FIELD MANUAL

FIELD ARTILLERY TARGET ANALYSIS AND WEAPONS EMPLOYMENT: NONNUCLEAR

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*This manual, together with (C)FM 6-141-2, 23 May 1975, supersedes (C)FM 6-141-1, 9 January 1967; (S)FM 6-141-2, 31 January 1968; (S)FM 6-99, 8 August 1962; (C)FM 6-99-1, 5 August 1964; (S)FM 6-155, 1 August 1962; and (C)FM 6-155-1, 5 August 1964; including all changes.

CHAPTER 1

GENERAL

1-1. Purpose

This manual provides guidance to commanders and staff officers in the nonnuclear employment of field artillery weapons systems and target effects of the selected artillery weapon systems. Within the scope of current security regulations and policies governing ammunition effects, this manual is intended to provide the user with as much unclassified material as possible. *To gain a thorough understanding of the material discussed and the capabilities and limitations of various ammunition against typical targets, this manual must be used in conjunction with FM 6-141-2.*

1-2. Scope

a. This manual comprises data for optimum nonnuclear employment of field artillery weapons using high explosive and selected ammunition [improved conventional munition (ICM)] in combat. Only general guidelines are discussed for the employment of chemical ammunition. *Specific information concerning chemical effects may be found in FM 3-10.* Data are derived from past and current test firings and analytical studies. All material presented is applicable, without modification, to both nuclear and nonnuclear warfare. The field artillery fire planner must normally consider the effects and employment of the 107mm (4.2-inch) mortar in fire support planning: therefore, effects data for the 107mm (4.2-inch) mortar have been included in this manual. The scope of the FM 6-141-Series (-1, -2.) includes—

(1) Comparative effects of weapons systems.

(2) Characteristics and capabilities of field artillery weapons.

(3) Characteristics and capabilities of high explosive, chemical, and selected ammunition.

(4) Typical targets and suggested methods of attack.

(5) Target coverage.

(6) Casualty effectiveness.

(7) Lethality.

(8) Single round hit probabilities, delivery and dispersion errors.

(9) Miscellaneous effectiveness data on various techniques.

b. Doctrine and techniques for the tactical employment of field artillery weapon systems are set forth in FM 6-20 and FM 6-140.

c. Doctrine for the tactical employment of chemical ammunition and chemical agents effects data are contained in FM 3-10-1 and FM 3-10-2.

d. Effects data on some developmental selected ammunition is contained in FM 6-141-2.

e. Nothing contained herein will preclude the furnishing of close fire support to the maneuver elements.

1-3. Changes

a. Owing to the nature of the material covered in this manual, additions and changes will be required as new data are developed. Changes and revisions will incorporate this new data as it becomes available.

b. Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons should be provided for each comment to ensure understanding and complete evaluation. **Comments should be prepared using DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forwarded direct to Commandant, US Army Field Artillery School, ATTN: ATSF-DOC-DL, Fort Sill, Oklahoma 73503.** Originators of proposed changes that would constitute a significant modification of approved Army doctrine may send an information copy, **through command channels, to Commander, US Army Training and Doctrine Command, Fort Monroe, Virginia 23651,** to expedite review and follow-up.

c. Staff planners at tactical echelons, and Service Schools providing target analysis and effects data instructions, may be provided JMEM documents (FM 101-60 Series) listed in appendix A upon specific request to Commander HQ, US Army Materiel Command (AMCRD-T) Alexandria, Virginia 22333.

1-4. Organization of the Manuals

a. This manual (Unclassified), and FM 6-141-2 (Confidential) are paragraphically organized in order to provide a repository once the material discussed therein becomes downgraded; to reduce

administrative problems when material is declassified; and to assist in cross-referencing.

b. The above referenced manuals cover the concepts of employment and effectiveness of non-nuclear field artillery weapon systems. FM 6-141-2 contains classified data on the comparative effects of selected and high explosive ammunition with the 105mm howitzer, 155mm howitzer, 8-inch howitzer, 175mm gun, and 107mm (4.2-inch) mortar. A discussion of chemical ammunition for the 105mm howitzer, 155mm howitzer, 8-inch howitzer, 107mm (4.2-inch) mortar, and Honest John Rocket is contained in chapters 3 of this manual and FM 6-141-2. Detailed material concerning high explosive and selected ammunition is presented in chapter 4. The characteristics and effectiveness data of cannon weapons systems are discussed in detail in chapters 5 of these two manuals according to degree classification. Accuracies afforded by some weapon systems (155mm howitzer, 8-inch howitzer) result in relatively insignificant variance in effects throughout the range capability of the weapon. Unclassified material concerning selected ammunition is discussed in chapters 4 and 5. Classified effects data are provided for all field artillery weapon systems in FM 6-141-2. Consult FM 6-141-2 for a classified discussion on subjects not covered in this manual.

CHAPTER 2

CONCEPTS OF EMPLOYMENT

Section I. TARGET ANALYSIS

2-1. General

a. Concepts and Analyses. The commander's concept of operation to accomplish the mission is the primary consideration in fire planning. Proper fire planning requires detailed target analysis and a thorough understanding of the capabilities and limitations of the weapon system at his disposal. The commander must also be thoroughly familiar will all types of ammunition including high explosive [including rocket-assisted], chemical, and selected ammunition. The initial decision to employ toxic chemical ammunition rests solely with the President of the United States. Field commanders will receive implementing directives relating to the initial employment of chemical agents through command channels.

b. Target Analysis. A military judgmental evaluation of an enemy target situation, based on both military factors and analytical data, such as type enemy unit, friendly weapons and ammunition available, range, target priority, and probable amount of ammunition required to defeat, neutralize, or otherwise disrupt activity of the target. Target analysis is, therefore, not simply a technical exercise to determine amounts and types of ammunition required to inflict a given damage (or casualty) level on a particular target. It is more than this; it is a continuous process of consultation and cooperation between the commander (decision maker) and the analyst (e.g., fire direction officer) involving tactical perspective, available units and materiel, and technical capability.

c. Techniques and Decisions. Techniques reflected in this manual should not replace tactical judgment based on sound experience. However, analysis can provide guidance that will allow the commander to make decisions when he is considering all aspects of the tactical situation.

d. Principles and Policies. The principles, policies, and concepts applicable to the employment of toxic chemical ammunition are contained in FM 101-40.

2-2. Target Analysis Factors

a. The most important consideration in target analysis is the damage inflicted on the enemy (desired effects on the target) as a function of friendly weapon capabilities. Some of the important factors that should be considered in target analysis include—

(1) Types and quantities of ammunition available
(2) Target location error
(3) Type and posture of target
(4) Size of target
(5) Weapon system delivery accuracy, range, and rate of fire
(6) Ammunition effectiveness (lethality)
(7) Probability of target moving
(8) Method of engagement
(9) Meteorological conditions
(10) Protection available

b. Combinations of these factors result in varying degrees of overall tactical effectiveness and efficiency. The most difficult task for the analyst is that of determining the significance of these relationships. Data and processes described in this manual are provided as tools for a thorough and detailed planning and execution of fire support.

2-3. Target Analysis Terms

An understnading of the following terms and definitions is necessary to use this manual properly:

a. Unit Effects Patterns. A unit effects pattern is that area designated on the ground within which damage (casualties) normally can be expected to occur. The unit may be a single piece, battery, or battalion. However, a small percentage of damage may also occur outside the normal effects pattern; for example, at a point 300 meters from the point of detonation the probability of a hit is 10^{-5}. For the 105mm Howitzer M1 (Comp B loaded) the maximum fragment travel range is approximately 563 meters. Unit effects patterns vary in shape, but in this manual the high explosive ammunition patterns have been limited to a circle in order to simplify procedures.

b. Radius of Effects. The radius of a unit effects the pattern.

c. Fraction of Coverage. The portion of a target area covered by a specific unit effects pattern is called the fraction of coverage (sometimes expressed as fractional coverage). The amount of coverage (percentage) attained depends on the

type of ammunition and the accuracy of the delivery system. If half of a platoon area is covered by a unit effects pattern, fractional coverage is 0.50.

d. Expected Fraction of Casualties. Fraction of casualties is the fraction, or percentage, of the total number of personnel in a target area which are expected to become casualties.

e. Expected Fraction of Damage. Fraction of damage is the fraction, or percentage, of the total number of items of materiel in a target area which are expected to become damaged or destroyed.

f. Average Coverage. Average coverage is the coverage expected on a target, or target area, and is obtained by totaling the coverages of all missions fired and dividing by the number of missions.

g. Delivery Accuracy. A measure of the ability to place rounds on or about an aimpoint. In this manual, delivery accuracy is assumed to have two components—precision (dispersion) and MPI error.

h. Mean Point of Impact (MPI). The point which has coordinates in range, in deflection, and in height that are the arithmetic means of the range coordinates, deflection coordinates, and burst heights of a set of burst points.

i. Precision (Dispersion). A measure of the scatter of burst points about the MPI of a group of rounds fired from a single weapon on any single occasion. In this manual, precision (dispersion) is assumed to have three components—a range component, a deflection component, and a height component. It is further assumed that each of these components is distributed normally about the MPI.

j. MPI Error. A measure of the scatter of MPI's about an aimpoint. In this manual, it is assumed that the mean of the MPI's is at the aimpoint and the MPI's are distributed normally about the aimpoint.

2-4. Critical Casualty Levels

Critical casualty levels will vary for a given target or target area. There is no known analytical method for calculating the exact casualty level or damage level required to defeat the target. However, as casualties mount, a critical casualty or damage level may be achieved after which the affected unit is no longer able to accomplish its mission. This casualty level is based on unit casualties and materiel losses. However, other less tangible factors such as troop experience, esprit, morale, and leadership will influence unit effectiveness. Studies indicate that a 30 percent casualty level will normally disrupt and disorganize an attacking infantry or mechanized unit to such an extent as to render it ineffective for an extended period of time. The length of this time period is dependent on the ability of the unit to reorganize and receive reinforcements. Figure 2-1 illustrates the probability that a unit suffering the indicated percent of casualties will be forced to break off an attack for 2 to 24 hours (curve A) and for at least 48 hours (curve B). A defending infantry or mechanized unit, on the other hand, can absorb higher casualty levels before being forced to withdraw and abandon its position, as shown in figure 2-2. The damage level required to render armored units ineffective will be somewhat higher however, at approximately 50-percent damage.

2-5. Target Classification

a. General. Targets encountered on the battlefield vary considerably in composition, degree of protection (shielding), and size of area. The targets of prime importance to field artillery in close support maneuver elements are hostile infantry or armored combat formations, and hostile mortar/artillery and rocket firing batteries. The effect of surprise fire against such targets cannot be overemphasized, particularly when nuclear weapons are not available. Although the dimensions of a target area are influenced by many factors, the area occupied by a specific tactical formation will not generally vary from established demensions, which are based on the strength, mission, and tactical doctrine of the force involved.

b. Categories of Targets. To simplify the comparison of effectiveness of a particular weapon, or round, to another, targets have been divided into four categories (table 2-1). Several examples are listed in each category. Under certain conditions, some examples could be listed in more than one category. For example, a motorized rifle battalion could be both a category 1 and a category 4 target.

c. Posture Sequences. A posture sequence is the relative position and/or the degree of protection afforded by terrain or by manmade objects. An attacking maneuver unit may have no protection; conversely, irregularities in the terrain may furnish a certain degree of protection. Numerous posture sequences can be applied in combat situations. Three posture sequences are used in this manual to describe the degree of protection acquired by personnel against fragmentation. These posture sequences are:

(1) A—Standing
(2) B—Prone
(3) C—Foxhole

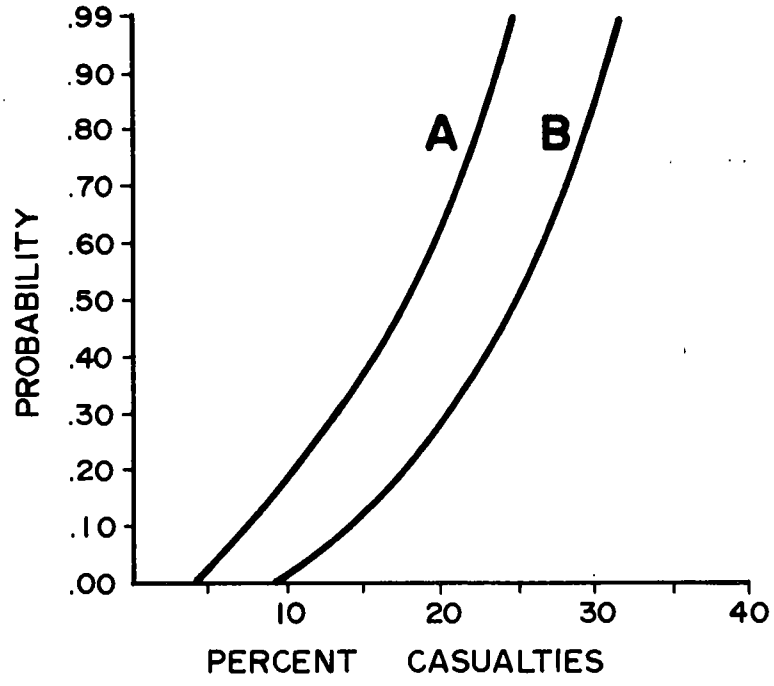

Figure 2-1. Probability-of-an-attack break.

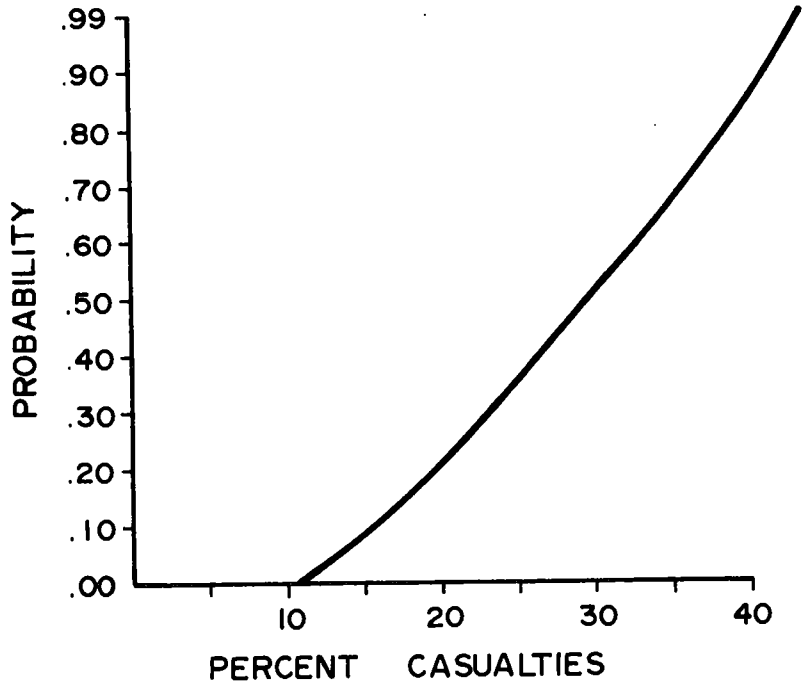

Figure 2-2. Probability-of-a-defense break.

Although the posture sequences depict specific positions of personnel on the ground, the sequences are established *for use in any situation having equivalent protection.* (For example, attacking troops traversing very irregular terrain may have protection, equivalent to that of prone personnel.)

Table 2-1. Categories of Targets

Categories of Targets	Examples
1. Area Personnel Targets	Squad Platoon Battery Company
2. Small Personnel Targets	Observation post Small patrol Command post
3. Small Materiel (Point) Targets	Tank Armored Personnel Carriers Bunker, machinegun
4. Area Materiel Targets	Armored formation Truck park Ammo dump POL dump Communication center

2-6. Target Size

a. The size of the area to be attacked normally is determined by the reported dimension of the target or the size of the area in which the target is known or suspected to be located. This information is obtained from target acquisition sources. Large targets may be subdivided and more than one target center be selected. Subareas should be tailored to the specific target complex.

b. The combination of a suitable posture sequence and a target size constitutes a classification useful to the fire direction officer. For example, suppose a platoon is dug in, in an approximately circular area of 200 meter radius. The fact that personnel are in foxholes combined with the fact that the target area has a radius of approximately 200 meters assists the analyst in determining amounts and types of ammunition needed to neutralize or destroy the target.

2-7. Lethality

See paragraph 4-4.

Section II. FUNDAMENTALS OF EFFECTIVE WEAPONS EMPLOYMENT

2-8. General

This section represents general fundamental guidelines that must be considered in order to achieve optimum weapons employment when firing high explosive and chemical ammunition.

2-9. High Explosive Ammunition

a. Employment Concepts. High explosive ammunition can be employed against all categories of targets. It is very effective against personnel targets (categories 1 and 2 in table 2-1), except when personnel have a high degree of protection. Only marginal effects can be achieved against categories 3 and 4 in table 2-1 when the target is tanks, armored personnel carriers or fortifications.

b. Effectiveness of Surprise Fire. See paragraph 2-9*b*, FM 6-141-2.

c. Lethality. See paragraph 2-9*c*, FM 6-141-2.

2-10. Toxic Chemical Ammunition

a. Employment Concepts. Toxic chemical agents can be employed in support of both defensive and offensive operations, under nuclear or nonnuclear conditions, and in limited or general wars. Toxic chemical agents are effective against targets in categories 1 and 2 in table 2-1. In categories 3 and 4 (table 2-1), toxic chemical agents are effective against the personnel in the materiel or fortifications, but will not destroy the materiel or fortifications. Chemical agents may be used in conjunction with high explosive and nuclear fire, or alone, depending on the tactical situation.

b. In Conjunction With HE or Nuclear Fires. See paragraph 2-10*b*, FM 6-141-2.

c. Nonpersistent or Persistent Effects. See paragraph 2-10*c*, FM 6-141-2.

d. Effectiveness of Surprise Fire. Surprise fire should be exploited to the maximum when employing nonpersistent chemical agents (agent GB) against well equipped enemy personnel. Exposure is accomplished before the personnel become aware of the agents presence and before they can react to take protective measures. Surprise fire is not required when employing persistent agents VX and HD.

2-11. Selected Ammunition

a. Employment Concepts. Selected ammunition is primarily an area target weapon extremely effective against category (1) targets. Ammunition effects are degraded relative to the degree of protection the target attains.

b. Effectiveness of Surprise. Surprise fire is approximately ten times more effective than fire against warned personnel when employing selected ammunition.

2-12. Effectiveness of Beehive Round In Direct Fire

This ammunition is extremely effective in *direct fire* against standing personnel in open terrain. Table 2-2 show recommended direct fire fuze settings for Beehive rounds (Charge 7). For a complete discussion as to the capabilities and limitations of this ammunition, see paragraph 2-12, FM 6-141-2.

2-13. Target Dispersion

The greater the dispersion of personnel or vehicles, the less damage or destruction can be expected from field artillery and mortar fires. This is valid whether dispersion applies to distances between units or to distances between elements within a unit. Throughout the manual, it is assumed that personnel are uniformly distributed within each target area.

2-14. Ammunition—Fuze Combination

a. High Explosive Ammunition. High explosive ammunition with the point-detonating (PD) fuze is more effective against standing personnel than HE ammunition fuzed with the M514A1 proximity fuze. When consideration is given to the variation in burst heights, and when HE ammunition is employed with the M728 (M514A1E1) proximity fuze, it is more effective against standing personnel than HE ammunition employed with the PD fuze. When personnel have a degree of protection equivalent to prone or foxholes, proximity fuzed ammunition is more effective.

b. Toxic Chemical Ammunition. Point-detonating (PD) fuzes are used when agents GB and HD are employed. Proximity and PD fuzes are used when agent VX is employed.

c. *Selected Ammunition.* Use Mechanical time fuzes.

d. APERS-T (Bee-hive) Ammunition. Use Mechanical time fuzes.

Table 2-2. Fuze Settings for Beehive Round (Charge 7)

Range	Elevation	Fuze setting		
		XM563		
meters	mils	E2	E3	E4
0—400	20	* MA	* MA	* MA
500	20	0.7	* MA	0.6
600	20	0.9	0.6	0.8
700	23	1.1	0.9	1.0
800	24	1.3	1.1	1.2
900	25	1.6	1.3	1.5
1000	27	1.8	1.5	1.7
1100	29	2.0	1.7	1.9
1200	30	2.2	2.0	2.1
1300	32	2.5	2.2	2.4
1400	34	2.7	2.4	2.6
1500	37	2.9	2.7	2.8
1600	39	3.2	2.9	3.1
1700	41	3.4	3.1	3.3
1800	44	3.7	3.4	3.6
1900	46	3.9	3.6	3.8
2000	49	4.2	3.9	4.1
2100	52	4.4	4.2	4.3
2200	54	4.7	4.4	4.6
2300	57	4.9	4.7	4.9
2400	60	5.2	5.0	5.1
2500	63	5.5	5.2	5.4
2600	66	5.8	5.5	5.7
2700	69	6.0	5.8	6.0
2800	72	6.3	6.1	6.2
2900	76	6.6	6.4	6.5
3000	79	6.9	6.7	6.8

* MA—Projectile will function at the muzzle.

CHAPTER 3

EMPLOYMENT OF TOXIC CHEMICAL AMMUNITION

Section I. GENERAL

3-1. General

This chapter provides general guidance in the employment of chemical ammunition by field artillery weapon systems. A brief description of the chemical agents available, including their characteristics, factors that influence their effects, and general guidelines for their employment are presented. Antipersonnel chemical agents available for use in field artillery weapon systems are: nerve agent GB, nerve agent VX, and blister agent HD. For specific details concerning the effectiveness of chemical agents and chemical ammunition, see FM 3-10-1, FM 3-10-2, and FM 3-10-3 (when published); for specific details on other chemical ammunition fires, see FM 6-40.

3-2. Employment Policies

The initial decision to employ chemical agents rests solely with the President of the United States. The Unites States will not implement the first use of chemical agents. Field commanders will receive implementing directives relating to the employment of chemical ammunition through command channels. The possibility of the usage of chemical ammunition places on commanders the responsibility to be thoroughly familiar with the characteristics, capabilities, and limitations of chemical agents, ammunition, and delivery systems at his disposal. It is imperative that training emphasis be placed on tactics and techniques peculiar to the field artillery employment of chemical ammunition.

3-3. Employment Concepts

The general concepts of employment outlined in paragraph 2-10 are applicable to this section. Reference to specific agents are included in the Field Manual, FM 3-10-2/NWIP 36-4/AFM 355-9/FM 11-3B, Chemical Agent Effects Data (when published).

Section II. CHEMICAL AGENTS

3-4. Agent GB

Agent GB is a highly volatile liquid nerve agent which is disseminated as an aerosol or vapor. It is employed primarily to attack personnel through the respiratory system. Against unprotected personnel, GB has the capability to produce casualties within minutes. Under most conditions, the duration of effectiveness of GB vapor is short, and is dependent upon the meteorological conditions and the type of ammunition used to disseminate the GB agent. The agent cloud will remain for longer periods of time in wooded areas or where there is little wind to move and dissipate the cloud. The walls of a shell crater, produced by an exploding GB round, will be slightly contaminated with liquid GB. Because of the accumulative effect of the agent, this will constitute a vapor hazard for several hours after detonation. T 3-215 contains detailed information on the effects of GB. See FM 3-10-1 and 3-10-2 for Chemical Tactical Employment and GB Target Analysis.

3-5. Agent HD

Agent HD (mustard) is a persistent slow-acting agent that produces delayed casualties through both vapor and liquid effects. It can be used for on-target casualty effects or to contaminate terrain and materiel. HD causes delayed casualties among *unmasked* troops through the effects of vapor and liquid on the respiratory track, skin, and eyes; and among *masked* troops, by effects on the skin. It acts slowly and produces delayed casualties from burn-like blisters within 8 to 24 hours after contact. Under most conditions, HD liquid has a long duration of effectiveness, usually from several days to several weeks. HD evaporates to cause a downwind vapor hazard. The effectiveness depends on the initial contamination, and upon meteorological conditions. See FM's 3-10-1 and 3-10-2 for Chemical Tactical Employment and HD Target Analysis.

3-6. Agent VX

Agent VX is a low volatile agent that produces

casualties primarily by absorption of droplets through the skin (percutaneously). When inhaled as a vapor or aerosol, VX like agent GB, produces incapacitation or death in a few minutes; however, little inhalable vapor or aerosol is produced by current dissemination methods. The most important characteristic of this agent is its ability (when in liquid form) to cause casualties among masked personnel by absorption through the skin. Depending on the amount, extent, and location of agent on the body, and on prophylactic measures taken, VX on *sensitive bare skin* can cause death in minutes. When the agent acts on the skin through clothing, the time required for casualties to develop may vary from about one-half hour to more than 24 hours, depending on the number of layers, thickness, and composition of clothing. The effects of VX on the body are similar to those of GB. Because VX is absorbed into vegetation and materiel, it will remain effective in the target area for several hours to a week (even weeks) depending on temperature, weather, and terrain. When disseminated by field artillery, meteorological conditions have little effect on the employment. The downwind vapor hazard from VX contamination is insignificant because of the low volatility of the agent. See FM's 3-10-1 and 3-10-2 for Chemical Tactical Employment and VX Target Analysis.

Section III. CHEMICAL AGENTS EFFECTS AND ANALYSIS

3-7. General

a. FM 3-10-1 is the basic manual for employment doctrine describing the use of chemical effects tables, how the effects tables are organized, definition of terms applying to chemical target analysis, and target analysis procedures.

b. FM 3-10-2, Chemical Agent Effects Data is for use by the Chemical Agent Casualty and Effects Analyst. The data contained in FM 3-10-2 is based on laboratory tests and field tests. Additional testing may cause the basic data to change; however, the target analysis procedures, employment techniques and casualty estimates are provided and effective for use in the field. The manual includes all effects data, both classified and unclassified.

3-8. Variables Considered in Computing Casualty Effects (FM 3-10-2)

a. Variables considered in computing casualty data and reflected in table headings are: protective posture or protection category; breathing rate (workrate); masking time; windspeed; atmospheric stability for GB artillery systems and downwind hazard distance tables; target size; and range to target. Figure 3-1 provides a quick reference for descriptions of these variables.

b. Although not actually reflected on the tables, acquisition errors, system errors (except for HD and BZ), piece errors, ammunition reliability, ammunition signature, temperature, delivery mode (for air-delivered ammunition), and orientation of firing units were considered in the mathematical model used to compute tabular data in the tables.

3-9. Points to Consider (FM 3-10-2)

a. Special delivery techniques must be used to obtain the fractional casualties given in the tables. For example, artillery-delivered GB and VX must be fired at specific aim points as described on the tabs at the beginning of each weapon system section.

b. Data in the GB bomb and dispenser tables represent the casualties that can be expected for the most favorable and the least favorable delivery modes. Since the most favorable delivery mode will not always be possible, target analysts can use these data as a guide for estimating casualties under varying conditions.

c. Fire unit integrity is maintained with the minimum level of fire being one collocated battery. Split batteries fire at the same aim point using the same sheaf as a collocated battery; however, split-battery fire may result in casualty levels different from those shown in the tables. HD may be employed without regard for fire unit integrity (zone fire).

d. When using multibattery fires, more than one battery will fire at the same point.

e. In multibattery fires, the range at which the majority of the fire units is located is used as the base range to target. In a situation where fire units are located at more than one range, use casualties computed for the longest range. Even though aim points are the same for weapons firing on one target from different ranges, dispersion of rounds will be greater from the farthest range. This increased dispersion could enhance overall target effects.

f. Casualties cannot be predicted accurately when using more than one type of weapon on the

GB PROTECTIVE POSTURES

TROOPS IN: OPEN
OPEN FOXHOLES
COVERED FOXHOLES
BUNKERS

WORKRATES

(Breathing rate)

LOW_____SLEEPING
MODERATE___NORMAL ACTIVITY
HIGH_____ACCELERATED ACTIVITY

MASKING TIME

9 SECONDS

RANGES

105MM HOW/GB_____1,000; 3,000; 5,000; 7,000; 9,000; 10,000 METERS

155MM HOW/GB_____2,000; 4,000; 7,000; 10,000; 12,000; 14,000 METERS

8-INCH HOW/GB_____3,000; 5,000; 7,000; 10,000; 12,000; 14,000; 16,000 METERS

HONEST JOHN RKT/GB--
MIN - 10 KM
> 10 KM - 16 KM
> 16 KM - 24 KM
> 24 KM - MAX

115MM RKT/GB and VX)
155MM HOW/VX) ALL RANGES
8-INCH HOW/VX)

GB RESPONSE, TIME

5 MINUTES
COUNTED FROM TIME OF EXPOSURE

DELIVERY MODES

(Air-delivered munitions)

Delivery mode is a combination of variables such as dive angle, release height, and aircraft speed. It influences area coverage, delivery accuracy and, consequently, the number of casualties on target.

Data in the GB bomb and dispenser tables represent the fractional casualties that can be expected under the most favorable and the least favorable delivery modes.

VX PROTECTION CATEGORIES

A___UNMASKED, ANY UNIFORM OR CLOTHING
B___MASKED, SUMMER UNIFORM
C___MASKED, HOODED, GLOVED, SUMMER UNIFORM; OR MASKED AND WINTER UNIFORM
D___MASKED, HOODED, GLOVED, TWO-LAYERED WINTER UNIFORM

VX RESPONSE TIMES

PROTECTION CATEGORY	RESPONSE TIME (HOURS)			
A_____	1/2	1	3	ULT
B_____	2	4	10	ULT
C_____	12	18	24	ULT
D_____	12	18	24	ULT

WINDSPEEDS

105MM HOW/GB)
155MM HOW/GB)---- 1, 2, 5, 12, and 18 KNOTS
8-INCH HOW/GB

OTHER GB) LIGHT WINDS---- 0-4 KNOTS
DELIVERY)--MODERATE WINDS-->4-11 KNOTS
SYSTEMS) STRONG WINDS--->11-20 KNOTS

ALL VX)
DELIVERY)--LIGHT WINDS---- 0-11 KNOTS
SYSTEMS) STRONG WINDS----> 11 KNOTS

HD SYSTEMS --- 2, 5, 8, 10, 15, and 20 KNOTS

BZ SYSTEMS--- 5 KNOTS OR LESS

TARGET SIZES

(Target radius in meters)

105MM HOW/GB---50, 100, 150, 200, 250, 300

155MM HOW/GB)
8-INCH HOW/GB) 50, 100, 150, 200, 250, 300, 400, 500

MASSIVE BOMBS/GB)
DISPENSERS/GB)--50, 100, 200, 300, 400, 500
4.2-INCH MORTAR/HD)

115MM RKT/GB)
and VX)--200, 300, 400, 500, 750, 1000

HONEST JOHN RKT/GB----100, 200, 400, 600

AERO-14B SPRAY TANK/VX--250, 500, 1000, 1500

TMU-28/B SPRAY TANK/VX----500, 1000, 1500

155MM HOW/VX)
8-INCH HOW/VX)--50, 100, 200, 300, 400, 500

Figure 3-1. Target analysis aid. Toxic chemical ammunition.

same target. If 155mm howitzers and 8-inch howitzers are fired on the same target, use the casualty estimate for the 155mm or the 8-inch, but not for both. When it is desirable or necessary to use more than one type of weapon on a single target, the analyst must subdivide the target and engage each segment with a different weapon. In this way, he can make a more accurate casualty estimate.

g. If mixed fires—chemical and HE—are to be used on a single target, casualties must be computed for chemical or HE, but not for both, because chemical casualties cannot be added to HE or nuclear casualties.

h. If more than one agent is to be delivered on a single target, the agent producing the most immediate effects should be fired first, and it is the only agent for which casualties can be determined.

i. On targets where troops are in more than one defensive posture, select the posture used by the majority of the troops as a table entry value.

j. Upwind delivery of chemical agents was not considered in writing this manual because the 9-second masking time precludes troops being exposed to agents within the time required for an agent cloud to travel across the target. Furthermore, windspeed and direction cannot be predicted accurately enough in the target area to insure that the agent cloud will cross the target.

k. Zeros in the tables indicate that no casualties can be expected, or that the casualty level will be insignificant. For weapon systems having very large delivery errors, "zero" casualties may result because the ammunition does not hit the target.

l. A blank space as in the bomb tables or a dash as in the VX spray tables indicates that casualties were not computed for that particular level of fire.

Section IV. CHEMICAL AMMUNITION, DELIVERY SYSTEMS AND EFFECTS

3-10. Weapon Systems Characteristics

See table 3-1, FM 6-141-2 for information on chemical ammunition and delivery systems.

3-11. Toxic Chemical Ammunition Effects Data

a. Agent GB, Artillery. See chapter 2, FM 3-10-2.

b. Agent GB, Rocket Systems. See chapter 3, FM 3-10-2.

c. Agent VX, Artillery. See chapter 7, FM 3-10-2.

d. Agent VX, Rocket Systems. See chapter 7, FM 3-10-2.

e. Agent HD, Ammunition. See chapter 9, FM 3-10-2.

CHAPTER 4

EMPLOYMENT OF STANDARD HIGH EXPLOSIVE AND SELECTED AMMUNITION

Section I. GENERAL

4-1. Purpose and Scope

This chapter provides general guidance to commanders for the employment of standard high explosive and selected ammunition. Tactical employment, attack of targets, general effects against typical targets, troop safety and the need for destruction of selected ammunition will also be discussed.

4-2. Description of Ammunition

a. General. Although TNT filled projectiles are still part of the Army's inventory, this manual considers *standard* high explosive ammunition to be composition B filled projectiles. Selected ammunition consists of projectiles containing subammunition (grenades) which are designed to base eject from the projectile and burst in the air, or on ground contact. The two types of selected ammunition are discussed in paragraph 4-2*b*, of FM 6-141-2.

b. Types of Selected Ammunition.

(1) *Antipersonnel.* See paragraph 4-2*b* (1), FM 6-141-2.

(2) *Dual purpose.* See paragraph 4-2*b* (2), FM 6-141-2.

4-3. Unit Effects Patterns

a. Standard HE Ammunition. Table 4-1 shows unit effects patterns for standard high explosive ammunition and weapons indicated. The figures in table 4-1 depict an area or radius within which casualties or damage can be expected to occur. This concept should not be confused with effectiveness. Effectiveness within a given pattern area is a function of the density of fragmentation within that pattern. It should be noted that unlike high explosive ammunition, selected ammunition distributes its subammunition (grenades) almost uniformly throughout the pattern area. Thus the density of fragmentation from selected ammunition is more uniform than high explosive. In the case of area personnel targets, selected ammunition will prove to be more effective. The following assumptions were the basis for computing the tables found within this manual.

Table 4-1. Unit Effects Patterns Standard HE Ammunition

Firing unit	Area covered (square meters)	Radius of effects (meters)
4.2-Inch Mortar Platoon (4 pcs)	61,575	140
105mm Howitzer Btry (6 pcs)	61,550	140
105mm Howitzer Bn (18 pcs)	145,150	215
155mm Howitzer Btry (6 pcs)	75,475	155
155mm Howitzer Bn (18 pcs)	151,950	220
8-Inch Howitzer Btry (4 pcs)	57,255	135
8-Inch Howitzer Bn (12 pcs)	101,800	180
175mm Gun Btry (4 pcs)	159,040	225
175mm Gun Bn (12 pcs)	282,744	300

(1) Grenades are considered to be uniformly distributed throughout the pattern area.

(2) Pattern areas are considered to be circular in shape.

b. Selected Ammunition. See paragraph 4-3b and table 4-5, FM 6-141-2.

c. Effects Patterns, (Grenades). See paragraph 4-3*c*, FM 6-141-2.

d. Effectiveness Against Materiel Targets. See paragraph 4-3d, FM 6-141-2.

4-4. Lethality

a. General. Lethal area is a measure of damage or casualty potential of an individual ammunition, projectile, or warhead. It is a mathematical measure, not a physical area in the sense of a specific geometrical configuration. To determine the lethal area, the effects area is divided into small subareas. Each subarea is multiplied by the probability of a casualty within the subarea and the products are summed. This sum is the lethal area in square units for the ammunition-target posture combination. Such items as fragment distribution, amount of protection (shielding), troop attitudes, and fragment velocity affect the magnitude of the lethal area. See tables 4-6 and 4-7, FM 6-141-2 for lethal areas, expressed in square meters, and lethality comparisons.

b. Computation of Casualties. Given the lethal area and the nature of the target, it is possible to

compute the expected fraction of casualties within a given target area. Such a computation has been done and the results are in the referenced Joint Munition Effectiveness Manuals for Surface-to-Surface Weapons (JMEM/SS) (FM 101-60-2, -3, -4, -5, -7, and -8). The following information should be known for such a computation:

(1) Appropriate dispersion errors.
(2) Number of rounds per volley.
(3) Target posture.
(4) Dud rates.
(5) Probable errors.
(6) Weapon system.

c. Lethal Areas (Dimensions) for Special Ammunition. There is a probability that a hit by a dual purpose grenade on certain exposed surfaces of tanks and armored personnel carriers (APC's) will immobilize the vehicle or destroy its firepower. An example of such an exposed surface is the engine compartment of a tank. If each exposed area (surface) is multiplied by the kill probability of the exposed area and these products are summed, the resulting figure represents the total area of a particular type vehicle that is vulnerable to one dual purpose grenade. Vulnerable areas for vehicles and lethal areas for personnel are analogous. See table 4-6 for single round lethal areas (square meters) against personnel in standing, prone and foxhole postures; table 4-7 for lethality comparisons and relative values of HE and selected ammunitions; and table 4-9 for single round lethal areas (square meters) against tanks, APC's and trucks (FM 6-141-2).

Section II. TACTICAL EMPLOYMENT

4-5. General

The procedures and techniques for tactical employment of field artillery, as set forth in FM 6-20 and FM 6-140, apply to cannon units when using both standard high explosive and selected ammunition. Procedures and techniques for the tactical employment of 107MM (4.2 inch) mortars are found in the FM 23-series.

4-6. The Field Artillery Fire Planning

The procedures and techniques used in preparing the artillery fire plan when selected ammunition is available are essentially the same as when planning other field artillery fires. Careful consideration is given to the most effective employment of available ammunition with particular attention to the integration with other nonnuclear fires. The commander or his fire direction officer must consider certain factors when deciding to attack a target or by planning fires using selected ammunition. Conformity to the scheme of maneuver of supported troops and evaluation of the enemy are factors of primary concern. In general, these considerations are discussed in FM 6-20.

4-7. Area to be Attacked

a. The size of the area to be attacked is normally determined by the size of the target or the size of the area in which the target is known or suspected to be located. This information is obtained from intelligence sources. Large target areas of irregular shape may require that more than one target center be selected (chap 30, FM 6-40).

b. It is difficult to specifically state the size of many targets, i.e., squad, platoon, company, or battalion assembly areas. Every attempt must be made to designate the area to be attacked by determining as best as possible the size of the target (i.e., 10m x 10m fortification) or the approximate area the target is occupying (i.e., a tank platoon, radius of the target area = 100m).

c. Proximity of the target center(s) to friendly elements is an additional consideration. Troop safety is discussed in section V, FM 6-141-2.

4-8. Results Desired

a. General. The two terms most commonly used to describe desired results (effects) of fires are:

(1) *Destroy (destruction).*

(a) Fire delivered for the sole purpose of destroying materiel objects. Expected results are usually expressed as a percentage of the target covered. For example, if 30 percent of the target is covered, it is assumed that 30 percent of the target will receive the specified level of damage. See paragraph 2-4 for criterion to render armored units ineffective (destroyed).

(b) A 'destroyed unit' is a unit that has been rendered completely ineffective. The unit will have lost its command facilities, materiel, and many key personnel. Generally, 30 percent coverage (casualty level) inflicted during a short time frame is sufficient to destroy the unit. However, care must be exercised in the use of the 30 percent figure, because the posture of the unit, its mission, and other variables may dictate higher or lower casualty figures for destruction.

(2) *Neutralize (neutralization).* Those fires which are delivered to hamper or interrupt movement and/or the firing of weapons, and to render personnel or material incapable of interfering with a particular operation. Generally, coverage of 10 percent or more (casualty level), of a unit, inflicted during a short time frame will be sufficient criterion to consider the unit neutralized, provided other factors are not overpowering.

b. Other Fires.

(1) Harassing fire is fire of lesser intensity than neutralization fire designed to inflict losses, to disturb enemy forces, to curtail movement, and in general to lower morale. Any coverage of less than 10 percent (casualty level) is considered adequate to achieve the results of harassing fire.

(2) Suppressive fires are those fires, direct or indirect, brought to bear on known or likely enemy locations to degrade the enemy's ability to place effective fires on friendly maneuver elements. These fires are categorized as immediate or planned. These fires may approach the casualty level coverage of neutralization fire on one hand, or harassing fire on the other.

4-9. Effects of Weather and Terrain

In addition to the size and type of projectile fires, the effectiveness of the fragments is also related to the type of vegetation in the target area, and the existing weather conditions. See paragraph 4-9 FM 6-141-2 for a detailed discussion.

Section III. ATTACK OF TARGETS

4-10. General

a. Concept of Operation. The commander's concept of operation to accomplish the mission is the primary consideration in the attack of targets. An analysis of targets is required to ensure that the expenditure of ammunition is used to its best advantage.

b. Target Analysis. Target analysis is the examination of potential targets to determine their military importance, priority of attack, and capabilities of attack by available weapons. Targets of opportunity as well as targets for prearranged fires are analyzed.

c. Target Capability. Target capability is the ability, actual or potential, of a target to influence the accomplishment of the supported unit's mission. Target capability is an essential consideration in determining the priority assigned to the attack of a target and the amount of fire delivered on a target.

d. Decision. The decision is made after determining the optimum means, method of attack, time of attack, and ammunition to be expended. The decision sets forth the type and amount of ammunition to be employed, the units of fire, the grid reference (desired center of impact), the time of attack, and where applicable, safety instructions to friendly troops, and the method of conducting post attack analysis.

4-11. Sequence of Analysis

a. An analysis of factors bearing on the attack of a specific target, or target complex, is made to determine the most efficient method of attack. The target is normally analyzed in the following sequence:

(1) Selection of target area centers.

(2) Weapon capability and availability.

(3) Ammunition capability and availability.

(4) Troop safety.

(5) Amount of ammunition required to attain the desired results, i.e., neutralization or harassment for the type of target and terrain.

b. Each successive step in the analysis is made considering the data obtained in the preceding steps. The explicit purpose of the analysis must continually be kept in mind to determine the most effective method of attack that will best accomplish the mission.

4-12. Effectivenss Tables

a. Effectiveness tables published in Joint Munitions Effectiveness Manuals for Surface-to-Surface weapons (JMEM/SS) provides guidance for determining expected fraction of casualties. FM's 101-60-2 (105mm); 101-60-3 (155mm); 101-60-4 (8-Inch); 101-60-5 (175mm); 101-60-7 (4-2-Inch) and 101-60-8 (Honest John) provide guidance for determining the expected fraction of casualties, based on the weapon and target radius. Current predicted delivery errors were used in determining the expected fraction for both coverage and casualties.

b. The data contained in the tables provide expected results for fractional casualties expressed as a decimal fraction. Firing of a limited number of rounds against representative target arrays were averaged as a mathematical sam-

pling. The tables do not include assured damage or a probability of achieving at least a given fraction of damage.

Caution: **There is no assurance that the exact percentage for either "expected" fraction of casualties will be provided by one given volley or even that the listed value for six volleys will be obtained in a given situation. Although not precisely within the mathematical definition, the method of averaging data used for the tables will result in less damage being realized for approximately 50 percent of the rounds and conversely, greater damage for the other 50 percent of the rounds.**

c. The essential entry data are the target radius and the expected fraction of casualties required. Once the target radius is determined, the columns are compared by checking values from left to right. In comparing columns, the initial value (lowest number of rounds) which exceeds the desired expected casualty fraction is selected. If troop safety is not a factor, the reduction of combat effectiveness of the enemy is the primary basis for selection. A concentrated loss inflicted on a limited portion of the target has less overall effect on the recuperability of an enemy unit than the same number of casualties distributed over all, or most, of the target area. Greater coverage will be more likely to disrupt a greater number of key elements with more impact on unit effectiveness.

d. Completion of the analysis (*c* above) results in the recommendation and decision. The decision is transmitted as a fire mission to the unit or units to fire.

Section IV. GENERAL EFFECTS AGAINST TYPICAL TARGETS

4-13. Area Personnel Targets

The effectiveness of fire against area personnel targets (category 1) is discussed in paragraph 4-13, FM 6-141-2.

4-14. Small Personnel Targets

The effectiveness of fire against small personnel targets (category 2) of each weapon system is discussed in chapter 5.

4-15. Small Materiel (Point) Targets

a. The number of HE rounds required to obtain at least one, two, or three hits, after adjustment, for three different targets are shown in the single shot hit probability tables of chapter 5. Fire is observed and adjusted on the center of the target. In developing the single shot hit probability tables the following assumptions were made:

(1) The target is located at random in the target area. However, it is assumed to be facing the weapon on the weapon target line, thus revealing the smallest target profile to the weapon.

(2) Angle of fall was considered in computing single shot hit probabilities.

(3) The vertical dimensions of fortifications cannot be approximated and an impact on the top of the fortifications is assumed necessary to hit the targets.

(4) Probable errors in range and deflection were chosen for range with an elevation of approximately 300 mils.

(5) Assault fire techniques of maximum charge may be used against targets with a vertical surface and would decrease the number of rounds required to hit the target. This technique as opposed to firing quadrants of approximatly 300 mils would, in many cases, reduce the range and deflection probable errors thereby reducing the number of rounds required to hit the target.

b. In considering the effectiveness of a weapon system it should be noted that the larger the caliber weapon, the greater the damage from a direct hit. Chemical ammunition is not effective against small materiel (point) targets, when the destruction of materiel is desired. However, chemical ammunition is effective against materiel and fortified targets when the criteria is personnel casualties.

c. The effectiveness of the 155mm howitzer and 8-inch howitzer dual purpose ammunition against small materiel targets (category 3) is shown in table 4-10, FM 6-141-2. A representative target (parked tank) is depicted at six different ranges. The table shows the number of rounds from one weapon required to achieve an average assurance of a firepower or mobility kill on the target after adjustment. See also figures 5-1 through 5-8, FM 6-141-2 for casualty effectiveness data.

d. The following kill criteria, or damage categories are useful when discussing antimateriel effectiveness of ammunition:

(1) *Mobility (M) Damage (Kill)*: Loss of tactical mobility due to damage which cannot be repaired by the crew on the battlefield. This is usually called an "M" Kill. Thus, an "M" Kill

. means that a vehicle is not capable of controlled movement on the battlefield.

(2) *Firepower (F) Damage (Kill)*: Loss of tactical firepower due to damage which cannot be repaired by the crew on the battlefield. Thus, there is an "F" Kill when controlled fire cannot be directed from the main armament.

(3) *Catastrophic (K) Damage (Kill)*: A vehicle has sustained a "K" Kill when both "M" and "F" Kills occur, and when the damage is not economically repairable.

4-16. Area Materiel Targets

a. Table 4-2 shows the high explosive ammunition requirements (and fraction of hits) against area materiel targets (category 4). The amount of ammunition required to attain fraction of hits on one or more small materiel targets (20 square meters) located at random in 100, 150, and 200 meter target areas is shown. Area fire is directed at the target area and is unobserved. The 20 square meter target is equivalent to a tank or a truck. Three conditions are considered a direct hit, an impact within 5 meters, and an impact within 10 meters. A direct hit is usually required to destroy a hard target (tank). A hit within 10 meters will destroy, or seriously damage a medium target (truck, radar station, missile launcher). Table 4-3 shows typical material damage from high explosive ammunition. Chemical ammunition is not effective against area material targets when the destruction of materiel is desired. However, if the criteria is to defeat personnel within the materiel targets, then chemical agents should be considered. The ammunition requirements are based on the assumption that the materiel targets are stationary; however, if the materiel target is moving, an adjustment in the ammunition requirements may be required.

Table 4-2. High Explosive: Ammunition Requirements, Area Materiel Targets (Category 4), Average

Weapon	4.2-inch Mortar	105MM How	155MM How	175MM Gun	8-Inch How
Range (Meters)	3,000m	8,000m	9,000m	15,000m	9,000m
Target radius (meters)	Rounds required to obtain fraction of hits (in parentheses)				
100:					
Direct hit	400(. 129)	360(. 114)	180(. 076)	60(. 02)	60(. 029)
Impact within 5 meters	400(. 419)	360(. 381)	180(. 268)	60(. 082)	60(. 110)
Impact within 10 meters	128(. 50)	131(. 50)	100(. 50)	60(. 290)	60(. 370)
150:					
Direct hit	400(. 091)	360(. 082)	180(. 048)	60(. 010)	60(. 017)
Impact within 5 meters	400(. 316)	360(. 287)	180(. 175)	60(. 058)	60(. 064)
Impact within 10 meters	183(. 50)	185(. 50)	156(. 50)	60(. 213)	60(. 230)
200:					
Direct hit	400(. 060)	360(. 054)	180(. 029)	60(. 009)	60(. 010)
Impact within 5 meters	400(. 217)	360(. 195)	180(. 107)	60(. 036)	60(. 037)
Impact within 10 meters	285(. 50)	288(. 50)	180(. 362)	60(. 138)	60(. 139)

b. See paragraph 4-16*b*, FM 6-141-2. Additional effectiveness data for selected ammunition is included in table 4-11 FM 6-141-2 and figures 5-1 through 5-8 of FM 6-141-2.

4-17. Materiel Targets—Calculations

See paragraph 4-17, FM 6-141-2, and figures 4-3 and 4-4.

4-18. Ammunition Limitations

See paragraph 4-18, FM 6-141-2.

Section V. TROOP SAFETY

4-19. Safe Distance Factors for Standard High Explosive Ammunition (Air Burst)

Three factors must be considered in determining safe distance information for friendly troops. These are:

a. Distribution of projectile bursts around the targets.

b. Size, travel distance, and the striking velocity of fragments from a bursting projectile.

c. The number of volleys fired and the number of troops in the vicinity of the target.

4-20. Safety Distances (Single Battery Volley, Single Individual)

Table 4-4 contains safety distances (and associated risks) for a single battery volley and a single individual. Commanders who use the troop safety risk data provided in table 4-4 should be aware of the applicability of the data.

Table 4-3. Typical Materiel Damage (From HE Detonations)

Materiel	Type of damage produced
Artillery pieces, heavy rockets	Scores recoil or launching slides, dents mechanisms, punctures pneumatic tires, damages optical devices, perforates light metal parts.
Artillery or mortar ammunition	Punctures containers, metal shell cases for fixed ammunition, scores rotating bands, starts secondary fires.
Light weapons (machineguns), antitank rocket launchers, etc.).	Perforates light metal prats or scores critical working parts to produce serious damage.
Electronic and communication equipment (radios, radars, field telephones, etc.).	Perforates and effectively damages all components.
Wheeled vehicles	Punctures body, windshields, tires, gas and oil lines, electrical components, radiators, gas tanks, etc., secondary fires.

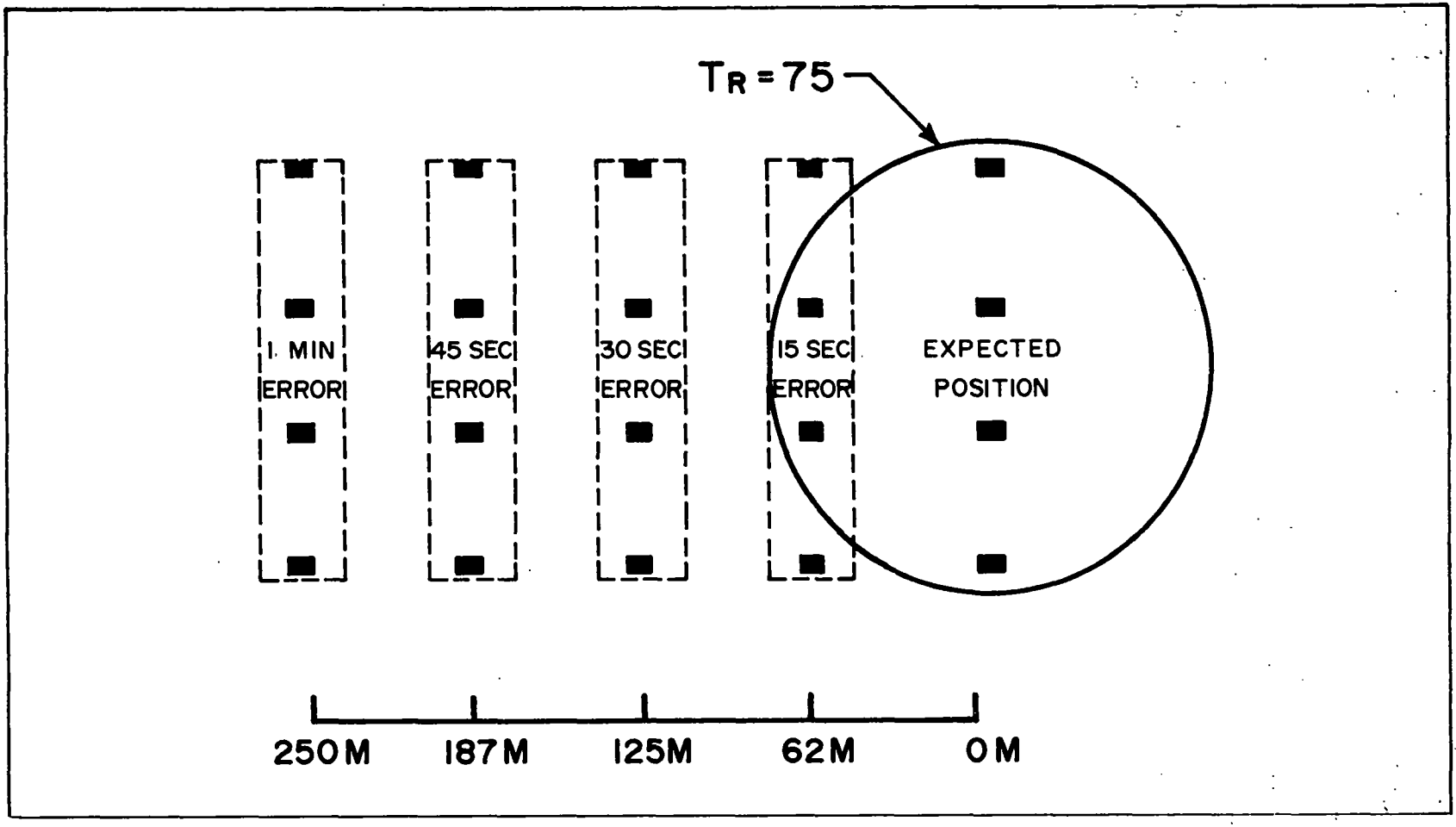

Figure 4-3. Forward observer time estimation errors and corresponding distances. Rate of target advance: 15 km/hr.

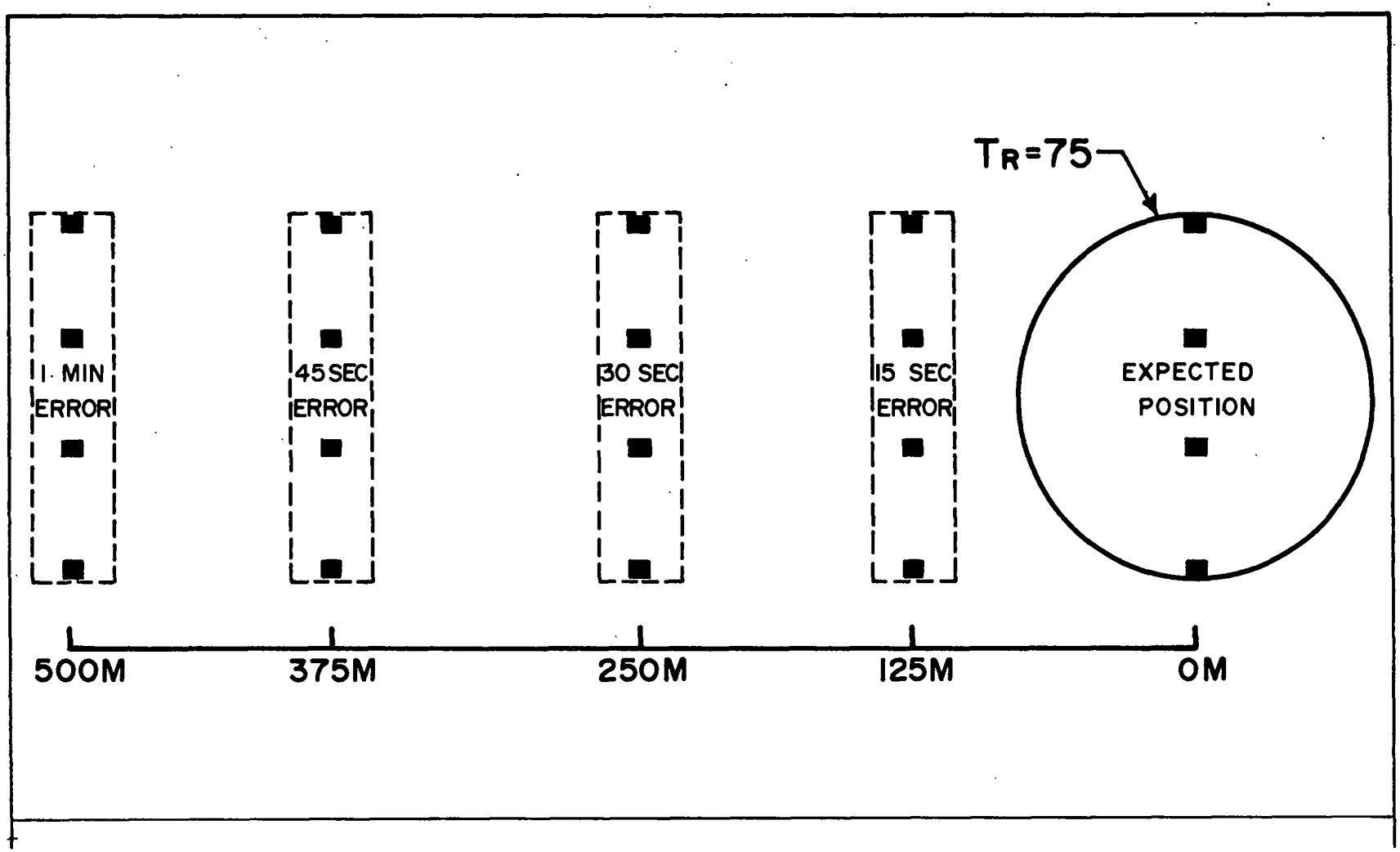

Figure 4-4. Forward observer time estimation errors and corresponding distances. Rate of target advance: 30 km/hr.

Table 4-4. Safety Distances for High Explosive Ammunition

'X' distance from target, m	Probability (risk) of a casualty-producing hit on troops located 'X' distance from target									
	4.2-inch mortar		105mm howitzer		155mm howitzer		175mm gun		8-inch howitzer	
	Target-Range, m		Target-Range, m		Target-Range, m		Target-Range, m		Target-Range, m	
	1,000	5,000	2,000	10,000	2,000	14,000	4,000	28,000	4,000	16,000
100	.05	.13	.07	.08	.13	.05	.10	.03	.13	.05
200	.002	.006	.01	.02	.02	.01	.02	.01	.02	.02
400	.0000008	.00001	.0003	.0007	.0006	.0009	.0007	.001	.0005	.001
600	.000000001	.00000003	.000008	.00003	.00002	.00007	.00002	.0002	.00001	.0001
800			.0000002	.000001	.0000005	.000005	.0000008	.00003	.0000003	.000009
1,000			.000000006	.00000005	.00000002	.0000004	.00000003	.000003	.000000008	.0000007
1,200				.000000002		.00000003		.0000004		.00000006

Note: MSD'S for HJ and Lance are secured from the appropriate firing table.

a. The data were derived specifically for airburst (20 meters) projectiles fired in a parallel sheaf using the Met + VE technique of fire. The data can also be used for ground or low airbursts. When the projectiles burst on, or very near the ground, the risks will increase in the proximity of the target (less than 200 meters) but will become smaller at distances greater than approximately 200 meters from the target.

b. The safety information is based on fragmentation data for forged steel, TNT loaded projectiles (Comp B for the 175mm). Comp B loaded, or high fragmentation steel projectiles, which break up into smaller fragments, will result in smaller risks at the greater distances from the target and conversely, greater risks may occur at shorter distances.

c. The battery and target locations are assumed to be known accurately. The occurrence of gross errors or mistakes, such as 10 or 100 mil quadrant or deflection error on a weapon are not included in the data.

4-21. Close Fire Support

Nothing contained herein will preclude the furnishing of close fire support to the maneuver combat elements. Request for fire from the maneuver combat elements will be answered when necessary without regard to the minimum safe distances involved. The supported maneuver commander submitting the fire request is responsible for the decision to call for fires when those fires are at less than minimum safe distance to friendly positions. The warning 'danger close' is given by the requestor to indicate that friendly troops are within 600 meters of the target. When mortars are firing, the 'danger close' warning factor is 400 meters.

4-22. Troop Safety for Selected Ammunition

See paragraph 4-22, FM 6-141-2. See table 4-8, FM 6-141-2 for minimum safe distance (selected ammunition).

Section VI. DESTRUCTION OF SELECTED AMMUNITION TO PREVENT ENEMY USE

4-23. Need for Destruction

a. Destruction becomes necessary under conditions where capture is imminent, evacuation is impossible, and the ammunition cannot be fired at the enemy.

b. Preventing any ammunition from falling into enemy hands is of primary importance.

4-24. Authority for Destruction

a. When subject to capture or abandonment, destruction of ammunition described herein, will be undertaken by the using arm only when, in the judgment of the unit commander concerned, such action is necessary in accordance with orders of, or policy established by, the army commander.

b. The conditions under which destruction will be effected are command decisions and may vary in each case, dependent upon a number of factors such as the tactical situation, security classification of ammunition (AR 380-5), quantity, type, and location of ammunition, facilities for accomplishing destruction and time available.

4-25. Method of Destruction

a. General. Effective destruction methods are dependent on prior planning and preparation. Written procedures and SOP's must be complete and detailed.

b. Detonation of Projectile. Detonation of individual rounds is the most certain method of destroying the projectile and grenade cargo. For detailed procedures, refer to the appropriate operators technical manuals.

c. Burning. If adequate demolition materiel is not available for destruction, all available combustible materiel will be used for burning the ammunition.

4-26. Disposition of Dud Grenades

Warning: **A high explosive grenade which has fallen as a dud will not be moved under any circumstances but will be destroyed in place by Explosive Ordnance Disposal personnel only.**

CHAPTER 5

CANNON WEAPON SYSTEMS

CHARACTERISTICS AND EFFECTIVENESS

Section I. GENERAL

5-1. Purpose

This chapter provides data on cannon weapon systems characteristics and effectiveness. The data contained herein is intended to provide general guidance to commanders and staff officers.

5-2. Scope

The chapter will include discussion and present data relative to the following:

a. Types of ammunition and fuzes for the 105mm, 155mm and 8-inch howitzers, the 175mm gun, and 107mm mortar.

b. Selected ammunition grenade data.

c. Typical targets and suggested methods of attack.

d. Single shot hit probabilities.

e. Singles shot hit probabilities against type targets.

f. Mean Point of Impact (MPI) errors.

g. Precision (Dispersion) data.

h. Average fraction of casualties against personnel targets.

i. Developmental selected ammunition data.

Section II. 105MM HOWITZER

5-3. Characteristics

a. M101A1 (Towed)

(1) Weight—4,980 pounds

(2) Maximum range:

(a) 11,000 meters with standard ammunition

(b) 14,500 meters with M548 Rocket Assisted Projectile

(3) Minimum high angle range—2,550 meters

(4) Traverse:

Left—400 mils

Right—409 mils

(5) Maximum muzzle velocity—(465 meters/sec.)

b. M102 (Towed)

(1) Weight—3,140 pounds

(2) Maximum range:

(a) 11,500 meters with standard ammunition

(b) 15,000 meters with M548 Rocket Assisted Projectile

(3) Minimum high angle range—2,160 meters

(4) Traverse—6,400 mils

(5) Maximum muzzle velocity—(494 meters/sec.)

c. M108 (Self-Propelled)

(1) Weight—46,921 pounds (combat loaded)

(2) Maximum range:

(a) 11,600 meters with standard ammunition

(b) 15,100 meters with M548 Rocket Assisted Projectile

(3) Minimum high angle range—2,160 meters

(4) Traverse—6,400 mils

(5) Maximum muzzle velocity—(494 meters/sec.)

5-4. Rate of Fire

a. Maximum. 10 rounds/minute for first 3 minutes.

b. Sustained. 3 rounds/minute.

5-5. Principal Types of Ammunition and Fuzes

a. Table 5-1 shows the types of ammunition and fuzes for the 105mm howitzer.

b. See table 5-2 for selected ammunition grenade data (M413 and M444). See also paragraph 5-5*b*, FM 6-141-2 for discussion of selected ammunition grenade performance data.

c. See table 5-10, FM 6-141-2 for 105MM Howitzer developmental selected ammunition information.

Table 5-1. Types of Ammunition and Fuzes for the 105mm Howitzer

Weapon	Ammunition type	Model	As fired weight of projectile (pounds)	Fuze action			
				Point detonating	Base detonating	Mechanical time	Proximity
105mm Howitzer M101A1, M102, M018	HE	M1 *	33.00	Yes	No	Yes	Yes
	APERS-T (Beehive)	M546	28.50	No	No	Yes	No
	HEAT	TP-T M67	28.80	No	No	No	No
	HEAT	XM622 **	22.35	No	No	No	No
	HEP, HEP-T	M327	23.40	No	Yes	No	No
	Smoke, HC	M84	32.86	Yes	No	Yes	No
	Smoke, WP	M60	34.80	Yes	No	Yes	No
	Colored smoke, BE	M84	(Green) 30.48; (Red) 30.68; (Yellow) 30.29.	No	No	Yes	No
	Gas, HD	M60	33.00	Yes	No	Yes	No
	Gas, GB	M360	35.40	Yes	No	No	No
	Illuminating	M314 Series	34.70	No	No	Yes	No
	HE, RAP	M548	28.50	Yes	No	Yes	Yes
	Gas, Tactical, C5	M629	33.60	No	No	Yes	No
	ICM	M413	33.00	No	No	Yes	No
	ICM	M444	33.00	No	No	Yes	No

* Uses CP Fuze
** Uses point initiating base detonating fuse

Table 5-2. Selected Ammunition Grenade Data

Weapon	Ammunition	Grenade		Grenade Quantity
		Model	Type	
105MM	M413	M35	AP(G)	18
105MM	M444	M39	AP(A)	18
155MM	M449	M43	AP(A)	60
155MM	M449A1	M43A1	AP(A)	60
155MM	M483	M42	*AP/AM(G)	88
155MM	M483	M46	*AP/AM(G)	24
8-Inch	M404	M43A1	AP(A)	104
8-Inch	M509	M42	DP	195
107MM	M453	M36	AP(A)	32

*AP / AM(G). The bottom three layers of the subammunition are M46 items with nonembossed sidewalls for strength purposes. The M42 has a controlled fragmentation sidewall.

Table 5-3. Typical Targets and Suggested Methods of Attack. 105mm Howitzer, Direct and Indirect Fire

Type of target	Unit	Shell*	Fuze** action
Indirect Fire			
Cave	Single Piece	HE	Q/D
Bridge	do	HE	Q/D
Building (frame)	do	HE, WP	Q
Squad (open)	Battery	HE, CHEM, ICM (AP)	Q/VT/Ti
Platoon (open)	do	HE, CHEM, ICM (AP)	Q/VT/Ti
Platoon (dug in)	do	HE, WP, CHEM, ICM (AP)	VT/Ti/Q
Command post	do	HE, WP, CHEM, ICM (AP)	VT/Ti/Q
Fortification	do	HE, CHEM	Q/D/(VT)
MG emplacement	do	HE, CHEM, ICM (AP)	Q/D/(VT)
Supply installation	do	HE, WP, CHEM	Q/VT/Ti
Communication center	do	HE, WP, CHEM, ICM (AP)	Q/VT/Ti
Radar installation	do	HE, CHEM	Q/VT/Ti
Rocket launchers	do	HE	Q/VT/Ti
Personnel carriers	do	HE, WP, CHEM	VT/Q
Tanks	do	HE, WP, CHEM	Q/(VT)
Platoon (open)	Battalion	HE, CHEM, ICM (AP)	Q/VT/Ti
Company (open)	do	HE, CHEM, ICM (AP)	Q/VT/Ti
Artillery battery	do	HE, WP, CHEM, ICM (AP)	VT/Ti/(Q)
Fortification	do	HE, CHEM	Q/D/(VT)
Mortar battery	do	HE, WP, CHEM, ICM (AP)	VT/Ti/(Q)
Supply installation	do	HE, WP, CHEM	Q/VT/Ti
Communication center	do	HE, WP, CHEM, ICM (AP)	Q/VT/Ti
Direct Fire			
Roadblock		HE	Q
Personnel carrier(s)		HEAT, HEP, HEPT	BD
Squad(s)		Beehive	Ti
Tank(s)		HEAT, HEP, HEPT	BD

*Chemical shells are toxic chemical ammunition.
**Fuzes in parentheses are for toxic chemical ammunition.

5-6. Typical Targets and Suggested Methods of Attack

Table 5-3 shows typical targets for the 105mm howitzer and suggested methods of attack. Chemical ammunition is effective against personnel. If the criteria is to destroy the materiel, chemical ammunition should not be employed.

5-7. Casualty Effectiveness

a. Tables 5-4 and 5-5, FM 6-141-2 give the expected fraction of casualties against personnel targets for projectiles M413 and M444 respectively. Personnel in the offense are considered equivalent to one-half standing and one-half prone for the first volley and all prone for the

subsequent volleys. Personnel in the defense are considered equivalent to one-half prone and one-half in foxholes for the first volley and all in foxholes for subsequent volleys.

b. Effectiveness data tables in FM 101-60-2 may be used in determining the number of volleys required to expect a desired percentage of casualties against personnel targets. Effectiveness data for area personnel targets are computed for only those rounds fired during the fire-for-effect phase and are divided according to the delivery techniques employed. The two techniques are observer adjusted and MET + VE. M1 ammunition on three target postures in open terrain or marsh grass is used. Personnel are assumed to be uniformly distributed throughout a circular target area. Target radii are for 50, 100, 150, 200, and 250 meters. The effectiveness numbers are based on a six howitzer (M101A1) battery firing a parallel sheaf from a "lazy W" or "star" formation. Data are shown for each range/angle of fall indicated in the tables.

5-8. Lethality

See paragraph 4-4.

5-9. Single Shot Hit Probabilities

Table 5-6 shows observed fire single shot hit probabilities of the 105mm howitzer against two representative targets and against a tank target (3 x 7m) front and side posture. The table shows probabilities after adjustment for both low and high angle fire when a single piece is employed. Table 5-7 shows the number of rounds required to expect an assurance of at least one, two, or three hits when the single shot hit probability is known.

5-10. Precision (Dispersion)

Table 5-8 shows precision (dispersion) data for low and high angle fire for the M101A1 and M102 howitzers respectively.

Table 5-6. Single Shot Hit Probabilities for 105mm Howitzer

M101A1

Range	Charge	Probable error		Probability of hitting target		*Tank 3x7m		Bridge: 10x200m	
		Range	Defl	10x10M	20x20M	Front	Side	L - 200	L - 10
Low Angle									
2,000	1	12	1	.223	.425	.107	.069	.999	.223
4,000	4	22	2	.112	.238	.033	.029	.906	.124
6,000	6	17	4	.093	.281	.023	.022	.601	.156
8,000	7	16	5	.083	.271	.019	.018	.500	.166
10,000	7	20	7	.049	.175	.011	.011	.368	.134
High Angle									
2,000	1	10	4	.158	.454	.038	.036	.601	.264
4,000	3	24	6	.048	.165	.011	.010	.423	.113
6,000	5	38	7	.026	.091	.005	.006	.340	.070
8,000	7	17	12	.035	.131	.008	.008	.223	.156
10,000	7	22	11	.029	.110	.006	.006	.238	.124

M102

Low Angle									
2,000	1	14	1	.192	.368	.092	.058	.999	.192
4,000	4	18	1	.150	.294	.070	.042	.999	.150
6,000	6	10	1	.264	.500	.128	.079	.999	.264
8,000	7	14	2	.174	.368	.052	.045	.908	.192
10,000	7	16	2	.151	.329	.046	.037	.908	.166
High Angle									
2,000	1	14	3	.142	.359	.035	.034	.740	.192
4,000	3	24	8	.037	.134	.008	.008	.328	.113
6,000	6	12	5	.112	.349	.025	.023	.500	.223
8,000	7	16	6	.070	.243	.016	.015	.425	.166
10,000	7	19	5	.070	.230	.016	.016	.500	.140

Note: All dimensions are in meters.

*3x7M: 3=Front, 7=Side

Table 5-7. Single Shot Hit Probabilities Against Type Targets for 105MM Howitzers, M101A1 and M102

	M101A1						M102					
	Charge	Range	Single shot hit probability	Rounds required for 90 % probability			Charge	Range	Single shot hit probability	Rounds required for 90% probability		
				1-Hit	2-Hits	3-Hits				1-Hit	2-Hits	3-Hits
Bridge 10 x 200*	6	6000	.156	13	24	32	6	6000	.264	7	13	18
Pillbox 10 x 10	6	6000	.093	23	39	54	6	6000	.264	7	13	18
Fortification 20 x 20	6	6000	.281	7	12	17	6	6000	.500	3	6	9
Tank 3x7M Front	6	6000	.023	>70	>70	>70	6	6000	.128	17	29	40
Tank 3x7M Side	6	6000	.022	>70	>70	>70	6	6000	.079	28	46	64

* Perpendicular to direction of fire. All dimensions are in meters.

Table 5-8. Precision (Dispersion) for 105mm Howitzers, M101A1 and M102

	M101A1 How					M102 How				
			Probable errors					Probable errors		
Range (meters)	Charge	Elevation (mils)	Range (meters)	Deflection (meters)	Angle of fall (mils)	Charge	Elevation (mils)	Range (meters)	Deflection (meters)	Angle of fall (mils)
Low Angle Fire										
2,000	1	296	12	1	314	1	264	14	1	279
3,000	2	411	18	2	448	2	359	19	1	388
4,000	3	491	23	3	546	3	413	22	2	457
5,000	4	505	29	3	575	4	421	23	2	476
6,000	5	452	33	4	526	5	382	14	4	442
7,000	6	407	22	4	490	6	376	11	1	460
8,000	7	365	16	5	479	7	336	14	2	459
9,000	7	444	18	6	577	7	408	15	2	550
10,000	7	544	20	7	697	7	495	16	2	653
High Angle Fire										
3,000	2	1148	19	4	1207	2	1197	19	6	1247
4,000	3	1066	24	5	1134	3	1136	24	8	1200
5,000	4	1047	31	6	1126	4	1122	28	10	1197
6,000	5	1094	38	7	1181	5	1154	19	10	1237
7,000	6	1146	28	9	1239	6	1166	14	5	1257
8,000	6	1044	32	9	1152	7	1195	16	6	1295
9,000	7	1112	20	11	1221	7	1132	17	6	1245
10,000	7	1018	22	11	1152	7	1057	19	5	1185

5-11. Mean Point of Impact (MPI) Errors

Table 5-9 shows the MPI errors for the 105mm howitzer.

5-12. Effects of Protection (Shielding)

a. General. One of the principal uses of the 105mm howitzer is for indirect fire against personnel; however, field artillery fire can be relatively ineffective when enemy personnel are shielded or protected.

b. HE Ammunition. See paragraph 5-12*b*, FM 6-141-2.

5-13. Precision Fire Against Materiel Targets

a. The 105mm howitzer is a reasonably effective precision fire weapon, however, one hit from a large caliber weapon (155mm or 8-inch howitzer) will produce greater damage than one hit from the 105mm howitzer. Various fire direction techniques, such as observer adjusted fire, MET plus VE and K-transfer, may be used when one piece is employed in an indirect fire mission against known materiel targets; observed fire, however, is preferred. Suppose that one M101A1 105mm howitzer is engaged in a fire mission against a bridge 10 meters wide and 200 meters long at a range of 6,000 meters (table 5-7). Upon completion of adjustment by the observer, the center of the dispersion area should be on, or very near, the center of the bridge. Upon commencement of fire for effect, the single round hit probability is .156. The probability of obtaining at least one hit on the bridge with the first 13 rounds is 90 percent.

b. If it is necessary to obtain two hits on the bridge, then approximately 24 rounds are required; to obtain three hits, a minimum of 32 rounds is needed. These numbers are for high assurance. In an observed fire mission, the observer will continue firing until the target has been destroyed.

5-14. Area Fire Against Materiel Targets

a. The effectiveness of the 105mm howitzer against materiel targets varies greatly depending upon the hardness of the target (para 4-16 and table 4-2). A direct hit is usually required to destroy a hard target (tank or APC). A hit within 10 meters will destroy, or seriously damage, a medium target, such as a truck, radar station, or a missile launcher.

b. When the 105mm howitzer is employed against an area target, the probability of obtaining a direct hit upon any single target element within the area is low.

Table 5-9. MPI Errors for 105mm Howitzer, M101A1

Observer Adjusted Delivery Technique			
		Probable error	
Range	Charge	Range	Deflection
1,000	1	18.9	18.2
3,000	4	24.3	18.2
5,000	6	24.3	18.2
7,000	7	24.3	18.2
9,000	7	25.6	18.2
11,000	7	28.3	18.2
MET plus VE Delivery Technique			
1,000	1	44.5	22.3
3,000	4	51.9	22.3
5,000	6	60.0	24.3
7,000	7	72.8	29.0
9,000	7	95.1	35.1
11,000	7	120.7	42.5

Note: Mean burst height for fuze VT M514A1E1 is 4.8 meters with PE of 1.55 meters. All dimensions are in meters.

5-15. Direct Fire Against Materiel Targets

At least one round normally is required for adjustment on a small target in direct fire. Fire for effect can then commence with the second round. With a trained crew, the single round hit probability in direct fire is high. For example, the single round hit probability on an enemy tank at 1,000 meters is 0.72.

Section III. 155MM HOWITZER

5-16. Characteristics

a. M114A1 (Towed)

(1) Weight—12,700 pounds
(2) Maximum range—14,000 meters
(3) Minimum high angle range—2,970 meters
(4) Traverse:
Left—418 mils
Right—448 mils
(5) Maximum muzzle velocity—1,844 ft/sec.

b. M109 (Self-Propelled)

(1) Weight—52,461 pounds (combat loaded)
(2) Maximum range—14,600 meters with unassisted (standard) ammunition. 19,400 meters with rocket-assisted (M549) ammunition.
(3) Minimum high angle range—2,500 meters
(4) Traverse—6,400 mils

(5) Maximum muzzle velocity—1,841 ft/sec.

c. M109A1 (Self-Propelled)

(1) Weight—53,000 pounds (combat loaded)

(2) Maximum range—18,600 meters with unassisted (standard) ammunition. See paragraph 5-16c (2), FM 6-141-2 for maximum range of M549 RAP.

b. M3/M4 Series

M114A1/M109	I-RD/Min/Sustained
M109A1	I-RD/Min/Sustained

(3) Minimum high angle range—2,500 meters

(4) Traverse—6,400 mils

(5) Maximum muzzle velocity—2,250 ft./sec.

5-17. Rates of Fire

a. Maximum. 4 rounds/minute for the first 3 minutes.

M119

Not Compatible

I-RD/MIN/60 min, then I-RD/3min/sustained

5-18. Principal Types of Ammunition and Fuzes

a. Table 5-11 shows the principal types of ammunition and fuzes for the 155mm howitzer.

b. See table 5-2 for selected ammunition grenade data (M449, M449A1, and M483).

c. See paragraph 5-18*c* and table 5-18, FM 6-141-2 for developmental selected ammunition data.

5-19. Typical Targets and Suggested Methods of Attack

Table 5-12 shows typical targets for the 155mm howitzer and suggested methods of attack. Chemical ammunition is effective against personnel. If the criteria is to destroy the materiel or fortifications, chemical agents should not be used.

5-20. Casualty Effectiveness

a. Table 5-17, FM 6-141-2 gives the expected fraction of casualties against personnel targets for projectile M449. Personnel in the offense are considered equivalent to one-half standing and one-half prone for the first volley and all prone for the subsequent volleys. Personnel in the defense are considered equivalent to one-half prone and one-half in foxholes for the first volley and all in foxholes for subsequent volleys.

Table 5-11. Authorized Projectile-Fuze Combinations for Howitzer M114A1/M109/M109A1 with Cannons M126/M185 Series

		IMPACT PD							MT		MTSQ						PROX			
		M48A3, M48A2	M51A5, M51A4	M57 (Mod)w / booster	M78 Series (CP)	M508 Series	M535	M557	M67A3	M565	M501 Series	M520 Series	M548	M564	M577	M582	M514	M514A3 (M514A1E1)	M728	Projectile weight as fired
Agent, H, Persistent—	M109A1		X			X		X				X								95.00
M110	M114A1, M109		X	X		X	X	X	X			X								
Agent, HD, Persistent—	M109A1		X			X		X				X								95.00
M110	M114A1, M109		X	X		X	X	X	X			X								
Agent, GB, Nonpersistent,	M109A1					X		X												101.60
M121, M121A1,	M114A1, M109					X	X	X									P	P	P	
Agent, VX, Persistent,	M109A1					X		X												101.60
M121, M121A1, M114A1	M109					X	X	X									P	P	P	
HE, RAP 549	M109A1																			96.00
	M114A1, M109							X									P			
HE, M107	M109A1		X		X	X		X				X				X				95.00
(Shallow Cavity) M114A1	M109		X	X	X	X	X	X	X			X		X						

Table 5-11. Authorized Projectile-Fuse Combinations for Howitzer M114A1/M109/M109A1 with Cannons M126/M185 Series—Continued

		IMPACT PD							MT		MTSQ						PROX			Projectile weight as fired
		M48A3, M48A2	M51A5, M51A4	M57 (Mod)w/ booster	M78 Series (CP)	M508 Series	M535	M557	M67A3	M565	M501 Series	M520 Series	M548	M564	M577	M582	M514	M514A3 (M514A1E1)	M728	
HE, M107	M109A1		X		X	X		X				X				X				95.00
(Deep Cavity)	M114A, M109		X	X	X	X	X	X	X			X		X			P	P	P	
HE, M483	M109A1																			104.00
	M114A1, M109														X					
HE, M449	M109A1									X			X							95.00
M449A1	M114A1, M109									X			X		X					
Illum M118	M109A1																			100.0
	M114A1, M109										X				X					
Illum, M485,	M109A1									X			X							90.00
M485A1, M485A2,	M114A1, M109									X			X		X					
Smoke, HC, BE	M109A1	X									X									95.0
M116E1	M114A1, M109	X									X									
Smoke, Green, BE,	M109A1	X									X									86.4
M116	M114A1, M109	X									X									
Smoke, Red, BE,	M109A1	X									X									95.00
M116B1	M114A1, M109	X									X									
Smoke, Yellow, BE,	M109A1	X									X									95.00
M116B1	M114A1, M109	X									X									
Smoke, WP, M110	M109A1		X			X		X				X		X						97.75
	M114A1, M109		X	X		X	X	X	X			X	X							

X = Authorized fuze
P = Remove supplementary charge before fitting proximity fuze to projectile.

Table 5-12. Typical Targets and Suggested Methods of Attack, 155mm Howitzer

Indirect Fire

Type of target	Unit	Shell*	Fuze**
Cave	Single piece	HE	Q/D
Bridge	do	HE	Q/D
Building (frame)	do	HE, WP	Q
Squad (open)	Battery	HE, CHEM, ICM (AP)	Q/VT/Ti
Platoon (open)	do	HE, CHEM, ICM (AP)	Q/VT/Ti
Platoon (dug in)	do	HE, WP, CHEM, ICM (AP)	VT/Ti/Q
Command post	do	HE, WP, CHEM, ICM (AP)	VT/Ti/Q
Fortification	do	HE, CHEM	Q/D/(VT)
MG emplacement	do	HE, CHEM, ICM (AP)	Q/D/(VT)
Supply installation	do	HE, WP, CHEM, ICM (AM/AP)	Q/VT/Ti
Communication center	do	HE, WP, CHEM, ICM (AM/AP)	Q/VT/Ti
Radar installation	do	HE, CHEM, ICM (AM/AP)	Q/VT/Ti
Rocket launcher	do	HE, ICM (AM/AP)	Q/VT/Ti
Personnel carriers	do	HE, WP, CHEM, ICM (AM/AP)	VT/Q
Tanks	do	HE, WP, CHEM, ICM (AM/AP)	Q/(VT)
Platoon (open)	Battalion	HE, CHEM, ICM (AP)	Q/VT/Ti
Company (open)	do	HE, CHEM, ICM (AP)	Q/VT/Ti
Artillery battery	do	HE, WP, CHEM, ICM (AM/AP)	VT/Ti/(Q)
Fortification	do	HE, CHEM	Q/D/(VT)
Mortar battery	do	HE, WP, CHEM, ICM (AM/AP)	VT/Ti/(Q)
Supply installation	do	HE, WP, CHEM, ICM (AM/AP)	Q/VT/Ti
Communication center	do	HE, WP, CHEM, ICM (AP)	Q/VT/Ti
		Direct Fire.	
Roadblock		HE	Q/D
Personnel carriers(s)		HE	Q
Squad(s)		HE	Ti
Tank(s)		HE	Q

*Chemical shells are toxic chemical ammunition.
**Fuzes in parentheses are for chemical ammunition.

b. Effectiveness data tables in FM 101-60-3 may be used in determining the number of volleys required to expect a desired percentage of casualties against personnel targets. Effectiveness data for area personnel targets are computed for only those rounds fired during the fire-for-effect phase and are divided according to the delivery techniques employed. The two techniques are observer adjusted and MET + VE. M107 ammunition on three target postures in open terrain or marsh grass is used. Personnel are assumed to be uniformly distributed throughout a circular target area. Target radii are for 50, 100, 150, 200 and 250 meters. The effectiveness numbers are based on a six howitzer M109 battery firing a parallel sheaf from a lazy W or star formation. Data are shown for each range/angle of fall indicated in the tables.

c. Figures 5-1 through 5-4 show the expected casualty effectiveness for the M483 projectile against personnel. Personnel in offense are equivalent to personnel half standing and half prone for the first volley, and all prone for the second and subsequent volleys. Personnel in defense are equivalent to personnel half prone and half in foxholes for the first volley and all in foxholes for the second and subsequent volleys. A 5 percent dud rate was considered in determining the effectiveness of selected ammunition.

5-21. Lethality

See paragraph 4-4.

5-22. Single Shot Hit Probability

Table 5-13 shows the observed fire, single shot hit probabilities of the 155mm howitzer. The table shows probabilities after adjustment for both low and high angle fire when a single piece is employed against two representative targets. Table 5-14 shows the number rounds required to expect an assurance of at least one, two, or three hits when the single shot hit probability is known.

5-23. Precision (Dispersion)

Table 5-15 shows the precision (dispersion) for low and high angle fire using HE ammunition.

Table 5-13. Single Shot Hit Probabilities for 155MM Howitzers, M109A1, M109, M114, M114A1, and M44A1

Range Low Angle	Charge	Probable error		Probability of hitting target		*Tank 3x7M		*Bridge 10x200M	
		Rn.	Defl.	10x10M	20x20M	Front	Side	10M	200M
M109A1									
4,000	3G	16	4	.100	.299	.024	.022	.166	.601
6,000	5G	15	5	.088	.287	.020	.020	.176	.500
8,000	6W	23	4	.071	.207	.016	.017	.118	.599
10,000	7W	26	5	.051	.166	.011	.012	.102	.495
12,000	7W	30	7	.034	.117	.007	.007	.091	.359
14,000	7W	34	8	.027	.093	.005	.005	.081	.314
16,000	8	51	9	.016	.059	.003	.003	.054	.240
18,000	8	58	12	.011	.039	.002	.002	.049	.168
High Angle									
4,000	3G	15	11	.042	.160	.009	.009	.176	.238
6,000	4G	26	12	.023	.086	.005	.005	.102	.221
8,000	5G	24	15	.020	.078	.004	.004	.113	.176
10,000	7W	25	14	.021	.078	.004	.004	.108	.191
12,000	7W	32	13	.017	.066	.004	.004	.086	.195
14,000	7W	37	12	.017	.062	.003	.003	.075	.209
16,000	8	57	16	.008	.032	.002	.002	.049	.126
18,000	8	62	14	.008	.032	.002	.001	.043	.139
M109									
4,000	3G	14	2	.174	.368	.052	.045	.192	.833
6,000	5G	13	3	.150	.387	.038	.037	.202	.740
8,000	6W	27	4	.061	.179	.014	.014	.102	.593
10,000	7W	27	4	.061	.179	.014	.014	.102	.593
12,000	7W	31	5	.043	.141	.010	.010	.086	.486
14,000	7W	36	6	.032	.111	.007	.006	.075	.399
High Angle									
4,000	3G	20	6	.057	.195	.013	.013	.134	.424
6,000	4G	22	9	.036	.130	.008	.008	.124	.294
8,000	5G	25	7	.043	.142	.008	.008	.108	.365
10,000	7W	31	9	.025	.093	.005	.006	.086	.286
12,000	7W	36	9	.022	.082	.005	.004	.075	.277
14,000	7W	40	8	.023	.081	.005	.005	.070	.299

Table 5-13. Single Shot Hit Probabilities for 155MM Howitzerrs, M109A1, M109, M114, M114A1, and M44A1—Continued

Range Low Angle	Charge	Probable error		Probability of hitting target		*Tank 3x7M		*Bridge 10x200M	
		Rn.	Defl.	10x10M	20x20M	Front	Side	10M	200M
				M114, M114A1, M44A1					
4,000	3G	19	1	.140	.279	.067	.042	.140	.999
6,000	5G	18	2	.137	.294	.040	.033	.150	.908
8,000	6W	32	2	.078	.166	.023	.020	.086	.877
10,000	7W	37	3	.056	.141	.013	.012	.075	.694
12,000	7W	43	4	.039	.112	.009	.007	.065	.531
14,000	7W	52	5	.027	.084	.006	.006	.054	.402
High Angle									
4,000	2G	24	2	.103	.223	.031	.025	.113	.904
6,000	4G	30	4	.055	.160	.013	.012	.091	.586
8,000	5G	33	5	.040	.132	.010	.010	.080	.480
10,000	6W	46	6	.025	.087	.006	.005	.059	.364
12,000	7W	51	8	.018	.065	.004	.004	.054	.268
14,000	7W	58	7	.018	.061	.004	.004	.049	.277

* Probabilities were computed for dimensions when parallel to line of fire.

Table 5-14. Single Shot Hit Probabilities Against Type Targets for 155MM Howitzers, M109A1, M109, M114, M114A1, and M44A1

	Charge	Range	Single shot hit probability	Rounds required for 90% probability		
				1-Hit	2-Hits	3-Hits
			M109A1 How			
Bridge 10x200*	5GB	6,000	.176	12	20	28
Pillbox 10x10	5GB	6,000	.088	25	42	58
Fortification 20x20	5GB	6,000	.287	7	12	17
Tank 3x7m Front	5GB	6,000	.020	>70	>70	>70
Tank 3x7m Side	5GB	6,000	.020	>70	>70	>70
			M109 How			
Bridge 10x200*	5GB	6,000	.202	10	18	25
Pillbox 10x10	5GB	6,000	.150	14	24	34
Fortification 20x20	5GB	6,000	.387	5	9	12
Tank 3x7m Front	5GB	6,000	.038	57	>70	>70
Tank 3x7m Side	5GB	6,000	.037	58	>70	>70
			M114, M114A1, M44A1 How			
Bridge 10x200*	5GB	6,000	.150	14	24	34
Pillbox 10x10	5GB	6,000	.137	16	27	38
Fortification 20x20	5GB	6,000	.294	7	12	16
Tank 2x7m Front	5GB	6,000	.040	55	>70	>70
Tank 3x7m Side	5GB	6,000	.033	65	>70	>70

All dimensions are in meters.
* Perpendicular to direction of fire.

Table 5-15. Precision (Dispersion) for 155MM Howitzers (M109, M109A1 and M114, M114A1, M44A1)

M109 and M109A1						M114, M114A1 and M44A1					
			Probable error					Probable error		
Range (meters)	Charge	Elevation mils	Range meters	Deflection meters	Angle of fall mils	Charge	Elevation mils	Range meters	Deflection meters	Angle of fall mils
Low Angle Fire										
2500	1GB	312/315	12/29	1/3	330/333	1GB	334	15	1	355
3000	2GB	297/302	12/16	1/3	318/323	2GB	314	16	1	338
4000	3GB	316/303	14/16	2/4	344/331	3GB	332	19	1	365
5000	4GB	306/295	13/17	3/4	340/330	4GB	317	20	1	357
6000	5GB	296/299	13/15	3/5	346/349	5GB	304	18	2	357
7000	5GB	365/368	16/18	3/6	431/434	5GB	376	22	2	447
8000	6WB	324/311	27/23	4/4	422/410	5GB	463	27	3	553
9000	7WB	271/267	25/25	3/5	401/399	6WB	391	36	3	508
10000	7WB	322/318	27/26	4/5	471/467	7WB	322	37	3	472
11000	7WB	380/374	29/28	4/6	545/538	7WB	379	40	3	546
12000	7WB	445/439	31/30	5/7	625/614	7WB	444	43	4	626
13000	7WB	524/512	33/32	5/7	715/698	7WB	522	48	4	716
14000	7WB	630/609	36/34	6/8	827/800	7WB	627	52	5	826
16000	8	/519	/51	/9	/769					
18000	8	/743	/58	/12	/984	2GB	1104	24	2	1152
High Angle Fire						3GB	1111	28	3	1167
4000	1GB	912/893	21/45	2/6	963/947	4GB	1152	30	4	1216
5000	3GB	1130/1147	23/23	6/11	1187/1214	4GB	1028	35	4	1109
6000	4GB	1160/1175	22/26	9/12	1223/1249	5GB	1114	33	5	1194
7000	4GB	1054/1078	25/32	8/12	1128/1157	5GB	999	38	5	1097
8000	5GB	1104/1114	25/24	7/15	1191/1201					
9000	5GB	1006/1012	28/28	7/14	1105/1110					
10000	6WB	1084/1124	40/27	10/11	1194/1229					
11000	7WB	1149/1174	33/28	9/14	1265/1295					
12000	7WB	1097/1125	36/34	9/13	1224/1251					
13000	7WB	1034/1064	38/34	8/13	1175/1200					
14000	7WB	947/781	40/37	8/12	1106/1131					
16000	8	/1065	/57	/16	/1241					
18000	8	/873	/62	/14	/1092					

Note: M109A1 data is to the right of the slash mark.

5-24. MPI Errors

Table 5-16 shows the MPI errors for the 155mm howitzer.

5-25. Effects of Protection (Shielding)

a. One of the principal uses of the 155mm howitzer is indirect fire against personnel; however, field artillery fire can be relatively ineffective when enemy personnel are shielded or protected.

b. See paragraph 5-25*b*, FM 6-141-2.

5-26. Precision Fire Against Materiel Targets

a. The 155mm howitzer is a reasonably effective precision fire weapon. Various fire direction techniques, such as observer adjusted fire, MET plus VE, and K-transfer may be used when one piece is employed in an indirect fire mission against known materiel targets; but observed fire is preferred. Suppose that one M109 155mm howitzer is engaged in a fire mission against a bridge 10 meters wide and 200 meters long at a range of 6,000 meters (table 5-14). Upon completion of adjustment by the observer, the center of the dispersion area should be on, or very near, the center of the bridge. Upon commencement of fire for effect, the single round hit probability is .202. The probability of obtaining at least one hit on the bridge with the first 10 rounds is 90 percent.

b. If it is necessary to obtain two hits on the bridge, then approximately 18 rounds are required; to obtain three hits, minimum of 25 rounds is needed. In an observed fire mission, the observer will continue firing until the target has been destroyed.

5-27. Area Fire Against Materiel Targets

a. The effectiveness of the 155mm howitzer against materiel targets varies greatly depending upon the hardness of the target (para 4-16 and table 4-2). A direct hit is usually required to destroy a hard target (tank or APC). A hit within 10 meters will destroy, or seriously damage, a medium target, such as a truck, radar station, or a missile launcher.

b. When the 155mm howitzer is employed against an area target, the probability of obtaining a direct hit upon any single target element within the area is low.

Table 5-16. MPI Errors for 155mm Howitzer, M109

Observer Adjusted Delivery Technique			
		Probable error	
Range	Charge	Range	Deflection
2,000	2G	18.9	18.2
4,000	4G	22.3	18.2
7,000	6W	28.3	18.2
10,000	7W	31.7	18.5
12,000	7W	35.1	18.9
14,000	7W	39.1	20.2
MET plus VE Delivery Technique			
2,000	2G	47.9	21.6
4,000	4G	56.7	22.3
7,000	6W	71.5	26.3
10,000	7W	79.6	36.4
12,000	7W	102.5	45.2
14,000	7W	127.5	58.7

Note: Mean burst height for fuze VT M514A1E1 is 4.8 meters with PE of 1.55 meters. All dimensions are in meters.

5-28. Direct Fire Against Materiel Targets

At least one round is normally required for adjustment on a small target in direct fire. Fire for effect can then commence with the second round. With a trained crew, the single round hit probability in direct fire is high. For example, the single shot hit probability on an enemy tank at 1,000 meters is 0.80.

Section IV. 8-INCH HOWITZER

5-29. Characteristics

a. M115 (Towed)

(1) Weight—29,700 pounds (firing position); 32,000 pounds (travel position)

(2) Maximum range—16,000 meters

(3) Minimum high angle range—4,200 meters

(4) Traverse:

Left—533 mils

Right—533 mils

(5) Muzzle velocity—1,950 ft/sec.

b. M110 (Self-Propelled)

(1) Weight—58,500 pounds (combat loaded)

(2) Maximum range—16,000 meters. See paragraph 5-29*b* (2), FM 6-141-2 for maximum range of XM650 RAP.

(3) Minimum high angle range—4,200 meters

(4) Traverse:

Left—533 mils

Right—533 mils

(5) Muzzle velocity—594 Meters/sec. (1,950 ft/sec.)

c. M110E2 (Self-Propelled)

(1) Weight—62,100 pounds (combat loaded)

(2) Maximum range—See paragraph 5-29 *c*(2), FM 6-141-2 for maximum ranges.

(3) Minimum high angle range—4,200 meters

(4) Traverse:

Left—533 mils

Right—533 mils

(5) Muzzle velocity—594 meters/sec. (2,455 ft/sec.)

5-30. Rates of Fire

a. Maximum. 1.5 rounds/minute for the first 3 minutes

b. Sustained. 0.5 rounds/minute

5-31. Types of Ammunition and Fuzes

a. Table 5-19 shows the principal types of ammunition and fuzes for the 8-inch howitzer.

b. See table 5-2 for selected ammunition grenade data (M404 and M509).

5-32. Typical Targets and Suggested Methods of Attack

Table 5-20 shows typical targets for the 8-inch howitzer and suggested methods of attack. Chemical ammunition is effective against personnel. If the criteria is to destroy the materiel for fortifications, chemical agents should not be employed.

5-33. Casuality Effectiveness

a. Table 5-21, FM 6-141-2 gives the expected fraction of casualties against personnel targets for projectile M404. Personnel in the offense are considered equivalent to one-half standing and one-half prone for the first volley and all prone for the subsequent volleys. Personnel in the defense are considered equivalent to one-half prone and one-half in foxholes for the first volley and all in foxholes for subsequent volleys.

Table 5-19. Types of Ammunition and Fuzes. 8-Inch Howitzer

Weapon	Ammunition type	Model	Weight of projectile (pounds)	Fuse action		
				Point detonating	Time	Proximity
8-Inch Howitzer M110 M110E2	HE Deep Cavity	M106	200.00	Yes	Yes	Yes
	Chemical, GB	M426	200.00	Yes	No	Yes
	Chemical, VX	M426	200.00	No	No	Yes
	ICM	M404	202.50	Yes	Yes	No
	HE, RAP	XM650	200.00	Yes	Yes	Yes
	ICM	M509	206.00	No	Yes	No

Table 5-20. Typical Targets and Suggested Methods of Attack, 8-Inch Howitzer

Type of target	Unit	Shell*	Fuze**
Indirect Fire			
Cave	Single piece	HE	Q/D
Bridge	do	HE	Q/D
Building (frame)	do	HE	Q
Artillery battery	Battery	HE, CHEM, ICM (AM/AP)	VT/Ti/Q
Platoon (open)	do	HE, CHEM, ICM (AP)	Q/VT/Ti
Platoon (dug in)	do	HE, CHEM, ICM (AP)	VT/Ti/Q
Command post	do	HE, CHEM, ICM (AP)	VT/Ti/Q
Fortification	do	HE, CHEM, ICM (AP)	Q/D(Ti/VT)
Mortar battery	do	HE, CHEM	VT/Ti/Q
Supply installation	do	HE, CHEM, ICM (AM/AP)	Q/VT/Ti
Communication center	do	HE, CHEM, ICM (AM/AP)	Q/VT/Ti
Radar installation	do	HE, CHEM, ICM (AM/AP)	Q/VT/Ti.
Personnel carriers	do	HE, CHEM, ICM (AM/AP)	VT/Q(Ti)
Tanks	do	HE, CHEM, ICM (AM/AP)	Q/(VT)
Company (open)	Battalion	HE, CHEM, ICM (AP)	Q/VT/Ti
Artillery battery	do	HE, CHEM, ICM (AM/AP)	VT/Ti/Q
Fortification	do	HE, CHEM	Q/D(Ti/VT)
Mortar battery	do	HE, CHEM, ICM (AM/AP)	VT/Ti/Q
Supply installation	do	HE, CHEM, ICM (AM/AP)	Q/VT/Ti
Communication center	do	HE, CHEM, ICM (AM/AP)	Q/VT/Ti
Direct Fire			
Roadblock		HE	Q/D
Personnel carrier(s)		HE	Q
Tank(s)		HE	Q

*Chemical shells are toxic chemical ammunition.

**Fuzes in parentheses are for chemical ammunition.

b. Effectiveness data tables in FM 101-60-4 may be used in determining the number of volleys required to expect a desired percentage of casualties against personnel targets. Effectiveness data for area personnel targets are computed for only those rounds fired during the fire-for-effect phase and are divided according to the delivery techniques employed. The two techniques are observer-adjusted and MET + VE. M106 (TNT loaded) ammunition on three target postures in open terrain or marsh grass is used. Personnel are assumed to be uniformly distributed throughout a circular target area. Target radii are for 50, 100, 150, 200, and 250 meters. The effectiveness numbers are based on M110 howitzers in two howitzer platoon, four howitzer "diamond" formation battery, or a four howitzer "lazy W" formation battery firing a parallel sheaf. Data are shown for each range/angle of fall indicated in the tables.

c. Figures 5-5 through 5-8, FM 6-141-2 show the expected casualty effectiveness for the M509 projectiles against personnel. Personnel in the offense are equivalent to personnel half standing and half prone for the first volley and all prone for the second and subsequent volleys. Personnel in defense are equivalent to personnel half prone and half in foxholes for the first volley and all in foxholes for the second and subsequent volleys. A 5 percent dud rate was considered in determining the effectiveness of selected ammunition.

5-34. Lethality

See paragraph 4-4.

5-35. Single Shot Hit Probability

Table 5-22 shows the observed, single shot hit probability of the 8-inch howitzer against two representative targets and against a tank target (3 x 7M) front and side posture. The table shows probabilities after adjustment for both low and high angle fire when a single piece is employed. Table 5-23 shows the number of rounds required for a 90 percent probability of at least one hit, two hits, or three hits when the single shot hit probability is known.

5-36. Precision (Dispersion)

Table 5-24 shows the precision (dispersion) data for low and high angle fire with HE (M106) ammunition.

5-37. MPI Errors

See table 5-25 for MPI errors for the 8-inch howitzer.

Table 5-22. Single Shot Hit Probabilities for an 8-Inch Howitzer

Range Low Angle	Charge	Probable error		Probability of hitting target		Tank 3x7M		Bridge 10x200M	
		Range	Defl	10x10M	20x20M	Front	Side	L - 200	L - 10
4,000	2	14	1	.192	.368	.092	.058	.999	.192
6,000	4	14	3	.142	.359	.035	.034	.740	.192
8,000	5	17	3	.114	.302	.030	.028	.740	.156
10,000	6	20	3	.099	.257	.026	.025	.739	.134
12,000	7	24	3	.084	.218	.021	.018	.736	.113
14,000	7	26	4	.061	.184	.014	.014	.595	.102
16,000	7	27	5	.051	.162	.011	.012	.494	.102
High Angle									
4,000	1	19	4	.084	.253	.020	.019	.600	.140
6,000	3	21	5	.064	.209	.015	.014	.499	.129
8,000	4	25	7	.040	.142	.008	.008	.365	.108
10,000	5	26	8	.034	.122	.007	.008	.326	.102
12,000	6	24	6	.048	.165	.011	.010	.423	.113
14,000	7	26	8	.034	.122	.007	.008	.326	.102
16,000	7	29	7	.034	.121	.007	.007	.360	.091

Note: All dimensions are in meters.

5-38. Effects of Protection (Shielding)

a. One of the principal uses of the 8-inch howitzer is for indirect fire against personnel; however, field artillery fire can be relatively ineffective when personnel are shielded or protected.

b. See paragraph 5-38*b*, FM 6-141-2.

5-39. Precision Fire Against Materiel Targets

a. The 8-inch howitzer is an effective precision fire weapon. In addition, one hit from an 8-inch howitzer will produce greater damage than one hit from a smaller caliber weapon; therefore, a direct hit is not always required in order to destroy a target. Various fire direction techniques, such as

observer adjusted fire, MET plus VE, and K-transfer, may be used when one piece is employed in an indirect fire mission against a known materiel target; but observed fire is preferred. Suppose that one 8-inch howitzer is engaged in a fire mission against a bridge 10 meters wide and 200 meters long at a range of 6,000 meters (table 5-23). Upon completion of adjustment by the observer, the center of the dispersion area should be on, or very near, the center of the bridge. Upon commencement of fire for effect, the single round hit probability is .192. The probability of obtaining at least one hit on the bridge with the first 11 rounds is 90 percent.

b. If it is necessary to obtain two hits on the bridge, then approximately 19 rounds are required; to obtain three hits, a minimum of 25 rounds is needed. In an observed fire mission, the observer will continue firing until the target has been destroyed.

5-40. Area Fire Against Materiel Targets

a. The effectiveness of the 8-inch howitzer against materiel targets varies greatly depending upon the hardness of the target (para 4-16 and table 4-2). A direct hit is usually required to destroy a hard target (tank or APC). A hit within 10 meters will destroy, or seriously damage, a medium target, such as a truck, radar station, or a missile launcher.

Table 5-23. Single Shot Hit Probabilites Against Type Targets for the 8-Inch Howitzer

Target description	Charge	Range	Single round hit probability	Rounds required for		
				1-Hit	2-Hits	3-Hits
Bridge 10x200 meters*	4	6,000	.192	11	19	25
Pillbox 10x10 meters	4	6,000	.142	15	26	36
Fortification 20x20 meters	4	6,000	.359	5	9	13
Tank 3x7m Front	4	6,000	.035	63	>70	>70
Tank 3x7m Side	4	6,000	.034	64	>70	>70

* Perpendicular to direction of fire. Dimensions are in meters.

Table 5-24. Precision (Dispersion) for the 8-inch Howitzer

Range (meters)	Charge	Elevation (mils)	Probable error		Angle of fall (mils)
			Range (meters)	Deflection (meters)	
Low-Angle Fire:					
3,000	1	267	12	1	282
4,000	2	305	14	1	326
5,000	3	315	14	2	343
6,000	4	317	14	3	354
7,000	5	302	16	3	367
8,000	5	363	17	3	436
9,000	6	320	19	2	431
10,000	6	377	20	3	499
11,000	7	309	23	3	470
12,000	7	360	24	3	537
13,000	7	417	25	4	605
14,000	7	479	26	4	674
15,000	7	552	27	5	748
16,000	7	643	27	5	835
High-Angle Fire:					
4,000	1	1191	19	4	1227
5,000	1	1035	23	3	1082
6,000	2	1022	24	3	1075
7,000	3	1056	24	5	1113
8,000	4	1104	25	7	1163
9,000	4	993	28	6	1062
10,000	5	1078	26	8	1150
11,000	5	977	28	8	1061
12,000	6	1084	24	6	1173
13,000	6	1002	26	6	1105
14,000	7	1119	26	8	1231
15,000	7	1060	28	8	1185
16,000	7	981	29	7	1123

Table 5-25. MPI Errors for 8-Inch Howitzer, M110

Range (meters)	Charge	Probable error (meters)	
		Range	Deflection
Observer Adjusted Delivery Technique			
3,000	2	21.6	18.2
5,000	4	21.6	18.2
7,000	5	27.0	18.2
10,000	6	31.0	18.2
12,000	6	31.0	18.2
14,000	7	39.1	20.2
16,000	7	43.2	21.6
MET Plus VE Delivery Technique			
3,000	2	48.6	22.3
5,000	4	58.0	22.0
7,000	5	68.8	25.0
10,000	6	85.0	33.1
12,000	6	104.5	41.8
14,000	7	112.0	50.6
16,000	7	134.9	62.7

Mean burst height for fuze, VT: M514A1E1 is 4.8 meters with PE =1.55 meters.

b. When the 8-inch howitzer is employed against an area target, the probability of obtaining a direct hit upon any single target element within the area is low.

5-41. Direct Fire Against Materiel Targets

At least one round is normally required for adjustment on a small target in direct fire. Fire for effect can then commence with the second round. With a trained crew, the single round hit probability in direct fire is high. For example, the single round hit probability on an enemy tank at 1,000 meters is 0.75.

Section V. 175MM GUN

5-42. Characteristics (M107)

a. Weight—62,100 pounds (combat loaded)
b. Maximum range—32,800 meters
c. Minimum high angle range—11,000 meters
d. Traverse:
Left—533 mils
Right—533 mils
e. Muzzle velocity—914 meters/sec. (3,000 ft/sec.)

5-43. Rates of Fire

a. Maximum. 1.5 rounds/minute for first 3 minutes.
b. Sustained. 0.5 rounds/minute

5-44. Principal Types of Ammunition and Fuzes

Table 5-26 shows the principal types of ammunition and fuzes for the 175mm gun.

5-45. Typical Targets and Suggested Methods of Attack

Table 5-27 shows typical targets for the 175mm gun and suggested methods of attack.

5-46. Casualty Effectiveness

a. Effectiveness data tables in FM 101-60-5 may be used in determining the number of volleys required to expect a desired percentage of casualties againt personnel targets.

Table 5-26. Types of Ammunition and Fuzes, 175mm Gun

Weapon	Ammunition type	Model	Weight of projectile (pounds)	Fuzes		
				Point detonating (M572 only)	Time	Proximity
175mm Gun, M107	HE	M437A2	147.75	Yes	Yes	Yes

Table 5-27. Typical Targets and Suggested Methods of Attack, 175mm Gun

Indirect Fire			
Type of target	Unit	Shell	Fuze
Cave	Single piece	HE	Q/D
Bridge	do	HE	Q/D
Building (frame)	do	HE	Q
Artillery battery	Battery	HE	VT/Ti/Q
Platoon (open)	do	HE	Q/VT/Ti
Platoon (dug in)	do	HE	VT/Ti/Q
Command post	do	HE	VT/Ti/Q
Fortification	do	HE	Q/D
Mortar battery	do	HE	VT/Ti/Q
Supply installation	do	HE	Q/VT/Ti
Communication center	do	HE	Q/VT/Ti
Radar installation	do	HE	Q/VT/Ti
Personnel carriers	do	HE	VT/Q
Tanks	do	HE	Q
Company (open)	Battalion	HE	Q/VT/Ti
Artillery battery	do	HE	VT/Ti/Q
Fortification	do	HE	Q/D
Mortar battery	do	HE	VT/Ti/Q
Supply installation	do	HE	Q/VT/Ti
Communication center	do	HE	Q/VT/Ti

b. The tables of effectiveness data for area personnel targets are computed for only those rounds fired during the fire-for-effect phase and are divided according to the delivery techniques employed. The two techniques are observer-adjusted and MET + VE. M437A2 (Comp B loaded) ammunition on three target postures in open terrain of marsh grass is used. Personnel are assumed to be uniformly distributed throughout a circular target area. Target radii are for 50, 100, 150, 200 and 250 meters. The effectiveness numbers are based on M107 guns in two platoon, four howitzer "diamond" formation battery, or a four gun "lazy W" formation battery firing a parallel sheaf. Data are shown for each range/angle of fall indicated in the tables.

5-47. Lethality

See paragraph 4-4.

5-48. Single Shot Hit Probability

Table 5-28 shows the observed fire, single shot hit probability of the 175mm gun against two representative targets and against a tank target (3 x 7m) front and side posture. The table shows probabilities after adjustment when a single piece is employed. Table 5-29 shows the number of rounds required for a 90 percent probability of at least one hit, two hits, or three hits when the single shot hit probability is known.

5-49. Precison (Dispersion)

Table 5-30 shows the precision (dispersion) data for the 175mm gun firing HE ammunition.

5-50. MPI Errors

See table 5-31 for the MPI errors for the 175mm gun.

5-51. Effects of Protection (Shielding)

a. General One of the principal uses of the 175mm gun is for indirect fire against personnel; however, field artillery fire can be relatively ineffective when enemy personnel are shielded.

b. High Explosive Ammunition. See paragraph 5-51 *b*, FM 6-141-2.

5-52. Precision Fire Against Materiel Targets

a. The 175mm gun is not an effective precision fire weapon. Various fire direction techniques

Table 5-28. Single Shot Hit Probabilities for the 175MM Gun

Range	Charge	Probable error		Probability of hitting target		Tank 3x7m		Bridge 10x200m	
		Range	Deflection	10x10m	20x20m	Front	Side	L - 200	L - 10
12,000	1	25	2	.098	.213	.029	.025	.902	.108
16,000	2	55	4	.029	.088	.007	.007	.469	.049
20,000	3	35	10	.020	.078	.004	.004	.250	.075
25,000	3	46	13	.012	.047	.003	.002	.173	.059
30,000	3	63	17	.007	.027	.002	.001	.112	.043

Note: Dimensions are in meters.

Table 5-29. Single Shot Hit Probabilities Against Type Targets for the 175MM Gun

Target description	Charge	Range	Single round hit probability	Rounds required for 90 % probability		
				1-Hit	2-Hits	3-Hits
Bridge 10x200 meters*	3	20,000	.075	30	49	67
Pillbox 10x10 meters	3	20,000	.020	>70	>70	>70
Fortification 20x20 meters	3	20,000	.078	28	47	65
Tank 3x7m Front	3	20,000	.004	>70	>70	>70
Tank 3x7m Side	3	20,000	.004	>70	>70	>70

*Perpendicular to direction of fire. Dimensions are in meters.

Table 5-30. Precision (Dispersion) for the 175mm Gun

Range (meters)	Charge	Elevation (mils)	Probable error		Angle of fall (mils)
			Range (meters)	Deflection (meters)	
8,000	1	233	21	1	322
9,000	1	278	22	2	385
10,000	1	328	23	2	449
11,000	1	382	24	2	516
12,000	1	443	25	2	586
13,000	2	237	46	3	394
14,000	2	271	49	4	457
15,000	2	309	52	4	521
16,000	2	350	55	4	585
17,000	2	395	58	5	649
18,000	2	445	61	5	714
19,000	3	241	33	9	455
20,000	3	266	35	10	510
21,000	3	293	37	10	566
22,000	3	322	39	11	622
23,000	3	353	41	11	678
24,000	3	385	44	12	733
25,000	3	420	46	13	786
26,000	3	457	49	13	839
27,000	3	496	52	14	891
28,000	3	538	55	15	940
29,000	3	584	59	16	986
30,000	3	634	63	17	1030

Table 5-31. MPI Errors for 175mm Gun, M107

Range (meters)	Charge	Probable error (meters) Range	Deflection
Observer Adjusted Delivery Technique			
7,000	2	43.2	21.6
12,000	2	55.3	26.3
17,000	2	66.8	28.3
22,000	3	45.2	22.3
27,000	3	57.3	27.0
32,000	3	73.5	29.0
MET Plus VE Delivery Technique			
7,000	2	62.7	27.0
12,000	2	87.0	37.1
17,000	2	120.1	60.0
22,000	3	136.2	62.7
27,000	3	192.2	92.4
32,000	3	261.7	125.5

Mean burst height for fuze, Proximity M728 M514A1E1 is 4.8 meters with PE=1.55 meters.

such as observer adjusted fire, MET + VE, and K-transfer may be used when one piece is employed in an indirect fire mission against known materiel targets; but observed fire is preferred. Suppose that one 175mm gun is engaged in a fire mission against a bridge 10 meters wide and 200 meters long at a range of 20,000 meters (table 5-29). Upon completion of adjustment by the observer, the center of the dispersion area should be on, or very near, the center of the bridge. Upon commencement of fire for effect the single round hit probability is 0.075. The probability of obtaining at least one hit on the bridge with 30 rounds is 90 percent.

b. If it is necessary to obtain two hits on the bridge, then approximately 49 rounds are required; to obtain three hits, a minimum of 67 rounds is needed. In an observed fire mission, the observer will continue firing until the target has been destroyed.

5-53. Area Fire Against Materiel Targets

a. The effectiveness of the 175mm gun against materiel targets varies greatly depending upon the hardness of the target (para 4-16 and table 4-2). A direct hit is usually required to destroy a hard target (tank or APC). A hit within 10 meters will destroy, or seriously damage, a medium target, such as a truck, radar station, or missile launcher.

b. When the 175mm gun is employed against an area target, the probability of obtaining a direct hit upon any single target element within the area is low.

Section VI. 107MM (4.2-INCH) MORTAR

5-54. Characteristics (M30)

a. Weight—672 pounds

b. Maximum range—5500 meters.

c. Minimum range—850 meters

d. Traverse—6,400 mils

e. Muzzle velocity—HE, full charge—960 ft/sec.

5-55. Rates of Fire

a. Maximum: 18 rounds/minute for first minute; 9 rounds/minute for succeeding 5 minutes.

b. Sustained: 3 rounds/minute (after 6 minutes).

5-56. Principal Types of Ammunition and Fuzes

a. Table 5-32 shows the principal types of ammunition and fuzes for the 107mm (4.2-inch) mortar.

b. See table 5-2 for selected ammunition grenade data.

5-57. Typical Targets and Suggested Methods of Attack

Table 5-33 shows typical targets for the 107mm (4.2-inch) mortar and suggested methods of attack.

5-58. Casualty Effectiveness

a. Effectiveness data tables in FM 101-60-7 may be used in determining the number of volleys required to expect a desired percentage of casualties against personnel targets.

b. The tables of effectiveness data for area personnel targets are computed for only those rounds fired during the fire-for-effect phase and are divided according to the delivery techniques employed. The two techniques are observer adjusted and MET + VE. The effectiveness numbers are based on platoon firing a parallel sheaf using M329A1 ammunition in open terrain, marsh grass, or temperate forest on three target postures. Personnel are assumed to be uniformly distributed throughout a circular target area. Target radii are for 50, 100, 150, 200 and 250 meters. Data are shown for each range/charge/angle of fall indicated in the tables.

5-59. Lethality

See paragraph 4-4.

5-60. Single Shot Hit Probability

Table 5-34 shows the observed fire, single shot hit probability of the 4.2-inch mortar against three representative targets. (One of which is two configurations of a tank.) The table shows probabilities after adjustment when a single piece is employed. Table 5-35 shows the number of rounds required to expect one, two, or three hits (on four separate targets) when the single shot hit probability is known.

Table 5-32. Types of Ammunition and Fuzes—107mm (4.2-Inch) Mortar

Weapon	Ammunition type	Model	Weight of projectile (pounds)	Fuzes		
				Point detonating	Time	Proximity
107mm (4.2-Inch) Mortar M30	HE	M329A1	27.07	Yes	Yes	Yes
	Smoke, WP	M328A1	28.66	Yes	No	No
	Gas, H	M2	24.67	Yes	No	No
	Gas, HD	M2A1	24.67	Yes	No	No
	Illuminating	M335A1	26.70	No	Yes	No
		M335A2	26.70	No	Yes	No
	Gas, Tactical, CS	XM630	25.70	No	Yes	No
		M453	30.00		Yes	

Table 5-33. Typical Targets and Suggested Methods of Attack for the 107MM (4.2-Inch) Mortar

Type Target	Unit	Shell	Fuze
Squad (Open)	Platoon	HE	Q/VT/Ti
Platoon (Open)	do	HE	Q/VT/Ti
Platoon (dug-in)	do	HE, WP	VT/Ti/Q
Command Post	do	HE, WP	VT/Ti/Q
Fortification	do	HE	Q/D
MG Emplacement	do	HE, WP	Q/D
Mortar Section	do	HE, WP	VT/Ti
Personnel carriers	do	HE, WP	VT/Ti

Table 5-34. Single Shot Hit Probabilities for the 4.2-Inch Mortar

Range	*Charge	Probable error		Probability of hitting target		Tank 3x7M		Bridge 10x200M	
		Range	Deflection	10x10m	20x20m	Front	Side	L - 200	L - 10
2,000	11 4/8	16	3	.123	.321	.031	.028	.740	.166
3,000	17 4/8	23	5	.059	.188	.013	.014	.498	.118
4,000	23 2/8	29	7	.034	.121	.007	.007	.360	.091
5,000	36 6/8	30	6	.039	.130	.009	.008	.414	.091

*Elevation = 900 mils. Dimensions are in meters.

Table 5-35. Single Shot Hit Probabilities Against Type Targets for the 4.2-Inch Mortar

Target description	Range	Single shot hit probability	Rounds required for 90% probability		
			1-Hit	2-Hits	3-Hits
Bridge 10x200 meters*	3,000	.118	18	32	43
Pillbox 10x10 meters	3,000	.059	37	65	>70
Fortification 20x20 meters	3,000	.188	11	19	27
Tank 3x7m Front	3,000	.013	>70	>70	>70
Tank 3x7m Side	3,000	.014	>70	>70	>70

*Perpendicular to direction of fire. Dimensions are in meters

5-61. MPI Errors

See table 5-36 for the MPI errors for the 4.2-inch mortar.

5-62. Precision (Dispersion)

Table 5-37 shows the precision (dispersion) data for the 4.2-inch mortar with HE (M329A1) ammunition.

5-63. Effects of Protection (Shielding)

See paragraph 5-63, FM 6-141-2.

5-64. Precision Fire Against Materiel Targets

a. The 4.2-inch mortar is not an effective precision fire weapon. Various fire direction techniques such as observer adjusted fire, MET plus VE, and K-transfer, may be used when one piece is employed in an indirect fire mission against known materiel targets; but observed fire is preferred. Suppose that one 4.2-inch mortar is engaged in a fire mission against a bridge 10 meters wide and 200 meters long at a range of 3,000 meters (table 5-35). Upon commencement of fire for effect, the single round hit probability is .118. The probability of obtaining at least one hit on the bridge with 18 rounds is 90 percent.

b. If it is necessary to obtain two hits on the bridge, then approximately 32 rounds are required; to obtain three hits, then a minimum of 43 rounds is needed. These numbers are for high assurance. In an observed fire mission, the observer will continue firing until the target has been destroyed.

5-65. Area Fire Against Materiel Targets

a. The effectiveness of the 4.2-inch mortar against materiel targets varies greatly depending upon the hardness of the target. A direct hit is usually required to destroy a materiel target.

b. When the 4.2-inch mortar is employed against an area target, the probability of obtaining a direct hit upon any single target element within the area is low.

Table 5-36. MPI Erros: 4.2-Inch Mortar*

Range meters	Charge	QE (mils)	Observer-adjusted MPI error		Met +"O" VE MPI error MPI error	
			Range	Deflection	Range	Deflection
1000	5 6/8 w/o	1065	28	18	51	22
2000	11 1/2 w/o	900	31	18	53	23
3000	17 1/2 w/o	900	32	18	57	25
4000	23 1/4 w/o	900	33	18	62	28
5000	36 3/8 w	900	33	18	73	35

*4.2-Inch Mortar M30
Cartridge: HE M329A1
Fuzes: PD-M557
VT-M513 (Mean HOB = 4.9 meters w / PE = 1.7 meters
Firing table: 4.2-H-2, Mortar, 4.2-Inch: M30

Table 5-37. Precision (Dispersion) for the 107mm Mortar

Range	Charge	Elevation (mils)	Probable error		Angle of fall (mils)
			Range	Deflection	
1,000	5 6/8	1065	9	1	1109
1,500	9 6/8	1065	12	2	1126
2,000	11 4/8	900	16	3	976
2,500	14 5/8	900	19	4	994
3,000	17 4/8	900	23	5	1010
3,500	20 1/8	800	26	6	935
4,000	22 7/8	800	29	7	952
4,500	31 2/8	*800	27	6	958
5,000	35 3/8	*800	30	6	973
5,500	39 5/8	*800	33	7	987

* With extension. Dimensions are in meters.

CHAPTER 6

ROCKET AND MISSILE WEAPONS SYSTEMS

Section I. GENERAL

6-1. General

This chapter is a guide for commanders for employment of Honest John and Lance Systems with nonnuclear warheads.

6-2. Description of Warhead

See paragraph 6-2, FM 6-141-2.

6-3. Effects Patterns

See paragraph 6-3, FM 6-141-2.

Section II. TACTICAL EMPLOYMENT

6-4. General

a. The procedures and techniques for the tactical employment of field artillery, as contained in FM 6-20 apply to Honest John and Lance units. Additional procedures and techniques for Lance are contained in FM 6-42.

b. Fire planning is covered in chapter 4.

c. The effects of weather and terrain are covered in chapter 4, FM 6-141-2.

6-5. Troop Safety

a. Honest John. Range or deflection must be considered in determining the minimum safe distance (MSD) that selected ammunition may be delivered in the proximity of friendly troops. The direction of fire is compared with the friendly troop disposition to determine whether troop safety is more dependent on the deflection probable error or the range probable error. The MSD is then determined from the appropriate firing table addendum using the predominant factor (range or deflection) for the proper column entry.

b. Lance. Minimum safe distance for Lance is determined by entering the firing table addendum and extracting the appropriate value from the supplementary data table.

Section III. TARGET ANALYSIS

6-6. General

a. Procedures and techniques discussed in FM 6-20 and chapter 4, are applicable to missiles and rockets.

b. It is technically possible to mass nonnuclear missiles and cannon field artillery on the same target simultaneously when a range overlap exists between the systems and sufficient time is available to accomplish simultaneous engagement. However, the engagement of a target by both missiles and cannon field artillery would be desirable only under conditions where each system possesses a unique effect which would be optimized against the designated target or on targets of such size that no available single system has the capability of providing the desired concentration of effects in the target area. Any decision to conduct a simultaneous attack would be based on analysis of the target, determination of the effects desired, and a selection of weapon systems which can best provide the desired effects. If a choice of both missile and cannon artillery attack was the result of the process, it would be incidental to providing the desired effects on the target.

6-7. Sequence of Analysis

See paragraph 4-11.

Section IV. HONEST JOHN

6-8. Characteristics

See paragraph 6-8, FM 6-141-2.

6-9. Rates of Fire

See paragraph 6-9, FM 6-141-2.

6-10. Types of Warheads and Fuzes
See table 6-1, FM 6-141-2.

6-11. Single Warhead Lethal Areas (square meters)
See table 6-2, FM 6-141-2.

6-12. Predicted Accuracy
See paragraph 6-12, FM 6-141-2. See also tables 6-3 and 6-4, FM 6-141-2.

6-13. Fire Direction Procedures
See paragraph 6-13, FM 6-141-2.

6-14. Effectiveness Tables
See paragraph 6-14, FM 6-141-2.

6-15. Materiel Damage
See paragraph 6-15, FM 6-141-2.

Section V. LANCE

6-16. Characteristics
See paragraph 6-16, FM 6-141-2.

6-17. Rates of Fire
See paragraph 6-17, FM 6-141-2.

6-18. Types of Warheads and Fuzes
See table 6-5, FM 6-141-2.

6-19. Effectiveness Tables
See FM 101-31-2, Nuclear Weapons Employment (addendum).

CHAPTER 7

COMPARISON OF HIGH EXPLOSIVE AND SELECTED AMMUNITION

7-1. General

This chapter presents a comparison of the effects of high-explosive and selected ammunition. Fundamental guidelines that must be considered in order to attain effective weapons employment are discussed.

7-2. Surprise Fire

a. General. See paragraph 7-2*a*, FM 6-141-2.

b. Observed and Unobserved *Fire.* See paragraph 7-2 *b*, FM 6-141-2.

c. Use of Antipersonnel Ammunition. See paragraph 7-2 *c*, FM 6-141-2.

d. Use of Dual Purpose Ammunition. See paragraph 7-2 *d*, FM 6-141-2.

7-3. Projectile Fuzing and Dud Rates.

See paragraph 7-3, FM 6-141-2.

7-4. Target Size

Each firing unit can effectively engage targets only up to a certain size. This maximum target size depends on the composition of the target and equivalent shielding of the personnel.

7-5. Terrain and Snow

See paragraph 7-5, FM 6-141-2.

7-6. Lethality Comparisons

A comparison of the lethality of high explosive and selected ammunition against personnel who are standing, prone, or in foxholes is shown in table 4-7, FM 6-141-2.

7-7. Comparative Effectiveness

See paragraph 7-7, FM 6-141-2.

7-8. Use of HE and WP Against Armor

a. A direct hit is the best means of destroying enemy armor. However, advancement can be hindered or even possibly a mobility, fire-power, or catastrophic kill can be achieved with HE ammunition when used to its best potential.

b. A combination of HE with a proximity fuze accompanied by WP could be effective against a tank with external fuel cells. The fragmentation of the HE round would puncture the fuel cells. The white phosphorus would then ignite the cells possibly causing a catastrophic kill.

c. Fragmentation will also cause the enemy to close all external openings, therefore decreasing visibility. The fragmentation could further decrease visibility and hinder advancement by destroying external sighting equipment, radio antennas, and other external equipment.

7-9. Training

a. Battalion and Battery Fire Direction Personnel. Normal fire direction procedures are used to determine graze burst data for high explosive ammunition. Corrections to obtain quadrant elevations and fuze settings for the optimum height of burst are found in appropriate firing table addenda which are unclassified. Procedures for determining these corrections are explained in the addenda, and fire direction personnel should be familiar with their use. No other special training is required.

b. Firing Battery Personnel. Personnel should receive an orientation of selected ammunition on the external nomenclature, fuzing, and safety requirements. No other special training is required for firing battery personnel when selected ammunition is deployed.

c. Forward Observers. Forward observers should receive an orientation on target selection and casualty reporting when using selected ammunition. In addition, observers should be trained to adjust effects patterns on the ground by movements in range and deflection and adjustments in the height of burst. They require little other special training to use selected ammunition, since normal adjustment is made with explosive ammunition. The nature of the target, as reported by the observer, should be the determining factor in the decision to employ selected ammunition in fire for effect.

CHAPTER 8

AERIAL FIELD ARTILLERY

Section I. INTRODUCTION

8-1. General

Aerial field artillery is a unit organized and employed using its organic aerial carriage and affixed weapon systems to accomplish the field artillery mission. These units deliver fires from aircraft in flight, employing speed, agility, and responsiveness to achieve surprise and destroy targets. See FM 6-102 for more information.

8-2. Principal Types of Aircraft

AH-1G Helicopter

a. Normal cruise speed—130 knots.

b. Endurance at cruise speed—2 hours 45 minutes.

c. Basic armament configuration:

(1) 7.62mm automatic gun integrated with the TAT-102A/XM28 turret.

(2) Two rocket pods.

8-3. Principal Types of Armament

a. XM28E1 armament sybsystem.

(1) Application: Nose turret of any combination below.

(2) Ammunition capacity: One 7.62mm gun and 4000 rounds; one 40mm grenade launcher and 300 rounds; two 7.62mm guns and 8000 rounds or two 40mm grenade launchers and 600 rounds.

(3) Weight—880-901 pounds with ammunition (depending on configuration).

(4) Effective range: 7.62mm gun—1100 meters, 40mm grenade launcher—1200 meters.

(5) Muzzle velocity:

7.62mm gun—2750 ± 30 ft/sec
40mm launcher—790 ± 20 ft/sec

(6) Rate of fire:

7.62 gun—2000-4000 SPM
40mm launcher—400 SPM

(7) Elevation: +20°, −50°

(8) Traverse: ±110°

b. XM-35, 20mm automatic gun armament subsystem.

(1) Application: One 20mm 6 barrel gun mounted on the left wing, inboard station of aircraft, in a fixed position.

(2) Ammunition capacity: 950 pounds.

(3) Weight: 1187 pounds with 1000 rounds of ammunition.

(4) Range: 3000 meters.

(5) Muzzle velocity: 3380 ± 50 ft/sec.

(6) Rate of fire: 750 SPM.

(7) Elevation: Attitude of aircraft.

(8) Traverse: Attitude of aircraft.

c. Rocket launcher armament subsystems

(1) XM157

(2) XM159

(3) M200

d. 2.75 inch rockets

(1) Warheads

(a) M-151 Fragmentation antipersonnel.

(1) Weight—10 pounds.

(2) Materiel—cast iron.

(b) XM-229 Fragmentation antipersonnel.

(1) Weight—17 pounds.

(2) Material—cast iron.

(c) WDU4A1A Flechette antipersonnel.

(1) Weight—10 pounds.

(2) Material—extruded aluminum.

(d) MK-5 Shaped Charge Antitank.

(1) Weight—10 pounds.

(2) Material—steel.

(e) MK-67 Smoke Incendiary

(1) Purpose: Target marking/antipersonnel

(2) Weight: 10 pounds

(3) Material: Aluminum

(f) M-156 Smoke Incendiary

(1) Purpose: Target marking/antipersonnel

(2) Weight: 10 pounds

(3) Material: Steel tubing

(2) Fuzes

(a) M-423 Point-detonating

(1) Arming distance: 104—300 feet.

(2) Activation: Percussion.

(3) Weight: 0.63 pounds.

(b) M-427 Point-detonating.

(1) Arming distance: 589—1398 feet.

(2) Activation: Percussion.

(3) Weight: 4.50 pounds.

(c) M-429 Proximity

(1) Arming distance: 500—1000 feet.

(2) Activation: Electrical.
(3) Weight: 5.02 pounds.
(d) Flechette
(1) Arming distance: 2000—3000 feet.
(2) Activation: Deceleration.
(3) Weight: Integral washed component.

Section II. EMPLOYMENT

8-4. Characteristics

Aerial field artillery is employed to provide aerial fire support to all maneuver forces throughout all areas of operations and may be assigned any of the standard tactical missions for field artillery. It provides a means of extending the fire support capabilities of surface weapons available to the force commander. It possesses mobility characteristics which provide for field artillery support in many situations in which the mobility characteristics of other types of field artillery are less suited. It is capable of rapid movement to mass fires over any type of terrain to compensate for the wide dispersion required for survival on the modern battlefield.

8-5. Positioning

The aerial field artillery unit commander is responsible for insuring that his unit is positioned so that it provides responsive and effective aerial field artillery fire support inherent to his mission. Selection of position areas is governed mainly by the mission, nature of the tactical operation, and the need for dispersion as a protective measure. The aerial field artillery headquarters is located wherever it can best fulfull its mission. Firing elements and some logistics elements of the battalion are deployed in the zone of operations of the supported unit as required, and displace as necessary for acccmplishment of the mission and for security. Responsiveness and flexibility are enhanced by locating aerial field artillery units well forward in areas that are secured by divisions or brigades. Rear elements normally remain in the division or brigade trains area to facilitate resupply and maintenance functions.

8-6. Chemical Weapons

Helicopter-delivered chemical weapons may be used to produce casualties or "flush-out" unmasked enemy troops in concealed or protected positions and to facilitate their capture or neutralization by other weapons. Consideration should be given to the integration of the ammunition in the fire plan. Details for employment are contained in FM 3-10-1 and TC 3-16.

8-7. Casualty Effectiveness

Effectiveness tables will be added when available.

APPENDIX A

REFERENCES

A-1. Field Manuals

FM 1-40	Helicopter Gunnery.
FM 3-10-1	Employment of Chemical Agents.
(C) FM 3-10-2	Chemical Agents Effects Data (U).
FM 3-10-3	Chemical Agents Effects Data (for training purposes only).
FM 6-20	Field Artillery Tactics and Operations.
FM 6-36	Field Artillery Battery, Lance.
FM 6-40	Field Artillery Cannon Gunnery.
FM 6-40-1	Field Artillery Honest John Rocket Gunnery.
FM 6-40-4	Field Artillery Lance Missile Gunnery.
(C) FM 6-42	Field Artillery Battalion, Lance (U).
FM 6-61	Field Artillery Battalion, Honest John.
FM 6-102	Field Artillery Battalion, Aerial Field Artillery.
FM 6-140	Field Artillery Organizations.
FM 21-40	Chemical, Biological, Radiological, and Nuclear Defense.
FM 21-41	Soldier's Handbook for Defense Against Chemical and Biological Operations, and Nuclear Warfare.
FM 23-91	Mortar Gunnery.
FM 23-92	4.2-inch Mortar, M30.
FM 101-10-1	Staff Officer's Field Manual Organizational, Technical, and Logistical Data, Unclassified Data.
FM 101-31-1	Staff Officer's Field Manual; Nuclear Weapons Employment Doctrine and Procedures.
*(C) FM 101-60-2	Effectiveness Data for Howitzer, 105mm M101A1 (U).
*(C) FM 101-60-3	Effectiveness Data for Howitzer, 155mm: M109(U).
*(C) FM 101-60-4	Effectiveness Data for Howitzer, 8-inch: M110 (U).
*(C) FM 101-60-5	Effectiveness Data for Gun, 175mm: M107 (U).
*(C) FM 101-60-7	Effectiveness Data for Mortar 4-2 inch: M30 (U).
*(C) FM 101-60-8	Effectiveness Data for Rocket 762mm: M50 (U).

A-2. Firing Tables

FT 4.2-H-2	Mortar, 4.2-inch, M30.
FT 8-J-4	Cannon, 8-inch howitzer: M2A1E1 on howitzer, heavy, self-propelled: 8-inch M110.
FT 105-AS-2	Cannon, 105mm howitzer: M137A1 (M137E1) and M137 on howitzer, light, towed: 105mm M102.
FT 105-H-7	Cannon, 105mm howitzer: M2A1 and M2A2 on howitzer, light, towed: 105mm M101A1.
FT 155-AH-3	Cannon, 155mm howitzer: M126 on howitzer, medium, self-propelled: 155mm M109.
FT 155-Q-4	Howitzer, medium, towed, 155mm M114A1
FT 175-A-1	Cannon, 175mm gun: M113, M113E1 on gun, field artillery, self-propelled: 175mm M107.
FTR 762 ADD-A-1	Firing table addendum to FTR 762-A-2, FTR 762-D-1, FTR 762-F-1 for Warhead section HE: M144; Warhead section HE: XM 186.
FTR 762 ADD-B-1	Firing table addendum to FTR 762-A-2, FTR 762-D-1, FTR-F-1 for Warhead, M6.

* See paragraph 1-3c.

FTR 762 ADD-C-1	Firing table addendum to FTR 762-H-1, FTR 762-J-1, FTR 762-L-1 for Warhead section HE: M144 (T2044E1); Warhead section HE: XM 186.
FTR 762 ADD-E-1	Firing table addendum to FTR 762-H-1, FTR 762-J-1, FTR 762-L-1 for Warhead section, M6E1.
FTR Lance Add A-1	Firing table addendum for XM251 Warhead.

A-3. Technical Manuals

TM 9-500	Data Sheets for Ordnance Type Materiel.
TM 9-1300-203	Artillery Ammunition for Guns, Howitzers, Mortars, and Recoilless Rifles.
TM 9-1336-486-12	Operator's and Organizational Maintenance Manual: Warhead Section, Guided Missile, XM 198 and XM198E1 Practice Warhead.
TM 9-1340-211-12	Operator's Manual: 762-mm rocket, M144 and XM 186 HE warheads.
TM 9-1340-213-12	Operators's Manual: 762-mm rocket, M6A1 HE warhead.
(C) TM 9-1425-485-10-1	System Description for the Lance Guided Missile System (U).
TM 55-1520-221-10	Operator's Manual Army Model AH-1G Helicopter.

A-4. Army Regulations

AR 380-5	Department of the Army Information Security Program.

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By Order of the Secretary of the Army:

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