CHAPTER 2

FUNDAMENTALS OF MORTAR GUNNERY

This chapter discusses the elements of firing data, ballistics, firing tables, fire planning, target analysis, and methods of attack. This information enables the FDC to engage the enemy even during adverse conditions.

Section I. ELEMENTS OF FIRING DATA AND BALLISTICS

Firing data are applied to the ammunition and the mortar so that the fired projectile bursts at the desired location. Those data are based on the direction, horizontal range, and vertical interval from the mortar to the target, the pattern of bursts desired at the target, and MET conditions.

2-1. DIRECTION

In mortar gunnery, direction is a horizontal angle measured from a fixed reference. The indirect fire team normally measures direction in mils clockwise from grid north, which is the direction of the north-south grid lines on a tactical map. The team emplaces its mortars on a mounting azimuth, then uses the direction to make angular shifts onto the target. Direction to the target may be computed, determined graphically, or estimated (Figure 2-1, page 2-2).

NOTE: The unit of angular measurement in mortar gunnery is the mil. A mil equals about 0.056 of a degree. There are 17.8 mils in a degree and 6400 mils in a 360-degree circle.

2-2. RANGE

Range is the horizontal distance, expressed in meters, from the mortars to the target. It is computed, measured graphically, or estimated. The range of a projectile depends on its muzzle velocity (which depends on charge and other factors) and the elevation of the mortar.

2-3. VERTICAL INTERVAL

Vertical interval is the difference in altitude between the mortar section and the target or point of burst. It is determined from maps, by survey, or by a shift from a known point.

2-4. DISTRIBUTION OF BURSTS

Distribution of bursts is the pattern of bursts in the target area. Normally, all mortars of the section or platoon in a standard formation fire with the same deflection, fuze setting, charge, and elevation. Since targets may be of various shapes and sizes and mortars may use terrain mortar positioning, it is best to adjust the pattern of bursts to the shape and size of the target. Sometimes, individual mortar corrections for deflections, fuze setting, charge, and elevation are computed and applied to achieve a specific pattern of bursts.

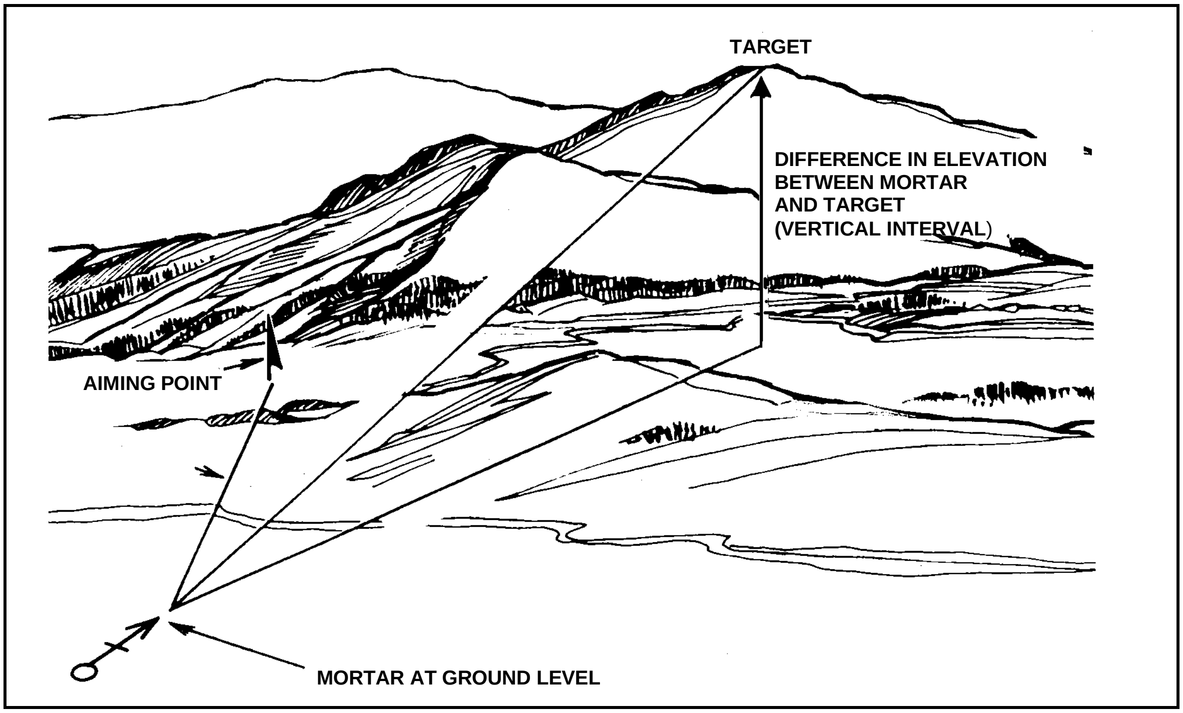

Figure 2-1. Direction to the target.

2-5. INTERIOR BALLISTICS

Interior ballistics deals with the factors affecting the motion of a mortar round before it leaves the muzzle of the barrel. The total effect of all interior ballistic factors determines the velocity with which the projectile leaves the muzzle. That velocity is called *muzzle velocity* and is expressed in meters per second (MPS).

2-6. NATURE OF PROPELLENTS AND PROJECTILE MOVEMENTS

Propellent is a low-order explosive that burns rather than detonates. The mortar fires semifixed ammunition. When the gases from the burning propellent develop enough pressure to overcome projectile weight and initial bore resistance, the projectile begins to move.

a. Gas pressure peaks quickly and subsides gradually after the projectile begins to move. The peak pressure, together with the travel of the projectile in the bore, determines the speed at which the projectile leaves the barrel.

b. Factors that affect the velocity of a mortar-ammunition combination are as follows:

(1) An increase or decrease in the rate of burning of the propellent increases or decreases gas pressure.

(2) An increase in the size of the chamber of the weapon, without a corresponding increase in the amount of propellent, decreases the gas pressure.

(3) Gas escaping around the projectile in the barrel decreases the pressure.

(4) An increase in bore resistance to projectile movement, before peak pressure, further increases the pressure.

(5) An increase in bore resistance at any time has a dragging effect on the projectile and decreases velocity. Temporary variations in bore resistance are caused by carbon buildup in the barrel.

2-7. STANDARD MUZZLE VELOCITY

Firing tables give the standard muzzle velocity for each charge. Values are based on a standard barrel and are guides, since they cannot be reproduced in a given instance. A specific mortar-ammunition combination cannot be selected with the assurance that it will result in a standard muzzle velocity when fired. Charge velocities are established indirectly by the military characteristics of a weapon. Since mortars are high-angle of fire weapons, they require greater variation in charges than do howitzers, which are capable of low-angle of fire. This variation helps achieve a range overlap between charge zones and desired range-trajectory. Other factors considered in establishing charge velocities are the maximum range specified for the weapon, and the maximum elevation and charge (with resulting maximum pressure) that the weapon can accommodate.

2-8. NONSTANDARD MUZZLE VELOCITY

In mortar gunnery techniques, nonstandard velocity is expressed as a variation (plus or minus MPS) from an accepted standard. Round-to-round corrections for dispersion cannot be made. Each factor causing nonstandard muzzle velocity is treated as independent of related factors.

a. **Velocity Trends**. Not all rounds of a series fired from the *same* weapon using the *same* ammunition lot will develop the *same* muzzle velocity. Some muzzle velocities are higher than average, and some are lower. This is called *velocity dispersion*. Under most conditions, the first few rounds follow a somewhat regular pattern rather than the random pattern associated with normal dispersion. This is called *velocity trend*. The magnitude and extent (number of rounds) of velocity trends vary with the mortar, charge, barrel condition, and firings that precede the series. Velocity trends cannot be predicted, so computer personnel should not attempt to correct for their effects.

b. **Ammunition Lots**. Each lot of ammunition has its own performance level when related to the same mortar barrel. Although the round-to-round probable error (PE) within each lot is about the same, the mean velocity developed by one lot may be higher or lower than that of another lot. Variations in the projectile, such as, the diameter and hardness of the rotating disk, affect muzzle velocity. Projectile variations have a much more apparent effect on exterior ballistics than on interior ballistics.

c. **Tolerances in New Weapons**. All new mortars of a given size and model do not always develop the same muzzle velocity. In a new barrel, the main factors are variations in the powder chamber and in the interior dimensions of the bore. If a battalion armed with new mortars fired with a common lot of ammunition, a velocity difference of 3 or 4 MPS between the mortars with the highest and lowest muzzle velocity would be normal.

d. **Wear of Barrel**. Heated gases, chemical action, and friction from projectiles during continued firing of a mortar wear away the bore. This wear is more pronounced when higher charges are being fired. Barrel wear decreases muzzle velocity by allowing more room for gases to expand. The gases escape past the rotating disk of the 4.2-inch mortar or the obturator ring of the 60-mm/81-mm/120-mm mortars, decreasing resistance to initial projectile movement and lessening pressure buildup. Wear can be reduced by careful selection of the charge and by proper cleaning of the weapon and ammunition.

e. **Rotating Disks**. Rotating disks allow proper seating, keep gases from escaping between the bore and the projectile, and create proper resistance to the projectile's initial movement. Also, disks allow uniform pressure buildup but minimum drag on the moving projectile, and they help give it a proper spin. Dirt or burrs on the rotating disk cause improper seating, which increases barrel wear and reduces muzzle velocity. If the bore is excessively worn, the rotating disk may not properly engage the lands and grooves to impart proper spin to the 4.2-inch mortar projectile. Not enough spin reduces projectile stability in flight, which can result in dangerously short, erratic rounds.

f. **Temperature of the Propellent**. Any combustible material burns rapidly when it is heated before ignition. When a propellent burns more rapidly, the resultant pressure on the projectile is greater, increasing muzzle velocity. Firing tables show the magnitude of that change. Appropriate corrections to firing data can be computed, but such corrections are valid only if they reflect the true propellent temperature. The temperature of propellents in sealed packing cases remains fairly uniform, though not always standard (70 degrees F).

(1) Once the propellent is unpacked, its temperature tends to approach the prevailing air temperature. The time and type of exposure to weather result in propellent temperature variations between mortars. It is not practical to measure propellent temperature and to apply corrections for each round fired by each mortar. Propellent temperatures must be kept uniform; if they are not, firing is erratic. A sudden change in propellent temperature can invalidate even the most recent corrections.

(2) To let propellents reach air temperature uniformly, ready ammunition should be kept off the ground. Ammunition should be protected from dirt, moisture, and direct sunrays. An airspace should be between the ammunition and protective covering.

(3) Enough rounds should be unpacked so that they are not mixed with newly unpacked ammunition. They should be fired in the order in which they are unpacked; hence, opened rounds are fired first.

g. **Moisture Content of Propellent**. Handling and storage can cause changes in the moisture content of the propellent, which affects the velocity. This moisture content cannot be measured or corrected; also, ammunition must be protected from moisture.

h. **Weights of Projectile**. The weight of like projectiles varies within certain weight zones. For the lighter 60-mm and 81-mm projectiles, the difference is minimal and has little affect on muzzle velocity. For the 4.2-inch mortar projectile, however, the difference must be considered. The appropriate weight zone is stenciled on the projectile as squares ([]) of weight. A heavier-than-standard projectile is harder to push through the barrel and has less muzzle velocity. A lighter projectile is easier to push through the barrel and has a higher muzzle velocity. The weight of the projectile is also a factor in exterior ballistics.

i. **Barrel Temperature**. The temperature of the barrel affects the muzzle velocity. A cold barrel offers more resistance to projectile movement than a warm barrel.

j. **Propellent Residues**. Residues from the burned propellent and certain chemical agents mixed with expanding gases are deposited on the bore surface in a manner similar to coppering. Unless the barrel is properly cleaned and cared for, such residues increase subsequent barrel wear by pitting, thus increasing abrasion by the projectiles.

k. **Oil or Moisture**. Oil or moisture in the barrel or on the rotating disk tends to increase the velocity of a round by causing a better initial gas seal and reducing projectile friction on the bore surface. Conversely, too much oil or moisture in the barrel decreases velocity, causing a short round.

2-9. EXTERIOR BALLISTICS

Exterior ballistics—mainly gravity and air—affect the motion of a projectile after it leaves the muzzle of the barrel. Gravity causes the projectile to fall; air resistance impedes it. When projectiles are fired in the air, their paths differ since projectiles of different sizes or weights respond differently to the same atmospheric conditions. Also, a given elevation and muzzle velocity can result in a wide variety of trajectories, depending on the combined properties of the projectile and the atmosphere.

2-10. TRAJECTORY

Trajectory (Figure 2-2) is the flight path followed by a projectile from the muzzle of the mortar to its point of impact. The ascending branch is the portion of the trajectory traced while the projectile is rising from its origin. The descending branch is that portion of the trajectory traced while the projectile is falling. The summit is the highest point of the trajectory. It is the end of the ascending branch and the beginning of the descending branch. The maximum ordinate is the altitude (in meters) at the summit above the point of origin.

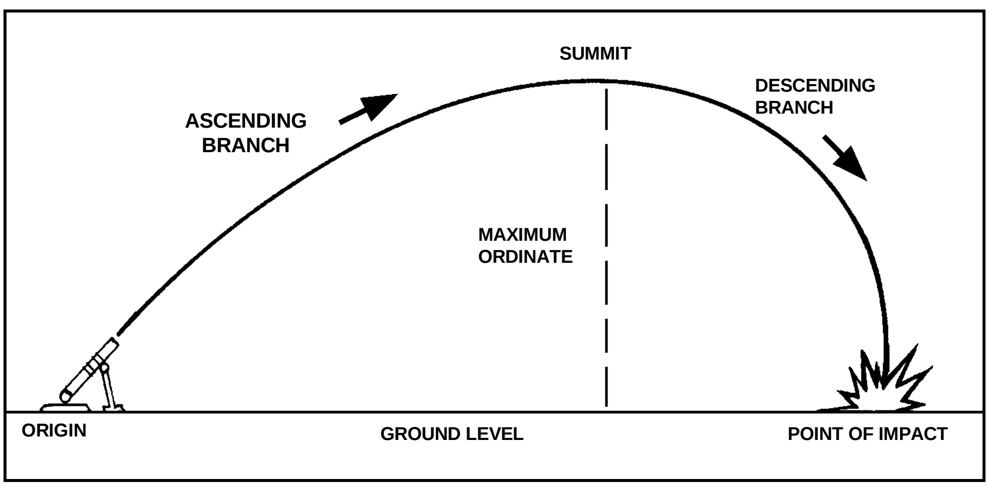

Figure 2-2. Elements of the trajectory.

a. **Trajectory in Atmosphere**. The resistance of the air to a projectile depends on the air movement, density, and temperature. An assumed air density and temperature, and a condition of no wind, are used as a point of departure for computing firing tables. The air structure so derived is called the *standard atmosphere*.

b. **Characteristics of Trajectory in Standard Atmosphere**. The velocity (Figure 2-2) at the level point is less than the velocity at origin. The projectile travels more slowly beyond the summit than before the summit so it does not travel as far.

Its descending branch is shorter than its ascending branch, and its angle of fall is greater than its angle of elevation.

(1) The spin initially imparted to the 4.2-inch mortar projectile causes drift (Figure 2-3). This characteristic has an effect on trajectory that must be considered when aiming.

(2) A trajectory in standard atmosphere is effected by the following factors:

- Horizontal velocity decreases with continued time of flight.
- Vertical velocity is affected not only by gravity but also by air resistance.

c. **Standard Conditions and Corrections**. Certain atmospheric and material conditions are accepted as standard. Those conditions are outlined in the introduction to the firing tables given below. When conditions vary from standard, the trajectory varies. Variations in the following conditions can be measured and corrected:

- Difference in altitude between the mortar and the target.
- Propellent temperature.
- Drift.
- Ballistic wind.
- Air temperature.
- Air density.
- Weight of the projectile.

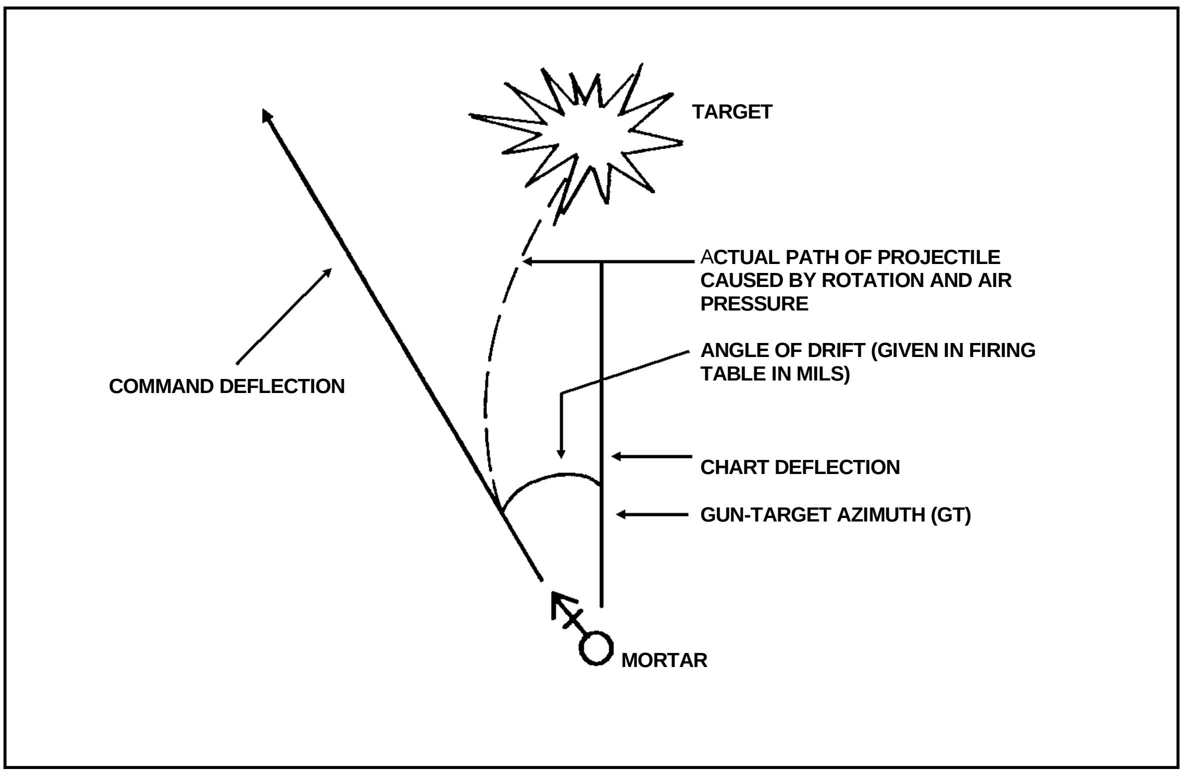

Figure 2-3. Drift.

Section II. FIRING TABLES

Firing tables are based on firing the weapon and its ammunition under, or correlated to, standard conditions (Figure 2-4). Those standards are the bases used to compensate for variations in the weapon, weather, and ammunition at a given time and place. The atmospheric standards in United States firing tables reflect the mean annual conditions in the north temperate zone. The main elements measured in experimental firing are angle of elevation, angle of departure, muzzle velocity, attained range, drift, and concurrent atmospheric conditions.

900 MILS TABLE D FT 4.2-K-2

BASIC DATA

CTG, HE, M329A2
FUZE, PD, M557

1	2	3	4	5	6	7	8	9
RANGE	CHARGE	D CHG PER 100 M DR	FS FOR GRAZE BURST FUZE M564	DR PER 1/8 INC D CHG	LINE NO.	TIME OF FLIGHT	AZIMUTH CORRECTIONS	
							DRIFT (CORR TO L)	CW OF 1 KNOT
M	INC	INC		M		SEC	MIL	MIL
1680	9 4/8	4/8	20.6	23	2	20.9	22.0	0.5
1700	9 5/8	4/8	20.8	23	2	20.0	22.0	0.5
1730	9 6/8	4/8	20.9	23	2	21.2	22.0	0.5
1750	9 7/8	4/8	21.1	23	2	21.3	22.0	0.5

Figure 2-4. Example of Firing Table 4.2-K-2.

2-11. PURPOSE

The main purpose of a firing table is to provide the data required to bring effective fire on a target under any condition. Data for firing tables are obtained by firing the weapon at various elevations and charges.

2-12. UNIT CORRECTIONS

Firing tables describe unit corrections as range corrections for an increase or decrease in range, wind, air temperature, density, and projectile weight, followed by the unit value in meters.

a. Each correction is computed on the assumption that all other conditions are standard. However, any correction will differ slightly from that computed if one or more of the other conditions are nonstandard. The amount of difference depends on the effect of the other nonstandard conditions. The effect of one nonstandard condition on the effect of another nonstandard condition is known as an *interaction effect*. The effect of a nonstandard condition depends on how long the projectile is exposed to that condition.

b. The extent to which weather affects a projectile can be determined from a meteorological (MET) message if the maximum ordinate achieved is known. Corrections for those effects can be compensated for in the appropriate firing tables.

2-13. STANDARD RANGE

The standard range is the range opposite the charge in the firing table, which is the horizontal distance from origin to level point. The attained range is that reached by firing with a given elevation and charge. If actual firing conditions duplicate the ballistic properties and MET conditions upon which the firing table is based, the attained range and the standard range will be equal. The command range corresponds to the given elevation and charge that must be fired to reach the target.

a. **Effect of Nonstandard Conditions**. Deviations from standard conditions, if not corrected in computing firing data, cause the projectile to impact or burst at other than the desired point. Nonstandard conditions that affect range also affect time of flight (TOF). Corrections are made for nonstandard conditions to improve accuracy. The accuracy of mortar fires depends on the accuracy and completeness of data available, computation procedures used, and care in laying the weapons. *Accuracy should not be confused with precision*. Precision is related to tightness of the dispersion pattern without regard to its nearness to a desired point. Accuracy is related to the location of the MPI with respect to a desired point.

b. **Range Effects**. Vertical jump is a small change in barrel elevation caused by the shock of firing. It causes minor range dispersion. In modern weapons, vertical jump cannot be predicted and is usually small, so it is not considered separately in gunnery.

(1) The weight of the projectile affects the muzzle velocity. Two opposing factors affect the flight of a projectile of nonstandard weight. A heavier projectile is more efficient in overcoming air resistance; however, its muzzle velocity is normally lower because it is more difficult to push through the barrel. An increase in projectile efficiency increases range, but a decrease in muzzle velocity decreases range. In firing tables, corrections for those two opposing factors are combined into a single correction. The change in muzzle velocity predominates at shorter times of flight; the change in projectile efficiency predominates at longer times of flight. Hence, for a heavier-than-standard projectile, the correction is plus at shorter times of flight and minus at longer times of flight. The reverse is true for a lighter-than-standard projectile.

(2) Air resistance affects the flight of the projectile in both range and deflection. The component of air resistance that is opposite to the direction of flight is called *drag*. Because of drag, both the horizontal and vertical components of velocity are less at any given time of flight than they would be if drag were zero, as in a vacuum. The greater the drag, the shorter the range; and the heavier the projectile, the longer the range, all other factors being equal. Some factors considered in the computation of drag are air density, air temperature, velocity, and diameter.

(a) The drag of a given projectile is proportional to the density of the air through which it passes. For example, an increase in air density by a given percentage increases the drag by the same percentage. Since the air density at a particular place, time, and altitude varies widely, the standard trajectories reflected in the firing tables are computed with a fixed relation between density and altitude. As the air temperature increases, the drag decreases, thereby increasing range.

(b) The faster a projectile moves, the more the air resists its motion. Examination of a set of firing tables shows that, for a given elevation, the effect of 1 percent of air density (1 percent of drag) increases with an increase of charge (muzzle velocity).

(c) Two projectiles of identical shape but different size do not experience the same drag. For example, a larger projectile offers a larger area for the air to act upon; hence, its drag will be increased.

(3) The finish of the shell surface affects the muzzle velocity. A rough surface on the projectile or fuze increases air resistance, thereby decreasing range.

(4) The ballistic coefficient of a projectile is its efficiency in overcoming air resistance compared to an assumed standard projectile. Each projectile and projectile lot, however, has its own efficiency level. Therefore, to establish firing tables, one specific projectile lot must be selected and fired. Based on the performance of that lot, standard ranges are determined. The ballistic coefficient of that lot becomes the firing table standard. However, other projectile lots of the same type may not have the same ballistic coefficient as the one reflected in the firing tables. If one of the other lots is more efficient—that is, has a higher ballistic coefficient than the firing table standard—it will achieve a greater range when fired. The reverse is true for a less efficient projectile lot.

NOTE: For ease in computations, all projectile types are classified into certain standard groups.

(5) Range wind is that component of the wind blowing parallel to the direction of fire and in the plane of fire. Range wind changes the relationship between the velocity of the projectile and the velocity of the air near the projectile. If the air is moving with the projectile (tail wind), it offers less resistance to the projectile and a longer range results; a head wind has the opposite effect.

Section III. FIRE PLANNING

The ability of mortar platoons to engage targets with accurate and sustained fires depends on the precision and detail of fire planning. Fire planning is concurrent and continuous at all levels of command. The principles of fire planning used by field artillery also apply to mortars. These principles are close and continuous support of the battalion, coordination with adjacent and higher units, and continuous planning.

2-14. TERMINOLOGY

Some of the common terms used in fire planning are defined as follows:

a. A **target** may be troops, weapons, equipment, vehicles, buildings, or terrain that warrant engagement by fire and that may be numbered for future reference. A solid cross designates a target on overlays, with the center of the cross representing the center of the target. The target number consists of two letters and four numbers allocated by higher headquarters. That numbering system identifies the headquarters that planned the target, distinguishes one target from another, and prevents duplication.

b. **Targets of opportunity** are targets for which fires have not been planned. Planned targets are scheduled or on call.

(1) *Scheduled targets* are fired at a specific time before or after H-hour, or upon completion of a predetermined movement or task.

(2) *On-call targets* are fired only upon request. They include targets for which firing data are kept current, and targets for which firing data are not prepared in advance—for example, a prominent terrain feature, such as a road junction, that the FO may use as a reference point.

c. A **group of targets** consists of two or more targets to be fired at the same time. Targets are graphically portrayed by circling and identifying them with a group designation (Figure 2-5). Mortars are normally assigned groups of targets. The group designation consists of the letters assigned to the maneuver brigade by the division TOC with a number inserted between them. For example, if the brigade is assigned the letters A and B, the first group of targets planned by the DS battalion FDC is designated A1B, the second group A2B, and so on. Similarly, if the division TOC has designated the letters A and Y, the first group is A1Y and the second is A2Y. The designation of a group of targets does not preclude firing at any individual target within the group.

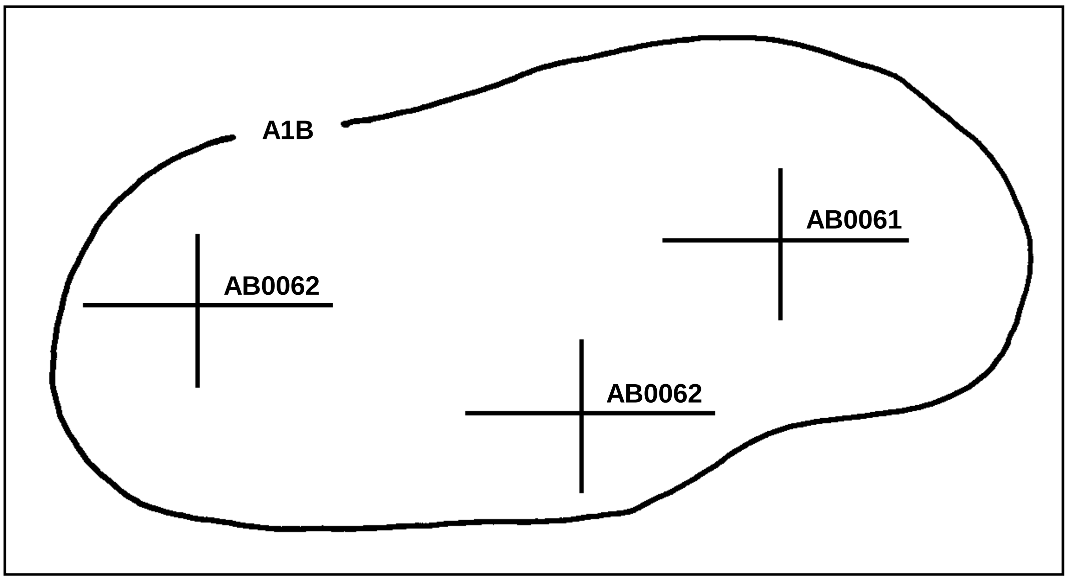

Figure 2-5. Group of targets.

d. A **series of targets** (Figure 2-6) is a number of targets or groups of targets planned to support the operation. For example, a series of targets may be planned on a large objective so that fires are lifted or shifted as the support unit advances. Graphically, a series is shown as individual targets or groups of targets within a prescribed area. The series is given a code name. The fact that a series of targets has been formed does not preclude the attack of individual targets or groups of targets within a series.

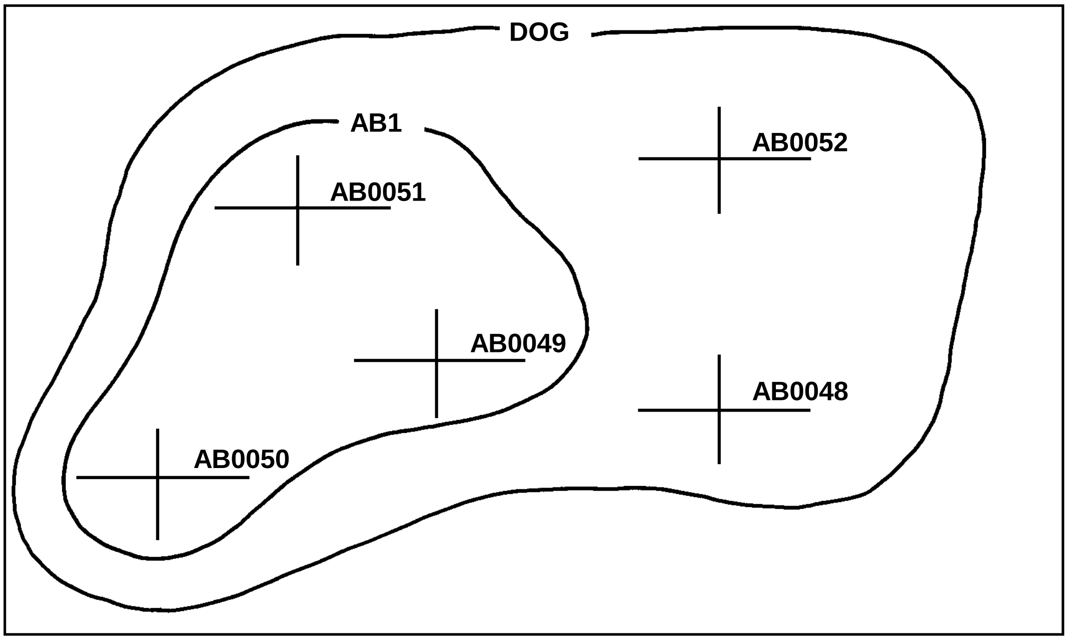

Figure 2-6. Series of targets.

e. The **final protective fire** (Figure 2-7) is an immediately available prearranged barrier of fire designed to impede enemy movement across defensive lines or areas. It is integrated with the maneuver commander's defensive plans. The shape and pattern of FPF may be varied to suit the tactical situation. The maneuver commander is responsible for the precise location of FPF. The FIST chief is responsible for reporting the desired location of the FPF to the supporting FDC. Authority to call for the FPF is vested in the maneuver commander (normally, the company commander or platoon leader) in whose area the FPF is located. The FPF is represented on a map or firing chart by a linear plot. The length of the plot depends on the type of unit assigned to fire the FPF. The designation of the unit that will fire the FPF is placed above the plot representing the FPF.

Figure 2-7. Final protective fires symbol.

f. A **preparation** is the intense delivery of fires according to a time schedule to support an attack. The commander decides to fire a preparation and orders the attack.

g. A **counterpreparation** is the delivery of intense planned fires when the imminence of an enemy attack is discovered. It is designed to break up enemy formations, to disorganize command and communications systems, to reduce the effectiveness of enemy preparations, and to impair the enemy's offensive spirit. The counterpreparation is fired on the order of the force commander. The fires are planned and assigned to firing units, and firing data are kept current.

h. A **program of targets** is a number of targets planned on similar areas such as a countermortar program. Although the artillery battalion in DS of the brigade normally plans counterpreparation, and programs and designates groups and series of targets, the battalion mortar platoon and company mortar section are considered in the planning since they are subsequently assigned the targets.

i. **Harassing fires** are planned on known enemy positions to inflict losses, to curtail movement, and to disrupt the enemy to keep him off balance. Interdiction fires are planned on critical areas (bridges, possible observation posts, road junctions) to deny the enemy the use of those areas. Harassing and interdiction fires should include the number of rounds to be fired and the times of firing. Varying the number of rounds and firing at irregular intervals greatly increase the effectiveness of those fires.

2-15. TARGET CONSIDERATIONS

Planned targets include areas of known, suspected, and likely enemy locations, and prominent terrain features. Those areas are determined through intelligence sources, knowledge of the situation, and map and terrain study. They are planned without regard to boundaries or weapon abilities. Duplication of effort will be resolved by the next higher headquarters.

a. **Known Enemy Locations**. Fires are planned on all known enemy locations that could hinder the support unit's mission.

b. **Suspected Enemy Locations**. These include areas such as probable OPs, troop positions, assembly areas, avenues of approach, and routes of withdrawal. Fires are planned on suspected locations so that fires are available if the target is confirmed.

c. **Likely Enemy Locations**. Targets in this category are determined from a careful study of the terrain and maps, and from a knowledge of the enemy's methods of placing troops and weapons.

d. **Prominent Terrain Features**. Hilltops, road junctions, manufactured objects, and other easily identifiable locations on a map and on the ground are planned as targets to provide reference points from which to shift to targets of opportunity.

2-16. SUPPORT OF OFFENSIVE OPERATIONS

Fires planned to support an attack consist of a preparation, if ordered, and subsequent fires. The preparation may be delivered before the advance of the assault elements from their LD and may continue for a short time thereafter. Fires planned for the preparation are normally limited to known targets and suspected areas. The delivery of fires on scheduled targets should be consistent with the threat imposed, time available for coordination, and availability of ammunition.

a. **Support Artillery**. An artillery preparation is usually phased to permit successive attacks of certain targets. The phasing should be planned to provide for early domination of enemy fire support means, then the attack of local reserves and command

and control installations, and later the attack of enemy forward elements. The detail and extent of preparation plans depend on the availability of intelligence.

b. **Battalion Mortar Platoon**. The battalion fire plan table for a preparation may include fires by the battalion mortar platoon. Once the preparation is fired, the mortar platoon is available for fire support of the battalion maneuver elements. In some situations, the battalion commander may exclude the mortars from the preparation and retain them for targets of opportunity throughout the attack.

c. **Company Mortar Section**. The company mortar section may be required to fire preparation fires. Those fires are limited to the engagement of enemy forward elements. Before committing the mortars to preparation fires, the commander should consider ammunition resupply and availability of mortars to quickly attack targets of opportunity.

d. **Fires Supporting the Attack**. Fires planned in support of the attack are shifted to conform to the movements of the supported unit. They are planned in the form of targets, groups of targets, and series of targets. They may be fired on a time schedule or on-call and may include targets from the LD to the objective, on the objective, and beyond the objective.

e. **Objectives**. Supporting fires have several specific objectives. They assist the advance of the supported unit by neutralizing enemy forces, weapons, and observation short of the objective. They assist the supported unit in gaining fire superiority on the objective so that the assaulting force can close to assault distance, and they protect the supported unit during reorganization. (On-call targets are planned on likely assembly areas and routes for enemy counterattacks.) Supporting fires prevent the enemy from reinforcing, supplying, or disengaging his forces. Also, they quickly provide mutual fire support to lower, adjacent, and higher headquarters.

2-17. SUPPORT OF DEFENSIVE OPERATIONS

Fires in support of defensive operations include long-range fires, close defensive fires, final protective fires, and fires within the battle area.

a. **Long-Range Fires**. Long-range fires are designed to engage the enemy as early as possible to inflict casualties, to delay his advance, to harass him, to interdict him, and to disrupt his organization. They consist of the fires of the supporting weapons within the battle area capable of long-range fires. The enemy is engaged by long-range weapons as soon as he comes within range. As a result, the volume of fire increases as the enemy continues to advance and comes within range of additional weapons. A counterpreparation designed to disrupt the enemy's attack preparations before the attack can be fired as part of long-range fires.

b. **Close Defensive Fires**. Close defensive fires are supporting fires employed to destroy the enemy attack formations before the assault.

c. **Final Protective Fires**. FPF are fires planned to prohibit or break up the enemy assault on the forward defense area. They consist of prearranged fires of supporting weapons to include machine gun FPLs and mortar and artillery FPF. Only those weapons whose FPF are in front of the threatened unit fire their assigned fires; all other available weapons use observed fire to supplement or reinforce the FPF in the threatened area. Direct-fire weapons engage targets in front of the threatened area to reinforce FPF or to engage other targets.

(1) The artillery and mortar FPF are integrated with the FPL of machine guns. Each artillery battery normally fires one FPF. The mortar platoon of the battalion may fire one or two FPF; however, the platoon's fires are more effective in one FPF than in two.

(2) The FPF of the DS artillery are available to the supported brigade and its battalions. The FPF of any artillery reinforcing DS battalion is normally available. The brigade commander designates the general areas for available FPF or allocates them to the maneuver battalions. The maneuver battalion commander, in turn, designates general locations or allocates them to maneuver companies.

d. **Fires Within the Battle Area**. The precise location of an FPF is the responsibility of the company commander in whose sector it falls. The exact locations of FPF within each forward company are included in the fire plan and reported to battalion. Fires within the battle area are planned to limit penetrations and to support counterattacks.

2-18. FIRE SUPPORT COORDINATION MEASURES

The FIST and fire support planners use fire support coordination measures to ensure that fires impacting in their zone will not jeopardize troop safety, interfere with other fire support means, or disrupt adjacent unit operations.

a. **Boundaries**. Boundaries determined by maneuver commanders establish the operational zone for a maneuver unit and the area in which the commander fires and maneuvers freely. A unit may fire and maneuver against clearly identified enemy targets near or over its boundary, as along as such action does not interfere with adjacent units.

b. **Coordination Measures**. Coordination measures designate portions of the battlefield where actions may or may not be taken. The fire FSCOORD/FIST chief recommends coordination measures; the commander establishes them. They facilitate operations by establishing rules and guidelines for selected areas for a given time. There are two categories: permissive and restrictive.

(1) *Permissive measures*. Permissive measures are drawn in black on overlays and maps. They are titled and indicate the establishing headquarters and the effective date-time group. Permissive measures allow fires into an area such as a free-fire area or across a line—for example, a coordinated fire line or FSCL—that need not be further coordinated as long as they remain within the zone of the established headquarters.

(a) A coordinated fire line is a line beyond which conventional surface fire support means (mortars, FA, NGF) may fire any time within the zone of the establishing headquarters without further coordination.

(b) A fire support coordination line is a line beyond which all targets may be attacked by any weapon system without endangering troops or requiring further coordination with the establishing headquarters. The effects of any weapon system may not fall short of this line.

(c) A free-fire area is a designated area into which any weapon system may fire without further coordination with the establishing headquarters.

(2) *Restrictive measures*. Restrictive measures are drawn in red. They are titled and indicate the establishing headquarters and the effective date-time group. Restrictive measures mean that fires into an area or across a line must be coordinated with the

establishing headquarters on a case-by-case basis. Examples of restrictive measures include a restrictive fire area, a no-fire area, a restrictive fire line, and an airspace coordination area.

(a) A restrictive fire area is an area in which specific restrictions are imposed and into which fires that exceed those restrictions will not be delivered without coordination with the establishing headquarters.

(b) A no-fire area is an area in which no fires or effects of fires are allowed. There are two exceptions: when establishing headquarters approves fires temporarily within a no-fire area on a mission basis; and when an enemy force within the no-fire area engages a friendly force, and the commander engages the enemy to defend his force.

(c) A restrictive fire line is a line established between converging friendly forces (one or both may be moving) that prohibits fires or effects from fires across the line without coordination with the affected force.

(d) An airspace coordination area is a block of airspace in the target area in which friendly aircraft are reasonably safe from friendly surface fires. It may be a formal measure but is usually informal.

2-19. COMPANY FIRE SUPPORT PLAN

The company commander's fire planning begins with receipt or assumption of a mission and continues throughout the execution of the mission. The company fire planning team consists of the company commander, FIST chief, mortar section/platoon leader, and platoon's FIST FOs. During the process of evaluating, refining, revising, and deciding how to accomplish the mission, the commander constantly seeks the most efficient and effective application of all resources to produce maximum combat power.

a. The FIST chief, as the commander's special staff officer for fire support, performs a critical role in this planning process. He ensures that the commander has all required information on available fire support and recommends how best to apply it in concert with other resources. For best results, the commander should include the team in every step of his decision-making process.

b. The company commander gives guidance to the fire planning team in the form of a concept. This concept outlines the scheme of maneuver and the desire for fire support. Later, when the FIST chief submits the proposed consolidated target list and company fire plan, the company commander approves or changes it.

c. The company commander supervises the preparation of the company fire plan and coordinates the fire planning activities. The FIST chief develops the company fire plan and consolidates it with copies of the target lists prepared by the platoon FOs. This consolidated list is then submitted to the company commander for approval.

d. The company fire planners inform the company commander of the fire support available. They also obtain the following information for or from the company commander:

- Location of forward elements.
- Scheme of maneuver.
- Known enemy locations, avenues of approach, and assembly areas.
- Fires desired.
- Exact location of the company and battalion mortar and artillery FPF.

- Location of the command post.

e. Upon receipt of this information, the fire planners start planning fires to support the company. Through map inspection and terrain analysis, the target lists are prepared (Table 2-1). If time and facilities permit, an overlay, giving a graphic representation, may also be prepared. The target list includes for each target the target number, map coordinates, description, and amplifying remarks if required. It does not include target altitudes, which are determined by the respective FDCs.

TARGET NUMBER	DESCRIPTION	LOCATION	REMARKS
C-	FPF	14898346	
1-66	FPF	15508330	
1-45	FPF	15908330	
AA0050	DEFENSIVE TARGET	15278336	
AA0051	DEFENSIVE TARGET	15368319	
AA0052	HILLTOP	14848250	
AA0053	HILLTOP	15038196	
AA0054	CROSSROADS	15248171	
AA0055	RIDGE	15118081	
AA0056	MORTAR POSITION	152802	100-METER ZONE
AA0150	DEFENSIVE TARGET	14948381	
AA0152	DEFENSIVE TARGET	15008325	
AA0153	DEFENSIVE TARGET	15528303	
AA0154	OP	1428287	
AA0155	OP	15108245	
AA0156	HILL	15128286	
AA0157	EMERGENCY POSITION	161188288	
AA0158	ROAD JUNCTION	14608190	
AA0159	ROAD JUNCTION	15638160	
AA0160	ROAD JUNCTION	16308183	
AO7000	DEFENSIVE TARGET	15808424	
AC7001	DEFENSIVE TARGET	15818353	
AC7002	DEFENSIVE TARGET	15968320	
AC7003	ROAD JUNCTION	15728272	
AC7004	BRIDGE	152791	DESTROY ON CALL

Table 2-1. Consolidated target list.

f. Target information can be submitted by any means available, such as telephone or radio, directly to an FDC. The FIST chief assigns numbers to targets not included in the list from the platoon FO or mortar platoon leader. Numbers from the separate target lists are transferred to the corresponding targets on the approved consolidated target list/company fire plan. The targets on the list are arranged by target number alphabetically and numerically.

g. Once the fire plan is approved, it is distributed to those who will need it to include FOs, rifle platoon leaders, FDC, company fire planners, and battalion S3. Also, the FIST chief sends a copy of the approved target list to the FSO at battalion headquarters.

2-20. BATTALION FIRE SUPPORT PLAN

Fire planning at battalion level is initiated the same as in the company. The battalion fire planning team consists of the battalion commander, S3, battalion mortar platoon leader, and FSO. The battalion mortar platoon must always be directly responsive to the desires of the battalion commander. The platoon leader takes a position that best assists the S3 in planning and obtaining fire support. The FSO is normally the battalion FSO; however, the battalion mortar platoon leader serves in the absence of the FSO.

a. The battalion commander and S3 present the commander's concept of the operation, which, as in the case of the company, includes the scheme of maneuver and the plan for fire support. After the FSO has consolidated the target lists prepared by the company fire planners, the battalion commander approves the consolidated target list as part of the battalion fire support plan. The written plan becomes an annex to the operation plan.

b. The FSO is usually the battalion FSCOORD and receives target lists from the company's FIST chief and from the battalion mortar platoon leader. Once duplications are deleted, all fire plans are updated by assigning target numbers or by consolidating targets. Then, the FSO submits all fire plans and target lists to the battalion S3 as the proposed battalion fire support plan.

c. The S3 ensures that the proposed fire support plan supports the scheme of maneuver. After the battalion commander approves the fire plan, the plan becomes an annex to the battalion operation plan. It is disseminated to all subordinate elements to include rifle companies and the battalion mortar platoon.

Section IV. TARGET ANALYSIS AND ATTACK

The FIST chief, when planning fires or when deciding to engage a target, ensures that the fire conforms to the scheme of maneuver of the support unit. He must also be informed of the present enemy situation. In target analysis and determining the method of attack, the FDC chief considers target description, registration data, size of attack area, and the maximum rate of fire.

2-21. TARGET DESCRIPTION

The method of attacking a target depends largely on its description, which includes the type, size, density, cover, mobility, and importance. Those factors are weighed against the guidelines established by the commander. The FDC then decides the type of projectile, fuze, fuze setting, and ammunition to be used.

a. Fortified targets must be destroyed by point-type fire using projectiles and fuzes appropriate for penetration. Mortar fire does not usually destroy armor, but it can harass and disrupt armor operations.

b. A target consisting of both men and materiel is normally attacked by area fire using air or impact bursts to neutralize the area. Flammable targets are engaged with HE projectiles to inflict fragmentation damage, and then with WP projectiles to ignite the material.

c. The method of attacking a target is governed by the results desired: suppression, neutralization, or destruction.

(1) Suppressive fires limit the ability of enemy troops in the target area to be an effective force. HE/PROX creates apprehension or surprise and causes tanks to button

up. Smoke is used to blind or confuse, but the effect lasts only as long as fires are continued.

(2) Neutralization knocks the target out of the battle temporarily. Ten percent or more casualties usually neutralize most units. The unit becomes effective again when casualties are replaced and equipment repaired.

(3) Destructive fires put the target out of action permanently. A unit with 30 percent or more casualties is usually rendered permanently ineffective, depending on the type and discipline of the force. Direct hits are required on hard materiel targets.

2-22. REGISTRATION AND SURVEY CONTROL

Firing corrections within the transfer limits should be maintained through registration, survey data, and current MET message. When those data are unavailable or inadequate, targets should be attacked with observed fire since unobserved fires may be ineffective. Surveillance should be obtained on all missions to determine the results of the FFE. If accurate, FFE without adjustments is highly effective against troops and mobile equipment because damage is inflicted before the target can take evasive action. All destruction missions and missions fired at moving targets must be observed, and FFE should be adjusted on the target.

2-23. SIZE OF ATTACK AREA

The size of the attack area is determined by the size of the target, or by the size of the area in which the target is known or suspected to be located. That information is usually an estimate based on intelligence and experience in similar situations. The size of the attack area is limited when considering units to fire. Mortars are the best weapons for engaging targets in depth. This is due to their versatility in making range changes and maintaining high rates of fire. All mortars can fire traversing fires with only minor manipulations.

2-24. MAXIMUM RATE OF FIRE

The greatest effect is achieved when surprise fire is delivered with maximum intensity. Intensity is best attained by massing the fires of several organic battalion units using TOT procedures. The intensity of fires available is limited by each unit's maximum rate of fire (Table 2-2) and ammunition supply. Maximum rates cannot be exceeded without danger of damaging the tube. To maintain those rates (either to neutralize a target or to attack a series of targets), mortars must be rested or cooled from previous firing. If not, the heat can cause ignition of the increment or charges on a round before it reaches the bottom of the barrel. The lowest charge possible should be used during prolonged firing, since heating is more pronounced with higher charges.

CARTRIDGE	MORTAR	MAXIMUM	SUSTAINED
60-mm MORTAR			
M720 M49AA	M224	30 RPM FOR 4 MINUTES 18 RPM FOR 4 MINUTES	20 RPM 8 RPM
81-mm MORTAR			
M362	M29	15 RPM FOR 2 MINUTES 27 RPM FOR 1 MINUTE	4 RPM
M362	M29E1	25 RPM FOR 2 MINUTES 30 RPM FOR 1 MINUTE	5 RPM

CARTRIDGE	MORTAR	MAXIMUM	SUSTAINED
M374/M375	M29	18 RPM FOR 2 MINUTES 30 RPM FOR 1 MINUTE	5 RPM
M374/M375	M29E1	25 RPM FOR 2 MINUTES	8 RPM
M374A3		30 RPM FOR 1 MINUTE	8 RPM
M821	M252	30 RPM FOR 2 MINUTES	15 RPM
4.2-INCH MORTAR			
ALL AMMUNITION	M30	18 RPM FOR 1 MINUTE THEN 9 RPM FOR THE NEXT 5 MINUTES	3 RPM
120-mm MORTAR			
NDI	M120	16 RPM FOR 1 MINUTE	4 RPM
M57 (NDI)	M120/M121		
M68 (NDI)			
M91 (NDI)			
M933		16 RPM FOR 1 MINUTE	4 RPM
M934		16 RPM FOR 1 MINUTE	4 RPM
M929 (WP)		16 RPM FOR 1 MINUTE	4 RPM
M930 (ILLUM)		16 RPM FOR 1 MINUTE	4 RPM

Table 2-2. Rates of fire.

2-25. AMOUNT AND TYPE OF AMMUNITION

The amount of ammunition available is an important consideration in the attack of targets. The CSR should not be exceeded except by authority of higher headquarters. When the CSR is low, missions should be limited to those that contribute the most to the mission of the supported units. When the CSR is high, missions fired may include targets that affect planning or future operations and targets that require massing of fires without adjustment.

a. The selection of a charge with which to engage a target depends on the elevation required. The range and terrain dictate the elevation to be used. Hence, targets at a great distance require the lowest elevations and greatest charge, while targets in deep defilade require the highest elevations. Targets in deep defilade and at great range are hard to engage. This is due to the low elevation required to reach those targets, which prevents the round from having the high trajectory needed. The 4.2-inch mortar uses one of three constant elevations and makes range changes by varying the charge. The 60-mm, 81-mm, and 120-mm mortars vary both the elevation and charge but attempt to stay at the lowest charge while varying the elevation.

b. The type of ammunition selected to engage a target depends on the nature of the target and characteristics of the ammunition available.

(1) High explosive (HE) is used for destruction, harassing, interdiction and neutralization fire.

(2) Chemical ammunition is used for producing casualties, incendiary effects, screening, marking, and harassing. The types of chemical projectiles include gas (CS) and white phosphorus (WP).

(3) Illumination uses a time fuze that gives an airburst depending on the time setting. The setting on the charge and elevation fired when the time fuze is used. The HOB can be adjusted to give the best illumination on the desired location.

c. HE ammunition has varied effects depending on the type of fuze used.

(1) *Quick and superquick fuzes*. Quick and superquick fuzes are used for impact detonation. When the HE projectile with a quick or superquick fuze passes through trees, detonation may occur in the foliage. Therefore, its effectiveness may be either improved or lost, depending on the density of the foliage and the nature of the target.

(2) *Proximity fuzes*. Proximity fuze is used with HE ammunition to obtain airbursts. A proximity or VT fuze detonates automatically upon approach to the object. It is used to obtain airbursts without adjusting the HOB. If the proximity element fails to function, a fuze quick-action occurs upon impact. The HOB varies according to the caliber of projectile, the angle of fall, and the type of terrain in the target area. If the terrain is wet or marshy, the HOB is increased. Light foliage has little effect on a proximity fuze, but heavy foliage increases the HOB by about the height of the foliage. The greater the angle of fall, the closer the burst is to the ground.

(3) *Fuze delay*. Fuze delay produces a mine action caused by the round's penetration before detonation. Fuze delay can be used to destroy earth and log emplacements. It is also effective against some masonry and concrete structures. Fuze delay is not used against armor. The depth of penetration depends on the type of soil and terminal velocity of the round.

(4) *Multioption*. Multioption fuze gives the user the option to select and use all types of fuzes previously mentioned. It has the setting of delay, impact, near surface burst, and proximity. This type of fuze will be replacing the other fuzes in the future.

(5) *Three-fuze family*. The M734 multioption fuze, the M745 point-detonating fuze, and the electronic time fuze make up the three-fuze family. The current M734 multioption fuze has received a materiel change, which is designated the M734A1 and fielded on the M929, 120-mm smoke. The M745 point-detonating fuze is fielded on the 60-mm/120-mm smoke, and the M933, 120-mm HE (training) round. These three fuzes are used on all 60-mm 81-mm, and 120-mm service and training rounds.

(6) *M734A1*. The M734A1 multioption fuze is an air-powered fuze with four selectable functions: PRX 60/81; PRX 120; IMP and DLY. All functions are selectable by the soldier before firing. In the HE proximity mode, the height of burst is constant over all types of targets. The impact mode causes the round to function on contact with the target. In the delay mode, the fuze functions about 30 to 200 milliseconds after target contact. The impact mode is the first backup function for either proximity setting. The delay mode is the backup for the impact and delay modes. The impact and delay modes have not been changed from the current M34 multioption fuze. The M734A1 uses ram air and setback to provide two independent environment sensors to comply with the safety requirements of military-standard 1316C. Radio frequency jamming can be detected. Radio frequency jamming initiates a graceful desensitizing of the fuze electronics to prevent premature fuze function. Once the fuze is out of the jammer range, the fuze electronics recovers and functions in the proximity mode if the designed height of burst has not been passed. To limit the time of fuze radio frequency radiation, the proximity turn-on is controlled by an apex sensor that does not allow initiation of the fuze proximity electronics until after the apex of the ballistic trajectory has been passed.

2-26. UNIT SELECTION

The unit selected for a mission must have weapons of the proper caliber and range to cover the target area quickly, effectively, and economically. Many targets are of such size as to allow a wide choice for selecting the units to be employed. If the unit selected to fire cannot mass its fires in an area as small as the target area, ammunition is wasted. Conversely, if a unit can cover only a small part of the target area at a time, surprise is lost during the shifting of fire. Also, the rate of fire for the area may not be adequate to get the desired effect. The decision is often critical as to whether to have many units firing a few rounds on a large target or a few units firing many rounds. Several factors affect the selection of units and the number of rounds to fire on a target. Some of those factors are discussed below.

a. **Availability of Mortar Fire**. When the number of available mortar units is small, more targets must be assigned to each mortar unit.

b. **Size of the Area to be Covered**. The size of the area to be covered must be compared to the effective depth and width of the sheaf to be used by the platoon or platoons available.

c. **Increased Area Coverage**. Targets greater in depth or width than the standard sizes can be covered by—

(1) Increasing the number of units firing.

(2) Dividing the target into several targets and assigning portions to different firing elements.

(3) Shifting fire laterally or using zone fire with a single unit or with a number of units controlled as a single fire unit.

(4) Traversing fire with each mortar that is covering a portion of the target.

d. **Caliber and Type of Unit**. The projectiles of larger calibers are more effective for destruction missions.

e. **Surprise**. To achieve surprise, a few rounds from many pieces are better than many rounds from a few pieces.

f. **Accuracy of Target Location**. Important targets that are not accurately located may justify the fire of several units to ensure coverage.

g. **Dispersion**. At extreme ranges for a given mortar, fire is less dense because of increasing PE. More ammunition is required to effectively cover the target. To compensate for that dispersion, the commander selects a unit, when possible, whose GT line coincides with the long axis of the target.

h. **Maintenance of Neutralization and Interdiction Fires**. These fires may be maintained by the use of a few small units. A unit may fire other missions during the time it also maintains neutralization or interdiction fires.

i. **Vulnerability of Targets**. Some targets should be attacked rapidly with massed fires while they are vulnerable. These targets could be truck parks and troops in the open.

2-27. TYPICAL TARGETS AND METHODS OF ATTACK

Mortar targets include enough enemy materiel, fortifications, and troops to justify ammunition expenditure. (See Table 2-3). Mortar fire is not effective against minefields and barbed wire. Also, HE ammunition is not effective for clearing minefields since mines are detonated only by direct hits. As a result, mortar fire fails to clear the minefield and compounds the problem of locating and removing the mines by hand and of moving equipment across the mined area. Mortars also require extravagant amounts of ammunition to breach barbed wire and should not be used.

TYPE OF TARGET	TYPE OF ADJUSTMENT	PROJECTILE	FUZE	TYPE OF FIRE	REMARKS (SEE FOOTNOTES)
GROUP I					
VEHICLES (RENDEZVOUS)	OBSERVED, UNOBSERVED	HE, WP	SQ, VT	NEUTRALIZATION, DESTRUCTION	(1), (2), (3)
VEHICLES (MOVING)	OBSERVED	HE, WP	SQ, VT	NEUTRALIZATION, DESTRUCTION	(2), (3), (5)
WEAPONS (FORTIFIED)	OBSERVED	HE	SQ, DELAY	NEUTRALIZATION, DESTRUCTION	AIRBURSTS ARE DESIRABLE IF THE WEAPON IS FIRING. AFTER THE WEAPON IS SILENCED, IT IS ATTACKED FOR DESTRUCTION. CHOICE OF FUZE IS DETERMINED BY TYPE OF FORTIFICATION. (SEE FORTIFICA-TION.)
WEAPONS (IN OPEN)	OBSERVED	HE, WP	VT	NEUTRALIZATION, DESTRUCTION	(1), (2), (3)
GROUP II					
PERSONNEL (IN OPEN)	OBSERVED, UNOBSERVED	OBSERVED, UNOBSERVED	VT, Q	VT, Q	TOT MISSIONS ARE MOST EFFECTIVE. FUZE QUICK SHOULD BE FIRED AT LOWEST PRACTICAL CHARGE (STEEP ANGLE OF FALL GIVES BETTER FRAGMENTATION.) INTERMITTENT FIRE IS BETTER THAN CONTINUOUS FIRE. (1)
PERSONNEL (IN DUGOUTS OR CAVES)	OBSERVED	HE, WP	VT	NEUTRALIZATION, HARASSING, DESTRUCTION	AIRBURSTS ARE NECESSARY, BUT SURPRISE IS NOT. WP IS USEFUL IN DRIVING SOLDIERS OUT OF HOLES AND INTO THE OPEN.

Table 2-3. Targets and methods of attack.

TYPE OF TARGET	TYPE OF ADJUSTMENT	PROJECTILE	FUZE	TYPE OF FIRE	REMARKS (SEE FOOTNOTES)
PERSONNEL (UNDER LIGHT COVER)	OBSERVED, UNOBSERVED	HE	SQ, DELAY	DESTRUCTION, ASSAULT, DIRECT	(4)
ROADS AND RAILROADS	OBSERVED, UNOBSERVED	HE	SQ, VT, DELAY (RICOCHET)	NEUTRALIZATION	(3)
		HE	DELAY, VT, Q	DESTRUCTION, HARASSING, INTERDICTION	CRITICAL POINTS, DEFILES, FILLS, CROSSINGS, CULVERTS, BRIDGES, AND NARROW PORTIONS MUST BE ATTACKED. DIRECTION OF FIRE SHOULD COINCIDE WITH DIRECTION OF ROAD.
			SQ, VT		(1), (3)
SUPPLY INSTALLATIONS	OBSERVED, UNOBSERVED	HE, WP		NEUTRALIZATION, DESTRUCTION	

(1) Area is neutralized with projectile HE (airbursts if practical); surprise is essential to produce casualties.

(2) Materiel remaining in the area should be attacked for destruction by using the appropriate projectile and fuze.

(3) Projectile WP should be combined with HE when the target contains flammable material and when the smoke will not obscure adjustment.

(4) Projectile HE with fuze quick is fired at intervals to clear away camouflage, earth cover, and rubble.

(5) The first objective in firing on moving vehicles is to stop the movement. For this purpose, a deep bracket is established so that the target will not move out of the initial bracket during adjustment. Speed of adjustment is essential. If possible, the column should be stopped at a point where vehicles cannot change their route and where one stalled vehicle will cause others to stop. Vehicles moving on a road can be attacked by adjusting on a point on the road and then timing the rounds fired so that they arrive at that point when a vehicle is passing it. A firing unit or several units, if available, may fire at different points on the road at the same time.

Table 2-3. Targets and methods of attack (continued).