



## Machine Gun Gunnery Theory

Effective machine gun use requires understanding machine gun gunnery theory. This understanding is what makes a machine gun an effective crew-served weapon capable of suppressing and controlling large target areas. Failing to understand and apply these concepts reduces a machine gun to a large and clumsy belt-fed rifle limited to engaging single point targets.

### Characteristics Of Fire

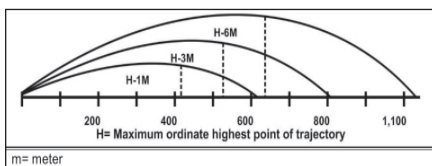
A gunner's knowledge of the machine gun is not complete until they learn about the action and effect of the projectiles.

The Line of Sight is an imaginary line drawn from the firer's eyes through the sights to the point of aim. The Burst of Fire is a number of successive rounds fired from the same hold and aim point, such as the same Traverse and Elevation mechanism setting, when the trigger is held to the rear. The number of rounds in a burst varies depending on the type of fire employed.

The trajectory is the curved path of the projectile in flight from the muzzle to impact. As the range to the target increases, so does the curve of trajectory.

Maximum ordinate is the high-

**Below:** Trajectory showing Height (in meters for the burst's path to reach different distances. Grazing fire (1 meter height is normally effective to about 600 meters. The height is 3 meters to reach 800 meters and 6 meters to reach 1,100 meters.



est point above the LOS the trajectory reaches between the muzzle of the weapon and base of target. It always occurs about two-thirds of the distance from weapon to target and increases with range.

### Cone Of Fire

The cone of fire is the pattern formed by the different trajectories of individual rounds in a burst as they travel downrange. Fired at a two-dimensional paper target the cone of fire should appear like a group and be roughly circular in shape. Various factors effects this but the gunner's Stability and Control have the biggest influence.

### Beaten Zone

The beaten zone is the elliptical pattern formed when the rounds within the cone of fire strike the ground or target area. The size and shape of the beaten zone changes based on the distance and slope of the target area but is normally oval or cigar shaped with the long axis along the gun-target line. At closer range the beaten zone is longer and narrower and becomes shorter and wider as distance increases. On rising ground, the beaten zone becomes shorter and ground that slopes away causes the beaten zone to become longer.

Gunners and automatic riflemen can take maximum effect of this by aiming at the center base of a target area as most rounds will either be direct hits or fall a bit short, increasing chances of on-target ricochets, better enabling spotting the strike of the rounds to adjust fire from, and increasing suppressive effect on the target area. The effective zone encompasses about 85% of the fired shots.

The danger space is along the gun-target line from muzzle to tar-



**Above:** Cone of fire creates the beaten zone downrange.

get where the trajectory does not rise above 1.8 meters above the ground, or the average height of a human adult.

These characteristics help describe various classes of fire.

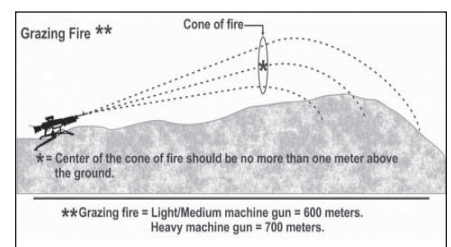
### Classification of Fire: Ground

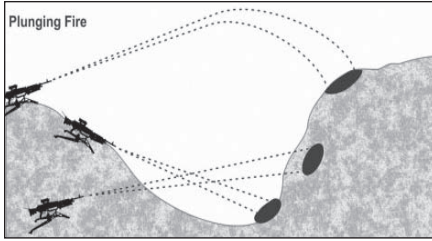
With respect to the ground, the two classes are grazing and plunging fire.

#### Grazing Fire

Grazing fire occurs when the center of the cone of fire does not rise more than one meter above the ground. Continuous grazing fire effectively creates a fence that is nearly impassable. The gunner does not have to aim at a particular target along the line when grazing fire is used because anything trying to pass that line when a burst is fired is almost certain to be hit. This is ideal for final protective fires along a final protective line in the defense and can be used offensively as well

**Below:** Grazing fire requires maintaining continuous danger space over uniform terrain.





**Above:** *Plunging fire is when fires are limited to the beaten zone, even if the crew is firing upward.*

anywhere the terrain is level or sloping uniformly along a line from the gunner's position. Dead space is any bit of ground that interrupts this continuous line, such as a small depression, and must be covered by a weapon from a different position or one capable of indirect fire, such as a grenade launcher. Over uniformly sloping terrain, 5.56 and 7.62mm machine guns can attain a maximum of 600 meters of grazing

**Below:** *Tracers from a machine gun illustrate the characteristics of danger space and beaten zone over ground. Good gunnery means learning how to establish and control this "fence" of coordinated fires.*



fire and heavy machine guns can push this to 700 meters. Grenade machine guns with a sharply arcing trajectory cannot use grazing fire.

**Plunging Fire**

Plunging fire occurs when there is little or no danger space from the muzzle to the beaten

zone, thus the weapon's effect is limited to placement of the beaten zone as grazing along the length of the gun-target line is not possible. Plunging fires happen when firing at long range beyond the grazing fire maximum effective range, when firing high to low ground or low to high ground, or firing across uneven terrain which breaks up the danger space needed to maintain grazing fire at points along the trajectory. Fires from grenade machine guns are always plunging fire.

**Classification of Fire: Target**

Fires with respect to the target include enfilade, frontal, flanking, and oblique fires. Leaders and gunners should always strive to position gun teams so that the long axis of fires, grazing and beaten zones falls along the long axis of the target and target areas.

**Enfilade Fire**

Enfilade fire occurs when the long axis of the beaten zone coincides or nearly coincides with the long axis of the target. Derived from the French meaning "to thread" enfilading fires takes maximum benefit of the effects of grazing and beaten zone.

**Frontal Fire**

Frontal fire occurs when engaging a force facing toward the gun position. It is enfilading fire when the target area is advancing forward in a column formation.

**Flanking Fire**

Flanking fire is delivered directly against the side of the target area and becomes enfilading fire when employed against a line formation.

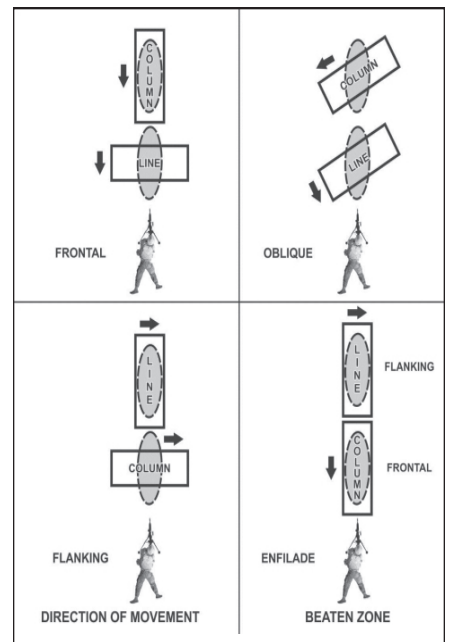
**Oblique Fire**

Oblique fire occurs when the long axis of fires is an angle other than a right angle to the front of the target.

Proper positioning of gun teams requires determining likely avenues of approach and setting up so as to place the long axis of fire along the long axis of the target area.

It's worth noting that routine qualification fails to take this into account as the ideal place to put

**Below:** *Classes of fire with respect to the target.*





**Above:** Enfilading fire on RETS targets from the crew's perspective. From this position the long axis of the target array matches up with the length of danger space and beaten zone, establishing the most effective fire. Note that most training ranges forbid this and force a much less effective face-on target engagement. No wonder our troops are ignorant of machine gunnery!

**Above:** Enfilading fires are most effective and may be frontal or flanking depending how the targets are arrayed.

crews on a transition range would be to fire across the side of the range as that would enfilade fires across all the targets in all of the lanes. Obviously, this will won't fit in the existing Surface Danger Zone and Range Control will be very angry with you, however, understanding this will help taking the machine gun marksmanship skills tested in qualification into real world application.

**Classification of Fire: Gun**

Classes of fire with respect to the weapon include fixed, traversing, searching, traversing and searching, swinging traverse, and free gun fires.

**Fixed Fire**

Fixed fire is possible when the point target or target area can be effectively engaged within the width and size of the centered beaten zone

or grazing fires with little or no manipulation required.

**Traversing Fire**

Most target areas will likely be bigger than the gun's beaten zone or grazing fire coverage and adjustment is necessary. Traversing disperses fires in width by successive changes left or right but not in elevation. When engaging a wide target area, the gunner selects multiple aim points or makes subsequent traverse adjustments after successfully landing an initial burst and making T&E adjustments from there in even increments to ensure even, continuous coverage along the target area. Given that a cone of fire should be 2-4 mils in size, an adjustment of 4 mils from burst to burst creates overlapping coverage.

**Searching Fire**

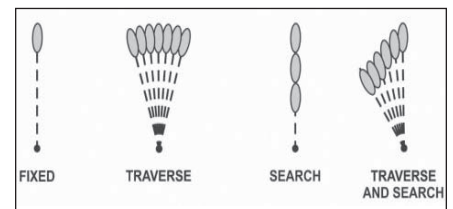
Searching distributes fires in-depth by successive changes in elevation. Gunners employ searching

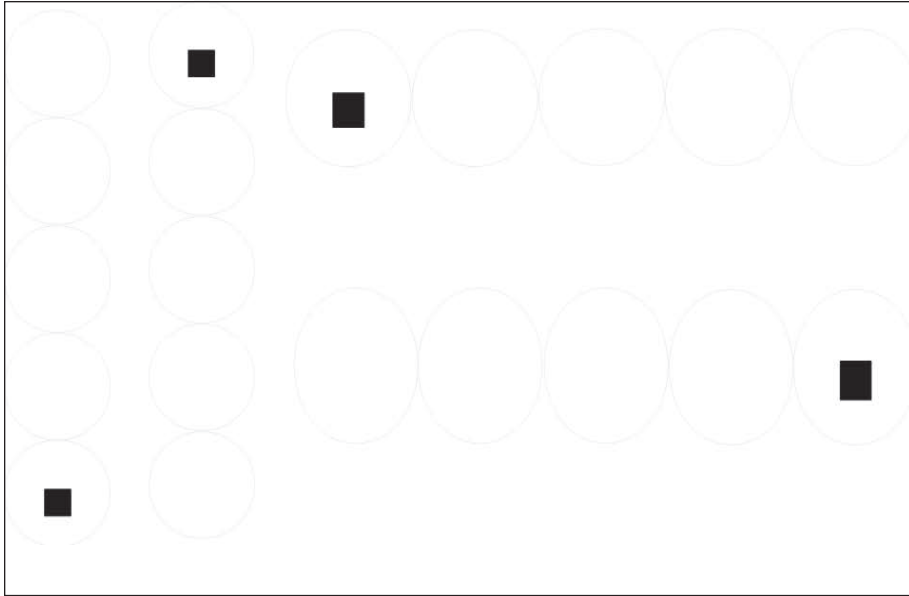
fire against a deep target or a target having depth and minimal width, requiring changes in only the elevation of the gun. The amount of elevation change depends upon the range and slope of the ground.

Traversing and Searching Fire combines elements of both traverse and search to distribute fires both in width and depth.

These concepts are important for gunnery but aren't really tested during routine qualification. The transition course is limited to fixed

**Below:** Classes of fire with respect to the gun.





**Above:** Improved gunnery fundamentals practice target. This target has four separate arrays of five circular pasters each, starting on the left side are Search Up and Search Down arrays. Next are the Traverse Right and Traverse Left. Each paster is a four-mil circle that is invisible from the gunner's position. Only the first target in each array has a one-mil black square at the paster's center base. The gunner aims in there, fires an initial accurate burst, and has to trust the T&E adjustments to engage each area after that as there isn't a visible target to aim at.

targets only and the 10-meter target has a bold outline for each paster so as to aim at each one individually.

While not included as a standard qualification, targets can be used to emphasize these points. For example, a target series that has one aim point reference for five target areas that are invisible to the gunner. A one-mil black square is at the bottom, left, top, or right side of a given target area. After aiming in a firing an initial accurate burst, the gunner has to trust T&E adjustments to en-

gage the remaining target areas.

Machine guns really shine when they apply accurate, controlled fires over a target area. Firing over terrain with grazing or enfilading fires may not give a convenient aim point to hold on. Gunners need to understand how to apply fires to get the desired effect. **USARCMF**

**Left:** Gun crew during field training set up in position. Stakes designate the limits of their sector of fire. The gun is currently set for grazing fire shot down a final protective line protecting the unit position to the crew's right side. Ideally, another gun crew is set up on the opposite end of the unit to protect this gun crew. The range card by the T&E allows the crew to employ their weapon while staying behind cover. The gunner can stay below the gun behind cover and still direct fires.



**Above:** Soldiers are sometimes confused about the gunnery role of machine guns because the weapons can also be employed as individual small arms. The need for gunnery skills with other crew-served weapons, like this mortar, is obvious because there is no other way to utilize them.