
APPENDIX B

TARGET EFFECTS PLANNING

Not only must fire support planners determine what targets to hit and when, but they must also decide how to attack each target. They must consider the complex relationship between the weapon fired, the round and fuze combination, the type of target, the terrain, and the effects desired. Because it is such a complex relationship, there are no definite rules. FSOs, mortar platoon and section leaders, and FDC chiefs should consider all the aspects of target effects when planning fires.

B-1. JOINT MUNITIONS EFFECTIVENESS MANUALS

The USAF publishes joint munitions effectiveness manuals (JMEMs) for all surface-to-surface weapons to include mortars. These manuals provide detailed data concerning the expected fraction of casualties to personnel targets or damage to materiel targets given the number and type of rounds fired. JMEMs are published for Army use as field manuals. FM 6-141-1 lists all current JMEMs. The data in JMEMs are taken from test firings, actual combat performance, and mathematical modeling.

- a. The JMEMs are normally classified "confidential." The battalion S1 can establish the classified documents account with the USAF to receive these manuals, and the S2 can store them when they are not being used.
- b. It takes some time to extract usable attack data from JMEMs. JMEMs should be used during training to develop SOPs and during deliberate planning rather than during actual calls for fire.
- c. The JMEMs provide effective data for many combinations of fuze/shell, target size, personnel posture, fortification, and terrain. They can be used to determine how many rounds to fire during each mission to cause a predetermined amount of enemy casualties. As a general guide, Figures B-1 through B-4 can be used, since they are based on extracts from JMEM data. These figures show the least amount of ammunition the mortar section or platoon should expend against platoon-sized targets attacking or defending on various terrain.

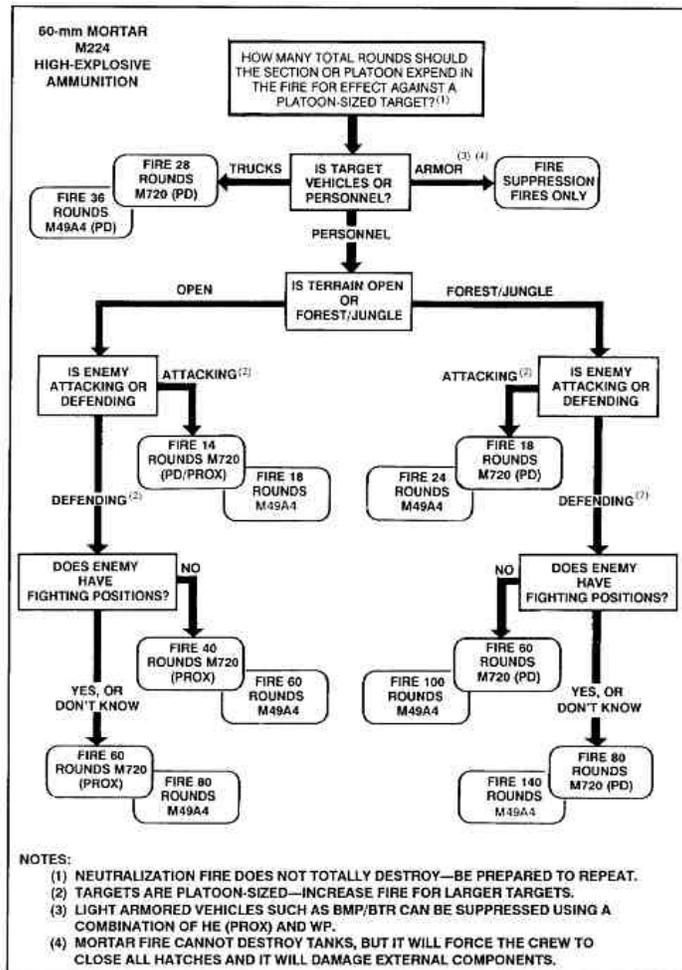


Figure B-I. Ammunition expenditure guide (60-mm).

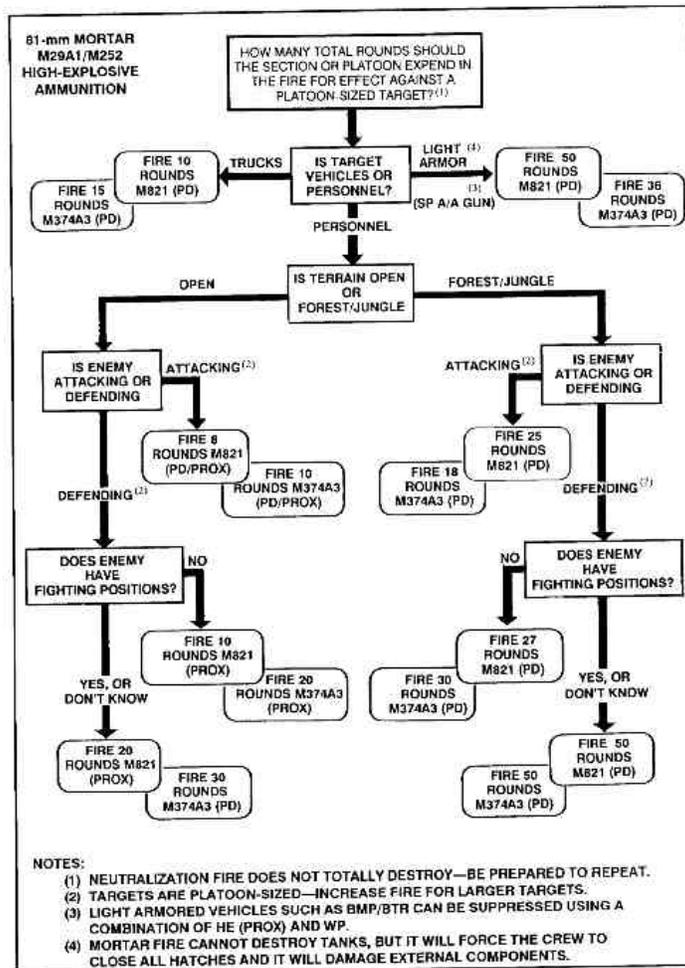


Figure B-2. Ammunition expenditure guide (81-mm).

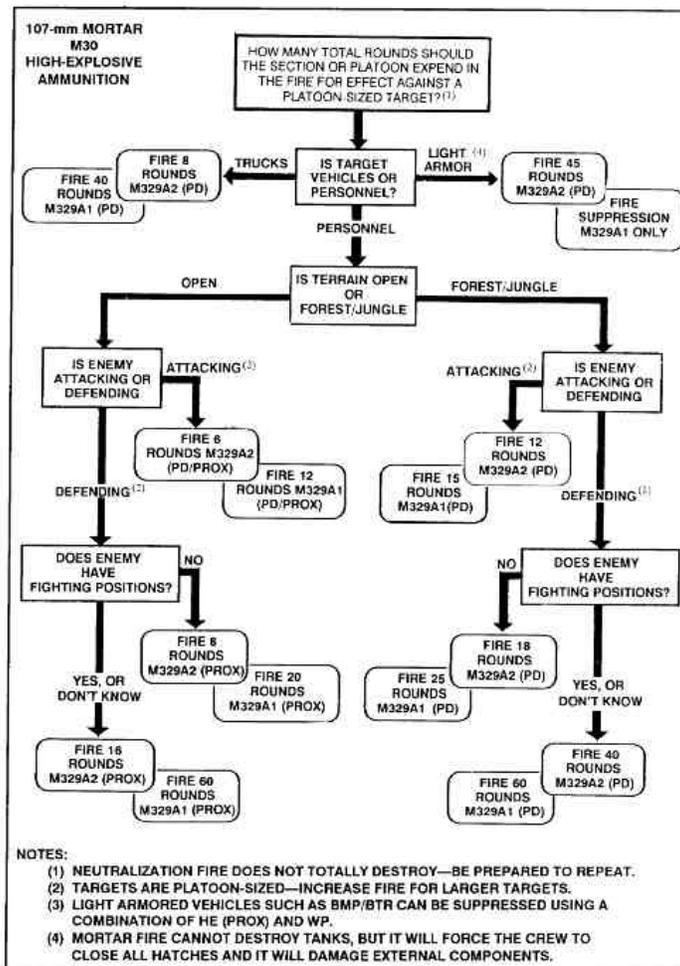


Figure B-3. Ammunition expenditure guide (4.2-inch).

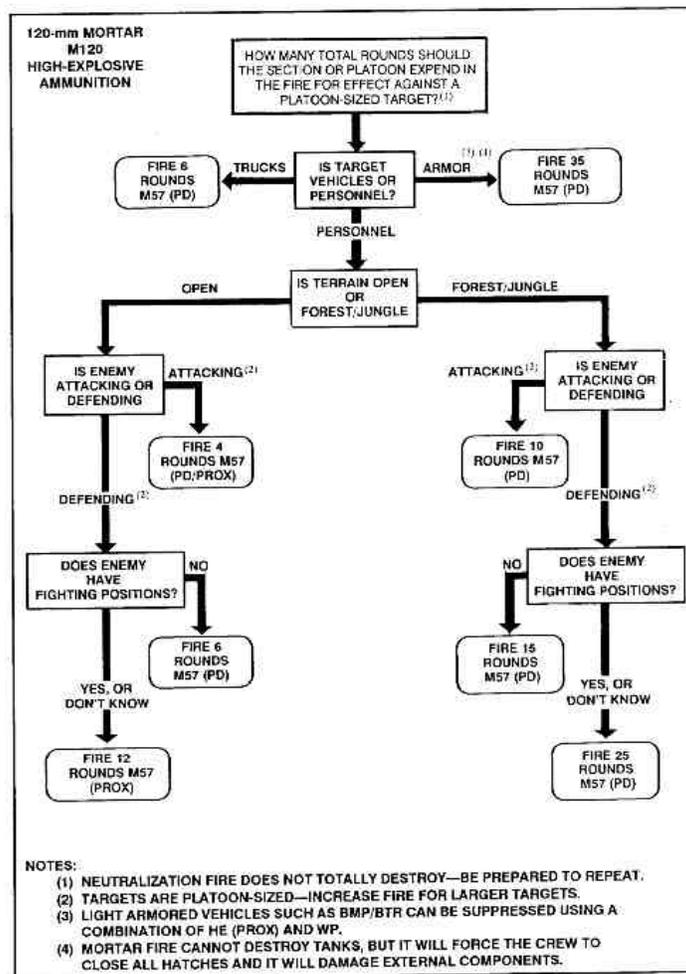


Figure B-4. Ammunition expenditure guide (120-mm).

B-2. HIGH-EXPLOSIVE AMMUNITION

When mortar rounds impact, they throw fragments in a pattern that is never truly circular and may even be irregular, based on the round's angle of fall, the slope of the terrain, and the type soil. However, for planning purposes, each mortar HE round is considered to

have a circular lethal bursting area. Figure B-5 shows a scale representation of the lethal bursting areas of mortar rounds.

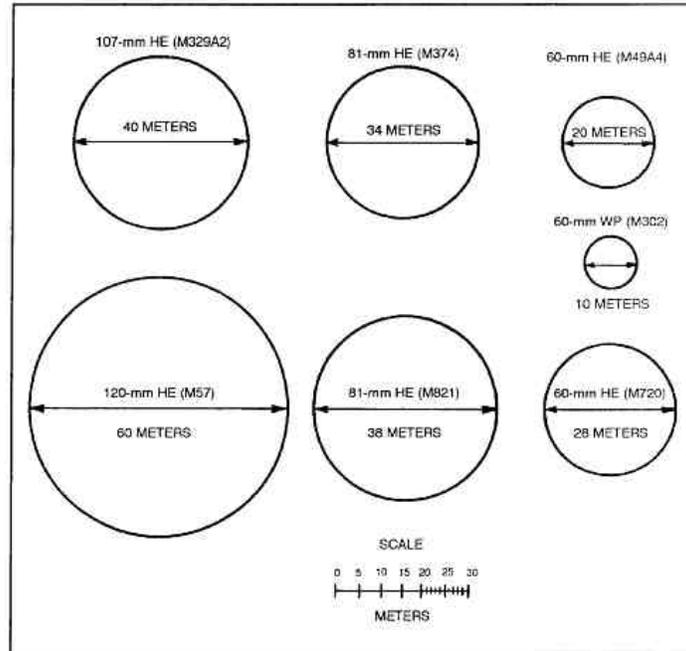


Figure B-5. Comparison of lethal bursting areas of US mortar rounds

B-3. FUZE SETTINGS

The decision as to what fuze setting to use depends on the position of the enemy.

- a. Exposed enemy troops that are standing up are best engaged with IMP or NSB fuze settings. The round explodes on, or near, the ground. Shell fragments travel outward perpendicular to the long axis of the standing target (Figure B-6).

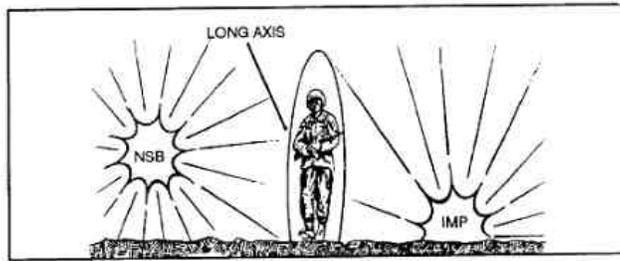


Figure B-6. Standing targets.

b. If exposed enemy troops are lying prone, the PRX fuze setting is most effective. The rounds explode high above the ground, and the fragments coming downward are once again traveling perpendicular to the long axis of the targets (Figure B-7).

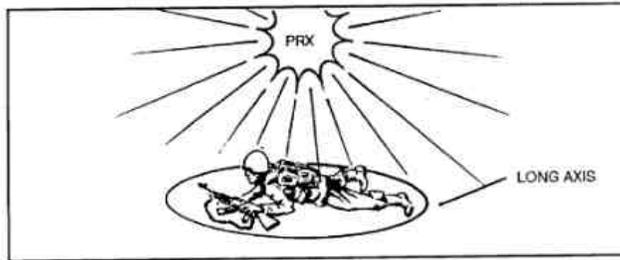


Figure B-7. Prone targets.

c. The PRX setting is also the most effective if the enemy is in open fighting positions, without overhead cover. Even PRX settings will not always produce effects if the positions are deep (Figure B-8).

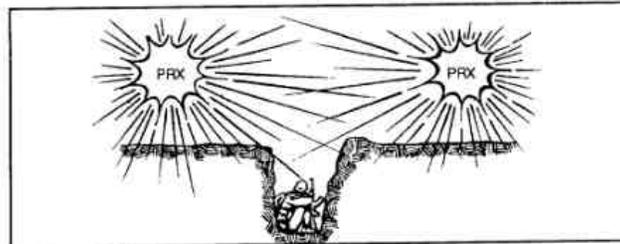


Figure B-8. Targets in open fighting positions.

d. The DLY fuze setting is most effective when the enemy is below triple canopy jungle or in fighting positions with overhead cover. Light mortars will have little effect against overhead cover; even medium mortars have limited effect. Heavy mortars can destroy a bunker with a hit or a near-miss (Figure B-9).



Figure B-9. Targets beneath triple canopy jungle.

e. Table B-1 gives information on the average lethal areas, in square meters, of mortar HE rounds against various targets. These figures can be used to develop the mortar ammunition RSR. Planners determine the size of the target or objective area, then divide the lethal areas of the mortar round into this figure to determine the number of rounds needed to cover the target with lethal fragments. This gives a rough idea of the least number of rounds needed to cover the target area once. JMEM data are used to further refine this number and to estimate the total number of rounds required.

MORTAR	SITUATION	IMP	PRX
60-mm MORTAR HE (M720) (NOTE 1) (1 ROUND)	STANDING ENEMY, OPEN TERRAIN	250	500
	PRONE ENEMY, OPEN TERRAIN	100	200
	CROUCHING ENEMY, OPEN POSITIONS (NOTE 2)	1	25
81-mm MORTAR HE (M374) (1 ROUND)	STANDING ENEMY, OPEN TERRAIN	700	900
	PRONE ENEMY, OPEN TERRAIN	300	600
	CROUCHING ENEMY, OPEN POSITIONS (NOTE 2)	5	30
107-mm MORTAR HE (M329A2) (1 ROUND)	STANDING ENEMY, OPEN TERRAIN	600	750
	PRONE ENEMY, OPEN TERRAIN	250	400
	CROUCHING ENEMY, OPEN POSITIONS (NOTE 2)	5	35
81-mm MORTAR HE (M374) (3 MORTARS/ 1 ROUND EACH)	STANDING ENEMY, OPEN TERRAIN	1000	1400
	PRONE ENEMY, OPEN TERRAIN	1000	1500
	CROUCHING ENEMY, OPEN POSITIONS (NOTE 2)	10	35
107-mm MORTAR HE (M329A2) (4 MORTARS/ 1 ROUND EACH)	STANDING ENEMY, OPEN TERRAIN	2400	2600
	PRONE ENEMY, OPEN TERRAIN	1000	1800
	CROUCHING ENEMY, OPEN POSITIONS (NOTE 2)	30	150
60-mm MORTAR HE (M720) (2 MORTARS/ 1 ROUND EACH)	STANDING ENEMY, OPEN TERRAIN	450	1000
	PRONE ENEMY, OPEN TERRAIN	200	450
	CROUCHING ENEMY, OPEN POSITIONS (NOTE 2)	5	30
120-mm MORTAR HE (M57) (1 ROUND)	STANDING ENEMY, OPEN TERRAIN	900	1100
	PRONE ENEMY, OPEN TERRAIN	350	600
120-mm MORTAR HE (M57) (3 MORTARS/ 1 ROUND EACH)	STANDING ENEMY, OPEN TERRAIN	2600	3000
	PRONE ENEMY, OPEN TERRAIN	1100	1800
NOTES:			
1. THE M49A4 HE ROUND, STANDARD B AMMUNITION FOR THE M224 MORTAR, IS ONLY 55 PERCENT AS EFFECTIVE AS THE NEWER M720 ROUND.			
2. AGAINST PERSONNEL IN OPEN POSITIONS, USE THE LOWEST ANGLE OF FALL POSSIBLE. IT GIVES TWICE THE COVERAGE OF THE STEEPEST ANGLE OF FALL.			

Table B-1. Approximate lethal areas (square meters), US mortars.

f. Against a standing, platoon-size enemy unit, a 60-mm mortar section that fires five rounds per mortar should inflict about 20 percent casualties. If the enemy is prone, these fires should inflict less than 10 percent casualties. This means that a light mortar section's FFE should seldom consist of any less than five rounds for each mortar, and often will require more.

g. Impact-fuzed rounds are normally the best for adjusting fire. If dense foliage prevents observation of the IMP-fuzed round, NSB or PRX settings will cause the round to

explode near the top of the trees where the burst can be better observed. If there is a combination of snow cover and fog in the target area, making adjusting rounds difficult to see, the DLY setting can be used for adjustments. This causes a plume of dirt or exposes the earth at the point of impact. The dark soil contrasts with the fog and snow, making adjustment easier.

B-4. EFFECTS OF TERRAIN ON HIGH-EXPLOSIVE FIRES

HE fires are the most common for destruction, neutralization, and suppression. Most mortar HE rounds can be fired with the M734 multi-option fuze. This fuze enables HE rounds to be detonated above the target surface, on the target surface, or after a short delay. Older ammunition that cannot use the multi-option fuze uses single- or dual-option fuzes to achieve almost the same effects. These effects vary depending on the ground, target, and size mortar fired.

a. Soft ground limits the effectiveness of surface-burst HE rounds for light, medium, and heavy mortars (light mortars being limited the most). One foot of soft ground, mud, or sand, or 3 feet of snow can reduce the effectiveness of surface-burst HE rounds by up to 80 percent. Light mortar rounds can land close (within a few yards) to a target on this type ground and still have no effect.

b. Hard, rocky soil and gravel actually increase the effectiveness of surface-burst HE rounds. The rock fragments are picked up and thrown by the blast, adding to the enemy's casualties (heavy mortars throw the most rock fragments).

c. Dense woods cause impact-fuzed HE rounds to detonate in the trees, producing airbursts. These airbursts can be dangerous to exposed troops since large wood splinters are added to the round's metal fragments. Wounds caused by large wooden splinters are often severe. Extremely dense woods, such as triple canopy jungle, cause most impact-fuzed HE rounds to detonate high in the trees without much of an effect at ground level.

B-5. EFFECTS OF COVER ON HIGH-EXPLOSIVE ROUNDS

Enemy forces will normally be either standing or prone. They may be in the open or protected by varying degrees of cover. Each of these changes the target effects of mortar fire.

a. Surprise mortar fire is always more effective than fire against an enemy that is warned and seeks cover. Recent studies have shown that a high casualty rate can be achieved with only two rounds against an enemy platoon standing in the open. The same studies required 10 to 15 rounds to duplicate the casualty rate when the platoon was warned by adjusting rounds and sought cover. If the enemy soldiers merely lay prone, they significantly reduce the effects of mortar fire. Mortar fire against standing enemy forces is almost twice as effective as fire against prone targets.

b. Proximity fire is usually more effective than surface-burst rounds against targets in the open. The effectiveness of mortar fire against a prone enemy is increased by about 40 percent by firing proximity-fuzed rounds rather than surface-burst rounds. The steeper the angle of the fall of the round, the more effective it is.

c. If the enemy is in open fighting positions without overhead cover, proximity-fuzed mortar rounds are about five times as effective as impact-fuzed rounds. When fired against troops in open fighting positions, proximity-fuzed rounds are only 10 percent as effective as they would be against an enemy in the open. For the greatest effectiveness against troops in open fighting positions, the charge with the lowest angle of fall should be chosen. It produces almost two times as much effect as the same round falling with the steepest angle.

d. If the enemy has prepared fighting positions with overhead cover, only impact-fuzed and delay-fuzed rounds will have much effect. Proximity-fuzed rounds can restrict the enemy's ability to move from position to position, but they will cause few, if any, casualties. Impact-fuzed rounds cause some blast and suppressive effect. Delay-fuzed rounds can penetrate and destroy a position but must achieve a direct hit. Only the 120-mm mortar with a delay-fuze setting can damage a Soviet-style strongpoint defense. Heavy bunkers cannot be destroyed by light or medium mortar rounds.

B-6. EFFECTS OF TERRAIN ON PROXIMITY-FUZED HIGH-EXPLOSIVE ROUNDS

The multioption fuze functions best over open, firm soil. Snow or sand can cause it to function low or on impact. Water or frozen ground can cause it to function early. If proximity-fuzed rounds are functioning high, they are still effective. The HOB can be reduced by using the NSB setting on the fuze. It cannot be increased except by choosing the steepest angle of fall possible.

a. Proximity-fuzed rounds fired over built-up areas can detonate if they pass close by the side of a large building. They can also function too high to be effective at street level. (Impact fuzes are the most effective in heavily built-up areas.)

b. In dense jungle or forest, proximity fuzes detonate too early and have little effect. Impact fuzes achieve airbursts in dense forests, and delay fuzes allow rounds to penetrate beneath the heavy canopy before exploding.

B-7. SUPPRESSIVE EFFECTS OF HIGH-EXPLOSIVE MORTAR ROUNDS

Suppression from mortar is not as easy to measure as the target effect. It is an effect produced in the mind of the enemy that prevents him from returning fire or carrying on his duties. Inexperienced or surprised soldiers are more easily suppressed than experienced, warned soldiers. Soldiers in the open are much more easily suppressed than those with overhead cover. Suppression is most effective when mortar fires first fall; as

they continue, their suppressive effects lessen. HE rounds are the most suppressive, but bursting WP mixed with HE has a great psychological effect on the enemy. Figure B-10 shows suppressive effects derived from live-fire studies and combat observations.

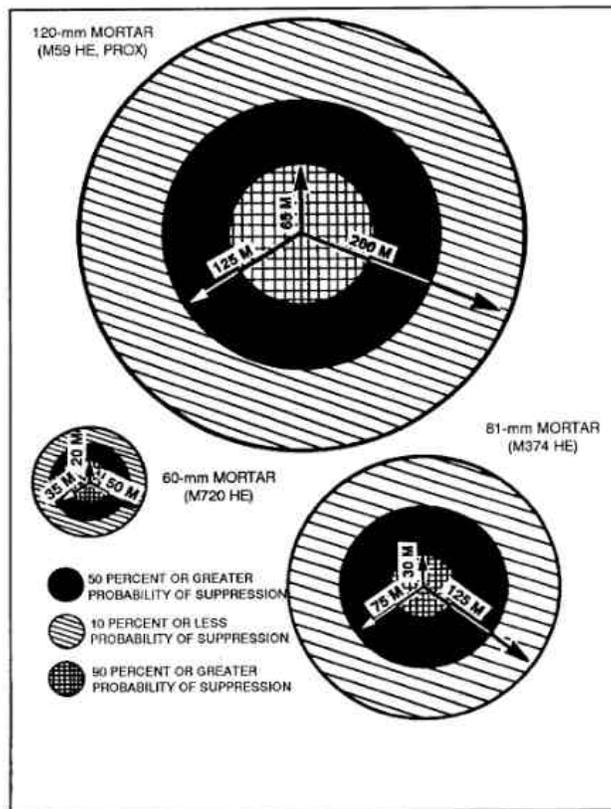


Figure B-10. Suppressive effects of US mortar rounds.

- a. If a 60-mm mortar round lands within 20 meters of a target, the target will probably be suppressed, if not hit.
- b. If a 60-mm mortar round lands within 35 meters of a target, there is a 50 percent chance it will be suppressed. Beyond 50 meters, little suppression takes place.
- c. If an 81-mm mortar round lands within 30 meters of a target, the target will probably be suppressed, if not hit.

- d. If an 81-mm mortar round lands within 75 meters of a target, there is a 50 percent chance that the target will be suppressed. Beyond 125 meters, little suppression takes place.
- e. If a heavy mortar round (proximity-fuzed) lands within 65 meters of a target, the target will probably be suppressed, if not hit.
- f. If a heavy mortar round (proximity-fuzed) lands within 125 meters of a target, there is a 50 percent chance the target will be suppressed. Beyond 200 meters, little suppression takes place. The 120-mm mortar round is better for suppression than the 107-mm, but both are excellent suppressive rounds.

B-8. EFFECTS OF MORTAR FIRE AGAINST VEHICLES

Mortar fires by themselves are not normally effective against vehicles, especially armored vehicles, but they can be most effective when combined with direct fires of antitank weapons. Mortar fires force the armored vehicle crewmen to button up, reducing their visibility and preventing them from firing the heavy machine guns mounted outside the vehicle. This allows dismounted infantry to approach closer, within range to use their handheld antiarmor weapons.

- a. Mortars are generally ineffective as a killer of tracked vehicles. The 120-mm heavy mortar has a moderate capability against BRDMs and BMPs. Mortar fragments from smaller mortars can damage exterior components of lightly armored scout vehicles, ATGM launchers, or self-propelled anti-aircraft guns and can reduce their effectiveness. Firepower or mobility kills are difficult to achieve without expending large amounts of mortar ammunition.
- b. Against moving heavily armored vehicles like tanks or BMPs, the best mortar fires can achieve is forcing the crew to button up. Against stationary tanks or BMPs, bursting WP rounds from medium and heavy mortars can be effective. These rounds must make almost a direct hit on the target to cause any damage.
- c. Point-detonating rounds are the most effective against trucks. Their low-angle fragments do the most damage to tires, wheels, and engines. Bursting WP rounds are also effective if mixed with the HE.

B-9. GUIDELINES FOR THE USE OF HIGH-EXPLOSIVE ROUNDS

The following guidelines are useful during the planning of mortar fires. As the battle progresses, the actual results should be reviewed and the guidelines modified.

- a. What is the enemy doing?
 - (1) If the enemy is unwarned, standing in the open, fire one impact-fuzed HE round from each mortar. Then fire the following rounds as proximity-fuzed.

(2) If the enemy is prone or crouching in open fighting positions, fire all rounds as proximity-fuzed.

(3) If the enemy's status is unknown, fire all proximity-fuzed rounds.

b. What is the ground in the target area like?

(1) If the ground in the target area is soft, swampy, or covered in deep snow, fire proximity-fuzed or near-surface burst rounds.

(2) On rocky and hard soil, fire a 50 percent mixture of proximity-fuzed and impact-fuzed rounds.

(3) If soil type is unknown, fire all proximity-fuzed rounds.

c. What is the vegetation in the target area like?

(1) If the target is within forest, fire point-detonating fuzes for all rounds.

(2) In extremely dense forest or jungle, fire point-detonating fuzes mixed with 50 percent delay fuzes.

d. What is the enemy position like?

(1) If the enemy is in bunkers, fire point-detonating rounds mixed with 50 percent delay fuzes.

(2) Do not depend on light or medium mortar fires to damage heavy bunkers or buildings.

(3) Expect heavy mortar fire to destroy some heavy bunkers and damage others, but also expect to fire large amounts of ammunition.

B-10. ILLUMINATION, SMOKE, AND WHITE PHOSPHORUS AMMUNITION

Illumination and obscuration missions are important functions for mortar platoons or sections. Atmospheric stability, wind velocity, and wind direction are the most important factors when planning target effects for smoke and WP mortar rounds. The terrain in the target area also effects smoke and WP rounds.

a. The bursting WP round provides a screening, incendiary, marking, and casualty-producing effect. It produces a localized, instantaneous smoke cloud by scattering burning WP particles.

b. The WP round is used mainly to produce immediate, close point obscuration. It can be used to screen the enemy's field of fire for short periods, which allows troops to

maneuver against him. The 60-mm WP round is not sufficient to produce a long-lasting, wide-area smoke screen, but the much larger WP round from the heavy mortar is.

c. The bursting WP round can be used to produce casualties among exposed enemy troops and to start fires. The casualty-producing radius of the WP round is much less than that of the HE round. Generally, more casualties can be produced by firing HE ammunition than by firing WP. However, the WP burst causes a significant psychological effect, especially when used against exposed troops. A few WP mixed into a fire mission of HE rounds may increase the suppressive effect of the fire.

d. The WP rounds can be used to mark targets, especially for attack by aircraft. Base-ejecting smoke rounds, such as the 81-mm M819 RP round, produce a dispersed smoke cloud, normally too indistinct for marking targets.

e. All bulk-filled WP ammunition needs special care when temperatures are high. The WP filler liquifies at temperatures of 100 degrees Fahrenheit. Since the WP does not fill all the space in the cartridge, the result is a hollow space in the upper part of the cartridge filler cavity. This causes the round to be unbalanced and, therefore, unstable in flight. WP ammunition should be protected from direct sunlight, if possible. When stored at high temperatures, it should be stacked with the fuze up. Keeping the WP ammunition under cover, digging ammunition bunkers, opening only as many rounds as needed, maintaining proper storage, and monitoring the ambient temperature will reduce the chances of firing unstable ammunition. In climates of extremely high temperatures, WP ammunition should be fired only if taken directly from vertical storage. This does not apply to the M252 mortar's base-ejecting RP smoke rounds. They need no special vertical storage.

f. The effects of atmospheric stability can determine whether mortar smoke is effective at all or, if effective, how much ammunition will be needed.

(1) During unstable conditions, mortar smoke and WP rounds are almost ineffective--the smoke does not spread but often climbs straight up and quickly dissipates.

(2) Under moderately unstable atmospheric conditions, base-ejecting smoke rounds are more effective than bursting WP rounds. The M819 RP round for the M252 mortar screens for over 2 1/2 minutes.

(3) Under stable conditions, both RP and WP rounds are effective. The higher the humidity, the better the screening effects of mortar rounds.

g. The M819 RP round loses up to 35 percent of its screening ability if the ground in the target area is covered with water or deep snow. During extremely cold and dry conditions over snow, up to four times the number of smoke rounds may be needed than expected to create an adequate screen. The higher the wind velocity, the more effective bursting WP rounds are, and the less effective burning smoke rounds become (Figure B-11).

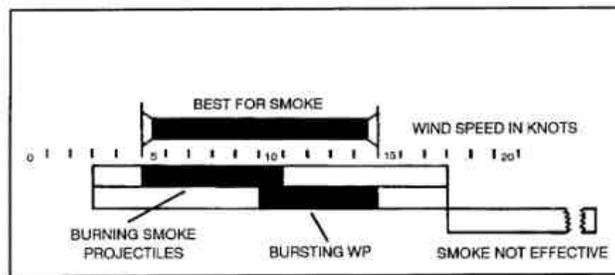


Figure B-11. Optimum wind speeds for mortar smoke and white phosphorus.

h. If the terrain in the target area is swampy, rain-soaked, or snow-covered, then burning smoke rounds may not be effective. These rounds produce smoke by ejecting felt wedges soaked in red phosphorus. These wedges then burn on the ground, producing a dense, long-lasting cloud. If the wedges fall into mud, water, or snow, they can be extinguished. Shallow water can reduce the smoke produced by these rounds by as much as 50 percent. Bursting WP rounds are affected little by the terrain in the target area, except that deep snow and cold temperatures can reduce the smoke cloud by about 25 percent.

i. Although bursting WP rounds are not designed to cause casualties, the fragments of the shell casing and bits of burning WP can cause injuries. Burning smoke rounds do not cause casualties and have little suppressive effect.

B-11. ILLUMINATION

Illumination rounds can be used to disclose enemy formations, to signal, or to mark targets. There are illumination rounds available for all mortars.

a. The 60-mm illumination round available now is the standard cartridge, illuminating, M83A3. This round has a fixed time of delay between firing and start of the illumination. The illumination lasts for about 25 seconds, and it provides moderate light over a square kilometer. The gunner must adjust the elevation to achieve height-of-burst changes for this round. The best results are achieved with practice. The maximum range of the illumination round is 950 meters. This range as well as the minimum range of 725 meters must be taken into account when planning illumination support.

b. The 60-mm illumination round does not provide the same degree of illumination as do the rounds of the heavier mortars and field artillery. However, it is sufficient for local, point illumination. The small size of the round can be an advantage where illumination is desired in an area but adjacent friendly forces do not want to be seen. The 60-mm illumination round can be used without degrading the night vision devices of adjacent units.

c. The new illumination round for the M224 and the M721 is ballistically matched with the M720 HE round. It is effective out to the full range of the mortar and produces improved illumination over the M83A3 round.

d. The medium and heavy mortars can provide excellent illumination over wide areas. The 120-mm mortar illumination round provides one million candlepower for 60 seconds.

B-12. SPECIAL ILLUMINATION TECHNIQUES

The following are three special illumination techniques that mortars have effectively used.

a. An illumination round fired extremely high over a general area will not always alert an enemy force that it is being observed. However, it will provide enough illumination to optimize the use of image intensification (starlight) scopes such as the AN/TVS-5 and the AN/TVS-4.

b. An illumination round fired to burn on the ground will prevent observation beyond the flare into the shadow. This is one method of countering enemy use of image intensification devices. A friendly force could move behind the flare with greater security.

c. An illumination round fired to burn on the ground can be used to mark targets during day or night. Illumination rounds have an advantage over WP as target markers during high winds. The smoke cloud from a WP round will quickly be blown downwind. The smoke from the burning illumination round will continue to originate from the same point, regardless of the wind.

B-13. SPECIAL CONSIDERATIONS WHEN USING THERMAL SIGHTS

Although illumination rounds may aid target acquisition when friendly forces are using image intensification devices, this is not so when thermal sights are used. As the illumination flares burn out and land on the ground, they remain as a distinct hot spot seen through thermal sights for several minutes. This may cause confusion, especially if the flare canisters are between the enemy and the friendly forces. WP rounds can also cause these hot spots that can make target identification difficult for gunners using thermal sights (tanks, BFV, TOW, or Dragon).