the unit and readied to employ on order from the leader and in the direction needing the supporting fire.

A-141. When machine guns move with the element undertaking the assault, the maneuver element brings the machine guns to provide additional firepower. These weapons are fired from a bipod, in an assault mode, from the hip, or from the underarm position. They target enemy automatic weapons anywhere on the unit's objective. Once the enemy's automatic weapons have been destroyed (if there are any), the gunners distribute their fire over their assigned zone or sector. In terms of engagement ranges, the machine gun in the assault engages within 300 meters of its target and frequently at point-blank ranges.

A-142. Where the area or zone of action is too wide to allow proper coverage by the platoon's organic machine guns, the platoon can be assigned additional machine guns or personnel from within the company. This may permit the platoon to accomplish its assigned mission. The machine guns are assigned a zone or a sector to cover and they move with the maneuver element.

M 249 MACHINE GUN IN THE OFFENSE

A-143. In the offense, M249s target any enemy-supporting weapons being fired from fixed positions anywhere on the squad's objective. When the enemy's supporting weapons have been destroyed, or if there are none, the machine gunners distribute their fire over that portion of the objective that corresponds to their team's position.

MEDIUM MACHINE GUNS IN THE OFFENSE

A-144. In the offense the platoon leader has the option to establish his base of fire element with one or two machine guns, the M249 light machine gun, or a combination of the weapons. The platoon sergeant or weapons squad leader may position this element and control its fires when the platoon scheme of maneuver is to conduct the assault with the Infantry squads. The M240B machine gun, when placed on a tripod, provides stability and accuracy at greater ranges than the bipod, but it takes more time to maneuver the machine gun should the need arise. The machine gunners target key enemy weapons until the assault element masks their fires. They can also be used to suppress the enemy's ability to return accurate fire, or to hamper the maneuver of the enemy's assault element. They fix the enemy in position and isolate him by cutting off his avenues of reinforcement. They then shift their fires to the flank opposite the one being assaulted and continue to target any automatic weapons that provide enemy support, and engage any enemy counterattack. M240B fires also can be used to cover the gap created between the forward element of the friendly assaulting force and terrain covered by indirect fires when the indirect fires are lifted and shifted. On signal, the machine gunners and the base-of-fire element displace to join the assault element on the objective.

MK 19 AND M2 IN THE OFFENSE

A-145. The MK 19 and M2 can be used as part of the base-of-fire element to assist the friendly assault element by suppressing enemy bunkers and lightly-armored vehicles. Even if ammunition fired from the guns is not powerful enough to destroy enemy vehicles, well-aimed suppressive fire can keep the enemy buttoned up and unable to place effective fire on friendly assault elements. The MK 19 and M2 are particularly effective in preventing lightly-armored enemy vehicles from escaping or reinforcing. Both vehicle mounted weapons can fire from a long range stand-off position, or be moved forward with the assault element.

MACHINE GUNS IN THE DEFENSE

A-146. The platoon's defense centers on its machine guns. The platoon leader sites the rifle squad to protect the machine guns against the assault of a dismounted enemy formation. The machine gun provides the necessary range and volume of fire to cover the squad front in the defense.

A-147. The primary requirement of a suitable machine gun position in the defense is its effectiveness in accomplishing specific missions. The position should be accessible and afford cover and concealment. Machine guns are sited to protect the front, flanks, and rear of occupied portions of the defensive position, and to be mutually supporting. Attacking troops usually seek easily-traveled ground that provides cover from fire. Every machine gun should therefore have three positions: primary, alternate, and supplementary. All of these positions should be chosen by the leader to ensure his sector is covered and that the machine guns are protected on their flanks.

A-148. The leader sites the machine gun to cover the entire sector or to overlap sectors with the other machine guns. The engagement range may extend from over 1,000 meters where the enemy begins his assault to point-blank range. Machine gun targets include enemy automatic weapons and command and control elements.

A-149. Machine gun fire is distributed in width and depth in a defensive position. The leader can use machine guns to subject the enemy to increasingly devastating fire from the initial phases of his attack, and to neutralize any partial successes the enemy might attain by delivering intense fires in support of counterattacks. The machine gun's tremendous firepower enables the unit to hold ground. This is what makes them the backbone or framework of the defense.

M249 MACHINE GUN IN THE DEFENSE

A-150. In the defense, the M249 adds increased firepower without the addition of manpower. Characteristically, M249s are light, fire rapidly, and have more ammunition than the rifles in the squad they support. Under certain circumstances, the platoon leader may designate the M249 machine gun as a platoon weapon.

MEDIUM MACHINE GUNS IN THE DEFENSE

A-151. In the defense, the medium machine gun provides sustained direct fires that cover the most likely or most dangerous enemy dismounted avenues of approach. It also protects friendly units against the enemy's dismounted close assault. The platoon leader positions his machine guns to concentrate fires in locations where he wants to inflict the most damage to the enemy. He also places them where they can take advantage of grazing enfilade fires, stand-off or maximum engagement range, and best observation of the target area. Machine guns provide overlapping and interlocking fires with adjacent units and cover tactical and protective obstacles with traversing or searching fires. When final protective fires are called for, machine guns (aided by M249 fires) place an effective barrier of fixed, direct fire across the platoon front. Leaders position machine guns to—

- Concentrate fires where they want to kill the enemy.
- Fire across the platoon front
- Cover obstacles by direct fire.
- Tie in with adjacent units.

MK 19 AND M2 IN THE DEFENSE

A-152. In the defense, MK 19 and M2 machine guns may be fired from the vehicle mount or dismounted from the vehicle and mounted on a tripod at a defensive fighting position designed for the weapon system.

A-153. These guns provide sustained direct fires that cover the most likely enemy mounted avenue of approach. Their maximum effective range enables them to engage enemy vehicles and equipment at far greater ranges than the platoon's other direct fire weapons.

A-154. When mounted on the tripod, the M2 and MK 19 are highly accurate to their maximum effective range and predetermined fires can be planned for likely high pay off targets. The trade off is these weapon systems are relatively heavy, and take more time to move.

A-155. These guns are not as accurate when mounted on vehicles as they are when fired from the tripod-mounted system. They are, however, more easily maneuvered to alternate firing locations should the need arise.

AMMUNITION PLANNING

A-156. Leaders must carefully plan for the rates of fire to be employed by machine guns as they relate to the mission and the amount of ammunition available. The weapons squad leader must fully understand the mission the amount of available ammunition and the application of machine gun fire needed to fully support all key events of the mission. Planning will ensure the guns do not run out of ammunition.

A-157. A mounted platoon might have access to enough machine gun ammunition to support the guns throughout any operation. A dismounted platoon with limited resupply capabilities has to plan for only the basic load to be available. In either case, leaders must take into account key events the guns must support during the mission. They must plan for the rate of machine gun fire needed to support the key events, and the amount of ammunition needed for the scheduled rates of fire.

A-158. The leader must make an estimate of the total amount of ammunition needed to support all the machine guns. He must then adjust the amount of ammunition used for each event to ensure enough ammunition is available for all phases of the operation. Examples of planning rates of fire and ammunition requirements for a platoon's machine guns in the attack follow.

KNOW RATES OF FIRE

A-159. Leaders and gunners must know how much ammunition is required to support the different rates of fire each platoon machine gun and assault weapon will require. Coupling this knowledge with an accurate estimate of the length of time and rates of fire their guns are scheduled to fire will ensure enough ammunition resources to cover the entire mission. As part of an example of the planning needed to use M240Bs in support-by-fire roles, the rates of fire for the M240B are listed in Table A-10.

Table A-10. M240B rates of fire.

Sustained	• 100 rounds per minute • Fired in 6- to 9-round bursts • 4-5 seconds between bursts (barrel change every 10 minutes)
Rapid	• 200 rounds per minute • Fired in 10- to 12-round bursts • 2-3 seconds between bursts (barrel change every 2 minutes)
Cyclic	• 650-950 rounds per minute • Continuous burst (barrel change every minute)

AMMUNITION REQUIREMENT

A-160. Leaders must calculate the number of rounds needed to support every machine gun throughout all phases of the operation. Ammunition must be allocated for each key event and to support movement with suppressive fires. For example, in the following list, key events are given for a platoon using two M240Bs in a support-by-fire position. Figure A-20 illustrates steps the leader must take to accurately estimate the ammunition required.

Calculating Ammunition Requirement for Two M240Bs in a Support-by-Fire Position

Identify Key Events
Breach chain link fence.
Counterattack 3-4 light-skinned enemy vehicles with 30 enemy passengers.
Consolidte and reorganize.

Allocate Ammunition to Each Key Event
Support the breach with rapid rate of fire for 30 seconds prior to breach and 30 seconds after (1 minute total) = 200 rounds per gun.
Defeat counterattack = 100 rounds per gun.
Consolidate and reorganize = 200 rounds per gun.

Support Movement With Suppressive Fires
Use sustained rate of fire (100 rounds per minute) to support movement to breach (10 minutes) = 1,000 rounds per gun.
Use sustained rate of fire (100 rounds per minute) to support movement from first objective to the next (5 minutes) = 500 rounds per gun.

Add Everything Together
Breach (200) + counterattack (100) + consolidate and reorganize (200) + first movement (1,000) + second movement (500) = 2,000 rounds per gun.
2 machine guns = 4,000 total rounds needed.

Analyze and Adjust if Necessary
"Is this too much ammunition? What do I have right now?"
Look at key events: "Can we flex there? No."
"How much fire have I planned for during my movements?'

- Sustained rate of fire = 100 rounds per minute (6- to 9-round burst every 4-5 seconds) × 10 minutes = 1,000 rounds per gun planned.
- "Do I need that many rounds?"

Work Backwards

- "I now want one 9-round burst every 10 seconds to support movements."
- 60 seconds divided by 10 seconds = 6 bursts per minute × 9-round burst = 54 rounds per minute × 10 minutes = 540 rounds per gun.
- This a difference of 460 rounds per gun from the original plan.
- New round count = 1,540 rounds per gun or 3,080 total rounds.

Total savings of 920 rounds by adding 5 seconds between suppressive fire bursts during movements.

Figure A-20. Example of ammunition requirement calculation.

Appendix B

Shoulder-Launched Munitions and Close Combat Missile Systems

Shoulder-launched munitions (SLM) and Close Combat Missile Systems (CCMS) are employed by the Infantry platoon to destroy enemy field fortifications or disable enemy vehicles at ranges from 15 to 3,750 meters. They can engage targets in assault, support-by-fire, and defensive roles, and are the Infantry platoon's highest casualty-producing organic weapons when used against armored enemy vehicles. This appendix addresses SLM and CCMS use by the Infantry platoon and discusses their capabilities and limitations.

SECTION I — MUNITIONS

B-1. SLM and CCMS are used against field fortifications, enemy vehicles, or other similar enemy targets. SLM are issued to Infantry Soldiers as rounds of ammunition in addition to their assigned weapons. While Javelins are organic to the Infantry weapons squad, tube-launched, optically-tracked, wire-guided (TOW) missile weapon systems are found in the assault platoons in the Infantry battalion's weapon company. This section discusses the specific types of SLM and CCMS the Infantry platoon or squad will employ. Section II discusses their employment considerations. Section III discusses safety. For complete information read FM 3-23.25, *Shoulder Launched Munitions*; FM 3-22.37, *Javelin Medium Antiarmor Weapon System*; FM 3-22.34, *Tow Weapon System*; and FM 3-22.32, *Improved Target Acquisition System, M41*.

SHOULDER-LAUNCHED MUNITIONS

B-2. SLM include the M136 AT4; the M72A3 light antiarmor weapon (LAW) and improved M72A7 LAW; and the XM141 bunker defeat munition (BDM). The XM141 has also been referred to as the shoulder-launched multipurpose assault weapon-disposable (SMAW-D). Table B-1 lists select SLM specifications.

B-3. All SLM are lightweight, self-contained, single-shot, disposable weapons that consist of unguided free flight, fin-stabilized, rocket-type cartridges packed in expendable, telescoping launchers (except the AT4 which does not telescope) that also serve as storage containers. The only requirement for their care is a visual inspection. SLM can withstand extreme weather and environmental conditions, including arctic, tropical, and desert climates.

B-4. SLM increase the lethality and survivability of the Infantry Soldier and provide him a direct fire capability to defeat enemy personnel within armored platforms. BDM provides the Soldier a direct fire capability to defeat enemy personnel located within field fortifications, bunkers, caves, masonry structures, and lightly armed vehicles and to suppress enemy personnel in lightly armored vehicles.

B-5. The individual Soldier will use SLM to engage threat combatants at very close ranges—across the street or from one building to another. The Soldier may employ SLM as a member of a support- by-fire element to incapacitate threat forces that threaten the assault element. When the assault element clears a building, the leader may reposition the SLM gunner inside to engage a potential counterattack force.

Table B-1. Shoulder-launched munitions.

SHOULDER-LAUNCHED MUNITION	M136 AT4	M72A3 LAW	M72A7 IMPROVED LAW	XM141 BDM (SMAW-D)
FIELD MANUAL	FM 3-23.25	FM 3-23.25	FM 3-23.25	FM 3-23.25
CARRY WEIGHT	14.8 lbs 6.7 kg	5.5 lbs 2.5 kg	8.0 lbs 3.6 kg	15.7 lbs 7.2 kg
LENGTH: CARRY EXTENDED	 102.0 cm N/A	 67 cm 100 cm	 75.5 cm 98 cm	 79.2 cm 137.1 cm
CALIBER	84-mm	66-mm	60-mm	83-mm
MUZZLE VELOCITY	290 m/s 950 f/s	144.8 m/s 475 f/s	200 m/s 656 f/s	217 m/s 712 f/s
OPERATING TEMPERATURE	-40° to 60° C -40° to 140° F	-40° to 60° C -40° to 140° F	-40° to 60° C -40° to 140° F	-32° to 49° C -20° to 120° F
MAXIMUM EFFECTIVE RANGE	300 m	Stationary 200 m Moving 165 m	220 m	500 m
MAXIMUM RANGE	2,100 m	1,000 m	1,400 m	2,000 m
MINIMUM ARMING RANGE	10 m	10 m	25 m	15 m

M136 AT4

B-6. The M136 AT4 is a lightweight, self-contained, SLM designed for use against the improved armor of light armored vehicles. It provides lethal fire against light armored vehicles, and has some effect on most enemy field fortifications.

Ammunition

B-7. The AT4 is a round of ammunition with an integral, rocket-type cartridge. The cartridge consists of a fin assembly with tracer element; a point detonating fuze; and a high-explosive antitank (HEAT) warhead (Figure B-1).

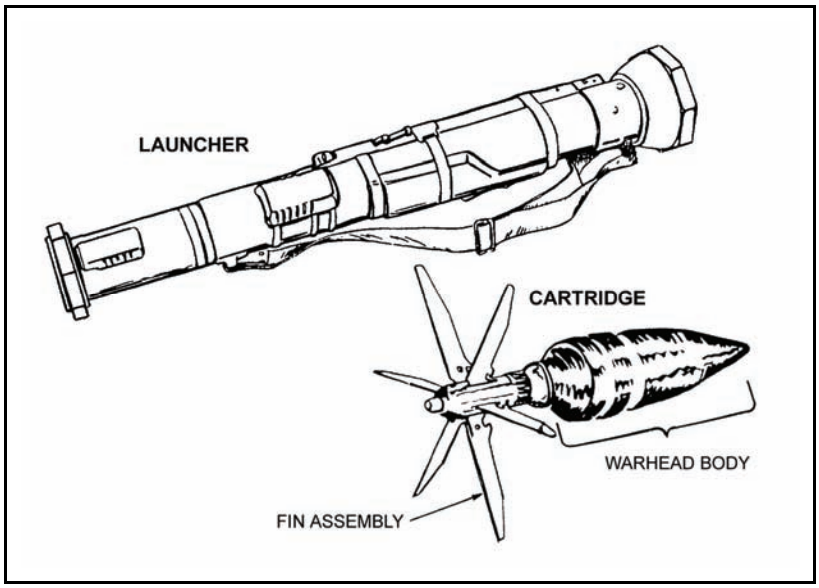

Figure B-1. M136 AT4 launcher and HEAT cartridge.

M72-SERIES LIGHT ANTITANK WEAPON (LAW)

B-8. The M72 LAWs used by Infantry platoons today are the M72A3 and M72A7. They are lightweight and self-contained SLM consisting of a rocket packed in a launcher (Figure B-2). They are man-portable, and may be fired from either shoulder. The launcher, which consists of two tubes, one inside the other, serves as a watertight packing container for the rocket and houses a percussion-type firing mechanism that activates the rocket.

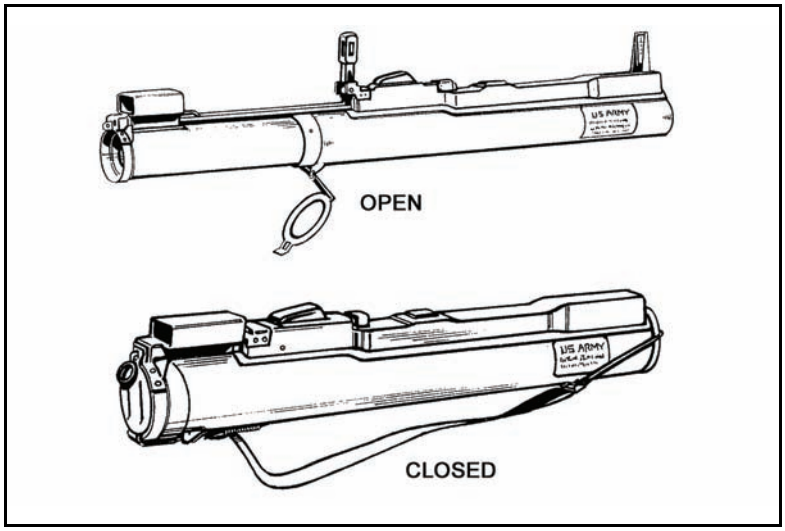

Figure B-2. M72A3 LAW.

M72A3

B-9. The M72A3 contains a nonadjustable propelling charge and a 66-mm rocket. Every M72A3 has an integral HEAT warhead in the rocket's head (or body) section (Figure B-3). Although the M72A3 is mainly employed as an antiarmor weapon, it may be used with limited success against secondary targets such as gun emplacements, pillboxes, buildings, or light vehicles.

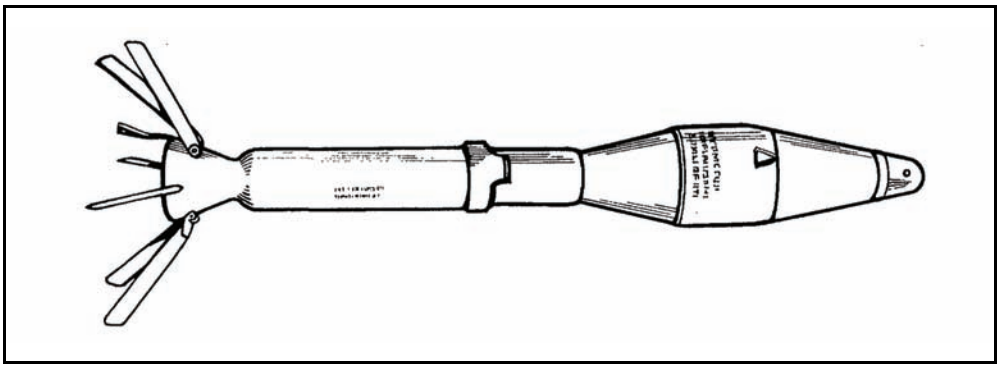

Figure B-3. M72A3 LAW 66-mm high-explosive antiarmor rocket.

Improved M72A7 LAW

B-10. The M72A7 is the Improved LAW currently employed by Infantry platoons. It is a compact, lightweight, single-shot, disposable weapon optimized to defeat lightly armored vehicles at close combat ranges (Figure B-4). The M72A7 offers enhanced capabilities beyond that of the original M72-series. The Improved M72 consists of a 60mm unguided rocket prepackaged at the factory in a telescoping, throw-away launcher. The system performance improvements include a higher velocity rocket motor that extends the weapon effective range, increased lethality warhead, lower and more consistent trigger release force, rifle-type sight system, and better overall system reliability and safety. The weapon contains a 60-mm rocket and an integral HEAT warhead. The warhead is designed to penetrate 150 millimeters of homogenous armor and is optimized for maximum fragmentation behind light armor, Infantry fighting vehicle(s) (IFV), and urban walls.

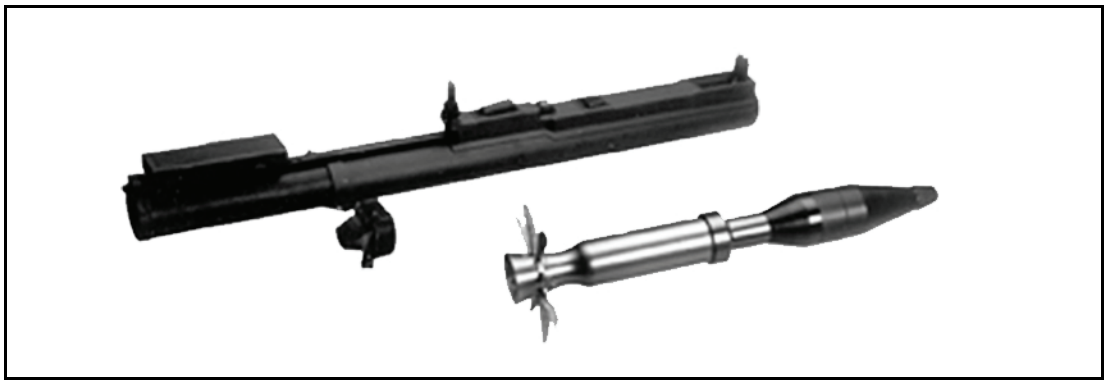

Figure B-4. Improved M72A7 LAW with rocket.

XM141 BUNKER DEFEAT MUNITION (SMAW-D)

B-11. The XM141 BDM was developed to defeat enemy bunkers and field fortifications (Figure B-5). The XM141 is a disposable, lightweight, self-contained, man-portable, shoulder-fired, high explosive multipurpose munition.

Figure B-5. XM141 bunker defeat munition.

Ammunition

B-12. The XM141 utilizes the 83-mm high explosive dual purpose (HEDP) assault rocket (Figure B-6). The 83-mm HEDP assault rocket warhead consists of a dual mode fuze, and 2.38 pounds of A-3 explosive.

B-13. Warhead function, in quick or delay mode, is automatically determined by the fuze when the rocket impacts a target. The XM141 is fired at hard or soft targets without any selection steps required by the gunner. This automatic feature assures that the most effective kill mechanism is employed. Warhead detonation is instantaneous when impacting a hard target, such as a brick or concrete wall or an armored vehicle. Impact with a softer target, such as a sandbagged bunker, results in a fuze time delay that permits the rocket to penetrate into the target before warhead detonation.

B-14. The XM141 BDM can destroy bunkers, but is not optimized to kill the enemy soldiers within masonry structures in urban terrain or armored vehicles. The XM141 BDM can penetrate masonry walls, but multiple rounds may be necessary to deliver sufficient lethality against enemy personnel behind the walls.

B-15. The XM141 has been used with great success in destroying personnel and equipment in enemy bunkers, field fortifications, and caves in recent operations.

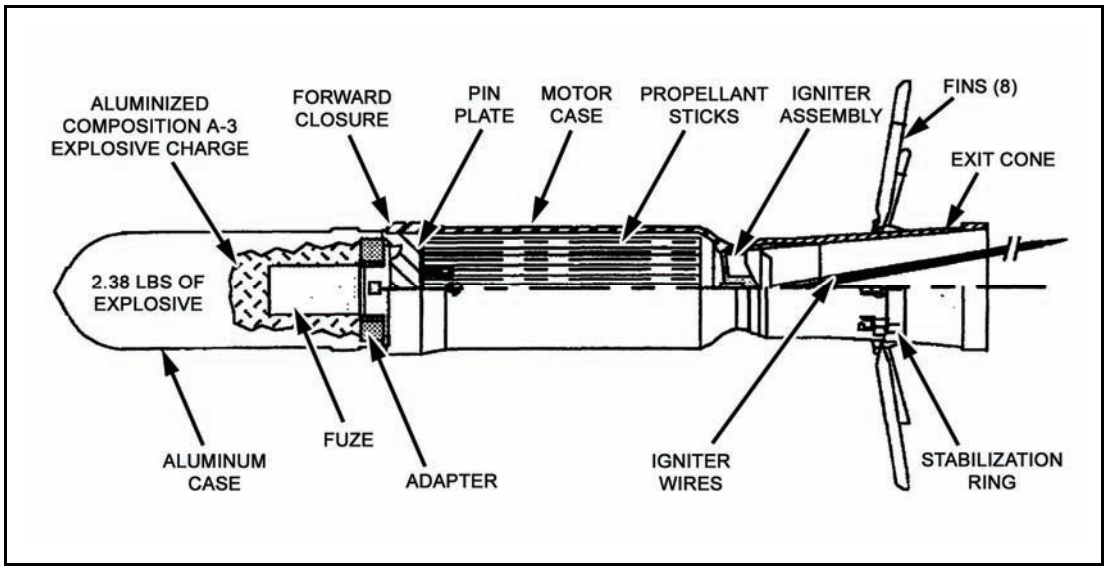

Figure B-6. XM141 high-explosive dual purpose assault rocket.

CLOSE COMBAT MISSILE SYSTEMS

B-16. CCMS are used primarily to defeat main battle tanks and other armored combat vehicles. In the current force, this category of weapons includes the TOW and the Javelin. The TOW and Javelin provide overmatch antitank fires during the assault and provide extended range capability for engaging armor during both offense and defense. These systems have a moderate capability against bunkers, buildings, and other fortified targets commonly found during combat in urban areas. The TOW's bunker buster round is capable of destroying the majority of urban targets.

JAVELIN

B-17. The Javelin is a fire-and-forget, shoulder-fired, man-portable CCMS that consists of a reusable M98A1 command launch unit (CLU) and a round (Figure B-7). The CLU houses the daysight, night vision sight (NVS), controls, and indicators. The round consists of the missile, the launch tube assembly (LTA), and the battery coolant unit (BCU). The LTA serves as the launch platform and carrying container for the missile. See FM 3-22.37 for complete information regarding the Javelin's technical specifications, care, maintenance, operation, gunnery skills training, training aids, and safety.

B-18. The Javelin CCMS' primary role is to destroy enemy armored vehicles out to 2,000 meters. The Javelin can be employed in a secondary role of providing fire support against point targets such as bunkers and crew-served weapons positions. In addition, the Javelin CLU can be used alone as an aided vision device for reconnaissance, security operations, and surveillance. When Bradley fighting vehicles are part of a combined-arms team, the Javelin becomes a secondary antiarmor weapons system. It supports the fires of tanks and TOWs, covers secondary armor avenues of approach, and provides observation posts with an antiarmor capability. The Javelin gunner should be able to engage up to three targets in two minutes, making him very effective against any armor threat.

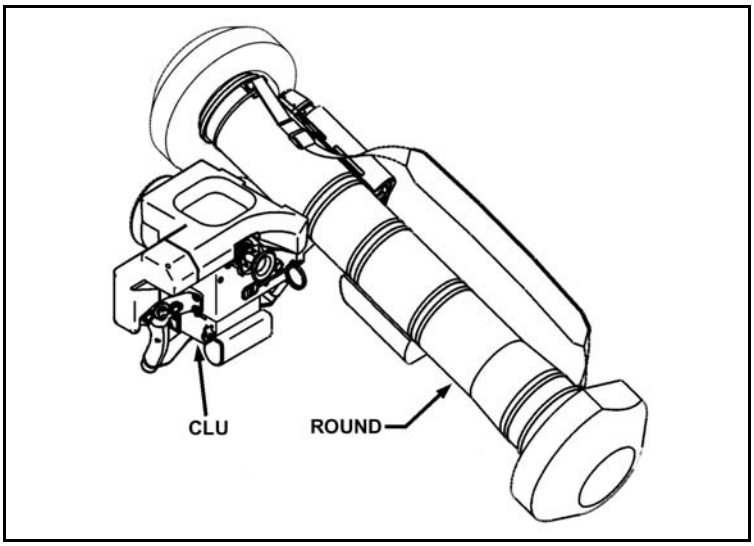

Figure B-7. Javelin close combat missile system.

Command Launch Unit

B-19. The M98A1 CLU is the reusable portion of the Javelin system. It contains the controls and indicators. The CLU provides further utility to the Infantry platoon by allowing accurate surveillance out to two kilometers in both day and night. CLUs have been used to spot and destroy enemy snipers in hidden positions over 1,000 meters away.

B-20. Tables B-2 through B-4 list the Javelin's capabilities and features, the physical characteristics of the CLU, and the physical characteristics of the round.

Table B-2. Javelin capabilities and features.

Javelin Missile System	Surface attack guided missile and M98A1 command launch unit
Type of System	Fire and forget
Crew	One- to three-Soldier teams based on TO&E
Missile modes	Top attack (default)
	Direct attack
Ranges	Top attack mode minimum effective engagement: 150 meters
	Direct attack mode minimum effective engagement range: 65 meters
	Maximum effective engagement range (direct attack and top attack modes): 2,000 meters
Flight Time	About 14 seconds at 2,000 meters
Backblast Area	Primary danger zone extends out 25 meters at a 60-degree (cone-shaped) angle
	Caution zone extends the cone-shaped area out to 100 meters
Firing From Inside Enclosures	Minimum room length: 15 feet
	Minimum room width: 12 feet
	Minimum room height: 7 feet

Table B-3. Physical characteristics of the command launch unit.

M98A1 Command Launch Unit	**With battery, carrying bag, and cleaning kit**	
	Weight: 14.16 lb. (6.42 kg)	
	Length: 13.71 in (34.82 cm)	
	Height: 13.34 in (33.88 cm)	
	Width: 19.65 in (49.91 cm)	
Sights	**Daysight**	
	Magnification: 4X	
	Field-of-view (FOV): 4.80° x 6.40°	
	Night Vision Sight	
	Wide field-of-view (WFOV) magnification: 4.2X	
	WFOV: 4.58° x 6.11°	
	Narrow field-of-view (NFOV) magnification: 9.2X	
	NFOV: 2.00° x 3.00° (approximately)	
Battery Type	**Lithium Sulfur Dioxide ($LiSO_2$) BA-5590/U (Nonrechargeable)**	
	Number required: 1	
	NSN: 6135-01-036-3495	
	Weight: 2.2 lbs. (1.00 kg)	
	Life:	4.0 hrs below 120°F (49°C)
		3.0 hrs between 50°F to 120°F (10°C to 49°C)
		1.0 hrs between -20°F to 50°F (-49°C to 10°C)
		0.5 hrs above 120°F (49°C)

Table B-4. Physical characteristics of the round.

Complete Round (Launch tube assembly with missile and BCU)	Weight: 35.14 lb. (15.97 kg)
	Length: 47.60 in (120.90 cm)
	Diameter with end caps: 11.75 in (29.85 cm)
	Inside diameter: 5.52 in (14.00 cm)
Battery Coolant Unit	Weight: 2.91 lb. (1.32 kg)
	Length: 8.16 in (20.73 cm)
	Width: 4.63 in (11.75 cm)
	Battery type: lithium, nonrechargeable
	Battery life: 4 min of BCU time
	Battery coolant gas: argon

Missile

B-21. The Javelin missile consists of the guidance section, the mid-body section, the warhead, the propulsion section, and the control actuator section. A discussion of the guidance section and warhead follows.

Guidance Section

B-22. The guidance section provides target tracking and flight control signals. It is the forward section of the missile and includes the seeker head section and the guidance electronics unit.

Warhead Section

B-23. The Javelin missile uses a dual charged warhead (Figure B-8) that contains a precursor charge and main charge.

- **Precursor Charge**. The precursor charge is an HE antitank shaped charge. Its purpose is to cause reactive armor on the target to detonate before the main charge reaches the armor. Once the reactive armor is penetrated, the target's main hull is exposed to the warhead's main charge. If the target is not equipped with reactive armor, the precursor provides additional explosives to penetrate the main armor.
- **Main Charge**. The main charge is the second charge of a dual-charge warhead and is also an HE antitank shaped charge. The primary warhead charge is designed to penetrate the target's main armor to achieve a target kill.

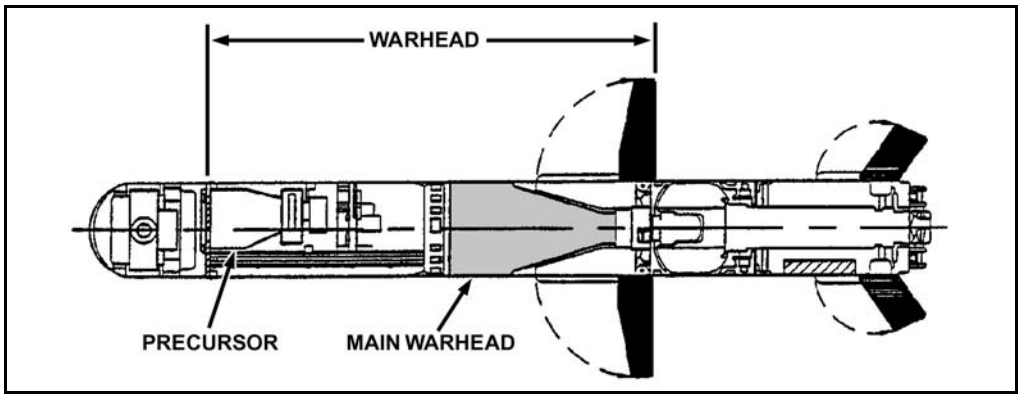

Figure B-8. Javelin missile warhead.

Capabilities and Limitations

B-24. The Javelin has some unique capabilities that provide the unit with an effective antiarmor weapon system. However, the Infantry leader should also understand the system's limitations in order to effectively employ this system (Table B-5).

Table B-5. Javelin capabilities and limitations.

	Capabilities	Limitations
Firepower	• Maximum effective range is 2,000 meters. • Fire-and-forget capability. Missile imaging infrared (I2R) system gives missile ability to guide itself to the target when launched by the gunner. • Two missile flight paths: ▪ Top attack – impacts on top of target. ▪ Direct attack – impacts on front, rear, or flank of target. • Gunner can fire up to three missiles within 2 minutes. • Dual-shaped charge warhead can defeat any known enemy armor. • NVS sees little degradation of target image. • Countermeasures used by enemy are countered by the NVS filter.	• CLU sight cannot discriminate targets past 2,000 meters. • NVS cool-down time is from 2.5 to 3.5 minutes. • Seeker's cool-down time is about 10 seconds. • BCU life, once activated, is only about 4 minutes. • FOV can be rendered useless during limited visibility conditions (rain, snow, sleet, fog, haze, smoke, dust, and night). Visibility is limited by the following: ▪ Day FOV relies on daylight to provide the gunner a suitable target image; limited visibility conditions may block sun. ▪ NVS uses the infrared naturally emitted from objects. *Infrared crossover* is the time at both dawn and dusk that terrain and targets are close enough in temperature to cause targets to blend in with their surroundings. ▪ *Natural clutter* occurs when the sun heats objects to a temperature close enough to surrounding terrain that it causes a target to blend in with terrain. ▪ *Artificial clutter* occurs when there are man-made objects that emit large amounts of infrared (for example, burning vehicles). ▪ Heavy fog reduces the capability of the gunner to detect and engage targets. • Flight path of missile is restricted in wooded, mountainous, and urban terrain. • Gunner must have line of sight for the seeker to lock onto a target.
Maneuver	• Man-portable. • Fire-and-forget capability allows gunner to shoot and move before missile impact. • Soft launch capability allows it to be fired from inside buildings and bunkers. • Maneuverable over short distances for the gunners.	• Weight of Javelin makes maneuvering slow over long distances. • The Javelin round is bulky and restricts movement in heavily-wooded or vegetative terrain.
Protection	• Passive infrared targeting system used to acquire lock-on cannot be detected. • Launch motor produces a small signature. • Fire-and-forget feature allows gunner to take cover immediately after missile is launched.	• Gunner must partially expose himself to engage the enemy. • CLU requires a line of sight to acquire targets.

TUBE-LAUNCHED, OPTICALLY-TRACKED, WIRE-GUIDED (TOW) MISSILE WEAPON SYSTEM

B-25. The Infantry TOW weapon system consists of the Improved Target Acquisition System (ITAS) launcher, which has tracking and control capabilities, and the missile, which is encased in a launch container. The launcher is equipped with self-contained, replaceable units.

B-26. The TOW is designed to destroy enemy tanks, fortifications, and other materiel targets. Its line-of-sight launcher initiates, tracks, and controls the missile's flight through command-link wire-transmitted guidance signals. It can be employed in all weather conditions as long as the gunner can see the target through the ITAS. The TOW also provides a long-range assault capability against heavily fortified bunkers, pillboxes, and gun emplacements.

B-27. The current versions of the TOW missile can destroy targets at a minimum range of 65 meters and a maximum range of 3,750 meters. The TOW 2B missile can destroy targets at a minimum range of 200 meters and a maximum range of 3,750 meters. TOW missiles in development are being produced to effectively engage enemy targets out to 4,500 meters.

Missile System Configurations and Types

B-28. The TOW CCMS consists of multiple configurations with numerous types of missiles. These configurations mainly consist of minor modified work orders that are transparent to the operator and are continually updated. All configurations use the same basic airframe, aerodynamic control system, command-link wire, and missile electronics designs. The current missile types are listed below.

- **Improved TOW**. The ITOW missile has an improved 5-inch warhead from the original TOW missile that includes extended probes for greater standoff and penetration. It can destroy targets at a minimum range of 65 meters and a maximum range of 3,750 meters.
- **TOW 2**. The TOW 2 missile has a full-caliber 6-inch warhead that includes an extended probe. In addition to the infrared radiator of the ITOW missile, TOW 2 has a second infrared radiator to provide hardened system performance against battlefield obscurants and countermeasures. The second radiator is called the thermal beacon and provides link compatibility with the electro-optical infrared nightsight, which is part of the TOW 2 launcher system.
- **TOW 2A**. The TOW 2A adds a small explosive charge in the tip of the extended probe that causes enemy reactive armor to detonate prematurely, thus allowing the TOW 2A's warhead to penetrate the main armor.
- **TOW 2B**. The TOW 2B has an entirely different warhead and kill mechanism than the previous TOW missiles. It is a top-attack missile (fly over/shoot down) that defeats enemy armor at its most vulnerable point—the top deck of the turret and hull. The TOW 2B has a tandem warhead that fires two explosively formed projectiles down through the thin upper deck armor of the enemy vehicle. The gunner tracks the target the same as any other TOW missile with the crosshairs on center mass, but the missile automatically flies 2.25 meters above the line of sight (LOS). When the missile senses that it is directly above the target (by means of the target's shape and magnetic field), it automatically fires its warhead. The TOW 2B missile can destroy targets at a minimum range of 288 meters when fired from the ground mount and 200 meters when fired from the HMMWV or BFV. The TOW 2B has a maximum range of 3,750 meters whether ground- or vehicle-mounted.
- **TOW 2B GEN 1**. The TOW 2B GEN 1 is similar to the TOW 2B but includes the addition of the GEN 1 Counter Active Protection System (CAPS), which is used to defeat enemy active protection systems.
- **TOW 2B Aero**. The TOW 2B Aero is an extended range version of the TOW 2B missile with an aerodynamic nose and has an effective range of 4,500 meters (Figure B-9). This longer range (compared to the 3,750 meter range of the previous TOW missiles) allows a TOW crew to fire well beyond the weapons range of its targeted vehicle.
- **TOW 2B Aero With GEN 1, 2, and 3A CAPS**. These versions of TOW 2B Aero have the addition of different generations of CAPS to defeat an enemy target's active protection system, allowing the TOW 2B missile to successfully engage any armored vehicle up to 4,500 meters (Figure B-9).
- **TOW Bunker Buster**. The TOW Bunker Buster (BB) replaces the TOW 2A warhead with a fragmenting bulk charge for non-armor targets (Figure B-10). The TOW BB has a range of 3,750 meters. Its missile is capable of defeating bunkers, breaching masonry walls, and engaging targets in support of urban operations.

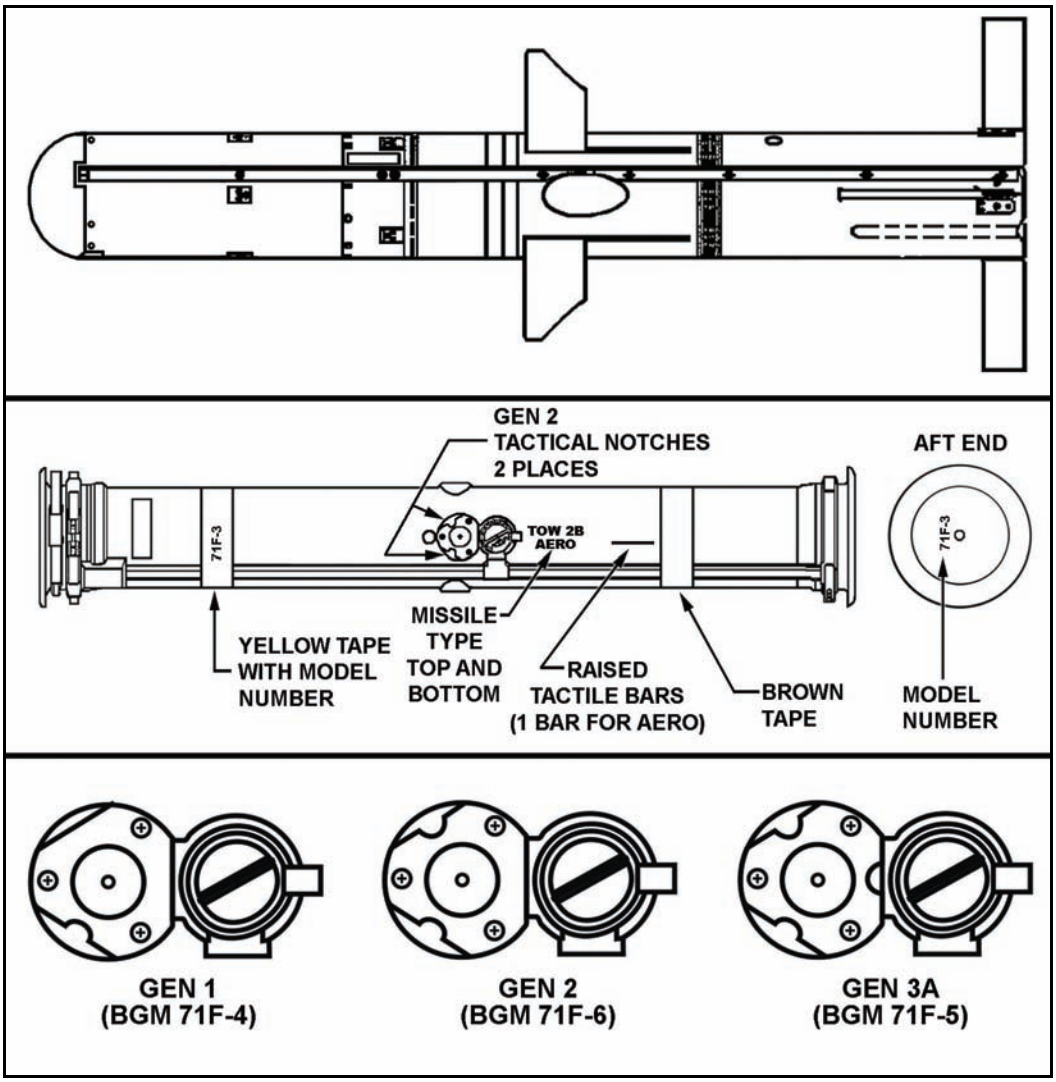

Figure B-9. TOW 2B Aero missile with identification.

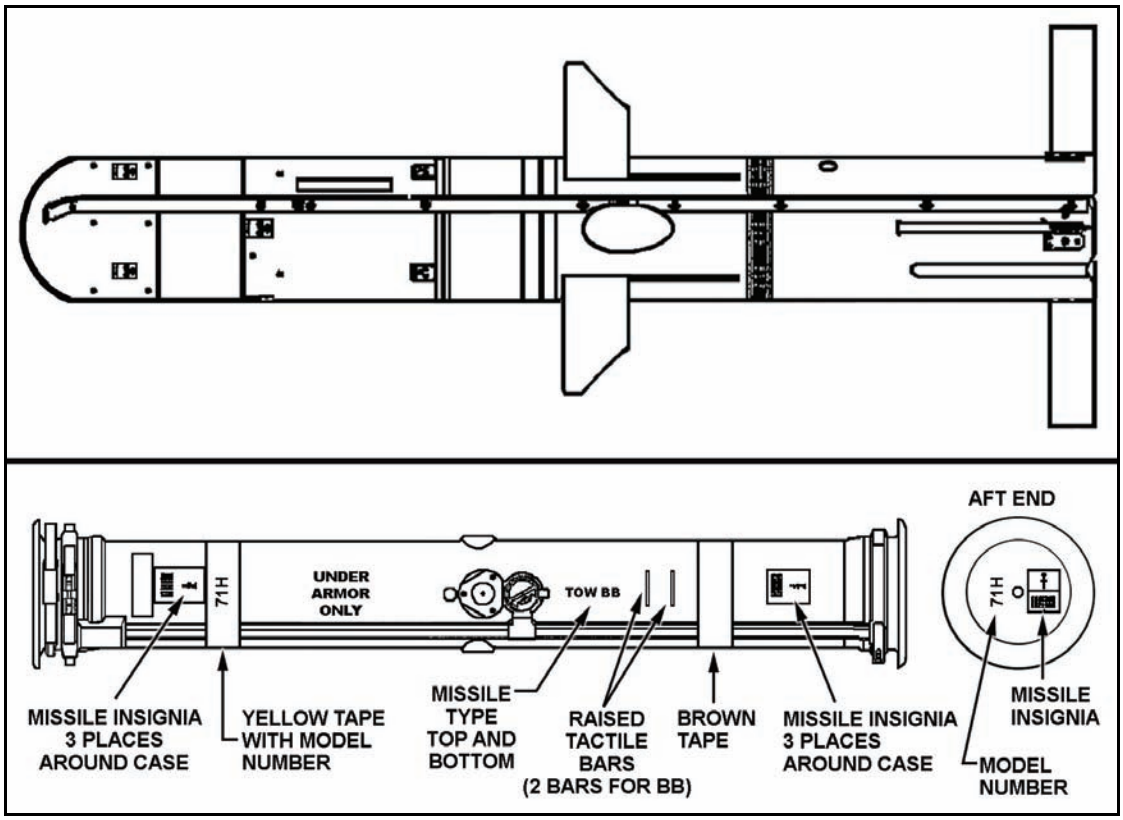

Figure B-10. TOW bunker buster (BB) missile and identification.

M41 Improved Target Acquisition System (ITAS)

B-29. The ITAS is primarily a mounted system that utilizes the M1121 HMMWV as the carrier vehicle. The M1121 HMMWV is a one-vehicle (1 1/4-ton truck) combat system that is air transportable, versatile, maintainable, and survivable. The vehicle carries one complete launcher system, seven encased missiles, and a three-man crew. The tactical or training situation may demand that the crew dismount the carrier and employ the ITAS in the dismounted or tripod configuration.

B-30. The M41 ITAS fires all existing and future versions of the TOW family of missiles. The ITAS provides for the integration of both the day sight and NVS into a single housing and for automatic boresighting. It has embedded training (for sustainment training) and advanced built-in test/built-in-test equipment (BIT/BITE), which provides fault detection and isolation.

B-31. The automatic missile tracking and control capabilities of the ITAS provide a high first-round-hit probability. To operate the system, the gunner places the track gates on the target, fires the missile, and centers the crosshairs on the target image until missile impact. The optical tracking and command functions within the system guide the missile to the target as long as the gunner keeps the crosshairs on target.

B-32. The ITAS provides the Infantry platoon with advanced optics during daylight and limited visibility to aid in surveillance and target acquisition in both defensive and offensive operations.

B-33. The ITAS can be vehicle-mounted or ground-emplaced (tripod-mounted) for operation. Missiles can be launched from either operational mode. The entire system can be carried by a single crew for short distances. Moving it over long distances without the vehicle will require two crews, which causes two systems to be out of operation at the same time. The vehicle-mounted launcher is more mobile and can be quickly prepared for use. The launcher can be assembled and disassembled without the use of tools.

SECTION II — EMPLOYMENT CONSIDERATIONS

B-34. The objective of the Army's warfighting doctrine is to concentrate decisive combat power at the right time and place, by massing fires rather than by massing forces, and by presenting the enemy with multiple threats. This section discusses SLM and CCSM employment considerations. A lethal mix of CCMs and SLM provide the Infantry unit with the flexibility to employ multiple systems designed to deliver maximum direct fire lethality and destroy enemy formations at both long range and in close combat. At close combat range (15-300 meters), SLM provide Soldiers with the ability to deliver direct fire lethality at very close proximity to the enemy. At extended range (300-4,500 meters), a mix of Javelin and TOW provides the Infantry leader with overwhelming combat overmatch. These weapons serve as key components by applying overlapping and interlocking fires to achieve synergy and mutual support for his maneuver force.

B-35. For a better understanding of how SLM and CCMS fit into the Infantry platoon's fire plan, see Chapter 3.

URBAN OPERATIONS AND FIELD FORTIFICATIONS

B-36. Operations in complex terrain and urban environments alter the basic nature of close combat. History tells us that engagements are more frequent and occur more rapidly when engagement ranges are close. Studies and historical analyses have shown that only 5 percent of all targets are more than 100 meters away. About 90 percent of all targets are located 50 meters or less from the identifying Soldier. Few personnel targets will be visible beyond 50 meters. Engagements usually occur at 35 meters or less.

B-37. Soldiers employ SLM in the short, direct fire, close-quarter engagement range of close combat. Their use is preferable in urban areas where other direct fire (M1 Abrams and M2/M3 BFV) and indirect fire systems (artillery and mortars) and CAS are incapable of operating due to risks of fratricide and collateral damage. In close combat, Soldiers employ SLM against a wide variety of targets. These include: personnel armed with individual and crew served weapons fighting from armored platforms (T-72s, BTRs, BRDMs); light armored personnel carriers and Infantry fighting vehicles (BMP1-3 and M113); modified personnel/Infantry vehicles; lightly armed vehicles; and enemy in fortified positions, behind walls, inside caves and masonry buildings, and within earthen bunkers.

B-38. CCMS teams provide overwatching antitank fires during the attack of a built-up area. They are best employed in these types of areas along major thoroughfares and in upper floors of buildings or roofs to attain long-range fields of fire. Because the minimum engagement distance limits firing opportunities in the confines of densely built-up areas, CCMS may not be the weapon of choice in the urban environment (FM 3-06.11). Urban area hazards include, fires caused by both friendly and enemy forces that may cause target acquisition and lock-on problems, clutter on the battlefield that may cause lock-on problems, and line-of-sight communications that may be limited by structures. CCMS unique flight path forces the gunner to think in three dimensions. Other urban environment hazards include overhead obstacles such as street signs, light poles, and wires, which could impede the missile's flight path.

SHOULDER-LAUNCHED MUNITIONS IN THE BUNKER DEFEAT ROLE

B-39. The current inventory of the M136 AT4 and the XM141 BDM in combination with the M72-series LAW provide the Infantry squad the capability to incapacitate personnel within earth and timber bunkers, masonry buildings, and light armored vehicles. However, neither system is fully capable of fire-from-enclosure.

B-40. SLM that can be safely fired from an enclosure to incapacitate personnel within earth and timber bunkers, masonry buildings, and light armored vehicles are currently being developed to increase the lethality, survivability, and mobility of the SLM gunner.

ENGAGEMENT OF FIELD FORTIFICATIONS AND BUILDINGS WITH SLM

B-41. The M72-series LAW and AT4 have proven to have only limited success inflicting casualties against enemy troops in field fortifications and buildings. The XM141 BDM was designed to enhance the destruction of these fortifications and enemy personnel inside them. The BDM's warhead contains a dual mode fuse that automatically adjusts for the type of target on impact. For soft targets, such as sandbagged bunkers, the XM141 warhead automatically adjusts to delayed mode and hits the target with very high kinetic energy. The warhead is propelled through the barrier and into the fortification or building where the fuze detonates the warhead and causes much greater damage. Soldiers should not expect to severely damage fortified targets with M72 LAWs or AT4s. However, if the recommendations shown in Table B-6 are used, Soldiers may be able to gain a temporary advantage.

Table B-6. Effects of the AT4 and M72A3 LAW on field fortifications or bunkers.

AIM POINT	EFFECT WHEN AT4 OR M72A3 IS FIRED AT AIM POINT	RECOMMENDED FIRING TECHNIQUE
Firing Port or Aperture	Rounds fired into firing ports or apertures may not have the desired effect on the enemy. The rounds may detonate against the rear wall of the position, causing little structural damage to the position or to the equipment or personnel within, unless they are hit directly. The AT4 produces less effect than the M72A3 LAW.	Coordinate fire: Fire CCM at a point 6 to 12 inches from the front edge of the firing ports in the berm. Fire small arms at the bunker or position to prevent personnel within from returning fire.
Berm	Firing at the berm causes the round to detonate outside the fighting position or inside the berm itself, creating only dust, a small hole in the berm, or minor structural damage to the position, but little damage to personnel or equipment unless they are hit directly. The AT4 produces less effect than the M72A3 LAW.	Firing the AT4 and LAW at berms should be avoided because of the negligible effects.
Window	The round may travel completely through the structure before detonating. If not, it creates dust and causes minor structural damage to the rear wall, but little damage to personnel or equipment, unless they are hit directly. The AT4 produces less effect than the M72A3 LAW.	Fire 6 to 12 inches from the sides or bottom of a window. CCMs explode on contact with brick or concrete, creating an opening whose size is determined by the type of round used.
Wall	The round detonates on contact, creating dust and causing a small hole and minor structural damage, but little damage to personnel or equipment, unless they are hit directly. Overpressure from the round entering the structure may temporarily incapacitate enemy personnel.	The M72-series LAW may be used to create a loophole, which is a hole large enough to throw hand grenades through. The AT4 produces less effect than the M72-series LAW.
Corner	Corners are reinforced and thus harder to penetrate than other parts of a wall. Any CCM round will detonate sooner on a corner than on a less dense surface. Detonation should occur in the targeted room, creating dust and causing overpressure, which can temporarily incapacitate personnel inside the structure near the point of detonation. The AT4 causes more overpressure than the M72-series LAW.	Avoid targeting corners because of the negligible effects.

CCMS Engagement Considerations

B-42. Urban engagement considerations for CCMS include engagement distance, thermal crossover, backblast, weapon penetration, and breaching structural walls. Details follow. TOW systems should always seek to engage at maximum range. If within 1,000 meters of an enemy, the flight time of the TOW missile would likely be greater than the flight time of a main gun tank round.

- **Engagement Distance.** The Javelin missile has a minimum engagement distance (150 meters in the attack mode and 65 meters in the direct attack mode), which limits its use in built-up areas. The TOW 2B has a minimum range of 200 meters and a maximum range of 3,750, which limits its use in built-up areas.
- **Crossover.** Sometimes the Javelin seeker or TOW round will not be able to distinguish between the background and the target because the two have the same temperature (crossover).
- **Time.** When a gunner comes across a target of opportunity, he may not be able to take advantage of it. The cool down time of the Javelin's NVS is 2.5 to 3.5 minutes. Javelin seeker cool down takes about 10 seconds. Once the BCU is activated, the gunner has a maximum of 4 minutes to engage the target before the battery coolant unit is depleted.
- **Backblast.** The soft launch capability of the Javelin enables the gunner to fire from inside buildings because there is little overpressure or flying debris.
- **Weapon Penetration.** The dual charge Javelin warhead penetrates typical urban targets. The direct attack mode is selected when engaging targets in a building. Enemy positions or bunkers in the open closer than 150 meters are engaged using the direct attack mode. Positions in the open farther than 150 meters are engaged using either the top or direct attack mode, depending on the situation.
- **Breaching Structural Walls.** The Javelin and TOW (except for the TOW BB) are not effective when breaching structural walls. Antitank guided missiles (ATGMs) are not designed to breach structural walls effectively. All CCMS are designed to produce a small hole, penetrate armor, and deliver the explosive charge. Breaching calls for the creation of a large hole. CCMS are better used against armored vehicles or for the destruction of enemy-fortified fighting positions.

ANTIARMOR ROLE

B-43. In the past decade, there has been a revolution in armor technology. Research and new developments have come from Europe, the United States, and Israel. These improvements are also becoming much more common in third world armies. In addition, many older tanks and other armored fighting vehicles are being retrofitted with improved armor protection. These advanced armor configurations improve the vehicles' survivability against all weapons. They are specifically designed to protect against HEAT warheads and essentially fall into four categories: reactive, laminated, composite, and appliqué. Improved armor types include:

- **Reactive Armor.** Reactive armor comes in several varieties, but the principle is essentially the same on all. The armor consists of blocks of explosives sandwiched between two metal plates and bolted on the outside of the vehicle. Small-arms and artillery shrapnel will not set off the blocks. However, when a HEAT round strikes the block, the explosive ignites and blows outwards. The blast and the moving steel plates disperse and deflect the jet of the HEAT warhead, dramatically reducing its ability to penetrate armor.
- **Laminated Armor.** Laminated armor consists of flat layers of steel armor plates with layers of ceramics, fiberglass, or other nonmetallic materials in between. This armor is highly effective against all types of weapons, but is difficult and expensive to manufacture. Vehicles with laminated armor are characterized by flat, slab sides, such as on the M1 Abrams and the German Leopard II.
- **Composite Armor.** Composite armor consists of a nonmetallic core (usually some kind of ceramic) around which the rest of the steel of the hull or the turret is molded. This is much more effective than conventional steel armor against all types of weapons, but less so than laminated armor.
- **Appliqué Armor.** Appliqué armor is essentially extra plates mounted or welded on top of the hull or turret of a vehicle. They can be made of any material, but are frequently made of ceramic or laminated materials. Like reactive armor, appliqué armor is an easy and cost-effective way of improving the protection of older vehicles.

EXPLOITING ARMORED VEHICLE WEAKNESSES

B-44. Because they are designed mainly for offensive operations against other armored vehicles (Figure B-11), armored vehicles usually have their heaviest armor in front. All vehicles are vulnerable to repeated hits on their flanks and rear, though the flank offers the largest possible target. Firers should always aim center of mass to increase the probability of a hit. The older the vehicle model, the less protection it has against SLM and CCMS. Newer versions of older vehicle models may use bolt-on (appliqué) armor to improve their survivability. Reactive armor usually covers the forward-facing portions and sides of the vehicle and can defeat shaped-charge weapons such as the SLM. When reactive armor detonates, it disperses metal fragments to 200 meters. SLM cause only a small entry hole in an armored vehicle target, though some fragmentation or spall may occur.

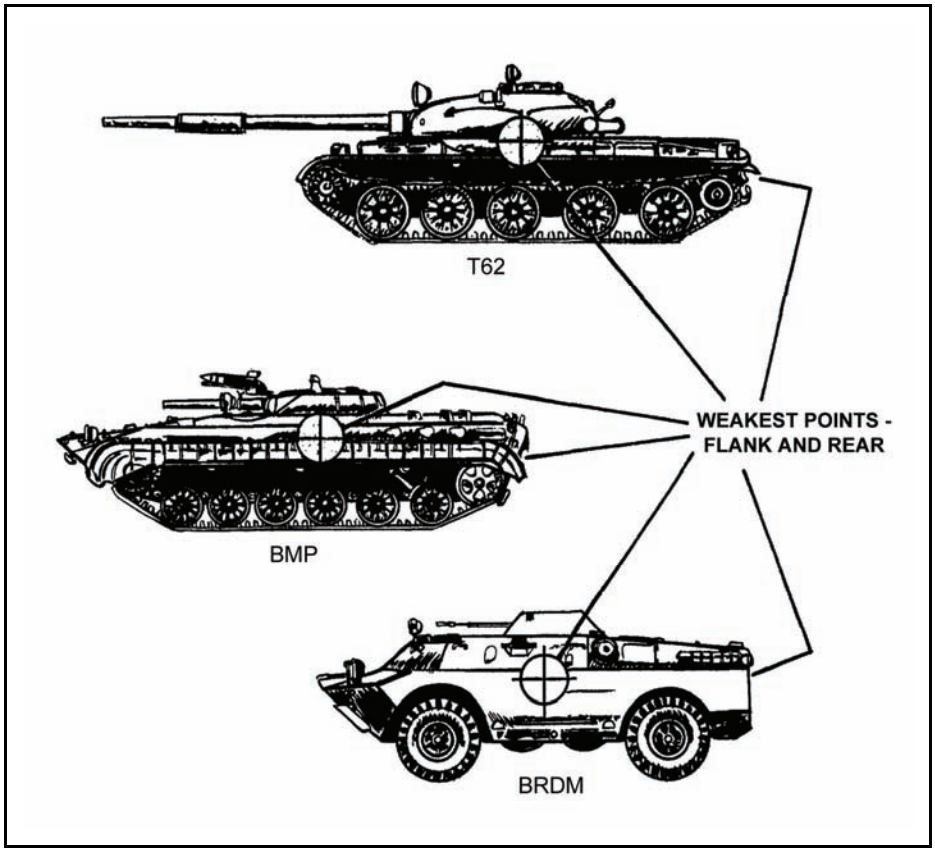

Figure B-11. Armored vehicle weak points.

B-45. Natural or man-made obstacles can be used to force the armored vehicle to slow, stop, or change direction. This pause enables the firer to achieve a first-round hit. If he does not achieve a catastrophic kill on the first round, he or another firer must be ready to engage the target vehicle immediately with another round.

B-46. The white area in Figure B-12 shows the most favorable direction of attack when the turret is facing to the front. The gray area shows the vehicle's principal direction of fire and observation when the turret is facing to the front). Volley fires can greatly degrade the additional protection that appliqué and reactive armors provide to the target vehicle.

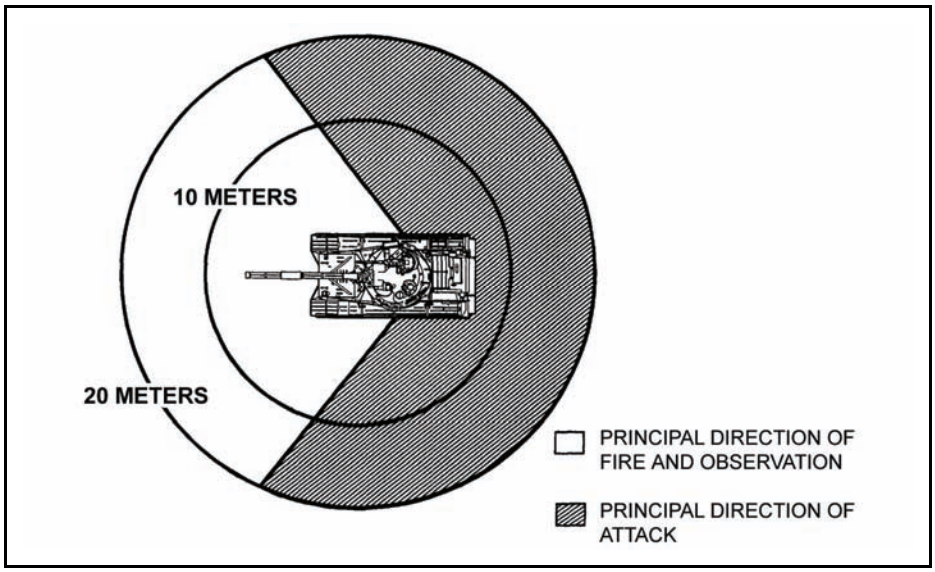

Figure B-12. Limited visibility of armored vehicles.

B-47. Armored vehicle kills are classified according to the level of damage achieved (Table B-7).

Table B-7. Armored vehicle kills.

Type Of Kill	Part of Vehicle Damaged or Destroyed	Capability After Kill
Mobility Kill	Suspension (track, wheels, or road wheels) or power train (engine or transmission) has been damaged.	Vehicle cannot move, but it can still return fire.
Firepower Kill	Main armament has been disabled.	Vehicle can still move, so it can get away.
Catastrophic Kill	Ammunition or fuel storage section has been hit by more than one round.	Vehicle completely destroyed.

SHOULDER-LAUNCHED MUNITIONS IN THE ANTIARMOR ROLE

B-48. When Soldiers employ the M136 AT4 and M72-series LAW to defeat threat armored vehicles, it requires Soldiers to engage threat vehicles using single or paired shots. Gunners require positions that allow engagement against the flank or rear of the target vehicles. They must seek covered and concealed positions from where targets can be engaged. However, the M136 AT4 cannot be fired safely from within an enclosure because it denies the protection offered by enclosed fighting positions and masonry buildings. FM 3-23.25 advises firing the M136 AT4 and XM141 BDM from an enclosure under combat conditions only when no other tactical option exists due to the risk of both auditory and non-auditory injury.

SLM Warhead Effects on Armor

B-49. SLM warheads have excellent armor penetration ability and lethal after-armor effects (especially the AT4 and M72A7). The extremely destructive shaped-charge explosives can penetrate more than 14 inches (35.6 centimeters) of rolled homogeneous armor (RHA). Types of warhead armor effects follow and are illustrated in Figure B-13.

- **Impact.** The nose cone crushes; the impact sensor activates the fuze.
- **Ignition.** The fuze element activates the electric detonator. The booster detonates, initiating the main charge.

- **Penetration.** The main charge fires and forces the warhead body liner into a directional gas jet that penetrates armor plate.
- **Spalling (After-Armor Effects).** The projectile fragments and incendiary effects produce blinding light and highly destructive results.

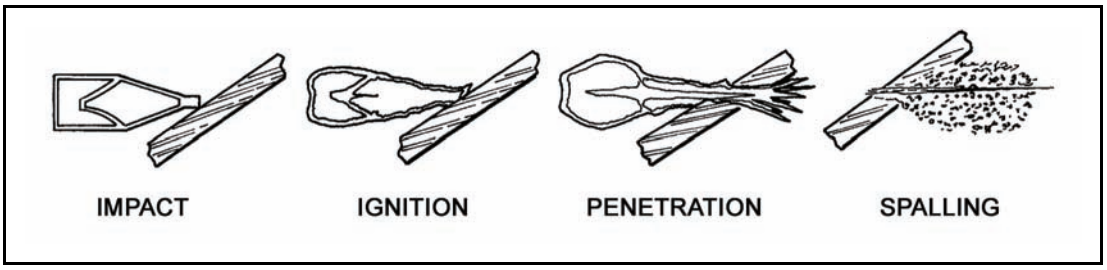

Figure B-13. Effects of SLM warheads on armor targets.

Engagement of Other Vehicles

B-50. The M72-series LAW proves more effective against light vehicles. The M136 AT4 proves more effective against armored vehicles. Non-armored vehicles such as trucks, cars, and boats are considered soft targets. Firing along their length offers the greatest chance of a kill, because this type of shot is most likely to hit their engine block or fuel tank.

Methods OF Engagement

B-51. The four engagement methods for SLM include single, sequence, pair, and volley firing. The leader evaluates the situation on the ground to determine which of these methods to use. Regardless of whether they are used singly or in combination, communications are needed as well. The methods of engagement are rehearsed IAW unit SOP.

Single Firing

B-52. A single Soldier with one SLM may engage an armored vehicle, but this is not the preferred method of engagement. Several SLM are normally required to effectively kill an armored vehicle. A single gunner firing one round must hit a vital part of the target in order to do damage (Figure B-14). A single firer can engage targets out to 225 meters with the LAW, or 300 meters with the AT4 (when he knows the actual range).

Figure B-14. Single firing.

Sequence Firing

B-53. A single firer, equipped with two or more SLM prepared for firing, engages the target. After engaging with the first round and observing the impact, the firer adjusts his point of aim. He then engages with another round until he destroys the target or runs out of rounds (Figure B-15).

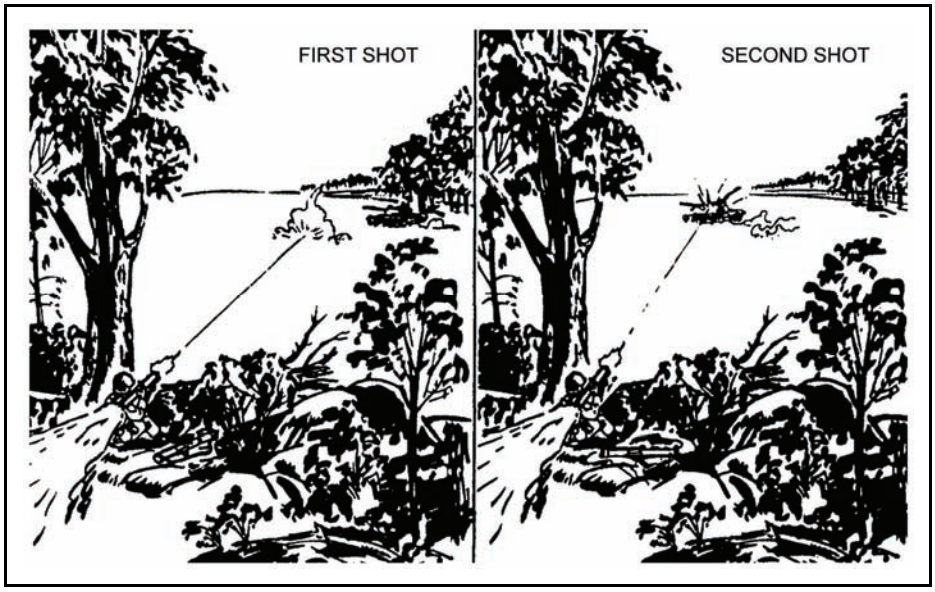

Figure B-15. Sequence firing.

Pair Firing

B-54. Two or more firers, equipped with two or more SLM prepared for firing, engage a single target. Before firing, the first firer informs the others of the estimated speed and distance to the target. If the impact of his round proves his estimate to be correct, the other firers engage the target until it is destroyed. If the impact of the round proves his estimate to be incorrect, the second firer informs the others of his own estimate, and then he engages the target. This continues until the target is destroyed or all rounds are expended (Figure B-16).

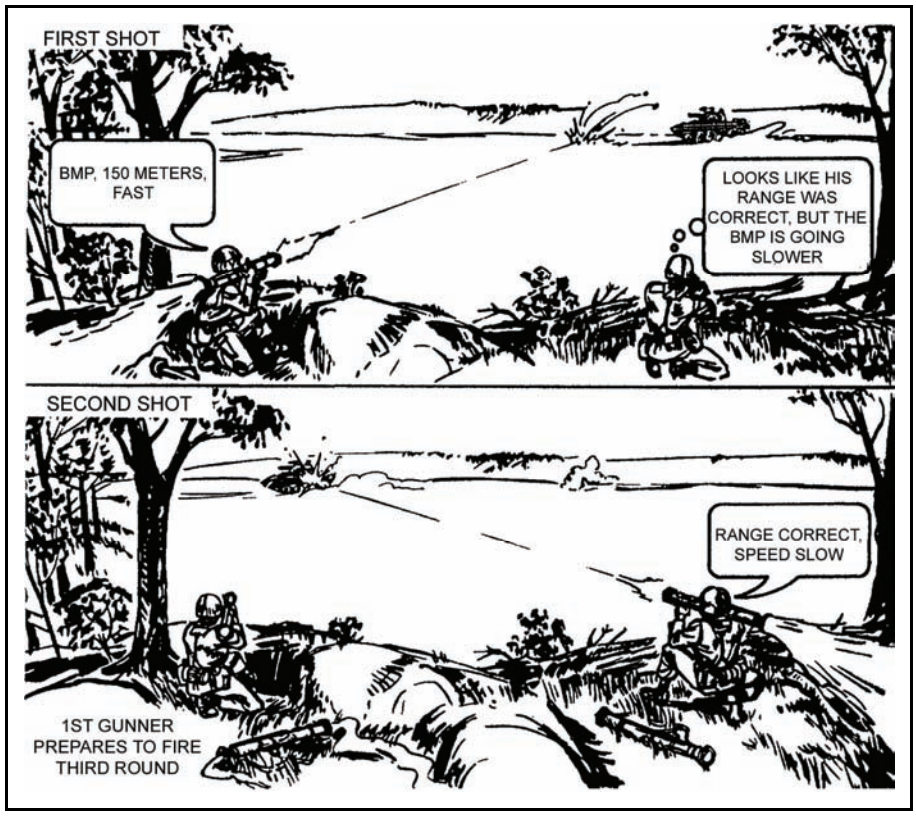

Figure B-16. Pair firing.

Volley Firing

B-55. Two or more firers can engage a single target when the range is known. These firers engage the target at the same time on a prearranged signal such as a command, whistle, mine, or TRP. This can be the most effective means of engagement as it places the most possible rounds on one target at one time, increasing the possibility of a kill (Figure B-17).

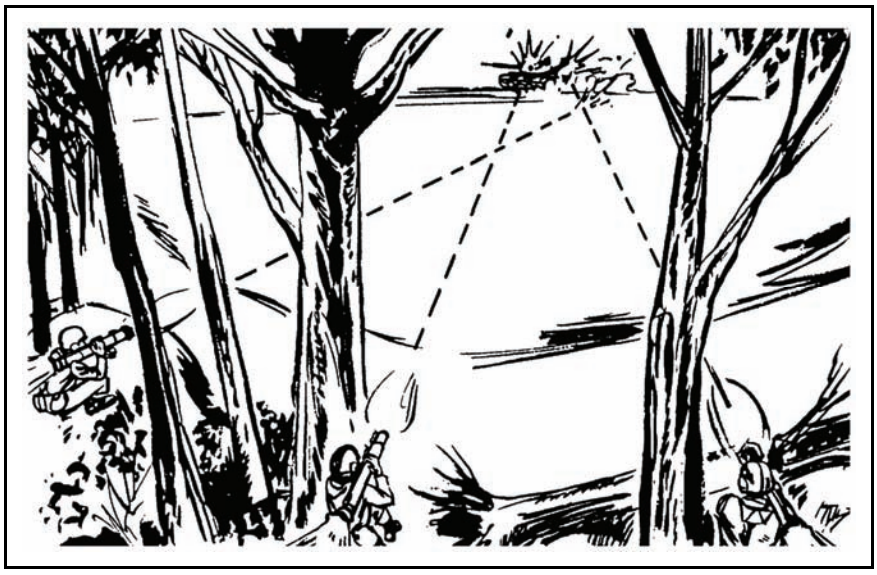

Figure B-17. Volley firing.

TOW COUNTERMEASURES TO IMPROVED ARMOR

B-56. TOW crews can expect to be issued a mix of TOW missile types on the battlefield, with widely varying capabilities. Gunners and leaders must be familiar with the different missile types and their respective capabilities. The proper type of missile must be chosen for each type of target (Table B-8).

B-57. TOW crews must strive harder than ever to find positions where they can engage enemy vehicles from the flank. Modern tanks with reactive armor have become increasingly difficult to kill from the front.

Table B-8. Missile selection priority chart.

THREAT VEHICLE-TYPE TARGETS	SELECTION PRIORITY			
	First	Second	Third	Fourth
Tanks with appliqué armor	TOW 2B	TOW 2A	TOW 2	ITOW
Tanks with explosive reactive armor	TOW 2B	TOW 2A	TOW 2	ITOW
Tanks without appliqué/ reactive armor	TOW 2B	TOW 2A	TOW 2	ITOW
Light armored personnel carriers	TOW 2	TOW 2A	TOW 2B	ITOW
Light armored wheeled vehicles	TOW 2	TOW 2A	TOW 2B	ITOW
Antiaircraft vehicles	TOW 2	TOW 2A	TOW 2B	ITOW
Armored vehicles in hull defilade positions	TOW 2B	TOW 2A	TOW 2	ITOW
Bunkers/fortifications	TOW BB	TOW 2	TOW 2A	ITOW

ANTIARMOR AMBUSH ROLE

B-58. Antiarmor ambushes are usually conducted to destroy small groups of armored vehicles, force the enemy to move more slowly and cautiously, or force the enemy into a choke point. Units conducting an antiarmor ambush can use Javelins or TOWs for this purpose. The Javelin and TOW have a slow rate of fire, so other weapons systems must be prepared to engage the vehicles while the Javelin gunners attach the CLU to new rounds or the TOW gunners load new rounds. The Javelin's 2,000-meter range and the TOWs 3,750 meter range allow flexibility in choosing ambush positions. In addition to fires into the kill zones, the Javelin and TOW can be employed in a security role to guard high-speed avenues of approach, to slow or stop enemy reinforcements, or to destroy vehicles attempting to flee the kill zone (Figure B-18).

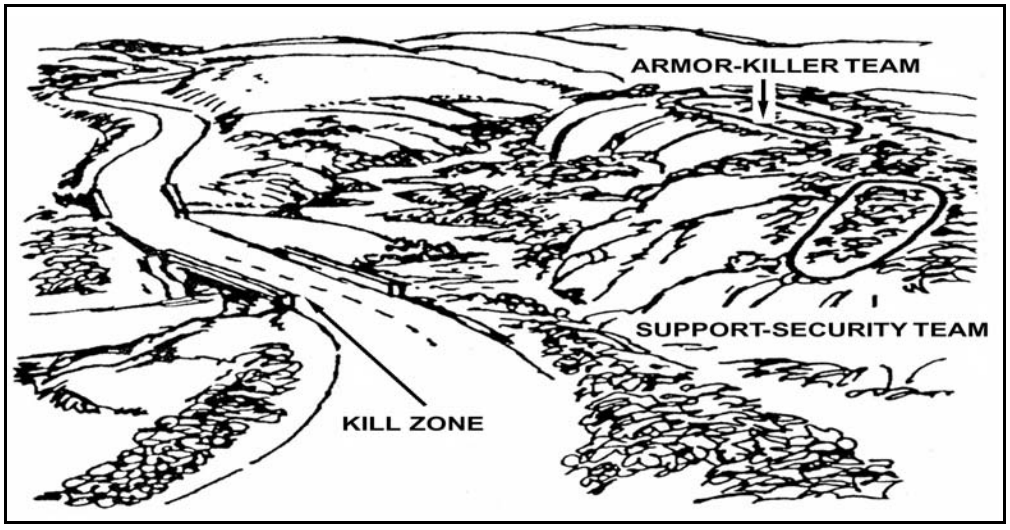

Figure B-18. Antiarmor ambush.

OFFENSIVE OPERATIONS

B-59. CCMS contribute to offensive operations by providing long-range fires that destroy enemy armor and protect the force from armored counterattacks. In the absence of armored targets, CCMS can engage enemy fortifications and hovering helicopters. CCMS are normally used in a support-by-fire role during offensive operations. The primary consideration for such employment is the availability of appropriate fields of fire and the armored threat. CCMS crews can effectively protect flanks against armored threats and can also provide overwatch for unit movement (Figure B-19).

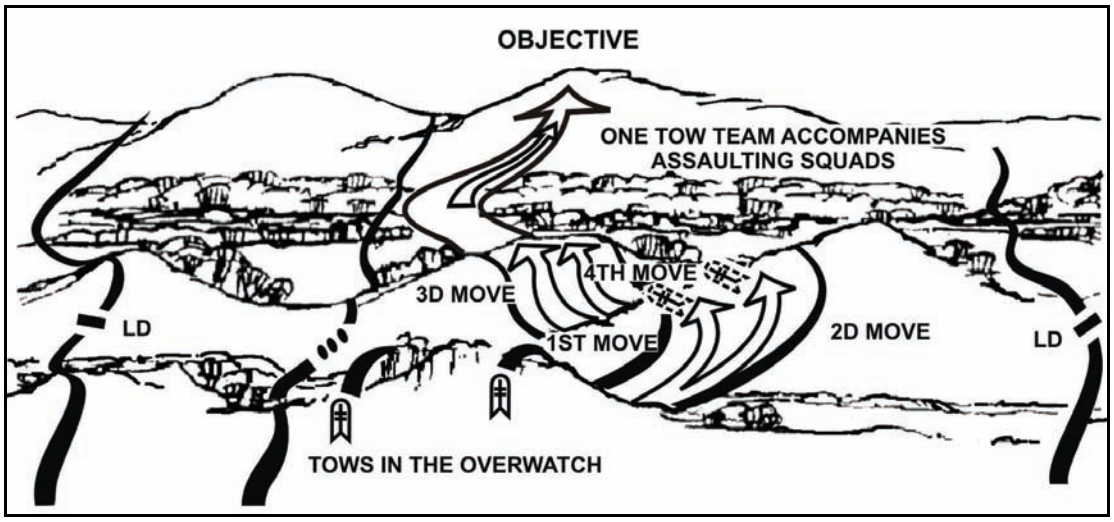

Figure B-19. TOW supporting offensive operations.

DEFENSIVE OPERATIONS

B-60. During planning, the leader considers the enemy armor threat, then positions antiarmor weapons accordingly to cover armor avenues of approach. He also considers the fields of fire, tracking time, and minimum engagement distance of each weapon. The section leader or squad leader selects a primary position and sector of fire for each antiarmor weapon. He also picks alternate and supplementary positions for them. Each position should allow flank fire and have cover and concealment. The leader should integrate the ITAS into his limited visibility security and observation plan. The squad leader selects the fighting position and assigns the sector of fire. Considering the fundamentals of antiarmor employment will greatly improve the crew's survivability. ITAS crews must coordinate with adjacent units to ensure security. The TOW's 3,750-meter maximum range makes it difficult for the enemy to engage the crew with direct fire, which forces the enemy to deploy earlier than intended. The gunner prepares a range card for his primary position. If time permits, he also prepares them for his alternate and supplementary positions (Table B-9).

B-61. Reserve forces armed with SLM may be employed to assist counterattacks to regain key positions. They are also used to block enemy penetrations, to meet unexpected enemy thrusts, and to provide support by fire to endangered friendly units during disengagements and withdrawals. In the event defensive positions are in danger of being overrun by enemy armored vehicles, SLM may be used against armored vehicles and lightly armored vehicles posing an immediate threat, including light tanks. The maximum range provides leaders with greater flexibility in positioning each round and provides a means of achieving overlapping sectors of fire for increased survivability.

Table B-9. Personnel duties.

Tasks to be Performed	Section Sergeant	Team Leader	Gunner/ Assistant Gunner
Integrate CCMS into the platoon tactical plan: • Select general weapons positions. • Assign sectors of fires. • Coordinate mutual support. • Coordinate with adjacent units.	 X X X X		
Reconnoiter for and select tentative CCMS firing positions (primary, alternate, and supplementary) and routes between positions.	X		
Supervise continual preparation and improvement of positions.	X	X	
Coordinate security for the CCMS teams.	X		
Inspect the selection of tentative firing positions, confirm or make adjustments.	X	X	
Supervise preparation of range card.	X	X	
Control movement of gunners between positions.	X	X	
Issue fire commands to gunners.	X	X	
Coordinate resupply and collection of extra rounds carried in platoon.	X		
Identify enemy avenues of approach.	X		
Prepare fighting position (primary, alternate, supplementary).		X	
Prepare range card.		X	X
Designate target reference points.	X		
Prestock rounds.		X	X
Prepare round for firing.			X
React to fire commands.			X
Engage targets.			X

SECTION III — SAFETY

B-62. Leaders must employ SLM/CCMS to effectively minimize danger to friendly Soldiers caused by the surface danger zone (SDZ) or backblast danger zones. They must weigh the risk of firing the missile in close proximity to friendly assault forces against the need to suppress or destroy enemy fortifications or vehicles from the support-by-fire or assault position. This section discusses SLM and CCMS safety.

SLM

B-63. Figures B-20 through B-27 and Table B-10 illustrate surface danger zone (SDZ) and backblast danger zone information for SLM. See DA PAM 385-63, *Range Safety*, and FM 3-23.25, *Shoulder-Launched Munitions*, for more specific information regarding this and other safety-specific information.

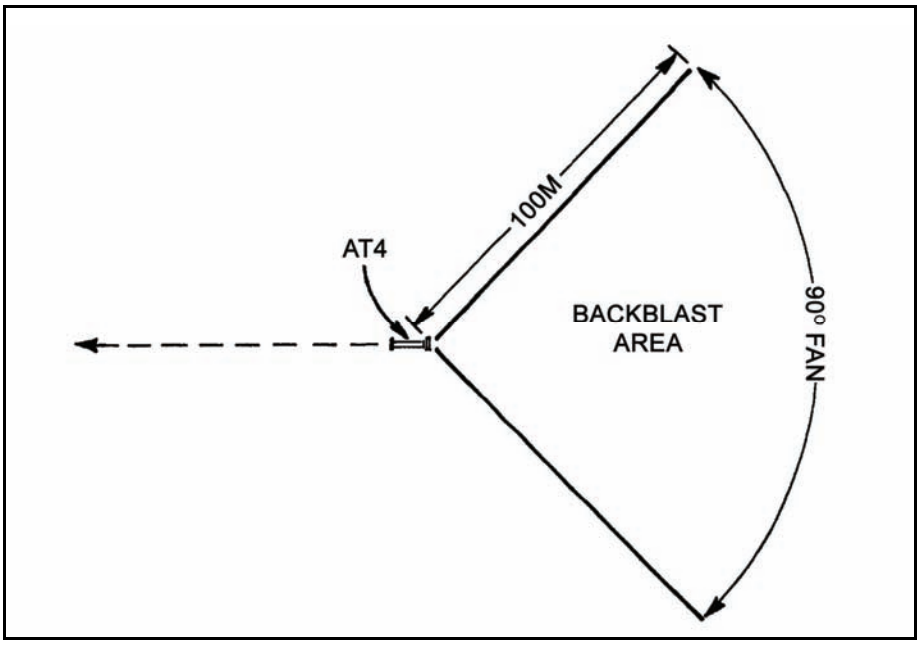

Figure B-20. M136 AT4 backblast danger area.

Table B-10. AT4 SDZ criteria in meters.

Type	Distance X	Minimum Range to Target	Area A	Area B	Area F[2]	
					Danger Zone Depth	Caution Area Depth
84-mm HEAT M136[1]	2,100	50	227	488	5[3]	95[4]
9-mm Trainer, M939	1,600	N/A	N/A	N/A	N/A	N/A

NOTES:
[1]Increased dud rates may occur when firing HE (M136) at impact angles of 10 degrees or less.
[2]Area F is 90-degree angle (45 degrees left and right) of rearward extension of launcher target line.
[3]Danger zone occupation could result in fatalities or serious casualties including, severe burns, eye damage, or permanent hearing loss. The hazards are baseplate fragments, debris, fireball, high noise levels, and overpressure.
[4]Caution area is an extension of the primary danger area. Occupation of this area could also result in severe casualties due to backblast, debris, high noise levels, and possible baseplate fragments. Primary danger area and caution area are conditions that may not be modified.

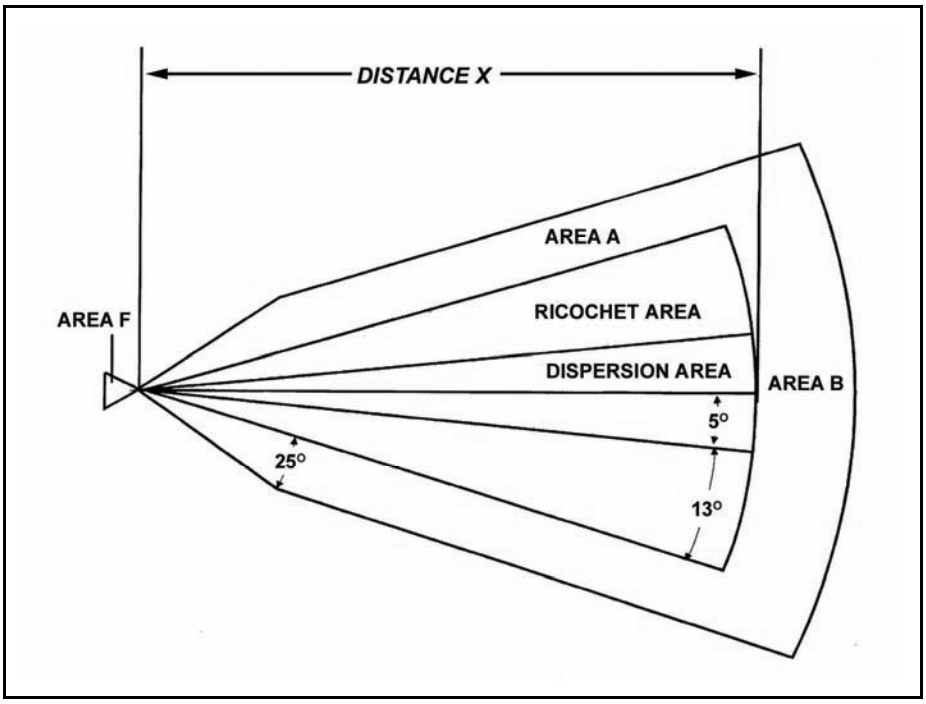

Figure B-21. SDZ for firing AT4.

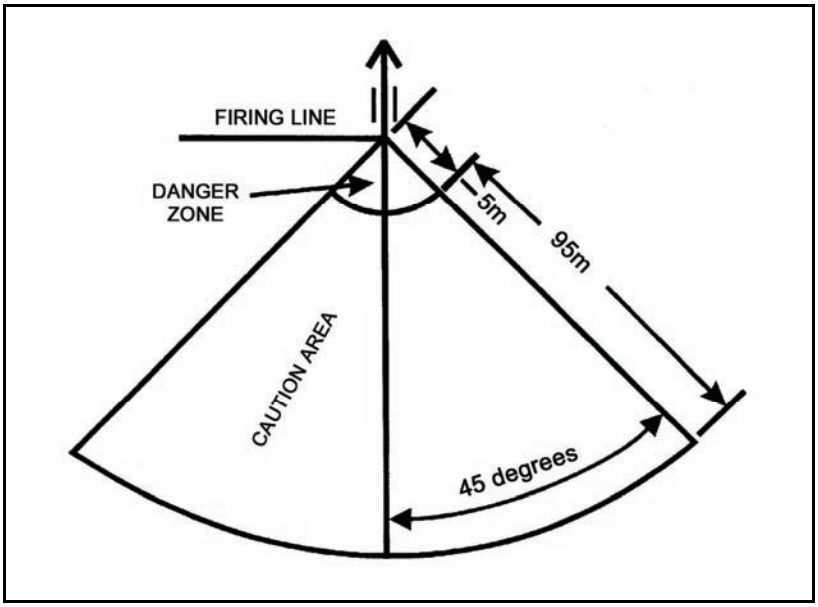

Figure B-22. SDZ area F for firing AT4.

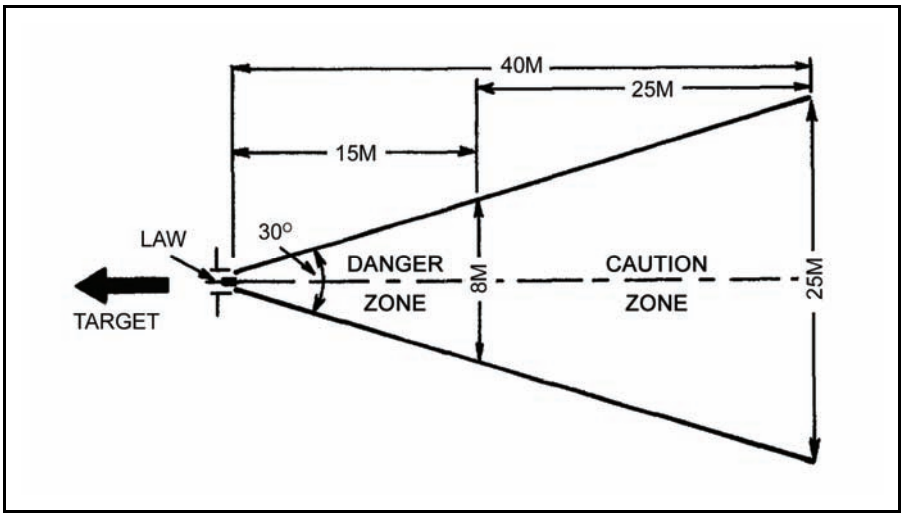

Figure B-23. M72A2/3 LAW backblast area.

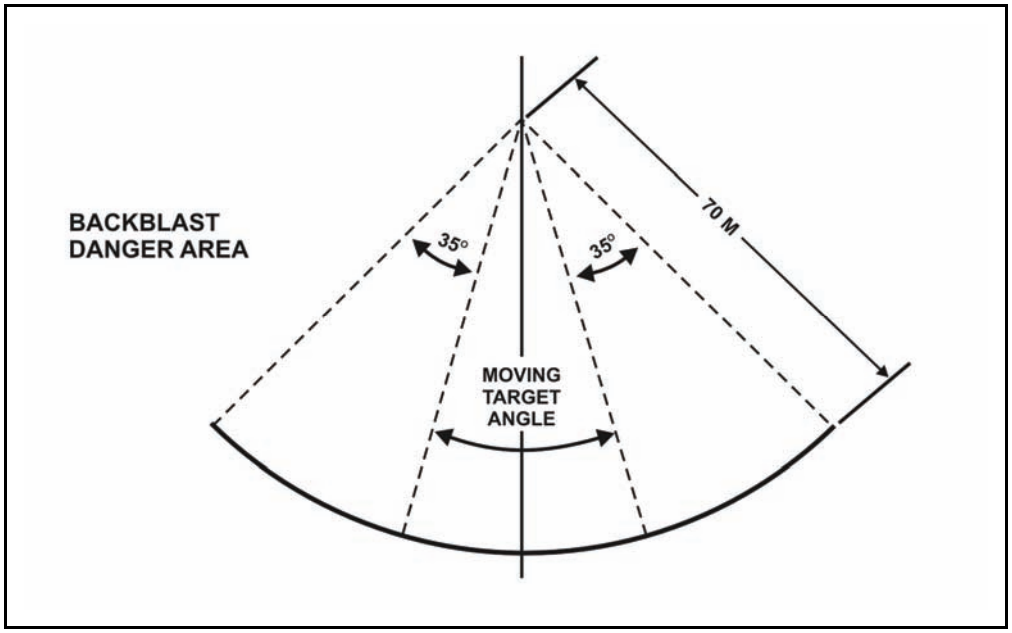

Figure B-24. Improved LAW backblast danger area.

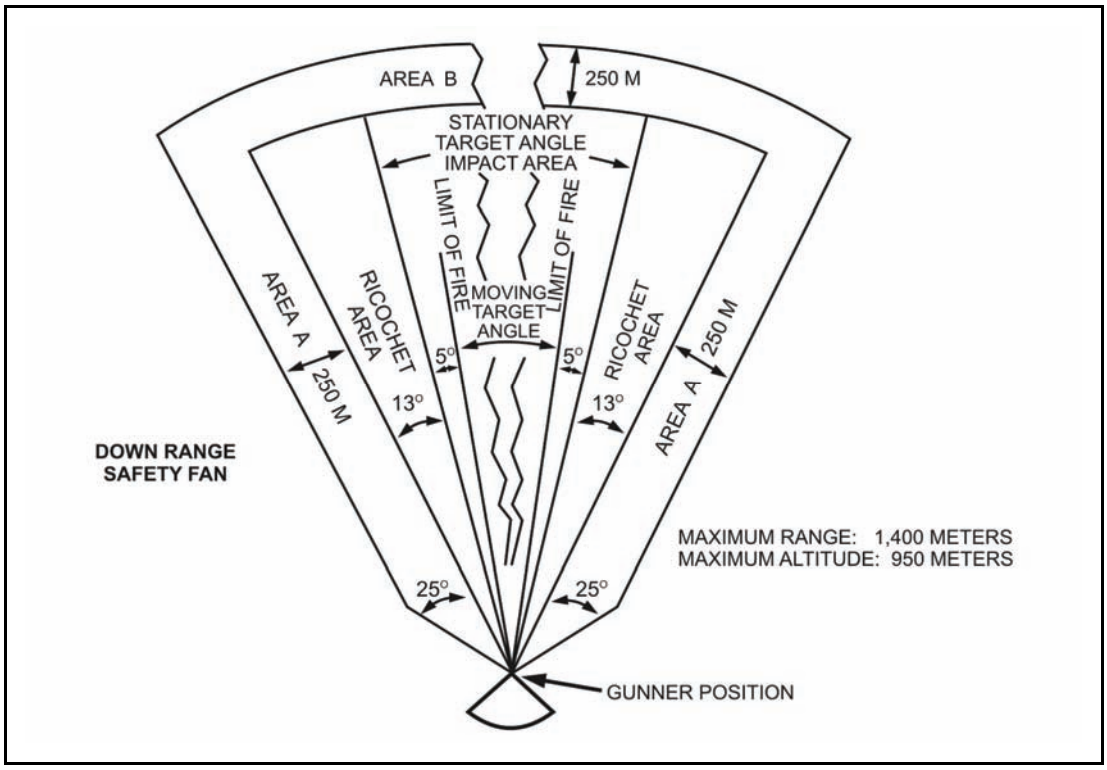

Figure B-25. SDZ for firing Improved LAW.

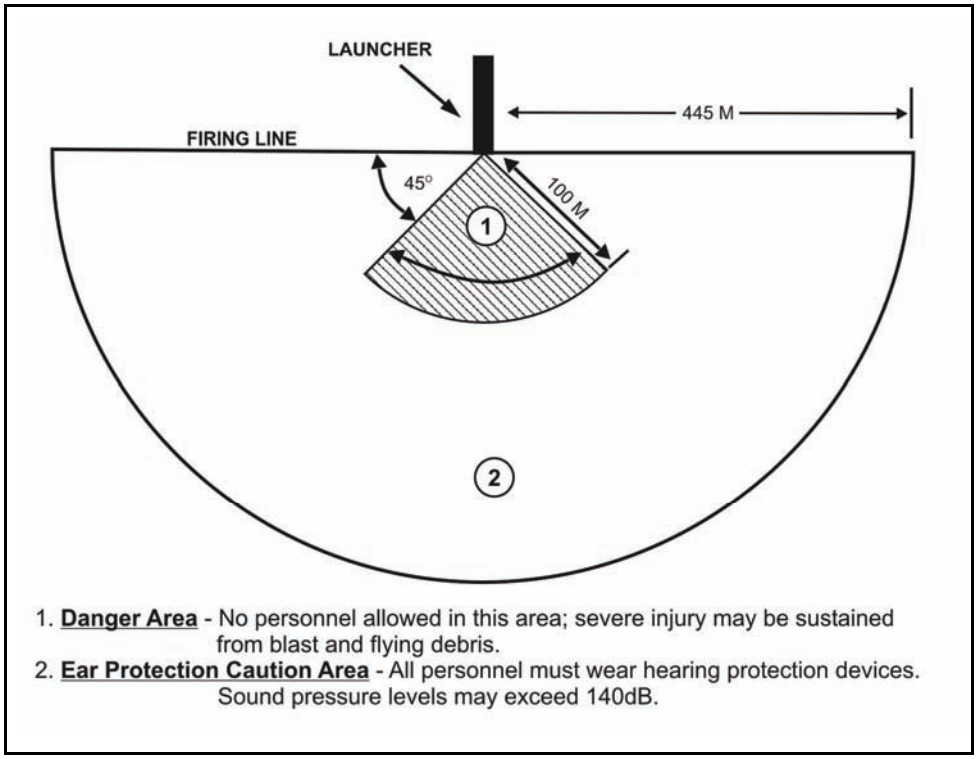

Figure B-26. XM141 BDM backblast danger area.

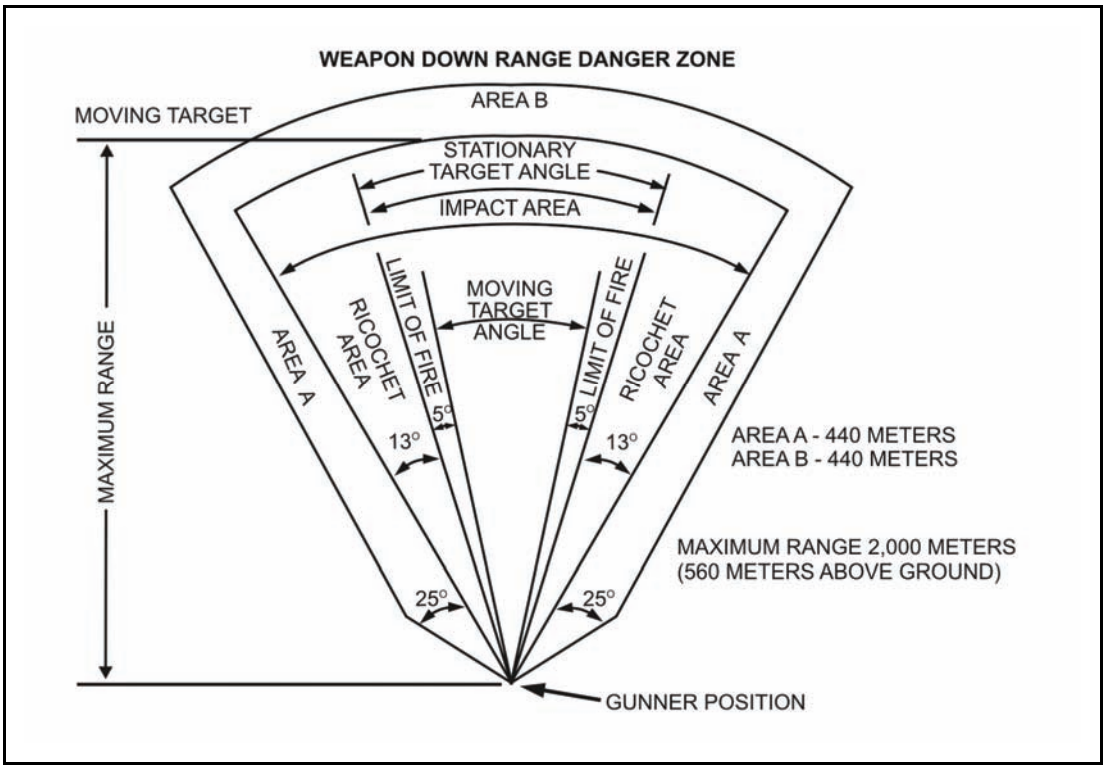

Figure B-27. SDZ for firing XM141 BDM.

COMBAT SAFETY FOR ALL SLM

B-64. Combat safety rules and procedures include all those that apply to training with the following modifications.

Engagement From an Enclosure

B-65. Firing from an enclosure creates unique hazards. Therefore, before positioning Soldiers in enclosures (combat only), leaders must consider several factors that affect safety. Only in combat, *when no other tactical option exists*, should the M136 AT4 and XM141 be fired from an enclosure. If it must be employed this way, the enclosure must meet the following minimum requirements. The M72-series LAW has been rated safe for use from an enclosure, but only when the enclosure meets the following minimum requirements.

- **Construction.** The building must be sturdily constructed to reduce structural damage that would occur in a weakly constructed enclosure such as one made of wood or stucco.
- **Size of Enclosure.** Minimum measurements for the enclosure are as follows:
  - AT4 and XM141 – minimum room size 17 by 24 feet; minimum ceiling height 8 feet (*combat only*).
  - LAW – minimum room size 12 by 15 feet.
- **Ventilation to the Rear and Sides.** To allow for backblast, at least 20 square feet of ventilation (for a standard 3-foot by 7-foot doorway) must be provided directly behind the firer. Doors and windows should be removed beside and behind the position to increase ventilation and reduce overpressure, noise, and blast effects. On the front wall, windows and doors should be reinforced, rather than removed, because removing would draw attention to the position. Reinforcing the windows also helps protect the firer from enemy direct-fire weapons.
- **Objects and Debris.** Any objects or debris to the rear of the weapon must be removed to prevent them from flying around the room and possibly injuring personnel as a result of the backblast.

- **Muzzle Clearance.** Muzzle clearance must be at least 6 inches.
- **Weapon Clearance.** Properly positioning the weapons within the enclosure is vital to the safety and survival of all personnel in the enclosure. The weapons should be positioned so no walls are within 5 meters to the rear or side of the weapon.
- **Non-Firing Personnel Positions.** If any other Soldiers are present, they must avoid standing in corners or near walls and must remain forward of the rear of the launcher.

Engagement from a Fighting Position

B-66. The M72-series LAW, M136 AT4, and SMAW-D can be fired from the standard Infantry fighting position. However, to increase accuracy and reduce danger to friendly Soldiers, the area to the rear of the firing position must have no walls, large trees, or other obstructions within 5 meters (5 1/2 yards). Ensuring the absence of such obstructions avoids deflection of weapon backblast onto the firer or into the position.

- **Individual Infantry Fighting Position.** The Soldier must lean against the rear wall and ensure that the venturi or the rear of the weapon protrudes past the rear of the position.
- **Two-Soldier Infantry Fighting Position.** Nonfiring personnel must remain clear of the backblast area. These positions should be constructed and sited so none are located in another position's backblast danger zone.
- **Modified Firing Position.** A modified firing position may be constructed to the side of the two-Soldier fighting position. Firing from a modified position reduces the possibility of injury to the firer or the other Soldier in the fighting position, while still offering the firer protection from enemy return fire.

OVERHEAD FIRE

B-67. SLM should not be fired over the heads of friendly Soldiers, unless the Soldiers have adequate protection against direct impact or other hazards.

JAVELIN

B-68. Figure B-28 shows the Javelin backblast danger area and SDZ. The primary danger area is a 60-degree sector, with the apex of the sector at the aft end of the missile launch motor.

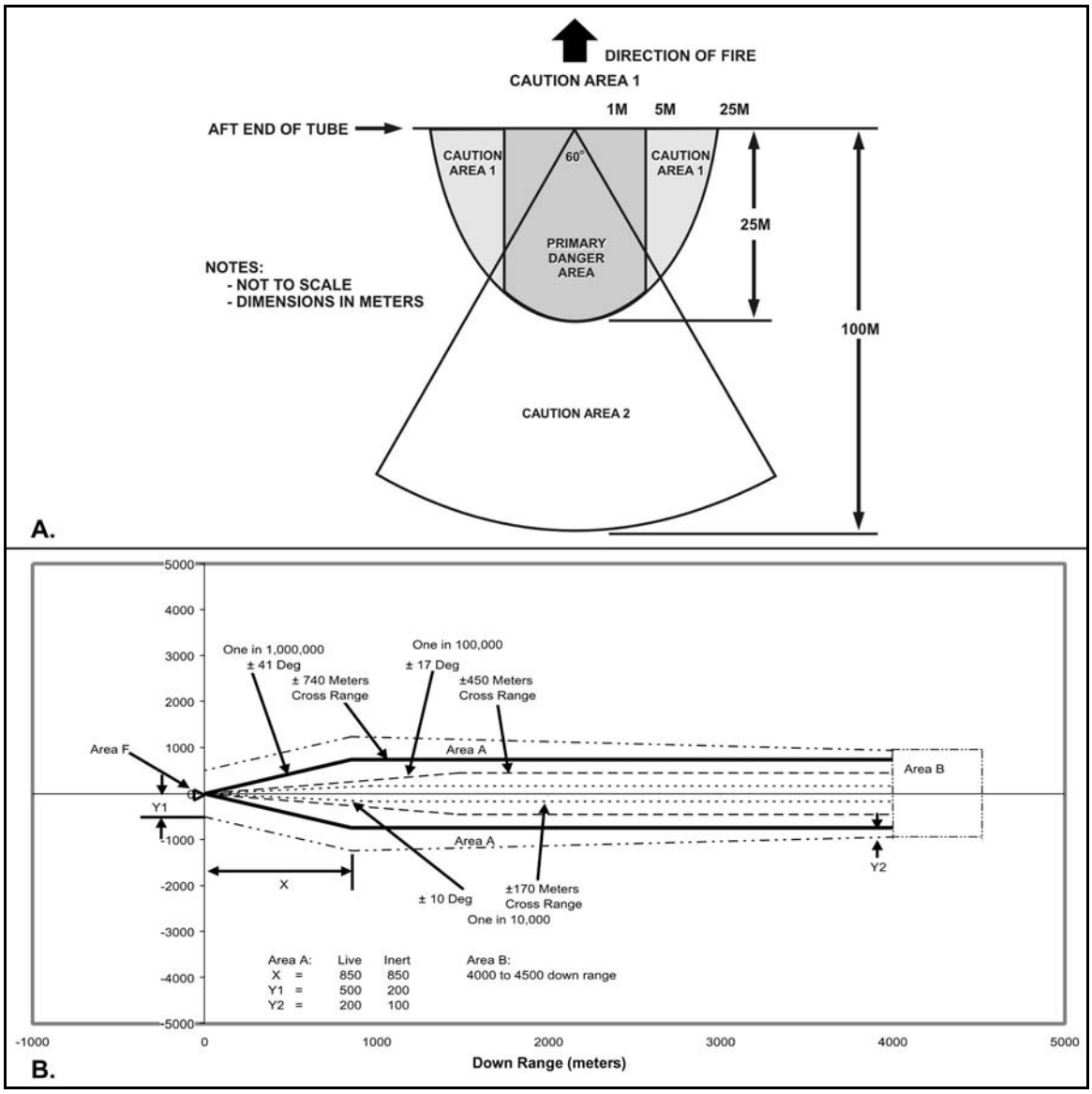

Figure B-28. Javelin backblast area and surface danger zone.

FIRING FROM ENCLOSURES

B-69. The Javelin can be fired from inside a building. However, the room from which it is fired must be at least 7 feet high, 12 feet wide, and 15 feet deep.

- **Debris.** Debris and loose objects are cleared from behind the launch site when firing within a confined area.
- **Venting.** When possible, doors and windows are opened to allow the backblast and overpressure to escape.
- **Structural Damage.** Escaping gases from the missile's first-stage motor are hot and flammable. The materials that can easily catch fire are removed before firing (for example, some types of curtains and throw rugs).
- **Hearing Protection.** All personnel within 25 meters of the Javelin must wear hearing protection.

- **Face Shield.** The face shield protects the gunner's face. It is possible to damage the face shield absorber between the indentation and the CLU main housing. If this part of the face shield is missing, the gunner must switch from firing the Javelin with the right eye to the left eye.

TOW

B-70. When firing from either a hasty or improved fighting position, the gunner must take into consideration obstructions directly to his front, to his rear, and to the sides of the fighting position.

FIRING LIMITATIONS

E-1. Some conditions may limit the firing and engagement capabilities of the TOW. The following information should be considered before engaging targets. (See TM 9-1425-450-12, *Operator and Organizational Maintenance Manual for TOW 2 Weapon System, Guided Missile System M220A2,* for updated firing limitations.)

- **Firing Over Bodies of Water.** Maximum and limited range firing over water varies according to missile type. If the range is less than 1,100 meters, the missile's range is not affected. However, if it is wider than 1,100 meters it can reduce the range of the TOW. A TOW position should be as high above and as far back from the water as the tactical situation allows. The squad or section leader should analyze his sector as soon as the position is occupied to determine if water will affect the employment of the TOW. Signals being sent through the command-link wires are shorted out when a large amount of wire is submerged in water.
- **Firing Over Electrical Lines.** If the command-link wires make contact with a live high-voltage power line, personnel can be injured or control of the missile could be lost. The launcher electronics may also be damaged. In addition to power lines, other high-voltage sources include street cars, electric train ways, and some moving target trolleys on training ranges.
- **Firing in Windy Conditions.** Gusty, flanking, or quartering winds can cause the launch tube to vibrate and spoil the tracking performance. The effect is similar to driving in a strong crosswind. Strong winds can move the missile around during flight, but as long as the crosshairs are kept on the center mass of the target, the weapon system itself can compensate for wind effects.
- **Firing Through Smoke and Area Fires.** Smoke can obscure the line of sight and hide the target when using the daysight tracker. A smooth tracking rate should be maintained as the target disappears into a smoke cloud so the missile will still be on target or very close as the vehicle goes out the other side of the smoke cloud. (This technique should be practiced during field tracking exercises.) A fire can burn through the command-link wire, causing loss of control of the missile.
- **Firing From Bunkers and Buildings.** In accordance with DA Pam 385-63, TOWs will not be fired from buildings, bunkers, or within 100 meters of a vertical or nearly vertical backstop without the approval of the commanding general.
- **Clearance Requirements.** The TOW muzzle must have at least nine inches of clearance at the end of the launch tube so the wings and control surfaces of the missile will not be damaged when they extend after clearing the launch tube. The muzzle of the launch tube must extend beyond any enclosure, window sill, or aperture. It must also have at least 30 inches of clearance between the line of sight and any obstruction from 500 to 900 meters downrange. A 30-inch line-of-sight clearance ensures a high probability the missile will not strike the ground on the way to the target (Figure B-29).
- **Firing TOW Bunker Buster Missile.** The missile warhead arms after launcher is between 35 and 65 meters. There is a very remote possibility of a TOW BB missile airburst 43 meters from launch platform. The probability of an inadvertent warhead detonation resulting in shrapnel injury to an exposed crewmember is also very remote. The crew is protected from shrapnel during firing from Stryker ATGM vehicles. The TOW BB is not currently fired from a HMMWV.

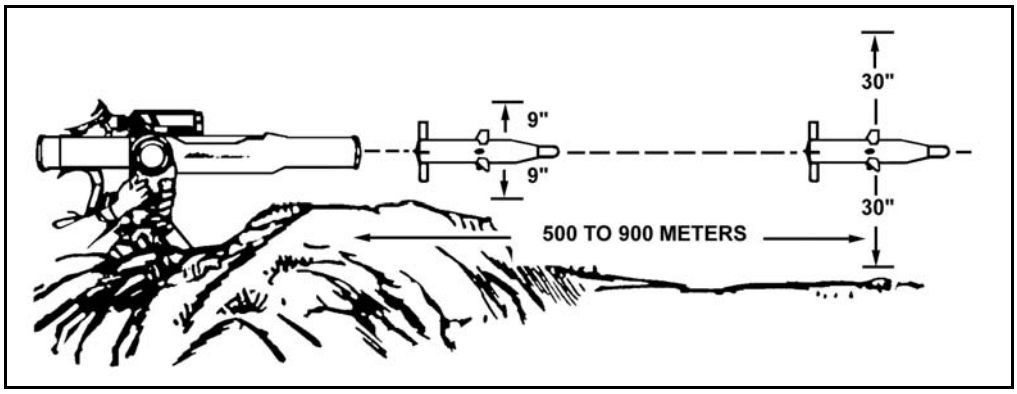

Figure B-29. Clearance requirements.

SURFACE DANGER ZONE

B-71. The surface danger zone for any firing range consists of a firing area, a target area, impact area, and danger areas surrounding these locations (Figure B-30). An additional area for occupation by personnel during firings may also be required. The shape and size of the surface danger zone varies with the type of missile or rocket being fired. (Refer to DA Pam 385-63 for dimensions.)

- **Primary Danger Area.** The primary danger area is a 90-degree cone with a 50-meter radius. The apex of the cone is centered at the rear of the missile launcher. Serious casualties or fatalities are likely to occur to anyone in the area during firing. Hazards include launch motor blast, high noise levels, overpressure, and debris.
- **Caution Area 1.** The caution area 1 extends in a radial pattern from each side of the primary danger area to the firing line with a radius of 50 meters. Permanent hearing damage could occur to personnel without adequate hearing protection in this area during firing. The hazards are high noise levels and overpressure.
- **Caution Area 2.** The caution area 2 is an extension of the primary danger area with the same associated hazards and personnel protection required. The radius of this area is 75 meters.
- **200-Meter Zone.** The 200-meter zone is the danger area for aerial firings 15.25 meters or more above ground level.

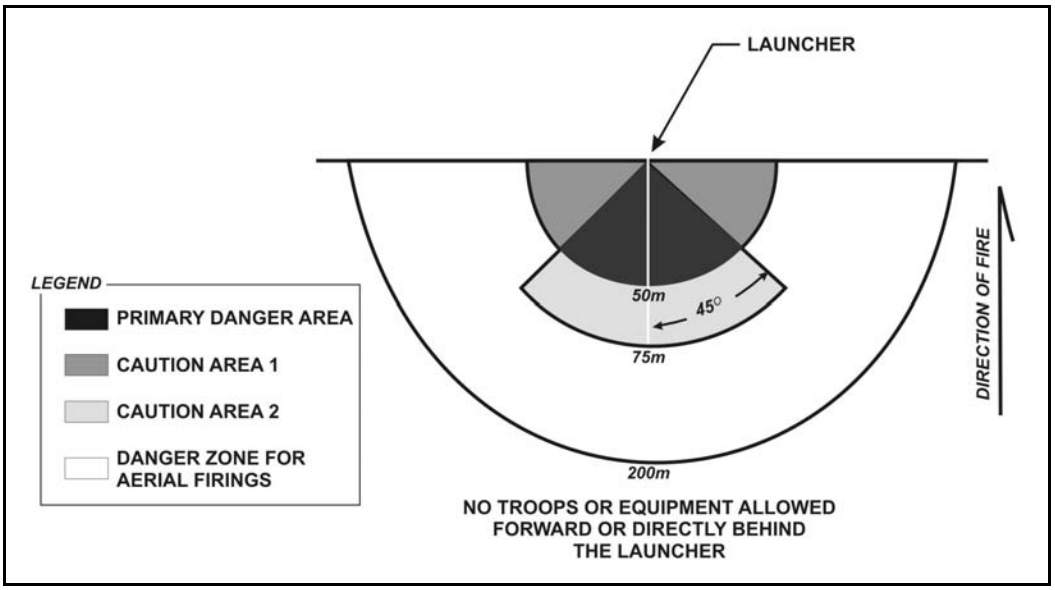

Figure B-30. Surface danger zone for firing basic TOW, TOW 2A, and TOW 2B missiles.

FIRING ANGLE LIMITATIONS

B-72. Azimuth and elevation firing angles are limited by the traversing unit, the vehicle, and other external restrictions. All elevation angles are referenced to the horizontal plane of the traversing unit. Azimuth angles are referenced to the long axis of the vehicle and depend on whether the launch tube points over the front or rear of the vehicle. The other reference line is the LOS from the TOW to the target.

B-73. When the TOW is tripod-mounted, a 360-degree lateral track is possible, because the traversing unit is not restricted in azimuth. Mechanical stops limit the elevation angle coverage to 20 degrees below and 30 degrees above the horizontal plane. Before the missile is fired, the LOS angle should be estimated at the expected time of launch and throughout the expected missile flight time. The firing position should be changed or a different target selected if an expected line-of-sight angle exceeds the firing limitation angle.

B-74. Firing angle limitations of TOW carriers are as illustrated in Figure B-31.

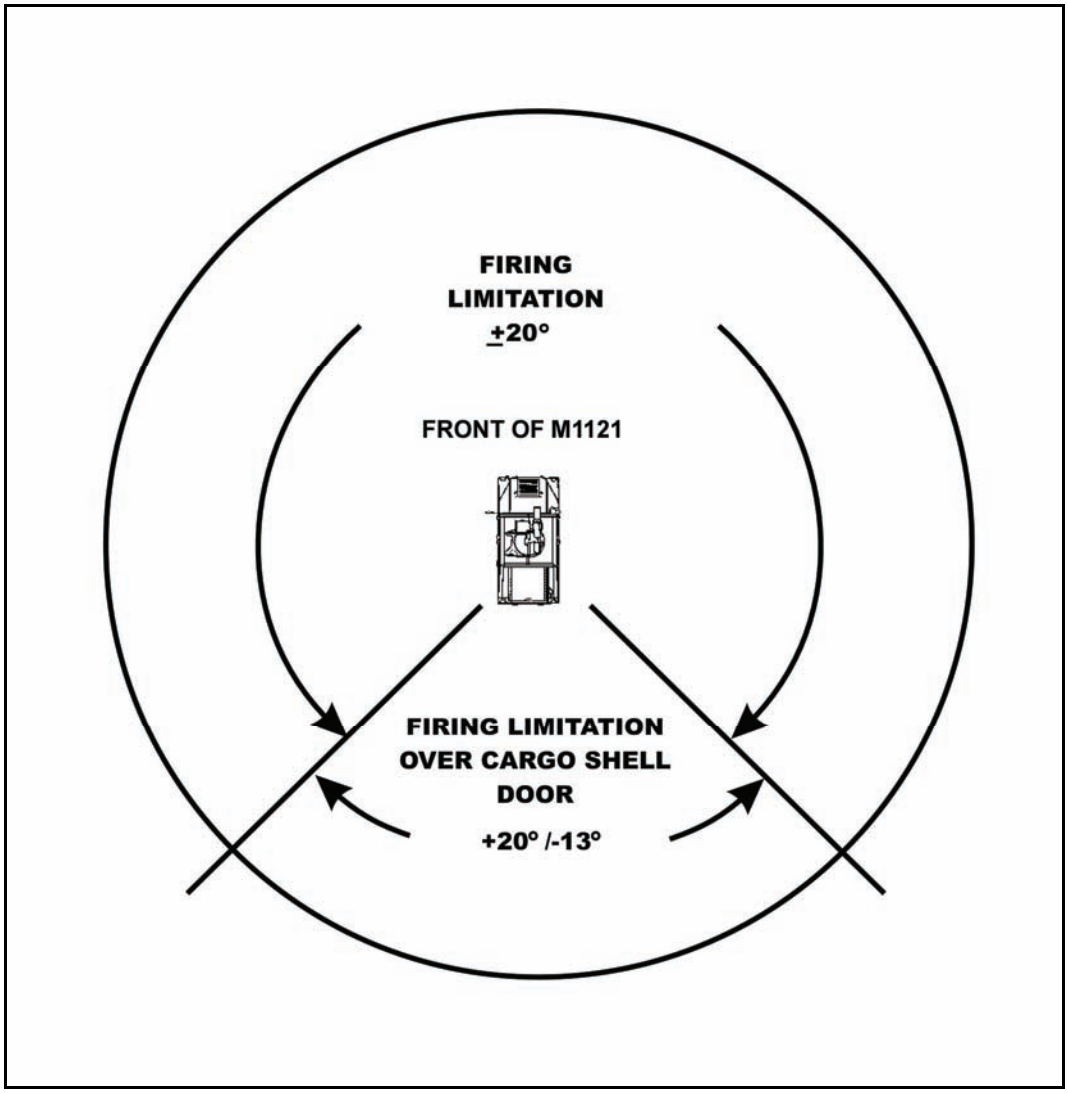

Figure B-31. M1121-mounted TOW firing angle limitations.