SUMMARY OF CHANGE

DA PAM 385-63
Range Safety

This revision, dated xxx –

1. Change on OIC/RSO requirements when firing Force on Force training ammunition (CCMCK/UTM) (Table 1-1)
2. Updates Army requirements for indoor firing ranges and shoothouses (para 2-7), including lead exposure limits (table 2-1).
3. Adds requirements concerning the use of ballistic concrete and shock-absorbent concrete (para 2-9).
4. Adds requirements for the use of steel reactive target engagements (para 2-10).
5. Replaces Certificates of Risk Acceptance (CoRA) with Deviation Approval and Risk Acceptance Documents (DARAD) (para 2-14d).
6. Adds surface danger zone data for radio-frequency TOW missiles (chap 7), Accelerated Precision Mortar Initiative (chap 9), artillery Precision Guidance Kit and 155mm Excalibur (chap 10).
7. Adds instructions to Army range managers concerning the use of high-powered microwaves in the range complex (chap 14).
8. Updates and adds danger zone data for various weapon systems, including technical data in the text, figures, and tables (throughout).
9. Removes references to obsolete or outdated munitions and weapon systems, including general tank cannon cartridges (chap 8), M712 Copperhead (chap 10), Kiowa Warrior OH-58D (chap 11), missile (chap 12).
10. Makes administrative changes (throughout).

Chapter 1 Introduction

1–1. Purpose

This pamphlet provides minimum requirements for the U.S. Army and Marine Corps Range Safety Programs prescribed in Army Regulation (AR) 385–63 and Marine Corps Order (MCO) 3570.1C. It also establishes standards and procedures for the safe firing of ammunition, demolitions, lasers, guided missiles, and rockets, and the delivery of bombs for training, target practice, and to the extent practicable, combat.

1–2. References

Required and related publications and prescribed and referenced forms are listed in appendix A.

1–3. Explanation of abbreviations and terms

Abbreviations and special terms used in this pamphlet are explained in the glossary.

1–4. Deviations

a. Deviations from range standards or procedures contained in AR 385–63/MCO 3570.1C and this document may be granted based on critical mission requirements. Risk management will be integrated into the deviation process. Deviations are limited to—

(1) Reducing surface danger zone (SDZ), laser surface danger zone (LSDZ), and weapon danger zone (WDZ) dimensions when terrain, artificial barriers, or other compensating factors make smaller danger zones safe.

(a) Deviations applied to danger zones extending beyond authorized range impact area(s)/installation boundaries must be based on the ability to sufficiently contain projectiles, hazardous fragments, laser beams, and both vertical and horizontal ricochets within the authorized range impact area(s)/installation boundaries and areas under military control (for example, leased land or training areas acquired through memorandum of agreement or memorandum of understanding).

(b) For the Marine Corps, deviations for danger zones extending beyond the installation boundaries must be validated by Commanding General (CG), Training Education Command, Range and Training Area Management (RTAM) Branch, Marine Corps Combat Development Command (MCCDC), 2300A Louis Road, Quantico, VA 22134–5001 using the Probabilistic SDZ Tool.

(2) Modifying prescribed procedures for a munitions' use appropriate for a state of training of participating personnel to increase training realism.

(3) Allowing personnel not authorized by chapter 3 of this pamphlet within the danger zone, unless prohibited.

b. At a minimum, all deviation authorizations will contain the following, as appropriate:

(1) Statement citing chapter, paragraph, and subparagraph of the specific condition requiring deviation, and the name and number of the operational range, training facility, or maneuver area involved.

(2) Description of the existing condition and anticipated hazards, subsequent hazard analysis, and risk analysis.

(3) Statement as to why a deviation is necessary and impact on training if not granted.

(4) Control measures taken to mitigate hazards and/or minimize risk and residual risk level.

(5) Installation and unit standard operating procedures (SOPs) governing the specific operational range, training facility, or maneuver area for which the deviation applies.

(6) Scaled topographical map depicting SDZ and requested deviation.

(7) Map coordinates of the firing position(s), target location, and quadrant or elevation of fire, if required. The firing position(s), direction of fire, and danger zones will be plotted on the scaled map with distances shown in meters (m).

(8) Computer-generated danger zones and terrain profiles created using the Range Managers Toolkit (RMTK) may be submitted with deviation requests in lieu of developing them through manual means, if deemed appropriate by the senior commander (Army)/installation commander (Marine Corps). These computer-generated danger zones and terrain profiles must be developed using the current approved version of the RMTK. Danger zones and terrain profiles must depict the gun target line (GTL), the left and right limits of fire, the relative elevation of the weapon system being fired, the target, and the natural terrain backstop or artificial barrier, as appropriate. Risk-management principles will be applied in determining if alternate danger zones are applicable.

c. Requests for deviation shall originate from the unit or activity conducting the event or the installation Range Management Authority (RMA) (Army), Range Control Officer (RCO) (Marine Corps). The installation RMA (Army), RCO (Marine Corps) makes the initial judgment regarding the suitability of a proposed deviation prior to submission to the approving authority. Requests will be coordinated through the appropriate chain of

command. For the Army, coordination will include both garrison and mission safety offices, legal review, environmental, and public affairs offices, as appropriate.

d. Deviations are valid for 1 year or less.

e. Deviations shall not be applied to other Federal agency directives, such as airspace or water traffic requirements.

f. Army commands (ACOMs), Army Service component commands (ASCCs), and direct reporting units (DRUs) communicate directly with the U.S. Army Training and Doctrine Command (TRADOC) Capability Manager - Ranges (TCM Ranges) for technical information and guidance on risk management. Marine Corps organizations may communicate directly with Training and Education Command, RTAM-Branch (C465) for technical information and guidance.

1–5. Requirements for range safety certification programs

a. Range safety certification programs will be used to train and qualify personnel in the duties of Officer In Charge (OIC) and Range Safety Officer (RSO) for firing exercises and maneuver operations. Army certification programs are normally conducted at the unit level in accordance with an established range safety certification program. Marine Corps OIC and RSO certifications will be conducted at the installation level only. Prior to attendance, Marine Corps personnel must complete the Range Safety (Basic) Distance Learning Course. The Marine Corps certificate is valid for 3 years. Government civilian personnel may serve as OIC or RSO per the guidance in table 1–1. Contractors may serve as RSO, but in accordance with Department of Defense Instruction (DODI) 1100.22 and Federal Acquisition Regulations Subpart 7.5, contractors may not serve as OIC.

b. Range safety certification programs will be integrated into organizational training.

c. Once satisfied through training and testing that individuals are qualified to perform the duties of OIC and RSO of the firing unit, battalion/squadron commanders will forward their names to range operations (Army), range control (Marine Corps) for appropriate action.

d. The RMA (Army), RCO (Marine Corps) will provide personnel designated as OICs and RSOs a range safety briefing on the use of the training complex as part of certification.

e. The installation RMA (Army), RCO (Marine Corps) and the garrison/mission safety staff (Army) will monitor the effectiveness of range safety certification programs for OICs and RSOs.

f. For the Army, a locally devised "Range Safety Card" program may be employed in lieu of unit-generated rosters of certified personnel if approved by the senior commander.

g. The senior commander (Army)/installation commander (Marine Corps) may reduce the OIC and RSO grade requirements in table 1–1 by not more than one grade, with the following exceptions:

(1) The OIC of battalion or larger combined arms live-fire exercise ((CALFEX) Army)/combined arms exercise ((CAX) Marine Corps) will be a field grade commissioned officer. Exercise RSO of battalion or larger CALFEX/CAX will be an E–7 or above.

(2) Marine Corps explosive ordnance disposal (EOD) units are exempt from OIC and RSO requirements when conducting EOD proficiency training on a Department of Defense Explosives Safety Board (DDESB) sited range. However, when EOD units are conducting operational training on any operational training range the OIC/RSO requirements in table 1–1 apply. EOD units conducting EOD operations will supervise demolition and disposal operations following the guidance contained in NAVSEA OP 5, NAVSEA SWO60–AA–MMA–010, and Explosive Ordnance Disposal Bulletin (EODB)/Technical Manual (TM) 60–series publications. Marine Corps EOD units conducting disassembly and inerting will assign a qualified EOD technician as an RSO. Commanding officers may designate in non-emergency SOPs other instances that require EOD units to use an RSO. The RSO may be an E–5 or above if they are currently qualified as an EOD officer or technician military occupational specialty (MOS) 2305/2336.

Table 1-1
Officer In Charge (OIC) and Range Safety Officer (RSO) appointment requirements

Notes:

[1] Civilians in the grade of General Schedule (GS)-07 and above, or equivalent, may act as OIC; GS–05 and above, or equivalent, may act as RSO.

[2] For the Marine Corps, OIC and RSO must be E–4 and above and be chemical, biological, radiological, and nuclear (CBRN)

Weapon system	OIC[1]			RSO[1]		
	Officer	Warrant officer (WO)	Noncommissioned officer (NCO)	Officer	WO	NCO
Practice hand grenades; sub-caliber training devices; laser devices; firing devices; simulators and trip flares; small arms and machine guns.	X	X	E-6	X	X	E-5
Chemical agents and smoke[2]	X	X	E-6	X	X	E-5
Aerial gunnery and air defense weapons; live grenades, grenade launchers, and grenade machine guns; live mines and demolitions; tank and fighting vehicle cannons.	X	X	E-7	X	X	E-6
Field artillery[3]	X	X	E-7	X	X	E-6
Mortars	X	X	E-6	X	X	E-6[4]
Air defense artillery rockets and guided missiles	X	X		X	X[5]	
Direct fire antitank rockets and missiles	X	X	E-7	X	X	E-6
Live-fire exercises using organic weapons, squad through company, battery, troop.	X	X	E-7[7]	X	X	E-6[7]
CALFEX/CAX using outside fire support, troop, battery, squad, platoon, company; or battalion and larger.[6]	X	X	E-7	X	X	E-6

MOS 5702/5711 when conducting CBRN or smoke training. For the Army, OIC and RSO must be CBRN qualified when conducting CBRN or smoke training.

[3] Use of E–7s as OICs is authorized only when approved by the senior commander (Army)/installation commander (Marine Corps). Duties of the RSO are normally performed by either the battery executive officer or the platoon leader.

[4] RSO for Marine Corps can be an E–5 for mortar training activities.

[5] Senior Range Safety Officer (SRSO) will be a chief warrant officer four, chief warrant officer four or higher, or a civilian in the grade of GS–12 or above.

[6] For battalion or larger CALFEX/CAX, OIC will be a field grade commissioned officer; exercise RSO will be E–7 or above.

[7] For the Army when conducting maneuver or shoot house training using force on force training ammunition (UTM or CCMCK) only, OIC will be E-6 or above and RSO will be E-5 or above.

Chapter 2
Ranges

2–1. Restricting access to and activities on impact areas

a. Unauthorized persons are prohibited from entering the installation training complex. When empowered, the installation RMA (Army), RCO (Marine Corps) is the approval authority for entry onto ranges and maneuver areas, and into any impact area - temporary, dedicated, or high hazard.

b. Unauthorized persons are prohibited from entering impact areas and other areas known or suspected to contain unexploded ordnance (UXO) by use of positive controls to include fencing and/or posting of UXO hazard warning signs. Commanders will ensure appropriate measures are used to restrict access to areas known or suspected to contain UXO. The commander will use risk management to determine the type and extent of marking and/or fencing required. Primary factors to consider in making this risk decision are accessibility of the public to restricted locations and the level of UXO hazards in the area.

c. Where practical, positive means of excluding livestock (such as fences or gates) must be established unless a written agreement negating this requirement is in effect with livestock owners.

d. The installation RMA (Army), RCO (Marine Corps), a designated representative, and/or EOD personnel will brief personnel, who have an operational requirement and are authorized access to an operational range's impact area, on the hazards associated with UXO and other hazards.

e. Access into temporary and/or dedicated impact areas will be strictly controlled. Those portions of temporary and dedicated impact areas authorized for training or other authorized purposes will be surface cleared of UXO before access is permitted. Cleared areas that become contaminated during live-fire exercises will be cleared when the exercise has been completed. Firing munitions into a UXO contaminated area for the purpose of clearing the area of UXO is not authorized. Training events that include firing mine clearing line charges or other similar munitions are not considered UXO clearing activities. Controlled burn activities to reduce ground cover to mitigate risks prior to a surface-clearing operation or contamination survey must be coordinated with appropriate installation staff offices. Fire will not be used to clear UXO.

f. Access to high-hazard impact areas will be limited to qualified EOD personnel, range operations (Army), range control (Marine Corps), range maintenance, and safety personnel designated by the installation RMA (Army), RCO (Marine Corps).

g. High-hazard impact areas that have improved conventional munition (ICM) or sub-munition duds are permanently contaminated and will not be cleared by Army personnel or entered by Army range personnel for range maintenance. Marine Corps EOD personnel, Operational Range Clearance contractors, and supporting Marine Corps personnel of any MOS are authorized access into ICM-contaminated impact areas to conduct range clearance operations and MOS proficiency training. Marine Corps EOD personnel will accompany the Marine Corps supporting personnel at all times while in the ICM contaminated area.

h. Entry into high explosive (HE) dud contaminated areas to extinguish fires may be an extremely high-risk operation that requires a thorough risk assessment and approval at the appropriate level of command.

i. Digging entrenchments, foxholes, slit trenches, or any other activities that disturbs earth within an impact area is not permitted unless authorized by the installation RMA (Army), RCO (Marine Corps). Maneuvers within a temporary impact area that include bivouac must prevent disturbing earth by driving poles, pegs, and so forth into the ground, trenching around tents, or any activity that could disturb a UXO located just beneath the ground surface. Open fires will not be permitted.

j. Unauthorized personnel are prohibited from handling UXO and munitions or removing them from the training complex. Procedures (for example, amnesty boxes) will be established for turn-in of ammunition and explosives (AE) items.

k. All normal vehicular and foot traffic approaches to ranges and impact areas will be guarded by range guards, properly instructed in their duties, or closed off by appropriate barriers, as determined by the installation RMA (Army), RCO (Marine Corps). When barriers are used, appropriate signs will be posted.

l. Aeronautical charts limit aerial access to ranges within restricted areas.

2–2. Posting warning signs, markers, and flags

a. Warning signs should comply with Section 200, Part 1926, Title 29, Code of Federal Regulations (29 CFR 1926) and DA Pam 385–11. Such signage should include a signal word (such as "Danger" or "Warning"), safety symbols that identify the hazard and hazard avoidance (such as a pictogram of an explosion and "Do Not Enter" symbol), and a text message (such as "Explosive Hazard, Keep Out") (refer to DA Pam 385–11). (Note: New signage, if constructed locally, shall be at least 33 centimeters (cm) by 43.5cm in overall size and of weather-resistant materials.) The sign will state "UNEXPLODED ORDNANCE - DO NOT ENTER" in two

lines of red, sans-serif capital letters in the lower white section of the sign. Lettering will be at least 5cm high and of weather-resistant materials or as dictated by the host nation. Signs should be constructed with non-reflective paint to enable the use of lasers. Warning signs will be posted around the installation training complex to warn and prohibit entry by unauthorized persons, and to alert authorized personnel entering a hazard area (see fig 2–1).

Figure 2–1. Sample warning signs

b. Signs at entry points to the training complex will prohibit trespassing and removal of items under penalties provided by law. Signs will also emphasize the dangers associated with unlawful entry and handling of dud ammunition. Where appropriate, signs will be in both English and the applicable foreign language.

c. Warning signs will be placed to ensure they are visible to individuals attempting to enter training complex live- fire areas at any point around its perimeter. They will be placed at 200m intervals or less, if practicable, or in a way that will ensure that a person cannot enter the range without seeing at least one sign within a legible distance.

d. Commanders will ensure UXO hazard signs are posted at a maximum of 200m intervals around all UXO locations.

e. Safety (danger, warning, caution) signs and signals will be used to warn personnel approaching a firing area. Scarlet danger flags supplemented by blinking red lights at night or during reduced visibility will be displayed from a prominent point, normally at the range entrance.

f. Signs warning personnel of the danger from projectiles, bombs, lasers, and UXO will be posted near the firing area at all times.

g. Internal and external limit of fire markers will be placed to denote right and left limits of fire. For the Army, internal and external limit of fire markers will be placed on direct-fire ranges only. See Training Circular (TC) 25–8 for limit-of-fire design requirements. When required, limit-of-fire markers shall be illuminated to ensure proper target area identification at times of limited visibility. Limit-of-fire markers should be thermalized when thermal weapons sights are used. In accordance with DA Pam 385–11, appropriate hearing protection, eye protection, and laser warning signs will be posted at each range and firing line.

h. Individual vehicles, tanks, fighting vehicles, and armored personnel carriers may display flags to show the vehicle's weapon status in accordance with the appropriate field manual. See paragraph 8–4 for more information.

2–3. Controlling other range usage

a. When the installation training complex is authorized for use by non-military organizations such as schools; county, municipal, State, or Federal agencies; organized clubs (including rod and gun clubs) or civic associations, the following requirements apply:

(1) The organization or agency will comply with requirements and procedures established by AR 385–63/MCO 3570.1C, this pamphlet, and local range regulations and SOPs.

(2) Requests for use will be coordinated with the installation RMA (Army), RCO (Marine Corps), appropriate safety office(s), and the Judge Advocate General; and submitted to the senior commander (Army)/installation commander (Marine Corps) for approval.

(3) Requests will identify if non-DOD associated minors will be involved in live-fire activities. If so, the activity must be an approved course of marksmanship training, unless otherwise approved by the senior commander (Army)/installation commander (Marine Corps).

(4) A written agreement must be completed between the installation and the non-military organization, detailing all rights and responsibilities of each party, liabilities, procedures, and regulatory and procedural requirements. For the Army, this agreement will be incorporated into the report of availability as required by AR 405–80.

(5) The non-military organization will designate an OIC and RSO. Personnel designated as OICs and RSOs will complete a pistol and rifle course approved by the National Rifle Association, or equivalent (for example, U.S. Pistol Shooters Association). The senior commander (Army)/installation commander (Marine Corps), based on input from the RMA (Army), RCO (Marine Corps), garrison safety office, Judge Advocate General, and other staff agencies, as appropriate, will determine the equivalency. For the Marine Corps, OICs and RSOs must complete the Range Safety (Basic) Distance Learning Course.

(6) The installation RMA (Army), RCO (Marine Corps) will ensure designated OICs and RSOs are briefed on their duties and responsibilities.

b. Military Family members engaging in authorized live-fire activities such as marksmanship training or participating in activities involving weapons firing, such as organizational or Family days, will comply with this pamphlet, installation range regulations, and SOPs. Requests for these activities will specify if minors will be involved. Unit will maintain a roster of all Family members for tracking and identification purposes.

c. Civilian personnel, such as military Family members and local populace, must receive authorization from the installation RMA (Army), RCO (Marine Corps) to enter the training complex to participate in or observe capabilities exercises, fire power demonstrations, training courses, competitions, or other types of live-

fire exercises. Such personnel will remain in designated safe areas as determined by the installation RMA (Army), RCO (Marine Corps).

d. Inspection team members or other official observers required to be on the firing line, firing position, or firing area will position themselves in safe areas as determined by the installation RMA (Army), RCO (Marine Corps). These personnel must wear appropriate safety equipment as specified by the local range regulations and the installation RMA (Army), RCO (Marine Corps).

e. Civilians, to include Family members and DOD civilians, must have approval from the installation RMA (Army), RCO (Marine Corps) to fire weapons within the installation training complex.

2–4. Coordinating use of special use airspace

a. Hazardous activities. Any activity considered hazardous to nonparticipating aircraft or requiring special use airspace (SUA) to segregate it from other users of the National Airspace System or in the airspace of host countries will not be conducted until appropriate SUA has been designated and activated for that purpose.

b. Types of activities that may require special use airspace. Types of activities that may require SUA include, but are not limited to: artillery fire, mortars, missiles and rockets, air-to-ground and ground-to-air weapon systems, aerial target practice, laser operations, demolition and explosive devices, electronic warfare devices, remotely piloted and unmanned aerial systems, conducting hazardous activities, small arms ranges and any other activity considered to be hazardous or non-compatible with other users of the airspace. SUA is required to be designated and activated prior to conducting any activity over 45m (150 feet (ft)) above ground level (AGL) (to include ricochets) that would be hazardous to aircraft. When determining requirements for any type of new SUA to support planned training, a risk assessment will be performed that identifies the degree of risk posed by hazards to existing airspace users from planned live-fire events.

c. Installation Range Management Authority (Army), Range Control Officers (Marine Corps) special use airspace. The installation's RMA (Army), RCO (Marine Corps) shall be involved in all SUA matters. For the Army, SUA will be established and managed in accordance with appropriate Federal Aviation Administration (FAA) regulations, applicable host nation rules and procedures, and AR 95–2. The installation air traffic and airspace (AT&A) officer is the focal point for SUA actions. For additional information and guidance, contact the appropriate ACOM, ASCC, DRU AT&A officer or Department of the Army representative (DAR). For the Marine Corps, SUA will be established and managed in accordance with appropriate FAA regulations or International Civil Aviation Organization rules, applicable host nation rules and procedures, OPNAVINST 3770.2K, MCO P3550.10, local SOPs, and range control procedures. All formal communications with the FAA must be in accordance with OPNAVINST 3770.2K.

d. Types of special use airspace. Types of SUA that may be established include, but are not limited to:

(1) *Restricted areas.* Airspace identified by an area on the surface of the earth within which the flight of aircraft, while not wholly prohibited, is subject to restrictions. Restricted areas will be designated when determined necessary to confine or segregate activities considered to be hazardous to nonparticipating aircraft. Examples of those activities include, but are not limited to, artillery, aerial gunnery, or guided missile firing.

(2) *Warning areas.* Airspace of defined dimensions that contains activity that may be hazardous to nonparticipating aircraft. The purpose of such warning areas is to warn nonparticipating pilots of the potential danger. A warning area may be located over domestic or international waters or both.

(3) *Military operations area.* Airspace of defined vertical and lateral limits established for the purpose of containing certain military training activities that include, but are not limited to, air combat tactics, air intercepts, acrobatics, formation flying, and low-altitude tactics in airspace as free as possible from nonparticipating aircraft.

(4) *Controlled firing area.* A controlled firing area (CFA) is established to contain activities that, if not conducted in a controlled environment, would be hazardous to nonparticipating aircraft. The distinguishing feature of a CFA, as compared to other SUA, is that its activities are suspended immediately when spotter aircraft, radar, or ground lookout positions indicate an aircraft might be approaching the area. Examples of CFAs are small arms or EOD ranges.

e. Display of special use airspace. SUA shall be shown on installation maps and overlays, as appropriate.

2–5. Small Arms Range Safety Area (Army)

For the Army, Small Arms Range Safety Areas (SARSAs) are areas the garrison commander establishes to contain small arms range activities that could be hazardous to non-participating aircraft. SARSAs are not SUA. Garrison commanders will ensure that users of Army small arms ranges that are located outside restricted airspace or CFAs follow the SARSA policy and procedures established below:

a. To protect aircraft, the garrison commander or designated representative (normally the installation range

manager) will establish or abolish SARSAs at each small arms range not located within SUA as required by this pamphlet. Unless otherwise identified in this pamphlet, the data in tables 4–1 through 4–32, will be used as the basic vertical component for each weapon system used on the range. When determining SARSA altitude boundaries, 152m (500 ft) will be added to that value and rounded up to the next 152m increment of altitude as a safety buffer. Garrison commanders will take appropriate action to ensure that airspace above and adjacent to small arms ranges is adequately monitored to preclude endangering aircraft operations. Garrison commanders will also consider maximum ordinate (Max Ord) and highest altitude of fire where the specific range operations call for it.

b. The garrison commander or designated AT&A officer will coordinate with the appropriate senior commander's AT&A officer and DAR for development of SARSA proposals and letters of agreement (LOA) with local air traffic control (ATC) facility personnel to assist in the early detection and notification of approaching aircraft. Garrison commanders will coordinate SARSA proposals through Headquarters, U.S. Army Aeronautical Services Agency for areas not covered by the DAR. SARSA proposal requests will include—

(1) Activity for which approval is being requested.

(2) Specific location and boundaries.

(3) Altitudes.

(4) Name, address, and phone number of the originator of the request.

(5) Proposed times of use.

(6) Desired effective date.

(7) Proposed safety precautions including visibility requirements, ceiling (cloud height) requirements, safety observers, communication links, and any other factors that enhance range safety.

(8) Instructions, if applicable, for the installation range OIC to notify the owner or manager of airports that might be affected by the SARSA.

(9) Attachments: risk assessment, map with SDZ and 5 miles buffer depicted and ATC LOA (if applicable).

c. Upon receipt of SARSA proposal, the DAR:

(1) Reviews the garrison commander's proposal to determine if the proposed SARSA presents conflict with the requirements of other airspace users.

(2) Encourages the proponent to explore the feasibility of conducting the activity in an existing restricted area where possible.

(3) Assists the AT&A officer in coordination with local ATC for LOA (if applicable) and reviews prior to signature.

(4) Prior to the establishment of the SARSA, reviews the proposal and informs the garrison commander of any recommendations by formal correspondence for proposal feasibility.

d. The following precautionary measures are mandatory requirements for all small arms ranges, as applicable:

(1) The ceiling (cloud height) will be at least 305m (1000 ft) above the ricochet height. The garrison commander or their designated representative should also consider highest altitude of fire and Max Ord in addition to ricochet height as a part of risk assessment.

(2) Visibility will be sufficient to detect nonparticipating aircraft and then establish a cease fire before penetration of the aircraft into the SDZ.

(3) The garrison commander may elect, based on risk analysis, to substitute radar surveillance for the ceiling and visibility requirements. This provision is contingent on the adequacy and availability of the radar service and the necessary communication links to the range OIC.

e. The garrison commander or designated representative will establish procedures that designate a responsible officer (normally the range OIC) for the surveillance of the airspace in the SARSA. Safety observer(s) and radar should be able to monitor airspace inclusive of a border extending 5 miles from the boundaries of the SDZ of the SARSA. Safety observers will maintain positive, immediate communication with the range OIC or range operations firing desk (Army), range control (Marine Corps) at all times. Safety observers will be thoroughly briefed on their duties and responsibilities. Range operations (Army), range control (Marine Corps) must have an adequate plan in place to support the range OIC in this effort.

f. All firing activities within the SARSA must cease upon notification of impending or actual incursion of the SARSA by nonparticipating aircraft.

g. For assistance on SARSA matters, contact:

(1) Garrison commander's AT&A officer.

(2) Senior commander's AT&A officer.

(3) The DAR responsible for your geographic area (see AR 95–2, for DAR contact information).

(4) Headquarters, U.S. Army Aeronautical Services Agency.

2–6. Coordinating use of navigable waterways

a. U.S. Army Corps of Engineers (USACE) maintains notices of the restricted danger zones published in 33 CFR 334. USACE is the only entity authorized to waiver water traffic requirements that apply to the live-fire of military munitions over navigable waters, to include inter-coastal waterways. Senior commanders (Army)/installation commanders (Marine Corps) will notify the USACE division or district commanders and the applicable U.S. Coast Guard District Office of—

(1) Waterway involved.

(2) Operations to be conducted.

(3) Sector of waterway needed for closure.

b. Federal laws that protect water traffic on navigable waterways authorize Secretary of the Army to prescribe regulations for use and navigation of waterways endangered or likely to be endangered by firings and target practice. USACE will publish a notice of the restricted danger zone under 33 CFR 334.

c. The senior commander (Army)/installation commander (Marine Corps) will not authorize firing until notice of the restricted danger zone is published in 33 CFR 334 and navigation maps have been revised. Additionally, the senior commander (Army)/installation commander (Marine Corps) will enforce closed waterways by radar and/or surface vessel surveillance. Firing will not commence until the U.S. Coast Guard has marked the restricted danger zone with buoys.

d. Military munitions containing phosphorous, including guided missiles or rockets, will not be fired or dropped into any inland waterway, lake, bay, wetlands, or other body of water.

e. Firing over navigable waters in overseas areas, to include inter-coastal waterways, will be performed within parameters of Status of Forces Agreements/Visiting Forces Agreements and appropriate host nation requirements.

2–7. Army safety requirements for indoor firing ranges and shoothouses

This paragraph provides Army requirements for the safe operation and maintenance of indoor firing ranges and shoothouses.

a. Lead intoxication.

(1) Commanders will ensure that Soldiers and maintenance personnel who operate in urban combat live-fire facilities understand the potential hazards of lead poisoning and the controls, based upon an individual's level of exposure, required to mitigate this hazard. Therefore, facility SOPs will address the Industrial Hygiene survey controls developed for the facility and facility personnel, and unit SOPs will address lead poison awareness to include safety precautions, hygienic standards, "do's and don'ts" on the range, methods to limit exposure, etc.

(2) Commanders will brief the following precautions prior to the conduct of live-fire exercises in indoor or semi-enclosed shooting facilities:

(a) Maintain good hygiene. Wash hands and face after completion of training.

(b) Do not use tobacco products of any kind on the range.

(c) Wash hands and face prior to consuming food products and liquids on the range.

(d) Do not collect spent brass casings in personal headgear.

(e) Do not use dry sweeping to clean lead-contaminated areas – use HEPA vacuums to limit exposure.

(f) Change clothing and footwear before returning to the unit area or going home (children are more susceptible to lead poisoning).

(g) Take steps to remove residual lead dust from hands and clothing to avoid cross-contamination of other personnel.

(3) Indoor firing ranges and shoothouses must comply with Occupational Safety and Health Administration standards (29 CFR 1910.1025) including medical surveillance requirements. Personnel exposures, which are intermittent, will be controlled per the criteria provided in table 2–1. Army Special Operations Command (USASOC) personnel must follow lead abatement guidance in USASOC Reg 385-1.

(4) The criteria in table 2–1 were developed to control intermittent lead exposure and establish maximum hours of exposure based on the airborne lead concentration and the number of days firing per year. These criteria are to be used as interim control measures only. Maximum effort will be made to reduce the airborne lead levels to 0.03 milligrams per cubic meter (mg/m3) or less.

(5) Lead exposures for personnel are determined by a sampling strategy that employs general-area and breathing-zone samples. Paragraph 2-7*b* contains guidance for air sampling. The Industrial Hygiene

Department of the U.S. Army Public Health Center will conduct the airborne lead sampling and provide the analysis and recommend the maximum allowable hours of exposure to be used as indicated table 2–1. Once an airborne lead concentration is determined, table 2–1 is used to set maximum allowable hours of exposure for each category of range user. Other potential lead exposures, including off-duty firing, may contribute to an individual's overall exposure and should be considered in establishing maximum allowable exposure time.

(6) The command safety manager, RMA, industrial hygienist, and medical authority will make recommendations to the appropriate risk decision authority to determine the need for medical surveillance. Medical surveillance is not required for intermittent users if the maximum allowable exposure hours from table 2–1 are enforced.

Table 2–1
Breathing zone exposure limits for intermittent atmospheric lead exposures (Army)

	Maximum hours of allowable exposure per day		
Concentrations (in mg/m^3)[1]	**Soldiers exposed fewer than 30 days per year**	**Soldiers in marksmanship teams or soldiers exposed more than 30 days per year and all nonmilitary personnel**	**Range users under 17 years of age**
0.000 to 0.029	8.00	8.00	4
0.030 to 0.039	8.00	6.00	3
0.040 to 0.049	8.00	4.50	2
Limited-use ranges			
0.050 to 0.059	6.50	4.00	2
0.060 to 0.079	5.00	3.00	1
0.080 to 0.099	4.00	2.25	1
0.100 to 0.149	2.50	1.60	0
0.150 to 0.199	2.00	1.20	0
0.200 to 0.299	1.25	0.75	0
0.300 to 0.399	1.00	0.60	0
0.400 to 0.499	0.75	0.45	0
0.500 to 0.749	0.50	0.30	0
0.750 to 0.999	0.35	0.24	0
1.000 or above	0.00	0.00	0

Note:
[1] These values are the actual concentrations measured over the sampling period and are not 8-hour, time-weighted averages.

b. Air sampling.

(1) Collect all lead samples on cellulose ester filters meeting the following specifications: pore size of 0.8 microns, 37millimeters (mm) in diameter, three-piece preloaded cassette, and closed face. Sampling rate should be 1 to 4 liters per minute for a minimum volume of 500 liters.

(2) In indoor firing ranges, sample on the firing line, 3m behind the firing line, and in adjacent areas (such as range office, supply room, or hallways). In small ranges (fewer than six firing positions), samples should be taken at each firing position on and off line. In larger ranges (six or more firing positions), breathing-zone and general-area samples should be taken in every other firing position and off line. In shoothouses, sample at each doorway and other locations where personnel may pause. Permanently assigned range personnel may be evaluated using data obtained from general-area and breathing-zone samples, if applicable. Take at least one air sample for lead in an area adjacent to the facility defined above during each monitoring period. The sample should indicate whether or not lead contamination is confined to the facility.

(3) The following actions are critical to proper evaluation:

(a) Sample during periods of maximum use.

(b) If firing is over an extended period of time, allow time for possible buildup of airborne concentrations before sampling.

(c) Sample during the use of higher-caliber ammunition if more than one type of ammunition is used.

(4) Calibrate all pumps before and after use by a method traceable to a primary standard (for example, bubble and burette).

c. Ventilation.

(1) Contaminations occur as byproducts of firing (that is, lead, carbon monoxide, and aldehydes) and must be removed from the facility through an adequate ventilation system. The maximum concentration of lead acceptable for an 8-hour daily exposure (time-weighted average) is 0.05 mg/m^3. A ventilation system designed to provide this protection is sufficient to remove other byproducts of firing.

(2) Optimum ventilation systems should intake make-up air behind the firing line and expel exhausted air

at the target line or bullet trap.

(3) Downrange air velocity can be measured or approximated by using a 30-second smoke candle and stop watch. Ignite the smoke candle behind the firing line and time the smoke from the moment the first plume crosses the firing line until it reaches the bullet trap. Calculate the air velocity in meters per second (m/s) by dividing the range distance or length (from firing line to bullet trap) (D) by time (T), or D/T=m/s. A minimum of 0.18m/s is required. This is equal to 0.017 cubic meters per second per square meter of cross-sectional area. During the smoke evaluation, observe the range for any "dead spots" (swirling of smoke up-range) or other turbulent airflow motions that may allow for increased exposure at or behind the firing line.

(4) Ensure proper disposal of contaminated waste (for example, filters).

d. Army requirements for inspection of indoor firing ranges and shoothouses. These facilities require periodic inspections to ensure compliance with current health and safety standards. The types of periodic inspections are initial, detailed, and annual.

(1) Initial inspections are one-time inspections made by qualified and competent safety or engineer personnel. The purpose of the initial inspection is to classify the authorized level of use of the facility. Based on the findings of the initial inspection, the facility will be classified as safe, limited, or unsafe. DA Form 5687 (Initial Inspection Checklist for Indoor Ranges) will be used to record the initial indoor firing range inspection. Criteria for initial inspection of shoothouses will be developed by the RMA, appropriate safety office, industrial hygiene office, and appropriate medical authority based on local conditions. A copy of the initial inspection will be maintained at the range and available for review.

(a) A facility classified as safe permits authorized firing for military and civilian use.

(b) A facility classified as limited permits only limited use under controlled conditions. The personnel exposure limits for intermittent atmospheric lead exposure will be used for limited operation of the facility.

(c) A facility classified as unsafe is not authorized for use under any conditions.

(2) Detailed inspections will be made by the support installation team composed of safety, facility engineer, and medical department activity representatives. Detailed inspections are in addition to the initial inspection. DA Form 5688 (Detailed Inspection Checklist for Indoor Ranges) will be used as a minimum for conducting the indoor firing range inspection. Criteria for detailed inspection of shoothouses will be developed locally as in paragraph (1), above. Findings from the detailed inspection will determine complete facility retrofit requirements. For new facilities, a detailed inspection will be made within 120 days of the initial inspection. It is important that appropriate safety, industrial hygienist and range authority representatives participate in the planning, preparation and execution stages of design and construction of all ranges.

(3) Annual inspections will be made by safety specialist (0018 series) or safety engineer (0803 series) personnel to ensure safety standards and procedures are maintained in the operation of the facility. The annual inspection will be made within 45 days of the anniversary date of the last annual inspection.

e. Disposition of Army inspection and evaluation results.

(1) Inspection and evaluation results will be provided to the next higher headquarters for action as appropriate. Supporting installation safety managers will maintain an information copy.

(2) The supporting facility coordinator will maintain a record of each inspection. Subsequent inspections will be made as a follow-up check against previous inspection results to assure required corrective action(s) noted has/have been accomplished and that there are not adverse changes to the building envelope, environmental conditions, and/or safe operating procedures.

f. Range safety inquiries. ACOMs, ASCCs, and DRUs may address inquiries pertaining to indoor range safety to TCM Ranges, Fort Eustis, VA 23604–5700.

g. Industrial hygiene inquiries. Inquiries pertaining to ventilation, air sampling and other industrial hygiene issues should be directed to Commander, U.S. Army Public Health Center (MCHB–IP–OFS), 5158 Blackhawk Road, Aberdeen Proving Ground, MD 21010–5403.

h. The use of Armor Piercing (AP) and tracer ammunition is not authorized for use in shoothouses or indoor/outdoor baffled ranges. These rounds have the potential of creating a fire or penetrating the walls and bullet traps.

i. Indoor and outdoor baffled ranges.

(1) Indoor and outdoor baffle ranges must have overhead baffles constructed with a minimum of 3/8 inch AR500 rated steel placed at an angle of 15 degrees to deflect errant rounds towards ground.

(2) For indoor ranges constructed with deceleration chambers, bullet impacts should not be concentrated into opening or throat of the deceleration chamber. Rounds should impact on steel ramps above or below the throat at an angle of 15 degrees or less leading into the throat.

(3) These type ranges support the use of 5.56mm (M855 and M855A1) and 7.62mm (M80 and M80A1) or other less powerful small arms ammunition.

(4) Inspections should be conducted regularly to observe for dimpling or deformation of steel.

j. *Shoothouses with 16 inch sand or gravel filled walls*

(1) Firing Short Range Training Ammunition (SRTA) does not require bullet traps

(2) Bullet traps are mandatory when firing M855 and M855A1.

(3) Considerations should be made to inspect the shoot house after each use to ensure no rounds penetrated the walls and that walls are filled to the recommended height with sand or pea gravel.

(4) These type ranges support the use of 5.56mm (M855 and M855A1) or other less powerful small arms ammunition.

k. Shoothouses with *3/8 inch or ½ inch AR500 Steel covered with 2 inch ballistic rubber.*

(1) This configuration supports firing directly on the wall with 5.56mm Short Range Training Ammunition (SRTA), M1037, 7.62mm (M973), and frangible small arms ammunition.

(2) Bullet traps are mandatory when firing 5.56mm (M855 and M855A1).

(3) Periodic inspections will be conducted to observe for any dimpling or deformation of steel.

l. *Shoothouses with 3/8 inch or ½ inch AR500 steel covered with 2 inch and 12 inch ballistic rubber (14 inch total "Hot Wall").*

(1) This configurations supports firing directly on the wall with 5.56mm (M855 and M855A1) and 7.62mm (M80 and M80A1). Bullet traps are not required.

(2) This configuration supports simultaneous room clearing.

(3) Periodic inspections will be conducted to observe for any dimpling or deformation of steel.

2–8. Marine Corps safety requirements for indoor and outdoor firing ranges

This paragraph provides Marine Corps requirements for the safe operation and maintenance of indoor firing ranges.

a. Indoor firing ranges will comply with the information listed within Department of Defense handbook (MIL–HDBK) 1027/3B and NEHC–TM 6290.99–10.

b. Marine Corps inquiries regarding indoor firing ranges will be directed to Commanding General, Training Education Command, Range and Training Area Management Branch, Marine Corps Combat Development Command (MCCDC), 2300A Louis Road, Quantico, VA 22134–5001.

c. Indoor firing ranges will be certified and recertified per MCO 3550.9.

d. The use of Armor Piercing (AP) and tracer ammunition is not authorized for use in shoothouses or indoor/outdoor baffled ranges. These rounds have the potential of creating a fire or penetrating the walls and bullet traps.

e. For known distance ranges ensure red safety line criteria is IAW figure 2-2.

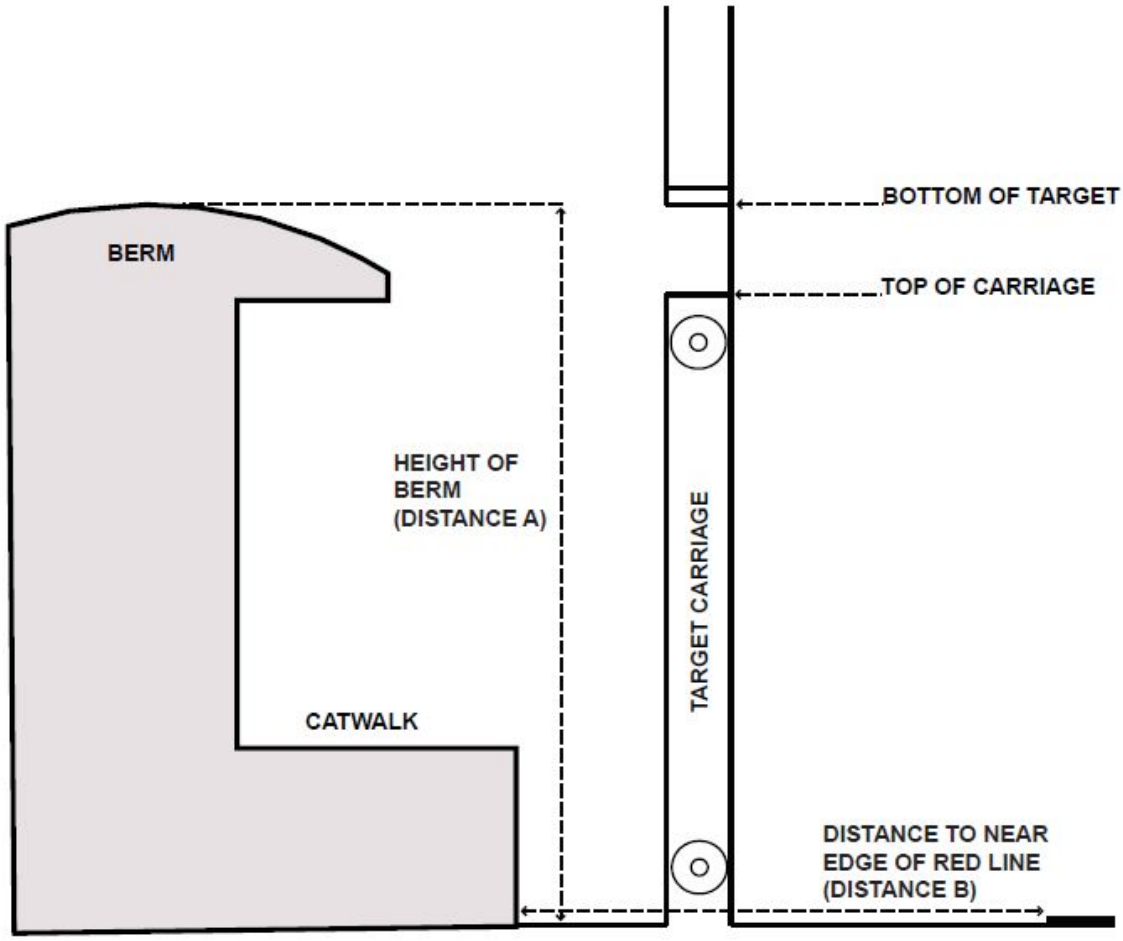


Figure 2-2 Red line for outdoor Known Distance target carriage pit area

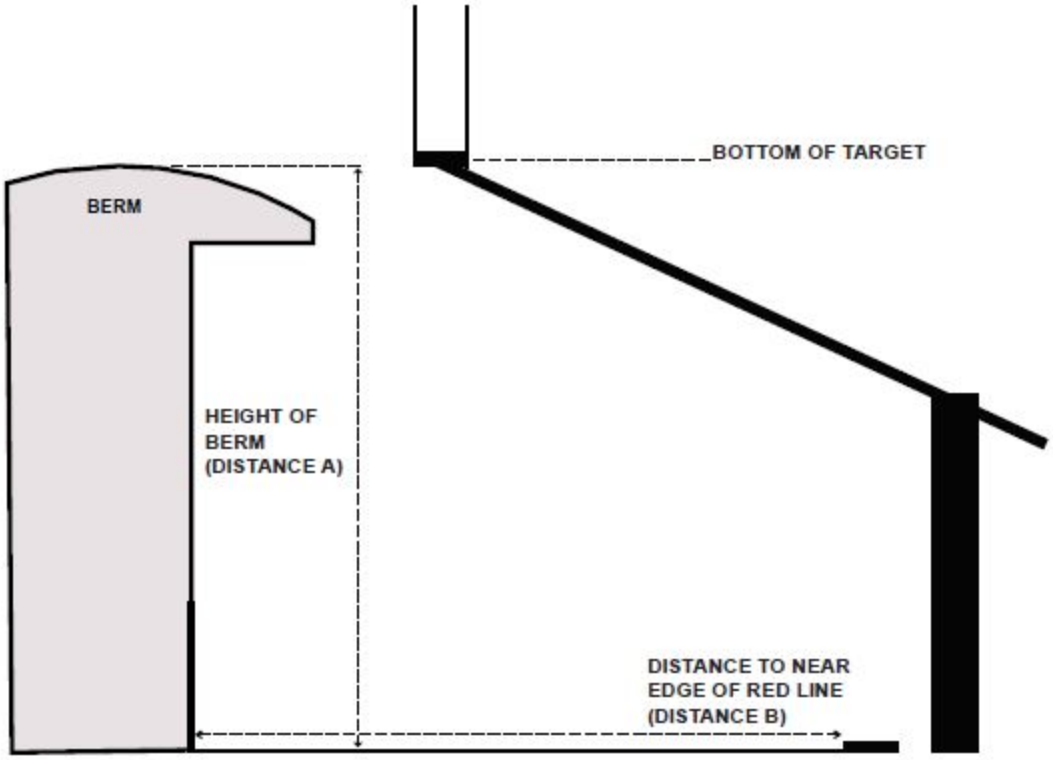


Figure 2-3 Red line for outdoor known distance target cantilever pit area

2-9. Use of ballistic concrete and Shock-Absorbent Concrete (SACON)

a. Service rifles (5.56mm) and pistols (9mm & .45 caliber) are authorized for use in both SACON (minimum 24-inch thickness) and ballistic concrete facilities. Ensure proper implementation of control measures to protect personnel and reduce the probability of ricochets. Ricochets from SACON and ballistic concrete are likely at angles less than 20 degrees with Service pistols. Additionally, concrete spall from all impacts should be considered during the risk mitigation process.

b. Use of 5.56mm M855A1 ammunition is authorized in both SACON and ballistic concrete facilities. The effects of this ammunition should be monitored and damage repaired in a timely manner.

c. Use of 7.62mm ammunition, including M80A1, is authorized in both SACON and ballistic concrete facilities. Effects of the larger caliber with regard to increased damage and accelerated deterioration of the concrete should be considered.

d. Firing .50 caliber ammunition is not authorized in SACON or ballistic concrete facilities due to its unpredictability and deep penetration that increases the likelihood that it will exit the facility.

e. Ballistic concrete and SACON are ballistically comparable and patching materials and procedures for the two materials are interchangeable. Both materials require 28 days cure time to reach their full density.

f. Use of bullet traps or 12-inch SACON repair blocks can be used in front of SACON walls to reduce wear on the walls. This will reduce wear on the first floor of two-story structures that would require significant maintenance efforts to replace wall blocks on the first floor.

2-10 Requirements for steel reactive target engagements.

Proper steel hardness and target placement must be strictly adhered to in order to maintain a safe training environment on Steel Reactive targets (SRTs).

a. Only SRTs with a certified Brinell hardness rating of AR400 to AR550 will be used for training

(1) Manufacturers (commercial or organizational) of SRT must provide a certificate of hardness to ensure the steel targets meet the minimum hardness rating of AR 400. The certificate must remain on file as long as the

targets are being utilized by the installation. Steel with an abrasion resistant coating coupled with 550 Brinell hardness steel (AR 550) is considered optimum for safety and longevity of use.

(2) Homemade or unit-constructed targets are not allowed due to inconsistency in design, functioning, and the uncertainty in steel quality or hardness. Welding of SRTs is not authorized as it weakens the molecular composition of SRT and changes the Brinell hardness of the steel and may create airborne lead hazards.

(3) Angle of deflection is the angle of travel of bullet fragments relative to the plane of the target surface towards the shooter. When a shooter is shooting directly at a target, the bullet splatter will angle off the target up to 20-degrees in all directions from the point of impact and travel up to 45m (50 yards). The majority of all bullet fragments will exit the target within the 20-degree Dispersion Area as illustrated in figure 2-3. A stationary target with a 20-degree forward cant (head forward of the body) produces the best angle of deflection with the most fragment consistency.

(4) When the impact surface of the SRT is no longer flat and smooth, the bullet impact causes an unpredictable splatter effect. SRTs that are warped, dented, cracked, or have holes burrowed into them, are considered unserviceable and must be replaced. Targets with dimples (slight surface depressions) that are 1/32" deep into the steel are also considered unserviceable.

(5) SRTs that are unserviceable will not be used closer than 100m from the shooter.

(6) Once frangible ammunition or M1037 Short Range Training Ammunition (SRTA) is used on SRT, ball and shotgun ammunition can no longer be used on it at distances closer than 100m. This ammunition pits and gouges SRT resulting in a target surface that is no longer smooth and presents an unpredictable ricochet hazard.

(7) Mounting bolts or hardware must not be face of SRTs exposed too firing as they create an unpredictable ricochet.

(8) PPE Level 0 and OSHA-approved wrap-around impact-resistant eyeglasses are mandatory for all personnel on the range within 50 meters of the firing line.

(9) For the Army, the minimum engagement distances for steel (reactive and non-reactive) targets are 7m with pistol, 25m with 5.56mm ammunition, or 100m with 7.62mm ammunition.

(10) For the Marine Corps, the minimum engagement distances for SRT are 7 yards for pistol and 10 yards for shotgun (“00” buckshot and birdshot only). 12 gauge Slug ammunition will not be fired at targets closer than 50 yards. Minimum engagement distances for 5.56mm and 7.62mm ball ammunition is 100 yards.

(11) EPR ammunition will damage steel targets faster than other service ammunition.

(12) 12 gauge slug ammunition will not be fired at steel targets at distances of 45m (50 yards) or closer.

(13) The RSO will ensure that no shooter violates the established range SDZ.

(14) Automatic fire is not authorized during steel target engagements.

(15) Applying grease or oil (“slicking”) to the target face is not authorized.

(16) Duties of the RSO will be addressed in the Installation SOP as outlined below. This listing is not to be considered all-inclusive.

b. Before firing, the RSO must ensure that all SRT have been certified as Brinell hardness rating of AR400 to AR550, and that the SRT are serviceable and operate as designed.

(1) Ensure that only Army/Marine Corp procured ammunition with a Department of Defense Identification Code (DODIC) are used on SRTs.

(2) Armor piercing ammunition will not be used to engage steel targets.

(3) PPE Level 0 and OSHA approved wrap-around impact resistant eyeglasses are mandatory for all personnel on range within 45m (50 yards) of the firing line.

(4) Place targets on soft sandy-type soil or place an absorbing material such as a sand box (minimum 30” x 30”) in front of the target to absorb the splatter and prevent projectiles from ricocheting off the ground. If more than one portable target is to be used, the targets will be set in a fashion so that the splatter from one target will not ricochet off the next shooter. Each target must be placed with the direction of fire and the angle of deflection taken into consideration.

(5) Careful consideration of the 20-degree Dispersion Area must be taken into account when multiple stationary SRTs are in a line. The number of shooters on the firing line have to be limited at closer distances to keep all personnel out of the 20-degree Dispersion Area refer to figure 2-4.

(6) Targets that are intended to flip, swing, or rotate must move freely and operate as intended. Ensure all targets are adjusted to fall with minimal bullet impact.

(7) Ensure all non-participating personnel remain 45m (50 yards) behind the firing line. The RSO will

observe and maintain control of the firing line to ensure shooters do not inadvertently move past the 20 degree dispersion area.

c. During firing, comply with minimal personnel supervisory requirement for RTA usage. Medical personnel must be on site with appropriate medical equipment available during all SRT live fire training.

(1) Ensure all personnel remain clear of the 20-degree Dispersion Area.

(2) Ensure targets are refaced with paint only.

(3) Ensure portable SRT are prevented from moving (laterally, rotationally, or downrange) from set-up position during training, which would change the 20-degree Dispersion Area(s) of the targets.

(4) Ensure that a minimum safe engagement distance(s) from the muzzle to the SRT is established and maintained for each weapon system used.

(5) Ensure the SRT remain adjusted to operate properly upon impact.

d. After firing resurface SRT with a coat of paint and lubricate all moving parts and mechanisms and inspect for wear and serviceability.

e. Lead abatement must be considered when handling steel target that have been shot.

(1) For USASOC personnel, contaminated targets will be thoroughly cleaned prior to cutting, welding, or braising to avoid hazardous gases created by embedded or coated bullet fragments.

(2) Personnel will wash hands immediately following the handling of contaminated steel targets. It is highly recommended that personnel use nitrile gloves for handling contaminated steel targets to reduce the exposure to the contamination.

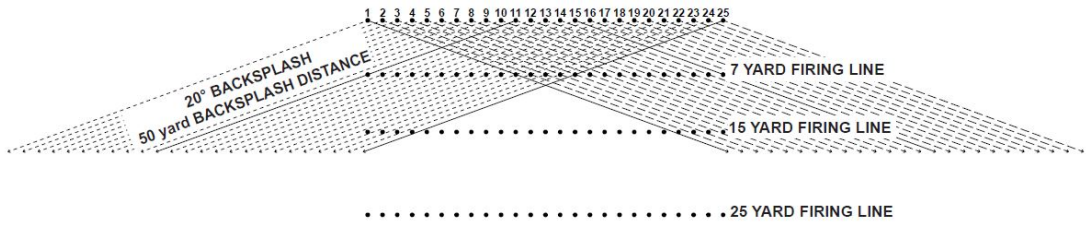


Figure 2-4 Multiple stationary Steel Reactive Target (SRT) without 20 degree downward cant

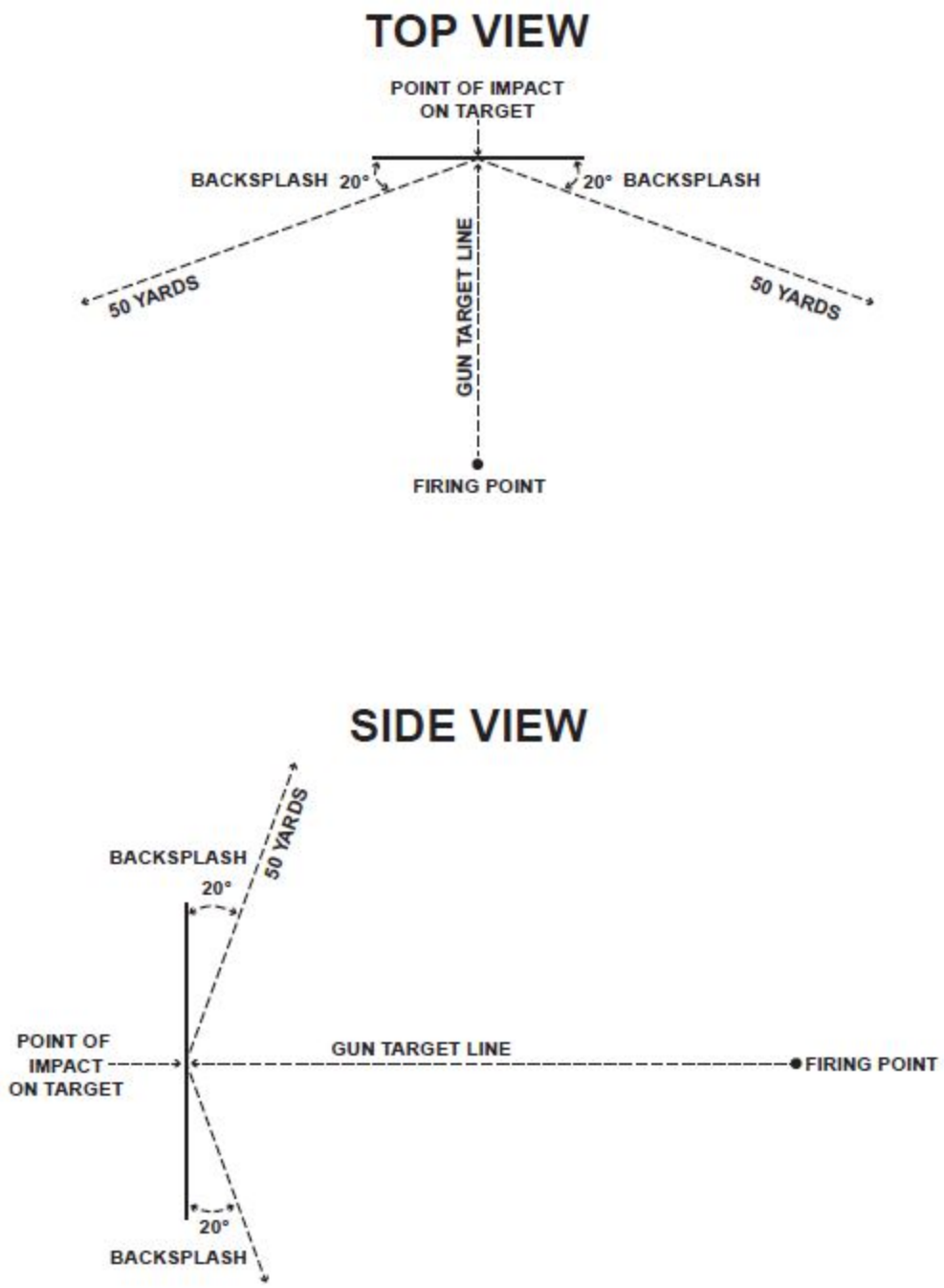


Figure 2-5Steel Reactive Targets (SRT) without 20 degree downward cant

2–11. Recreational ranges

a. Procedures in this pamphlet apply to recreational ranges located on Government property. Recreational activity on ranges must be approved by the installation commander on a case by case basis. Formal memorandums of agreement must be established with approved organizations participating in recreational range activity. Memorandums of agreement at a minimum must address the following:

(1) Liability for both safety and environmental National Environment Protection Action compliance.

(2) Emergency response requirements and responsibilities.

(3) Responsibilities for maintenance and best management practices of the range.

(4) Operating cost and consumables.

b. Archery target ranges will follow range designs included in the USACE Drawings (Planning and Design of Outdoor Sports Facilities) file number 750–90–01. Other designs including 3-dimensional archery ranges or field ranges simulating hunting scenarios must have a positive backstop. Additional guidance is available from the National Field Archery Association.

c. Shotgun (skeet/trap) ranges will follow range designs included in the USACE Drawings (Planning and Design of Outdoor Sports Facilities) file number 750–90–01. The shotfall danger zone will be a minimum of 275m (300 yards) as per 750–90–01 and the ranges must be limited to shot sizes 7.5, 8, 8.5, and 9 shot. Additional guidance is available from the National Skeet Shooting Association, and the National Sporting Clays Association. Military training used for shotgun firing (not on a recreational skeet/trap range) will be in accordance with SDZ requirements in chapter 4. Marine Corps shotgun ranges will be certified in accordance with MCO 3550.9.

2–12. Ammunition and explosive items on ranges

Procedures for transporting, storage, handling, and security of AE items are contained in DA Pam 385–64 or NAVSEA OP5 or in applicable field manuals (FMs) or technical manuals (TMs). In addition, the following instructions, with relevant references, pertain to operational ranges:

a. Positioning and issuing of ammunition and explosive. Positioning and issuing of AE, to include quantity-distance determinations, will be in accordance with DA Pam 385–64 or NAVSEA OP5, Volume 1. The RMTK may be used to plan for positioning and issuing of AE on operational ranges.

(1) Operational ranges require AE at various locations (for example, firing points) that are inherent to a training exercise or temporary or transient by nature. These locations do not require a site plan approved by the DDESB. However, permanent structures on ranges used for administrative storage or issuance of AE must be sited and approved by the U.S. Army Technical Center for Explosives Safety and subsequently by the DDESB.

(2) Distribution of AE to personnel will occur only in areas designated for that purpose, for example, ready lines, firing lines, attack positions, assembly areas, or defilade positions. Blank and live-fire AE will not be stored in or issued from the same location at the same time.

(a) Fuel storage areas will be located at separation distances from ammunition storage areas based on the amount of fuel.

1. Fuel quantities up to 500 gallons will be separated from each potential explosion site by at least 50 ft.

2. Fuel quantities between 500 to 5,000 gallons will be separated from each potential explosion site by at least 100 ft. U.S. Army ACOMs, ASCCs, and DRUs may address inquiries pertaining to indoor range safety to TCM Ranges, Fort Eustis, VA 23604–5700.

3. For fuel quantities greater than 5,000 gallons, refer to DA Pam 385–64 (Army) or NAVSEA OP5 (Marine Corps).

(b) Forward arming and refueling point operations, and separation distances for fuel, ready ammunition storage areas, and basic load storage areas will be in accordance with FM 3–04.111, FM 10–67–1, and Naval Air Systems Command (NAVAIR) 00–80T–109.

1. The quantity of ammunition unpacked for training will be kept to the minimum quantity needed for live-fire training or an exercise. Packaging material, propelling increments, and fuzes will be retained until completion of the live-fire portion of the training or exercise. Units will not burn wooden containers or indiscriminately use or dispose of ammunition to preclude its return to a storage facility. {Exception: GTR–18 Smokey Sam rockets are issued by the case with a quantity of 12 rockets and 12 igniter rods. Planning use of these pyrotechnics requires careful consideration of the effects of moisture on unpacked items. All unpacked rockets must be expended and only full, unbroken cases returned to the ammunition supply point (ASP)}. Broken and/or unserviceable increments (powder bags) will be handled in accordance with installation range SOPs.

2. Guided missiles, rockets and components, such as fuels, propellants, oxidizers, and explosives in ready storage or at the firing location will be positioned to minimize the possibility of ignition or detonation by motor exhaust or by an accident involving the firing of a missile or rocket. Such military munitions will be stored in dry locations, protected from direct rays of the sun, and adequately ventilated. Marine Corps Smokey Sams, Smokey Guns, and pyrotechnics will be stored as outlined in appropriate Marine Corps TMs, or NAVAIR technical publications.

3. During pre-fire preparation, guided missiles, rockets, and components will be handled and assembled in a manner consistent with this pamphlet, local range SOPs, and appropriate FM and TM. Any alteration to guided missiles or rockets and their associated equipment is prohibited except as authorized by official

publications or by CG, Army Materiel Command (AMC).

4. All AE, unpacked for use but not used, will be repackaged into its original packing configuration prior to return to the ASP. AE that is easily degraded by short-term exposure to moisture, such as propelling charges, pyrotechnic signals, and simulators, will be unpacked only for the minimum amount of time consistent with mission requirements.

(c) Requests for current status of AE not listed in Naval Supply Systems Command (NAVSUP) P–801 will be sent to Navy Operational Logistics Support Center (NOLSC) Mechanicsburg, PA, Defense Switched Network 430–2107/ commercial (717) 605–2107 (Marine Corps).

(d) Defective AE will be reported in accordance with MCO 8025.1E (Marine Corps).

b. Suspension or disposition of ammunition and explosives involved in malfunctions and accidents. The suspension or disposition of AE involved in malfunctions and accidents will be in accordance with AR 75–1, DA Pam 385–40, and MCOs 8025.1E and P5102.1B. Firing suspensions are published in Technical Bulletin (TB) 9–1300–385, NAVSUP P–801, and appropriate TMs.

(1) Any AE suspended and listed in TB 9–1300–385 or NAVSUP P–801 and their supplements will not be fired in training.

(2) Firing of "restricted" AE listed in TB–9–1300–385 or NAVSUP P–801 and their supplements will be conducted in accordance with the restriction requirements.

(3) AE determined to be defective will not be fired. Defective AE will be reported to the installation quality assurance specialist, ammunition surveillance office or the explosives safety office via the RMA (Army), RCO (Marine Corps). Examples of defects include, but are not limited to:

(a) Fuzes or fuzed rounds that are inadequately tightened, insecurely staked, or missing safety devices.

(b) Safe and arming mechanisms, if so equipped, in an armed position.

(c) AE showing deterioration or corrosion.

(d) AE showing evidence of defects in material or assembly.

(e) AE and/or unopened AE packaging which shows evidence of tampering. It will not be issued until cleared by competent explosives safety authority.

c. Unexploded ordnance and misfire procedures and reporting.

(1) The range OIC will report all UXO to the installation RMA (Army), RCO (Marine Corps). In the case of grenades or other munitions that may be immediately hazardous to personnel (for example, bursting radius), firing will be halted until qualified EOD personnel clear the dud. In other cases, firing need not be halted. Duds not cleared by EOD personnel before the unit departs the training complex will be reported in writing to the installation RMA (Army), RCO (Marine Corps) for determination of clearance scope.

(2) Misfire procedures in training manuals/current operating manuals for the appropriate weapon system will be followed. Misfires that present an immediate hazard to personnel or require an immediate cease-fire will be reported to the range operations firing desk (Army), range control (Marine Corps).

(3) AE malfunctions or defects will be reported in accordance with appendix A of AR 75–1 (Army) or MCO 8025. 1E (Marine Corps).

(4) Range clearance and destruction of UXO on operational ranges will be in accordance with DODI 3200.16 and approved Service procedures.

d. Blank ammunition. The following precautions will be observed during the use of blank ammunition:

(1) The blank firing adapter (BFA) is a necessary component for operational safety. Weapon systems for which approved BFAs are manufactured will not be fired without the proper BFA. The distance at which weapons can be safely fired at unprotected troops without causing injury is somewhat reduced with the BFA. However, 5m safe separation distance will not be reduced. This distance, with a dispersion angle of 10 degrees left and right of the GTL, does not exclude possible injury to the unprotected eye. Hearing protection (ear plugs) should be worn while firing blank ammunition.

(2) Army combat uniform and Marine Corps combat utility uniforms offer skin protection and should be worn at all times. For Army, eye protection will be used. For Marine Corps, eye protection should be used.

(3) A violation of the safe separation distance could result in serious injury, and within 1m may cause fatal injuries.

2–13. Range personal protective equipment requirements

a. Training casualties on operational ranges must be minimized through the use of appropriate personal protective equipment (PPE). This pamphlet provides recommendations as to the level of PPE to be used with specific weapon systems. These PPE levels are found in table 2–2. Ultimately, the commander must decide the

appropriate level of PPE based on thorough risk assessment.

b. All personnel within the hearing hazard zone will wear approved hearing protection. The size of the hazard zone varies with the weapon. For mixed-use ranges, it is usually convenient to establish the zone based on the loudest weapon used. For administrative convenience, the size of the hearing protection zones can be increased to encompass areas within convenient access or demarcation points. For the Army, the senior commander may, based on risk management, mitigate risk of noise hazard to the lowest possible level consistent with mission accomplishment. The Marine Corps requires that all personnel exposed to gunfire or artillery or missile firing, under any circumstances, will wear hearing protective devices. The following list of distances to the hazard contours for common military weapons is conservative:

(1) 0.50 caliber: 55m to the side; 12m to the rear.

(2) 0.45 caliber: 12m to the side; 4.5m to the rear.

(3) 9mm: 9m to the side; 6m to the rear.

(4) 7.62mm: 20m to the side; 8m to the rear.

(5) 5.56mm: 24m to the side; 6m to the rear.

c. Approved eye protection (or eye armor) will be used, especially during force-on-force training maneuvers or scenarios by personnel undergoing training, as well as those in close proximity (for example, evaluators, observers, and very important persons). Based on risk assessment, the senior commander (Army)/installation commander (Marine Corps) may reduce or eliminate requirement for eye protection, if the decision is made that reduced vision created by use of eye protection outweighs its value. For the Army, to prevent serious eye injury the only approved eye protection for use with close combat mission capability kit (CCMCK) is the standard-issue sun, wind, and dust goggles (national stock number 8465–01–328–8268), which must be worn until all training has ceased. Alternate face masks with integrated goggles may be used only if listed in TM 9-6920-3700-10.

d. The discharge of weapons creates hazardous impulse noise levels and in the firing range, the impulse noise may act differently when it reflects off hard surfaces. Repeated exposure to impulse noise greater than 140 decibels can cause significant hearing loss. The noise exposure limit is at 84 decibels on the A-weighted scale (decibels (A)) for frequencies of 20 to 16,000 hertz)) for an 8-hour time-weighted average. When time-weighted average exposures are greater than 84 decibels (A), personnel exposed to these activities shall be included in the Hearing Conservation Program.

e. For the Army, USASOC personnel will comply with USASOC Regulation 385-1, for PPE requirements.

Table 2–2
Personal protective equipment (PPE)

Personal protective level	Personal protection required
0[1]	Army combat uniform/standard utility uniform, hearing/eye protection
1[1]	Body armor and helmet, hearing/eye protection
2[1]	Body armor with front/back enhanced small arms protective insert plates and helmet, hearing/eye protection
3	Body armor with front/back/side enhanced small arms protective insert plates and helmet, hearing/eye protection

Notes:

[1] Eye protection is encouraged. Based on risk assessment, the unit commander may require ballistic and/or laser eye protection.

2–14. Army requirements for areas known to contain improved conventional munitions and sub-munitions

This section prescribes Army controls to address hazards associated with maintenance, characterization, clearance, or removal actions at ranges and other areas known to contain ICMs and sub-munitions.

a. Applicability.

(1) Activities that involve ICM or sub-munitions undertaken by Active Army, Army National Guard, U.S. Army Reserve personnel, Army civilian employees, Army contractors, and other DOD components.

(2) Operational and former ranges and other areas owned or controlled by the U.S. Army, both in the United States and overseas.

(3) Activities conducted by other Services on Army-owned or Army-controlled property.

(4) Does not apply to the following:

(a) Research, development, test or evaluation.

(b) Acceptance or proof testing.

(c) Practice sub-munitions.

(d) World War 2-era bomblets (for example, M83 butterfly bombs, and M54 series incendiary bomblets).

(e) Formerly used defense sites.

b. Functions.

(1) The Director of Army Safety, Office of Chief of Staff, in coordination with the Office of the Deputy Chief of Staff (ODCS), G–3/5/7 (DAMO–TRS), ODCS, G–4 (DALO–SUM) and Deputy Assistant Secretary of the Army for Environment, Safety and Occupational Health (DASA–ESOH) provide safety oversight and risk assessment criteria for range clearance activities (for example, target maintenance, environmental sampling, and clearance) that may involve ICM or sub-munitions.

(2) The Judge Advocate General is responsible for providing advice on applicable statutory and regulatory requirements affecting activities that involve ICM and sub-munitions.

(3) The U.S. Army Technical Center for Explosives Safety (USATCES)—

(a) Provides, upon request, comments on requests for Deviation Approval and Risk Acceptance Documents (DARAD) for range clearance activities for areas known or suspected to contain ICMs and sub-munitions.

(b) Maintains an inventory of Army operational and former ranges and other properties where ICMs and sub-munitions are known or suspected to be present.

(4) Commanders—

(a) Ensure that ODCS, G–3/5/7 (DAMO–TRS), Director of Army Safety (DACS–SF), ODCS, G–4 (DALO–AMA), and USATCES (JMAC–ESM) are informed of any ranges or other areas known to contain ICMs or sub-munitions.

(b) Ensure ranges or other areas known to contain ICMs or sub-munitions are clearly marked and entry to these areas is restricted, with access controlled.

(c) Prohibit range clearance activities on operational ranges and removal actions on former ranges, training facilities, or maneuver areas known or suspected to contain ICMs or sub-munitions, unless a DARAD is submitted and approved per DA Pam 385–30.

(d) Have authority to approve DARAD per DA Pam 385–30.

c. Mandatory requirements. Mandatory requirements for operational ranges, training facilities, or maneuver areas known or suspected to contain ICM and sub-munitions.

(1) Ranges, training facilities, or maneuver areas known or suspected to contain ICMs or sub-munitions will be clearly marked, both physically and on the installation's master plans, to identify the hazard. Entry to such areas is prohibited with any authorized access to be strictly controlled.

(2) Before access is granted to an operational range, training facility, or maneuver area, the installation RMA will determine whether ICM or sub-munitions are known or suspected to be present. The RMA, in coordination with installation safety and EOD representatives, will determine if it is safe to authorize access and establish prerequisite precautions. Personnel authorized access to areas known or suspected to contain ICMs or sub-munitions will be fully advised of the potential dangers and safeguards to be followed, and escorted by EOD or UXO-qualified personnel.

(3) If an ICM or sub-munition is found on a range, training facility, or maneuver area that is not known to contain ICM or sub-munitions, use of the range will be suspended until the installation range operations conducts the procedures in paragraph 2–14*c*. The expeditious destruction of any ICM or sub-munition(s) encountered is authorized.

(4) Range operations or safety personnel will ensure that previously unreported areas known or suspected to contain ICM or sub-munitions are reported immediately through command channels to the ODCS, G–3/5/7 (DAMO–TR), Director of Army Safety (DACS–SF), ODCS, G–4 (DALO–AMA), and USATCES (JMAC–ESM). At a minimum, the report will include the location, the type of ICM or sub-munition, the boundaries (by coordinates) of the area, the suspected source (for example, weapon system and event in which the ICM or sub-munitions were most likely used), the date of discovery, a point of contact, and, if available, digital pictures of the discovered item. The location should be marked on the installation master plan and local supporting EOD units should be notified.

d. Deviation Approval and Risk Acceptance Document, DA Form 7632.

(1) A DARAD is required prior to the conduct of clearance activities or a removal action in an area where ICMs or sub-munitions are known or suspected to be present.

(2) A DARAD will be developed and approved per DA Pam 385–30.

(3) Copies of approved DARAD will be electronically forwarded to: Office of the Chief of Staff, Director of Army Safety (DACS–SF), with copies furnished to ODCS's Director of Training G–3/5/7 (DAMO–TR), (DASA–ESOH)'s Assistant for Munitions and Chemical Matters), ODCS's G–4 (DALO–AMA), and USATCES (JMAC–ESM).

(4) An amended DARAD will be submitted for any condition that increases the level of explosive safety risk.

e. Hazard control requirements.

(1) Operations will be conducted in a manner that exposes the minimum number of people to the smallest quantity of explosives for the shortest period of time.

(2) All work activities will be coordinated with and have the approval of all appropriate levels of command and all organizations or Services involved.

(3) All work activities will be conducted per controls outlined in approved planning documents (for example, work plans, explosives safety risk assessments, hazard analyses, and site safety and health plans).

(4) Only EOD or UXO-qualified personnel may conduct clearance or removal actions in areas known or suspected to contain ICMs or sub-munitions. Qualifications for UXO personnel are in DDESB Technical Paper 18.

(5) The final disposition of UXO that are ICMs and/ or sub-munitions will be per EOD-approved procedures. When possible, such military munitions will be blown in place. Prior to destruction of the UXO, all personnel will be removed beyond the specified safe separation distance.

(6) Should an explosive-related incident involving injury to personnel occur:

(a) It will be reported per AR 385–10.

(b) All activities will be stopped until a review and validation of procedures has been completed and approved by the commander with responsibility for the activities.

Chapter 3
Danger Zones

3–1. General

a. Every weapon system and the ammunition/ordnance related to that weapon system requires a danger zone. The danger zones in this pamphlet represent minimum safety requirements; they are adequate only when employed with properly functioning safety equipment and devices, and when trained and competent personnel follow published firing procedures. They are three-dimensional areas derived from computer modeling and/or laboratory data. Danger zone size and shape are dependent on the performance characteristics of the weapon system, ammunition, training requirements, geographical location, and environmental conditions. They should not account for human error.

b. Danger zones can be constructed manually or by using geo-spatial data and the RMTK in either a desktop or web-based environment. Danger zones created using the RMTK must be developed using the current approved version of the RMTK. The RMTK can be downloaded (desktop) and/or accessed (Web-based) at https://srp.army.mil or https://rtam.tecom.usmc.mil.

3–2. Types of danger zones

There are three types of danger zones:

a. Laser surface danger zone (air-to-ground; ground-to-ground). A LSDZ consists of the target area in addition to horizontal and vertical buffer zones. It reflects the minimum land and air requirement, to include terrain mitigation, needed to safely employ a given laser. The LSDZ accounts for direct hazards (main beam) and indirect hazards (reflections). The boundaries of the LSDZ depend on which of the two overlapping zones, direct or indirect, are larger. If there are no specular reflectors on the range and the laser does not present a diffuse reflection hazard, there will not be an indirect hazard zone. LSDZs must accommodate stationary firing points (fixed positions) as well as mobile firing positions, in addition to fixed and moving targets. Figure 3–1 contains the basic elements of a LSDZ.

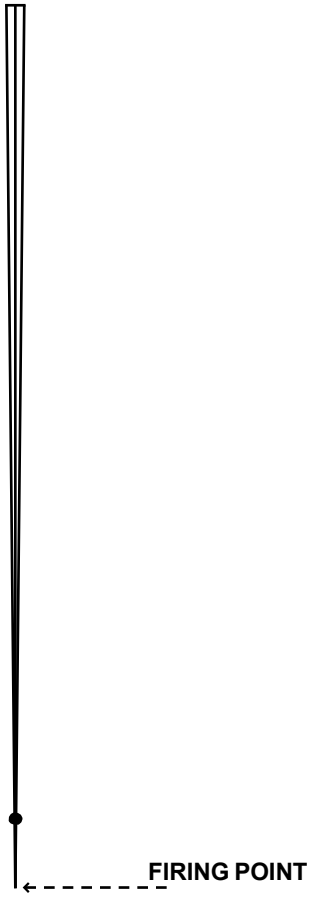


Figure 3–1. Basic elements of a laser surface danger zone

b.Surface danger zone (ground-to-ground). An SDZ delineates that portion of the earth and the air above in which personnel and/or equipment may be endangered by ground weapons firing or demolition activities. These SDZs are designed to make the probability of hazardous fragment or round escapement from installation boundaries unlikely and minimize the danger to the public, installation personnel, facilities/equipment, or property. The two basic SDZs are the cone and the "batwing." The batwing SDZ provides for greater containment of ricochets. Figures 3–2 and 3–3 contain cone and batwing SDZs for small arms direct-fire weapons without explosive projectiles. Figures 3–4 and 3–5 are cone and batwing SDZs for small arms direct-fire weapons with explosive projectiles. Figures 3–6 and 3–7 are SDZs for mortars and field artillery cannon in the indirect fire mode. Certain weapons, for example, tube-launched, optically-tracked, wire-guided (TOW) and FGM–148 Javelin missiles, have unique SDZs. They will be addressed in the appropriate chapter.

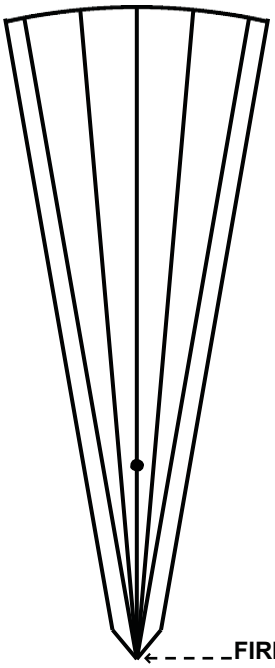


Figure 3–2. Cone surface danger zone for small arms direct-fire weapons without explosive projectiles

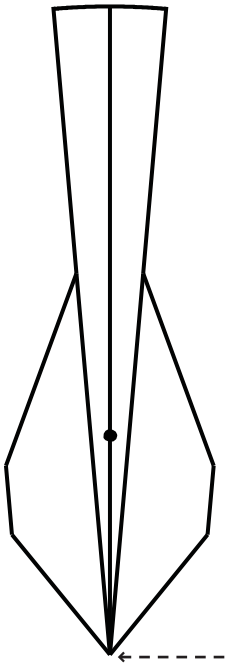


Figure 3–3. Batwing surface danger zone for small arms direct-fire weapons without explosive projectiles

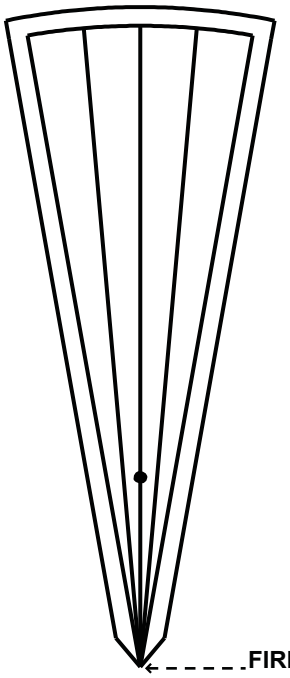


Figure 3–4. Cone surface danger zone for small- arms direct-fire weapons with explosive projectiles

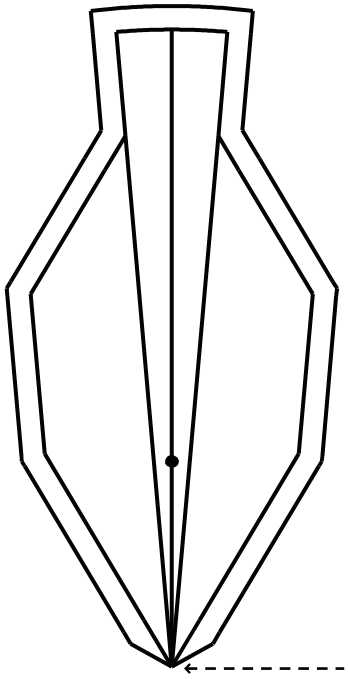


Figure 3–5. Batwing surface danger zone for small- arms direct-fire weapons with explosive projectiles

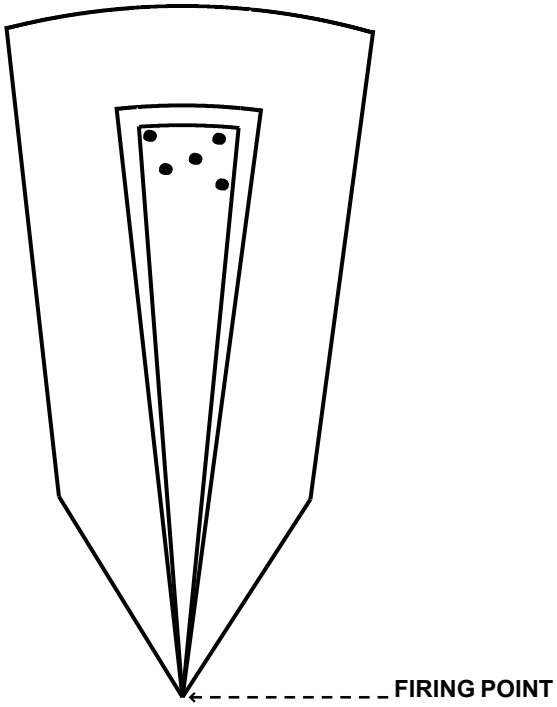


Figure 3–6. Surface danger zone for indirect fire, mortars

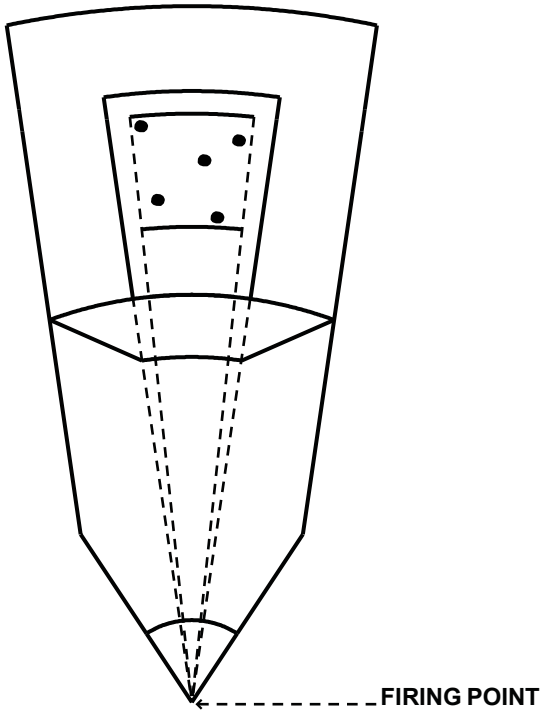


Figure 3–7. Surface danger zone for indirect fire, field artillery cannon

(1) *Multiple firing point/target surface danger zones.* A single SDZ for a particular weapon system may be expanded to accommodate multiple firing positions and/or targets for that weapon system. Figure 3–8 contains a SDZ for multiple fixed firing positions and multiple fixed targets. Figure 3–9 contains a SDZ for a single fixed firing position and multiple fixed targets. Figure 3–10 contains a SDZ with multiple fixed firing points and single fixed target. Figure 3–11 contains a SDZ with multiple fixed firing points and multiple fixed or moving

targets.

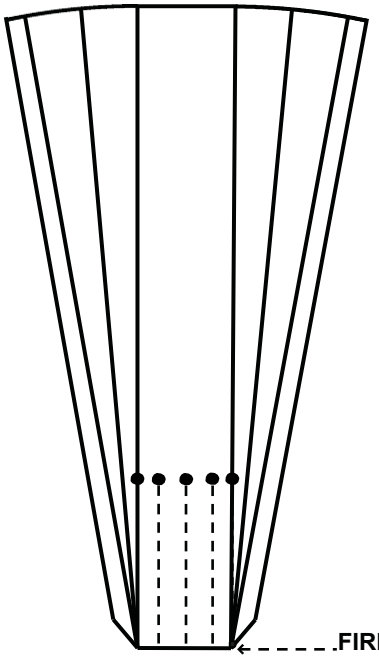


Figure 3–8. Multiple surface danger zone; multiple fixed firing points and multiple fixed targets

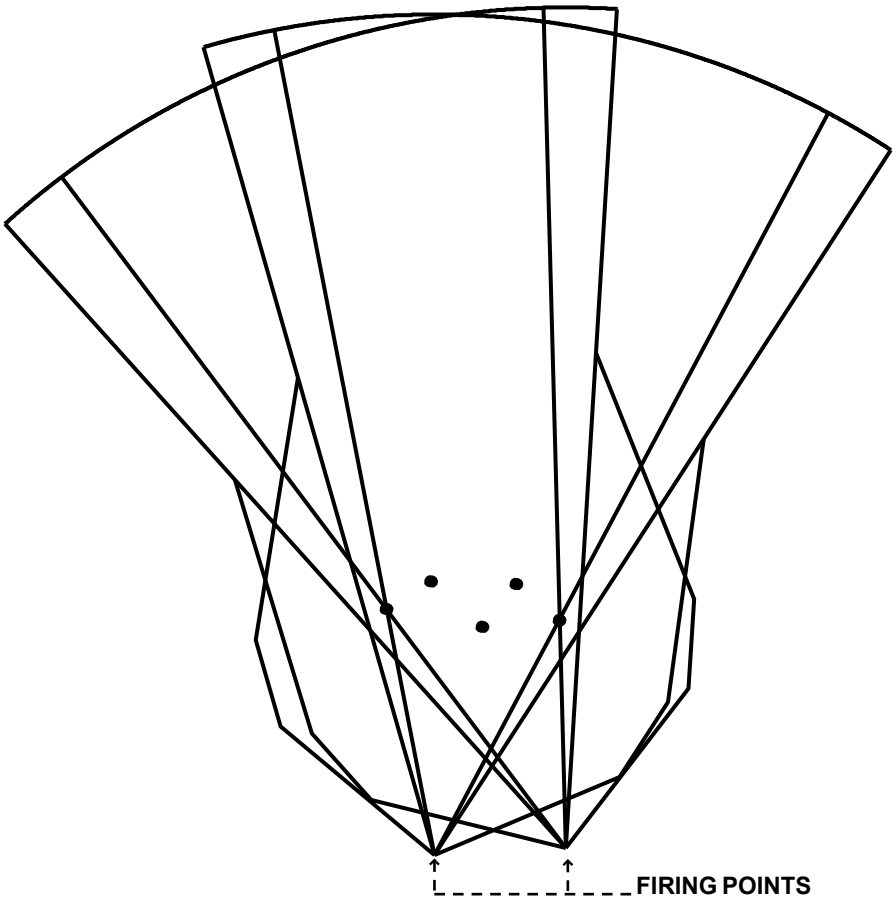


Figure 3–9. Multiple surface danger zone; multiple fixed firing points and multiple fixed or moving targets

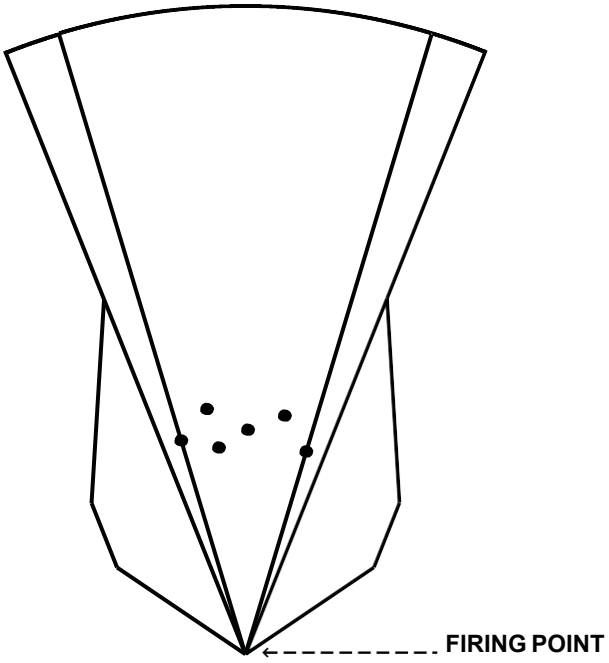


Figure 3–10. Multiple surface danger zone; single fixed firing point, multiple fixed targets

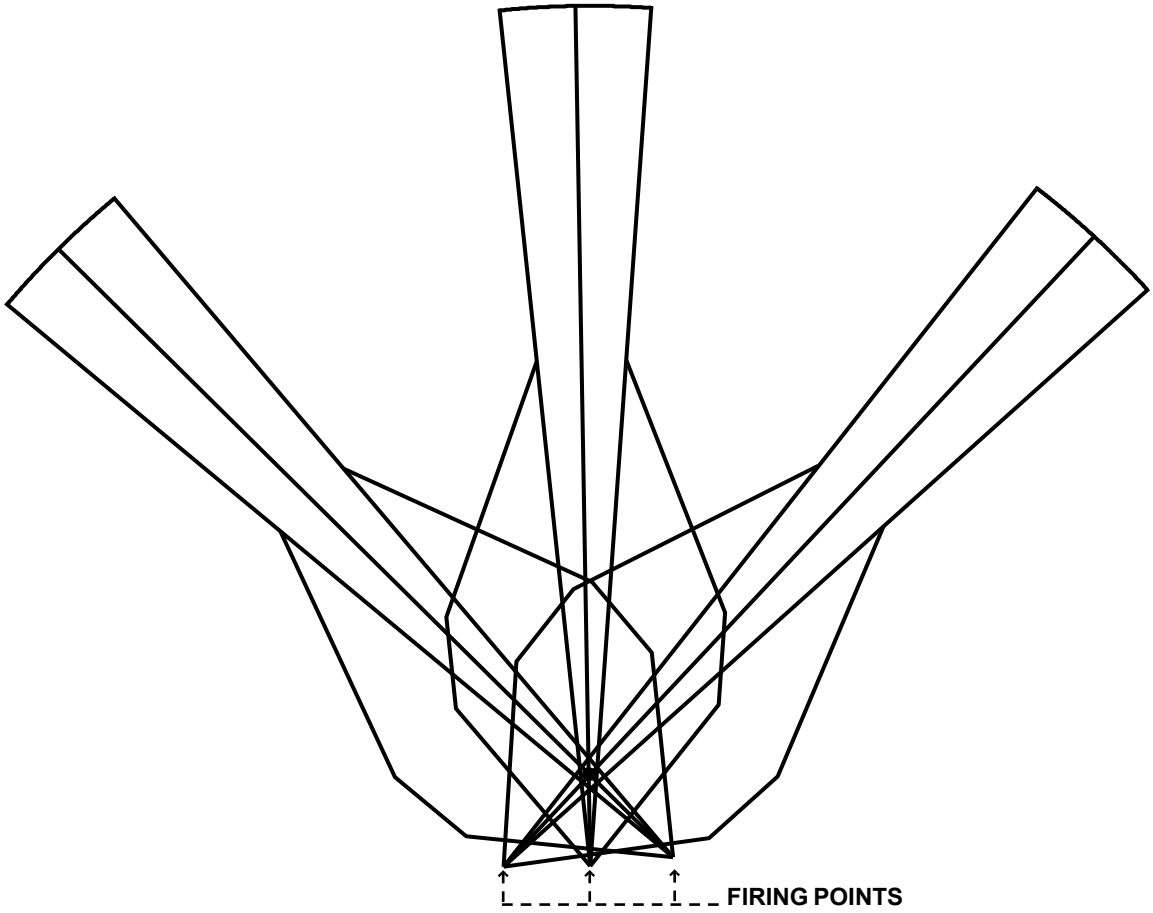


Figure 3–11. Multiple surface danger zone; multiple firing points; single target, fixed or moving targets

(2) *Movement box.* A movement box is designed to accommodate movement to an objective. Shooters move within the designated "box" and may engage multiple targets or moving targets downrange. For the Marine Corps, movement boxes for live-fire maneuver/movement exercises will use the batwing SDZ. For the Army, the batwing SDZ will be considered for movement boxes for live-fire maneuver/movement exercises. Figure 3–12 contains a movement box with the batwing SDZ. Target engagement scenarios must ensure fires remain within the established SDZ.

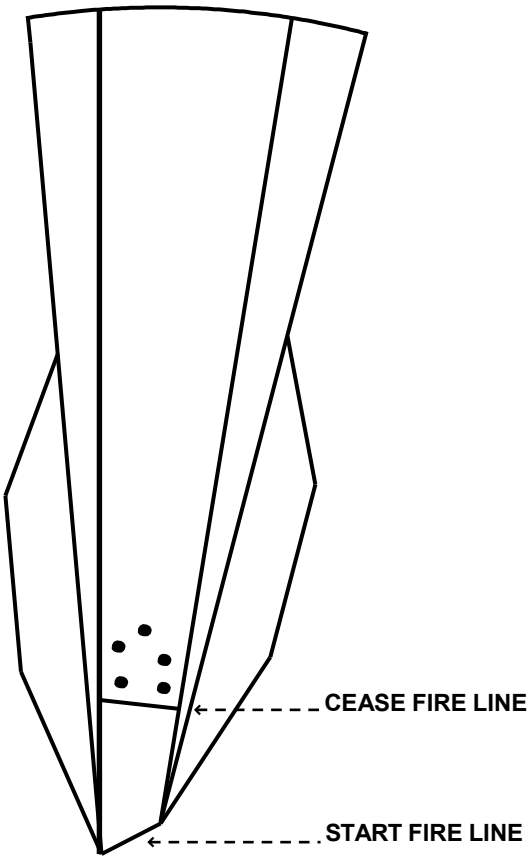


Figure 3–12. Movement box surface danger zone; multiple firing points, fixed or moving targets

(3) Composite danger zones.

(a) CALFEXs (Army) and CAXs (Marine Corps) involve combined arms teams conducting coordinated fire and maneuver training in executing the assault, seizure, and defense of appropriate objectives. Tactical air support may be included with appropriate WDZs. Combining multiple danger zones for a CALFEX/CAX scenario is the definitive application of danger zones. Regardless of the number and types of danger zones a CALFEX/CAX requires, a systematic approach will result in successful definition of each LSDZ/SDZ/WDZ and allow training to be safely accomplished.

(b) Danger zones of multiple weapon systems in a CALFEX/CAX scenario result in a composite LSDZ/SDZ/WDZ. The composite LSDZ/SDZ/WDZ identifies total real estate requirements at a given sequence (or phase) of the exercise. Numerous sequenced or time-phased composite danger zones may exist depending on the complexity of a particular CALFEX/CAX. Figure 3–13 is a composite SDZ.

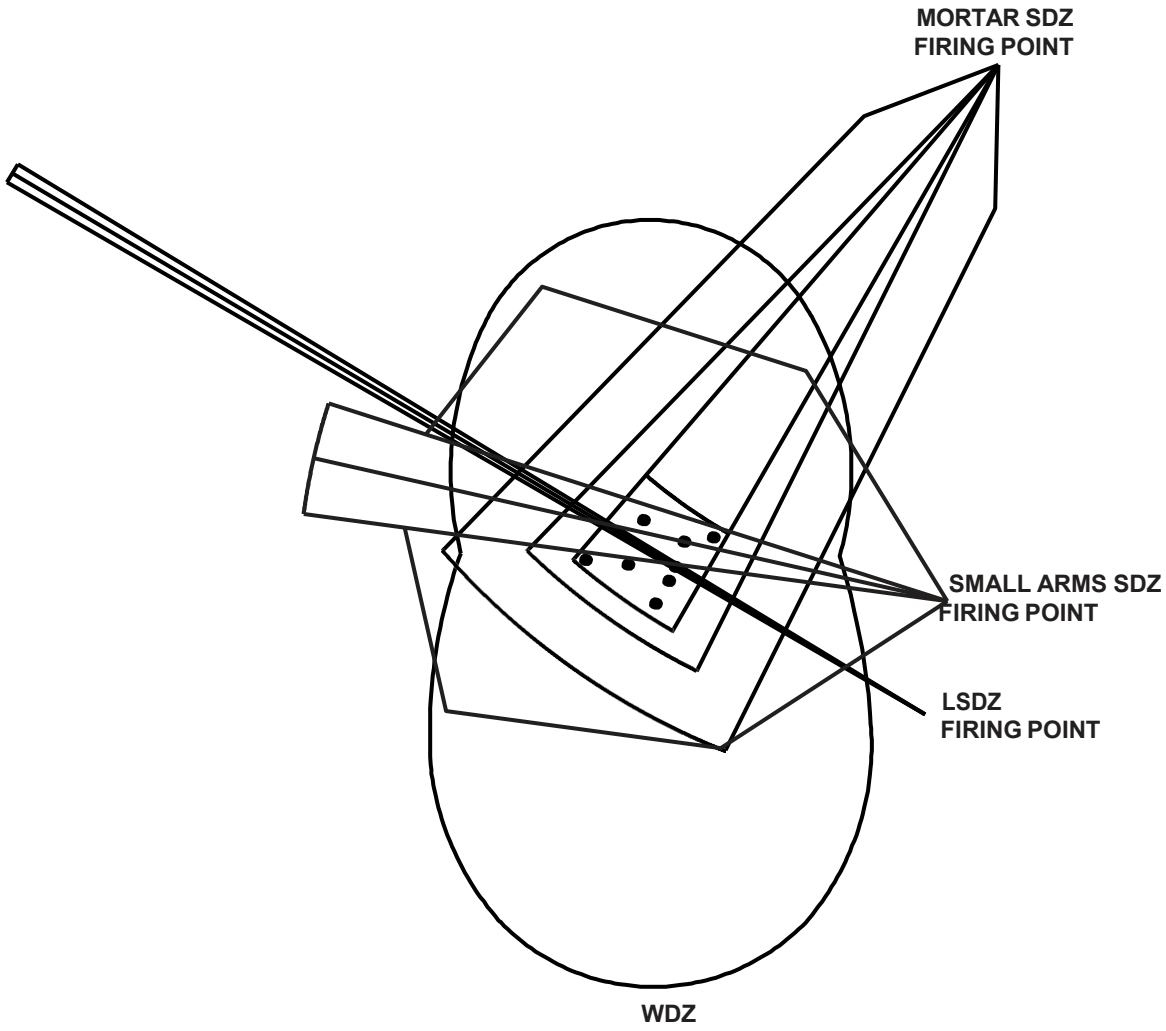


Figure 3–13. Composite surface danger zone

a. Weapons danger zone (air-to-ground). A WDZ encompasses the ground and airspace for lateral and vertical containment of projectiles, fragments, debris, and components resulting from the firing, launching, and detonation of aviation-delivered ordnance. It reflects the minimum land and air requirement, to include terrain mitigation, needed to safely employ a given weapon. The WDZ accounts for inaccuracy, failures, ricochets, and broaching/porpoising of a specific weapon/munition type delivered by a specific aircraft type. The WDZ "footprint" is based on weapon characteristics, type of delivery being executed, platform (aircraft) delivering the ordnance, target and soil characteristics, terrain, and level of containment acceptable to the senior commander (Army)/installation commander (Marine Corps). Figure 3–14 depicts the basic elements of a WDZ.

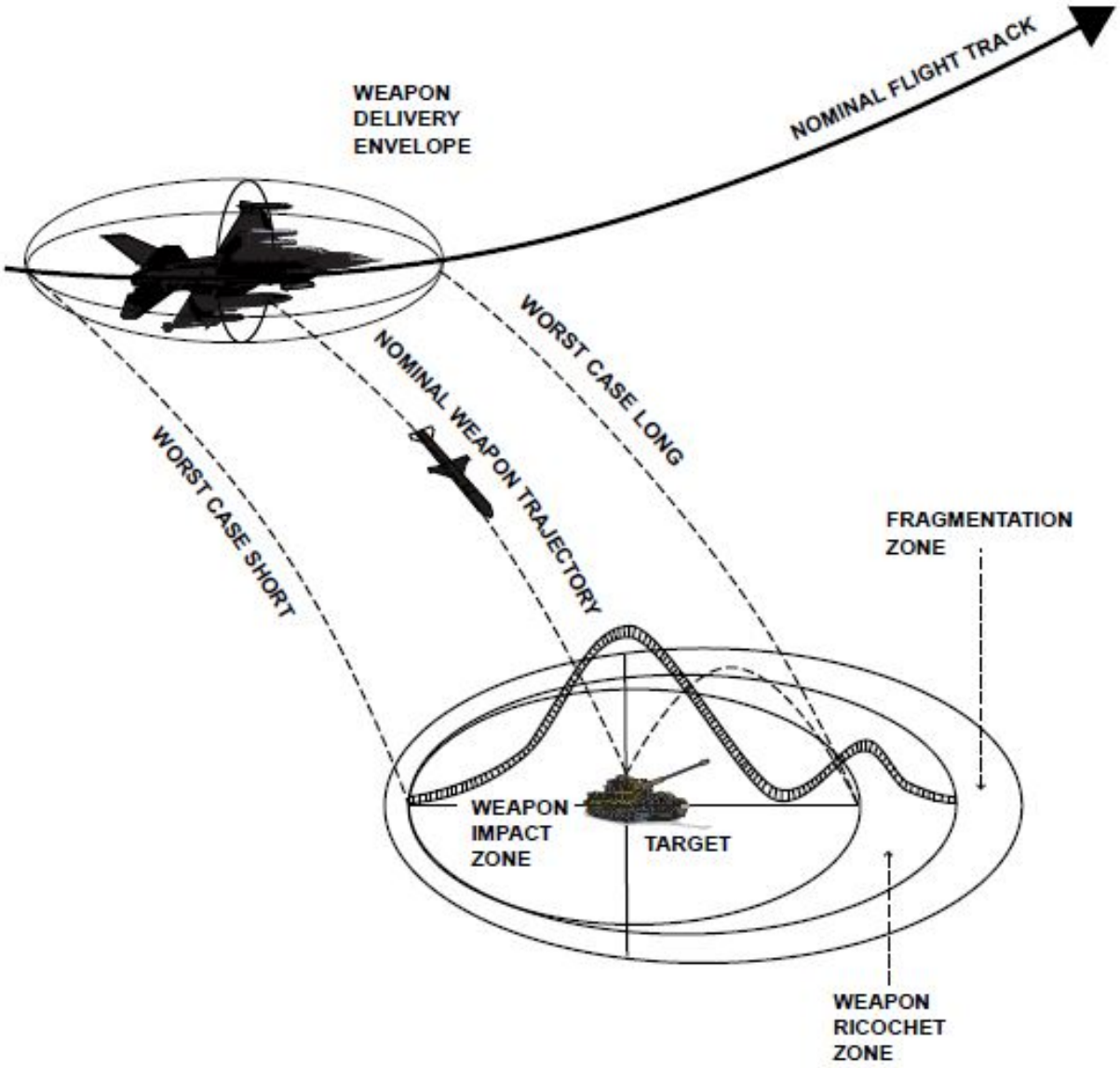


Figure 3–14. Basic weapon danger zone profile

3–3. Authorization for personnel within danger zones

a. The following personnel are authorized to be within a danger zone, subject to the restrictions in the applicable sections of this pamphlet and application of the risk management process by the senior commander (Army)/installation commander (Marine Corps):

(1) Crews directly involved in the firing of a weapon system or munition.

(2) Tactical air control party or joint terminal attack controllers (JTACs) controlling aviation ordnance deliveries.

(3) Aircrew operating within danger zones as part of an exercise.

(4) During indirect field artillery firing personnel may be in Areas A through E subject to the restrictions in chapter 10.

(5) Designator operators (laser) during AGM–114 HELLFIRE antitank guided missile operations.

(6) Personnel downrange when approved overhead small arms ammunition is fired.

(7) Personnel wearing approved laser eye protection within the LSDZ.

(8) Personnel downrange when supporting training on known distance firing ranges, when protection is provided.

(9) Designated mission essential personnel.

b. Authorization of any other personnel within danger zones requires deviation approval per AR 385–63/MCO 3570.1C and paragraph 1–4 of this pamphlet.

Chapter 4
Small Arms

4–1. Firing conditions

a. For the purpose of this pamphlet, small arms are man-portable, individual and crew-served weapon systems of .50 Caliber or less used primarily against personnel and lightly armored or unarmored equipment. Small arms SDZ diagrams and tables provided in this chapter are the standard for the proper construction of small arms direct fire SDZs with or without exploding projectiles.

b. The cone SDZ may be applied when designing or conducting training on static/known distance style ranges that do not involve fire and movement or fire and maneuver. Figure 4–1 is a cone SDZ for firing small arms direct-fire weapons without exploding projectiles. Figure 4–2 is a cone SDZ for firing small arms direct-fire weapons with exploding projectiles.

c. The batwing SDZ provides for greater containment of all ricochets.

(1) For the Army, the batwing will be applied when designing ranges that involve fire and movement, fire and maneuver, flanking fire, and/ or when ricochet hazards outside the range boundary may endanger nonparticipating personnel. . Decision on use of batwing or cone will be based on level of risk and approval of appropriate command risk acceptance authority in accordance with DA Pam 385–30.

(2) For the Marine Corps the batwing will be applied when designing or conducting training on ranges that involve fire and movement, fire and maneuver, flanking fire, and/or when ricochet hazards outside the range boundary may endanger nonparticipating personnel. Figures 4–3 and 4–4 are batwing SDZs for firing small arms direct-fire weapons without exploding projectiles. Figure 4–5 is a batwing SDZ for firing small arms direct-fire weapons with exploding projectiles.

*d.*When firing small arms with or without exploding projectiles on small arms ranges with known distance and unknown distances involving hand-held and shoulder-fired weapons or weapons firing from ground or vehicle-mounted platforms, the standard 5 degree dispersion area for the SDZ may be reduced to 2 degrees when:

(1) Conducting static (non-fire and movement/maneuver) training on known distance and unknown distance small arms ranges with hand-held or shoulder-fired weapons when firing from fixed or stationary positions.

(2) Training on ranges involving personnel conducting precision fires from stationary positions.

(3) Ground-mounted weapons conducting static (non-fire and movement/maneuver) training on known distance and unknown distance small arms ranges that are mounted on appropriate tripods. The traversing and elevation mechanism for that weapon system will be used for all fires.

(4) Vehicle-mounted weapons conducting static (non-fire and movement/maneuver) training on known distance and unknown distance small arms ranges are mounted on appropriate vehicle mounts. The traversing and elevation mechanism for that weapon system will be used and locked in place for all fires.

(5) Risk management process documentation for the unit conducting training has been approved by the installation RMA (Army), RCO (Marine Corps) or other appropriate approving authority. Training events in which the SDZ dispersion area has been reduced from 5 to 2 degrees will be specifically addressed in the risk management worksheet.

e. The .50 cal MK211 cartridge will not be fired on known distance qualification ranges with earthen berms due to improper impact media, as well as range safety and operational range clearance concerns. Firing this cartridge into dedicated impact areas may be authorized when access is controlled, and maintenance activity that could cause a projectile that has malfunctioned to function (i.e., grass cutting, sustainment/serviceability maintenance with equipment, etc.) is not permitted.

4–2. Surface danger zones

a. Surface danger zone data for small arms is found in tables 4–1 through 4–29. The column “Ricochet vertical hazard” contains data which represent ricochet vertical hazard only.

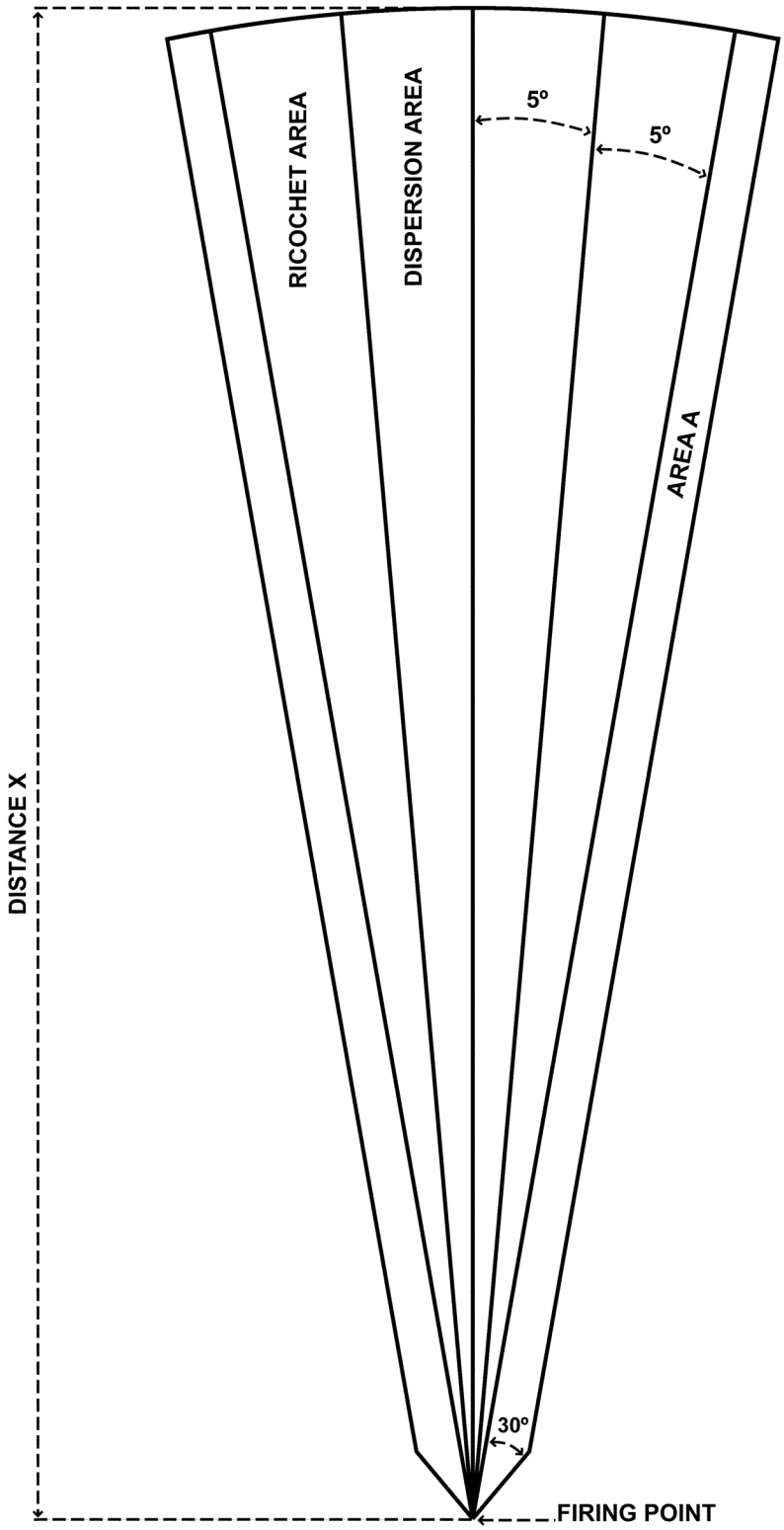


Figure 4–1. Cone surface danger zone for firing small arms direct-fire weapons without exploding projectiles

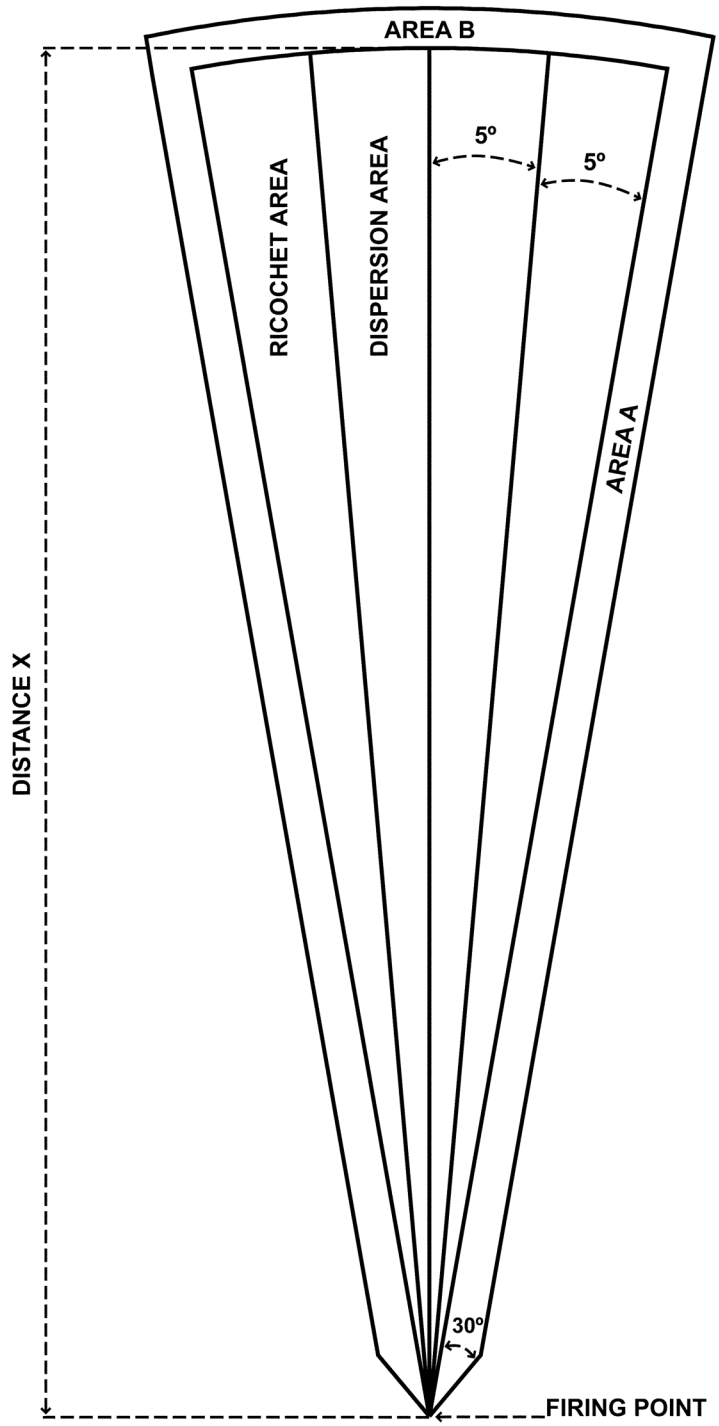


Figure 4–2. Cone surface danger zone for firing small arms direct-fire weapons with exploding projectiles

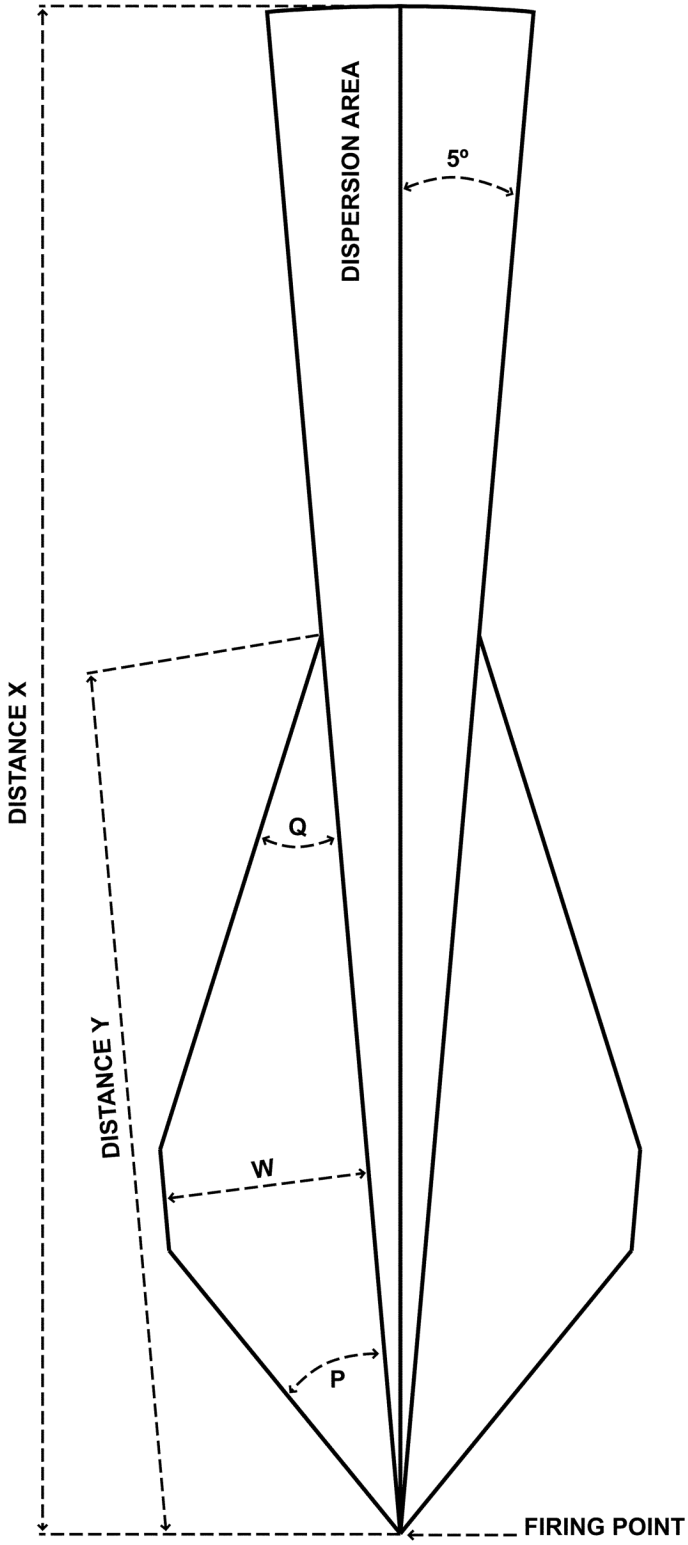


Figure 4–3. Batwing surface danger zone for small arms direct fire weapons without exploding projectiles, except 5.56mm M1037 Short Range Training Ammunition (SRTA), 7.62mm M793 (SRTA) Ball and M794 SRTA Tracer

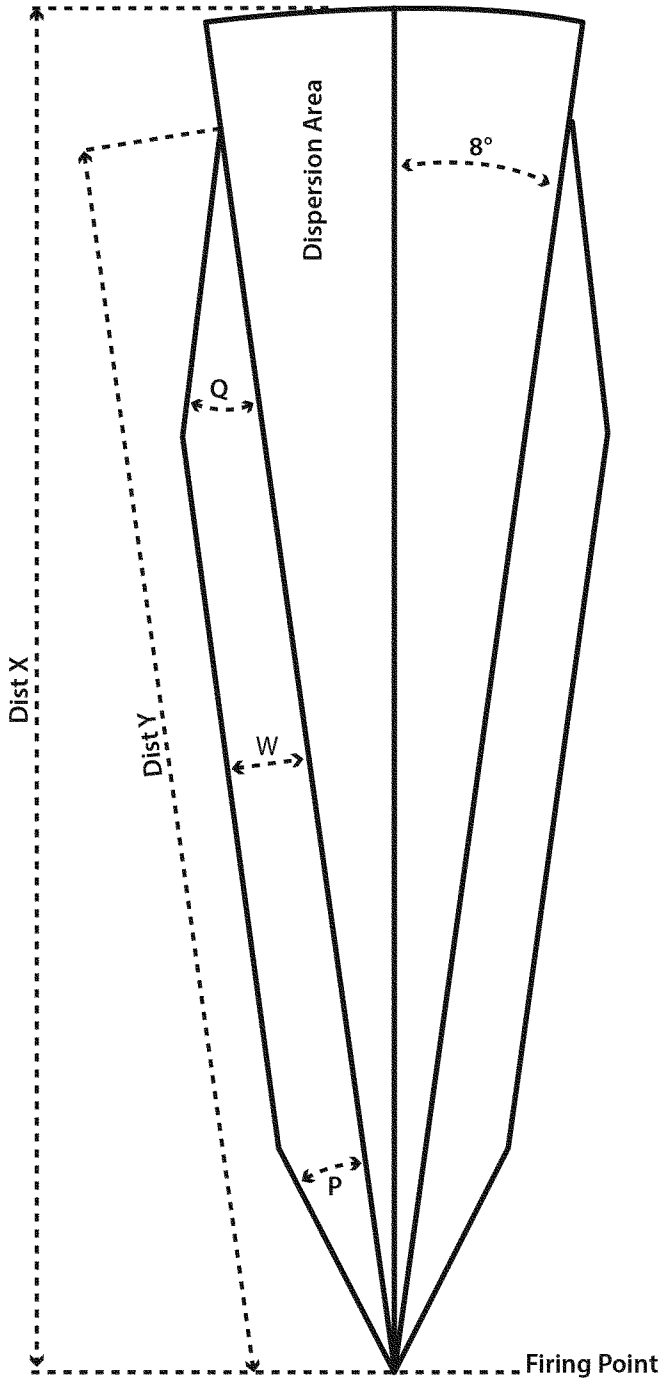


Figure 4–4. Surface danger zone for M1037 Short Range Training Ammunition (SRTA)

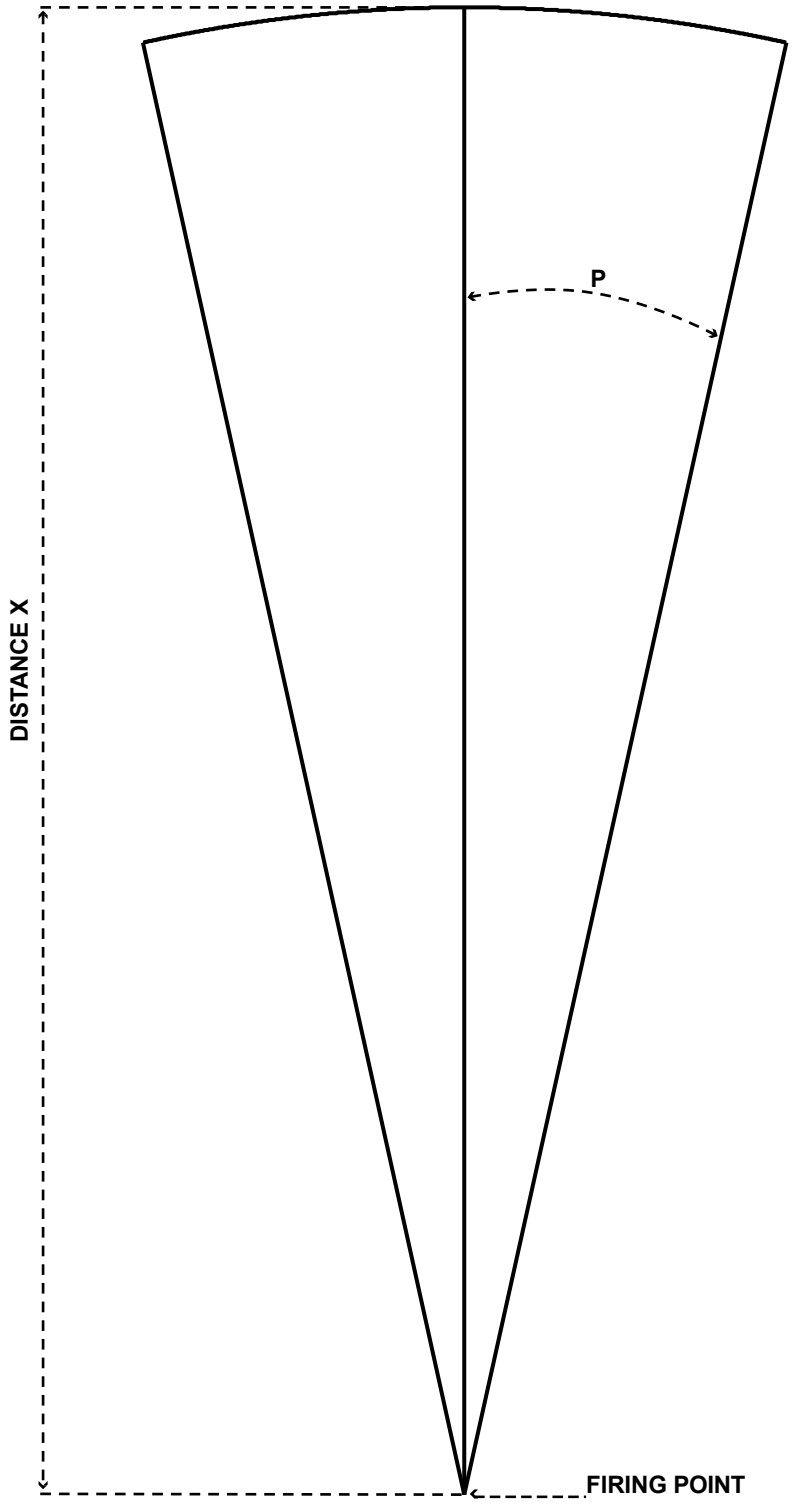


Figure 4–5. Surface danger zone for 12 gauge XM1030 breaching round

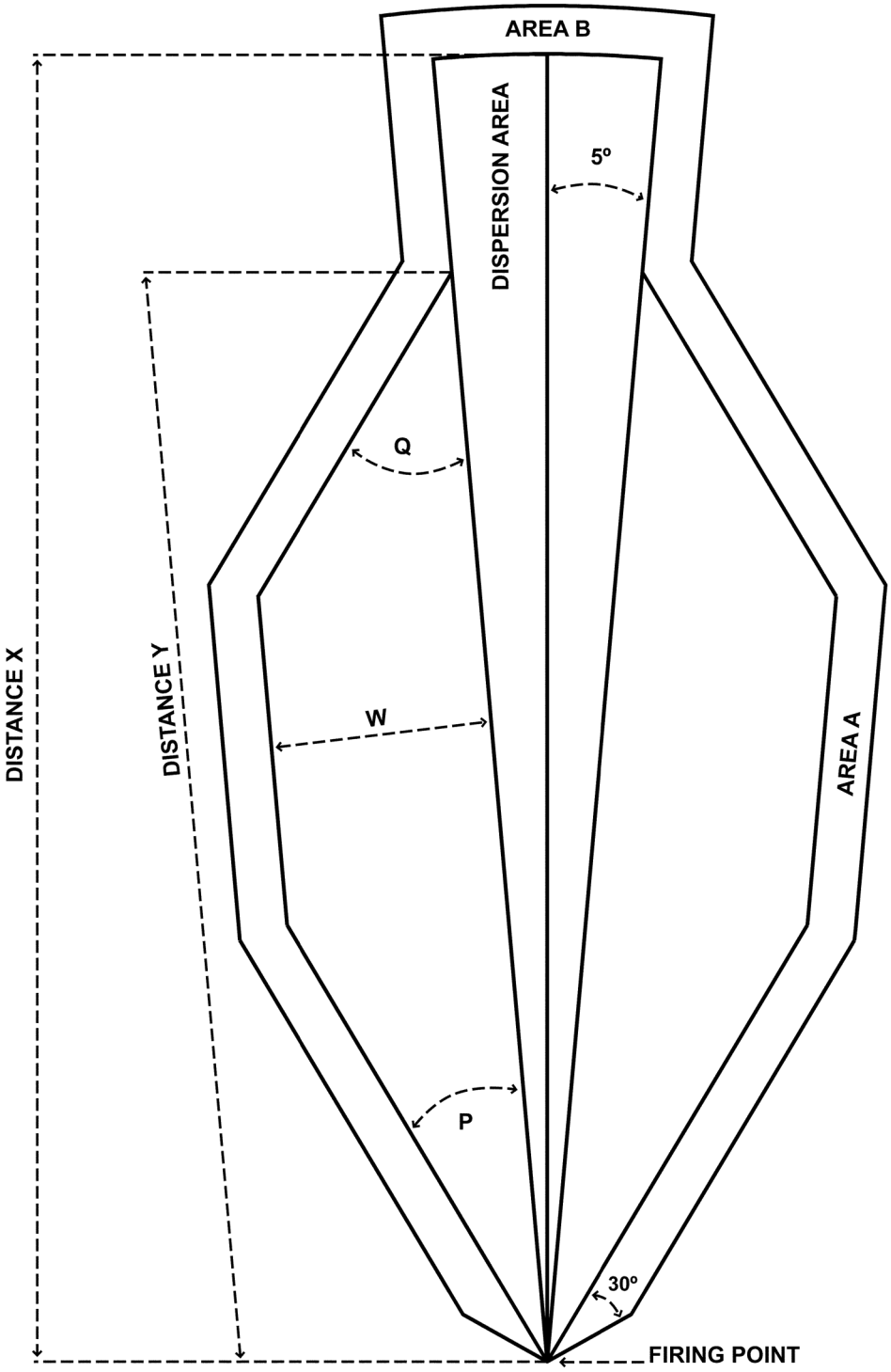


Figure 4–6. Batwing surface danger zone for small arms direct-fire weapons with exploding projectiles

b. Figure 4–6 is the SDZ for the M903 Saboted Light Armor Penetrator (SLAP), M962 SLAP tracer (SLAP–T), MK 211 Mod 0 armor-piercing-incendiary (API), and MK 211 Mod 1 API .50 caliber ammunition.

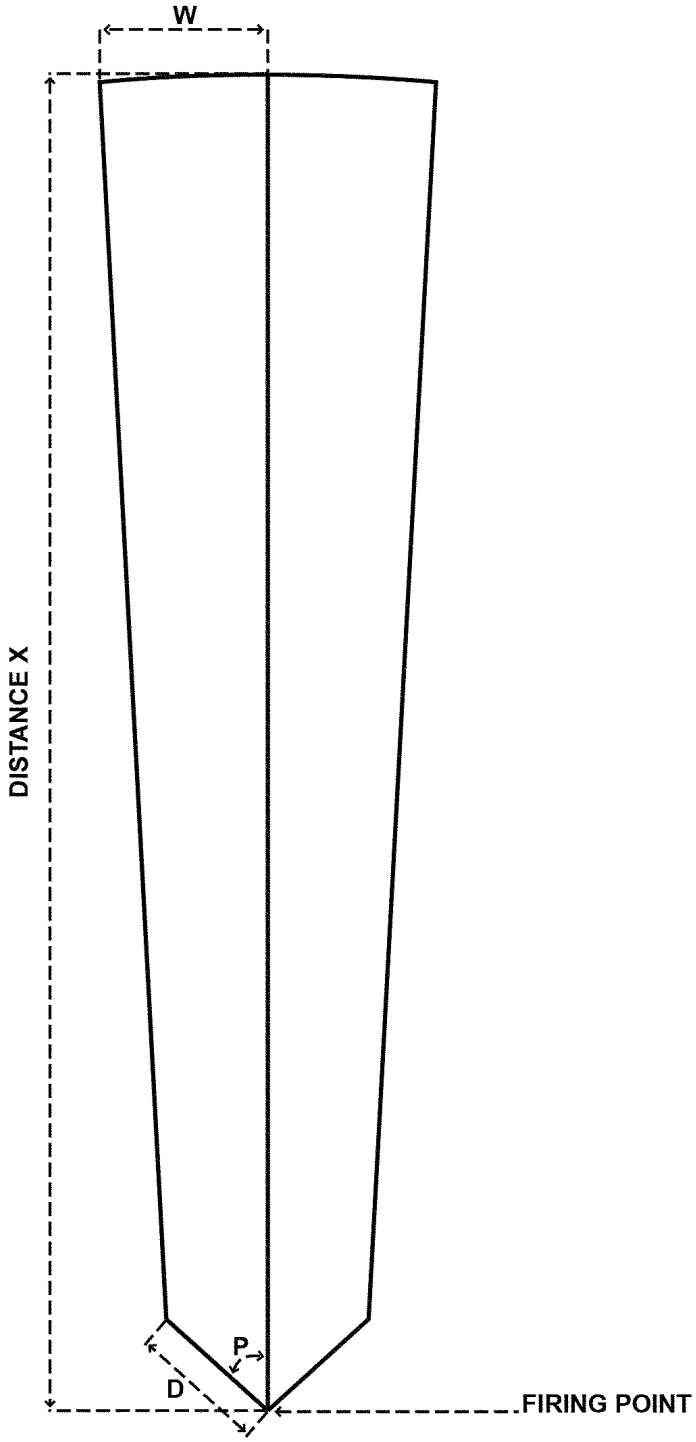


Figure 4–7. Surface danger zone for .50 caliber Saboted Light Armor Penetrator (SLAP) MK211, MK211 MOD 1

c. Figure 4–8 is the .50 caliber M903 SLAP and M962 SLAP–T sabot discard area.

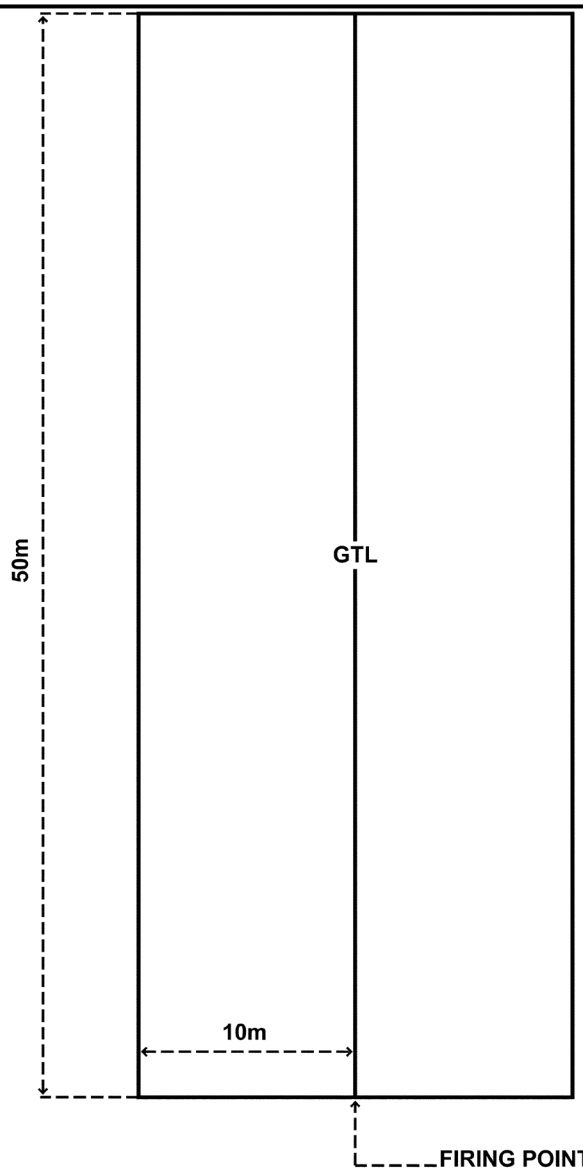


Figure 4–8. Surface danger zone for .50 caliber Saboted Light Armor Penetrator (SLAP) MK211 sabot discard area

When firing the 12-gauge shotgun with 7½, 8 and 9 shot, use the SDZ shotfall data provided in figure 4–8 for trap ranges and figure 4-9 for skeet ranges. For the XM1030 12-gauge breaching round, use the SDZ data provided in figure 4-5 and table 4-1. All other 12-gauge buckshot, slug, or other shot larger than 7½ shot will use data provided in figures 4–1 and 4–3, and table 4–1.

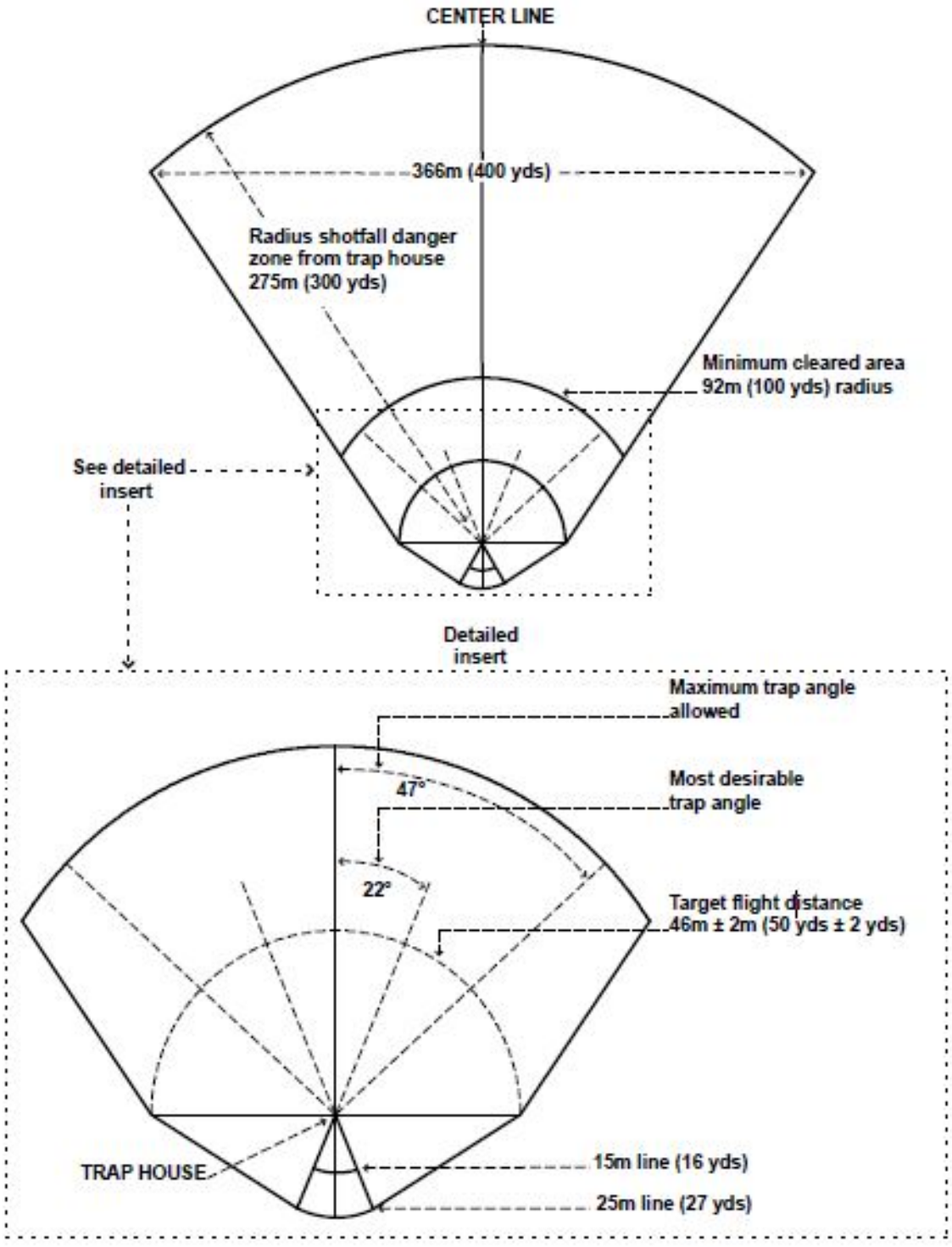


Figure 4–9. Surface danger zone, shotfall for trap ranges

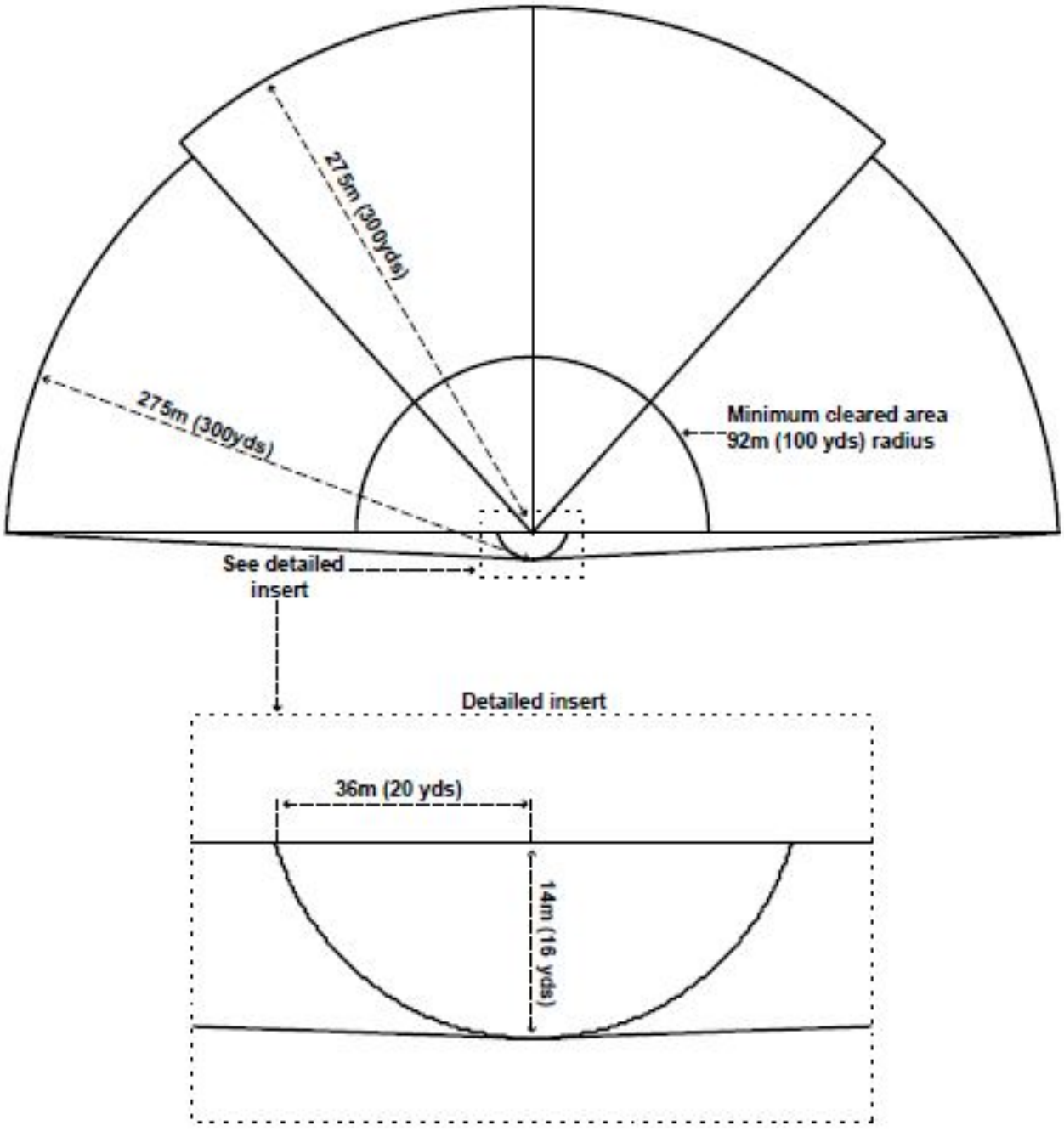


Figure 4–10. Surface danger zone, shotfall for skeet ranges

d. Table 4–1 contains SDZ data for 12-gauge shotguns.

Table 4–1.
Surface danger zone data for 12-gauge shotgun

Ammunition 12-Gage	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[1] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
12-gauge slug, shot size larger than 7½	Earth/ Water	1,073	710	125	100	NR	21.96	33.34	136
	Steel/ Concrete	1,073	830	287	100	NR	56.91	40.17	197
12-gauge 7½, 8, and 9 shot	Earth/ Water	275	NR	NR	NR	NR	NR	NR	NR
	Steel/ Concrete	275	NR	NR	NR	NR	NR	NR	NR
12- gauge XM1030 Breaching	Earth/ Water	375	NR	NR	NR	NR	12.50	NR	NR
	Steel/ Concrete	375	NR	NR	NR	NR	12.50	NR	NR

Legend for Table 4-1:
NR=Not Required
Notes:
[1] Area A applies to cone SDZ only.

e. Table 4–2 contains SDZ data for blank ammunition with BFA.

Table 4–2.
Surface danger zone data for all small arms blank ammunition with blank firing adapter[1]

Ammunition Blank	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
5.56mm 7.62mm .50 caliber	NR	5	NR	NR	NR	NR	NR	NR	NR

Legend for Table 4-2:
NR=Not Required
Notes:
[1] The dispersion and ricochet area for all small arms blank ammunition is 10 degrees.

f. Table 4–3 contains SDZ data for .22 caliber ammunition, small arms direct-fire weapons.

Table 4–3.
Surface danger zone data for .22 caliber weapons

Ammunition .22 Caliber	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[1] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
Ball LR	Earth/ Water	1,400	1,033	155	100	NR	24.00	15.90	96
	Steel/ Concrete	1,400	1,125	386	100	NR	63.40	30.30	245

Legend for Table 4-3:
LR=Long Rifle
NR=Not Required
Notes:
[1] Area A applies to cone SDZ only.

g. Table 4–4 contains SDZ data for 9mm small arms direct-fire weapons.

Table 4–4.
Surface danger zone data for 9mm weapons

Ammunition 9mm[1]	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[2] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
Ball M882, M1, Subsonic	Earth/ Water	1,800	1,077	158	100	NR	23.10	15.80	93
	Steel/ Concrete	1,800	1,211	399	100	NR	61.10	30.40	253

Legend for Table 4-4:
NR=Not Required
Notes:
[1] SDZ data for Special Effects Small Arms Marking System (SESAMS) and Close Combat Mission Capability Kit (CCMCK) ammunition
is located in chapter 14 of this publication.
[2] Area A applies to cone SDZ only.

h. Table 4–5 contains SDZ information for .38 caliber weapons.

Table 4–5.
Surface danger zone data for .38 caliber weapons

Ammunition .38 Caliber	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[1] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
38 caliber Spec Ball M41, .38 Wadcutter	Earth/ Water	1,806	1,110	153	100	NR	22.57	16.07	89
	Steel/ Concrete	1,806	1,258	389	100	NR	60.59	35.36	245

Legend for Table 4-5:
NR=Not Required
Notes:
[1] Area A applies to cone SDZ only.

i. Table 4–6 contains SDZ information for .45 caliber weapons.

Table 4–6.
Surface danger zone data for .45 caliber weapons

Ammunition .45 Caliber	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[1] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
Ball, Tracer, Wadcutter, Match	Earth/ Water	1,690	1,016	117	100	NR	21.11	16.69	100
	Steel/ Concrete	1,690	1,111	290	100	NR	54.74	30.77	186

Legend for Table 4-6:
NR=Not Required
Notes:
[1] Area A applies to cone SDZ only.

j. Table 4–7 contains SDZ data for 5.56mm weapons.

Table 4–7.
Surface danger zone data for 5.56mm weapons

Ammunition 5.56mm[1]	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[2] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
M193 Ball	Earth/ Water	3,100	2,004	458	100	NR	35.20	23.10	319
	Steel/ Concrete	3,100	1,666	323	100	NR	19.00	26.90	219
M196 Tracer	Earth/ Water	3,100	2,066	362	100	NR	35.10	26.80	355
	Steel/ Concrete	3,100	2,023	243	100	NR	19.20	22.80	243
M856 Tracer	Earth/ Water	3,089	1,607	355	100	NR	32.80	23.20	261
	Steel/ Concrete	3,089	1,592	277	100	NR	18.60	21.00	261
M862 Plastic Short Range	Earth/ Water	250	165	24	100	NR	15.40	20.00	16
	Steel/ Concrete	250	136	5	100	NR	3.30	7.30	4

Legend for Table 4-7:
NR = Not Required
Notes:
[1] SDZ data for CCMCK ammunition is located in chapter 14 in this publication.
[2] Area A applies to cone SDZ only.

k. Table 4–8 contains SDZ data for 5.56mm M855 Ball

Table 4–8.
Surface danger zone data for 5.56mm M855 ball[1]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[2] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	2,958	2,450	215	100	NR	34.00	15.00	158
	Armor	2,958	2,275	95	100	NR	13.00	7.50	96
1000	Earth	3,049	2,515	222	100	NR	34.25	15.70	163
	Armor	3,049	2,343	99	100	NR	13.25	7.90	99
2000	Earth	3,143	2,580	229	100	NR	34.50	16.40	168
	Armor	3,143	2,411	103	100	NR	13.50	8.30	103
3000	Earth	3,240	2,645	236	100	NR	34.75	17.10	174
	Armor	3,240	2,479	107	100	NR	13.75	8.70	106
4000	Earth	3,341	2,710	243	100	NR	35.00	17.80	179
	Armor	3,341	2,547	111	100	NR	14.00	9.10	109
5000	Earth	3,446	2,775	250	100	NR	35.25	18.50	184
	Armor	3,446	2,615	115	100	NR	14.25	9.50	113
6000	Earth	3,554	2,840	257	100	NR	35.50	19.20	190
	Armor	3,554	2,683	119	100	NR	14.50	9.90	116
7000	Earth	3,668	2,905	264	100	NR	35.75	19.90	196
	Armor	3,668	2,751	123	100	NR	14.75	10.30	120

Legend for Table 4-8:
NR = Not Required
Notes:
[1] To correct for tail winds, Distance X must increase by 27m per m/s or 13.90m per knot of tail wind, measured along the line of fire. To correct for cross range winds, the dispersion angle must increase by 0.37 degrees per m/s or 0.19 degrees per knot of cross wind, measured perpendicular to the line of fire.
[2] Area A applies to cone SDZ only.

l. Table 4–9 contains SDZ data for 5.56mm M855A1 enhanced performance round (EPR) ball ammunition.

Table 4–9.
Surface danger zone data for 5.56mm M855A1 Enhanced Performance Round (EPR) ball[1]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[2] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	3,521	3,100	400	100	NR	60.00	15.00	295
	Armor	3,521	3,050	360	100	NR	45.00	14.00	272
1000	Earth	3,630	3,200	420	100	NR	60.00	15.00	305
	Armor	3,630	3,150	370	100	NR	45.00	14.00	280
2000	Earth	3,743	3,300	430	100	NR	60.00	15.00	314
	Armor	3,743	3,250	390	100	NR	45.00	14.00	288
3000	Earth	3,859	3,400	440	100	NR	60.00	15.00	324
	Armor	3,859	3,350	400	100	NR	45.00	14.00	297
4000	Earth	3,980	3,500	450	100	NR	60.00	15.00	334
	Armor	3,980	3,450	420	100	NR	45.00	14.00	306
5000	Earth	4,105	3,600	460	100	NR	60.00	15.00	344
	Armor	4,105	3,550	430	100	NR	45.00	14.00	315
6000	Earth	4,234	3,700	470	100	NR	60.00	15.00	354
	Armor	4,234	3,650	440	100	NR	45.00	14.00	324
7000	Earth	4,369	3,800	490	100	NR	60.00	15.00	365
	Armor	4,369	3,750	450	100	NR	45.00	14.00	333

Legend for Table 4-9:
NR=Not Required
Notes:
[1] To correct for tail winds, Distance X must increase by 29m per m/s or 15m per knot of tail wind, measured along the line of fire. To correct for cross range winds, the dispersion angle must increase by 0.40 degrees per m/s or 0.20 degrees per knot of cross wind, measured perpendicular to the line of fire.
[2] Area A applies to cone SDZ only.

m. Table 4–10 contains SDZ data for 5.56mm M856A1 enhanced performance round (EPR) tracer.

Table 4–10.
Surface danger zone data for 5.56mm M856A1 Enhanced Performance Round (EPR) tracer[1]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[2] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	2,574	1,625	190	100	NR	58.00	19.00	162
	Armor	2,574	1,900	210	100	NR	48.00	15.00	171
1000	Earth	2,657	1,679	197	100	NR	58.30	19.15	166
	Armor	2,657	1,958	217	100	NR	48.15	15.15	177
2000	Earth	2,742	1,733	204	100	NR	58.60	19.30	171
	Armor	2,742	2,016	224	100	NR	48.30	15.30	183
3000	Earth	2,831	1,787	211	100	NR	58.90	19.45	177
	Armor	2,831	2,074	231	100	NR	48.45	15.45	188
4000	Earth	2,924	1,841	218	100	NR	59.20	19.60	182
	Armor	2,924	2,132	238	100	NR	48.60	15.60	194
5000	Earth	3,020	1,895	225	100	NR	59.50	19.75	189
	Armor	3,020	2,190	245	100	NR	48.75	15.75	201
6000	Earth	3,120	1,949	232	100	NR	59.80	19.90	195
	Armor	3,120	2,248	252	100	NR	48.90	15.90	207
7000	Earth	3,224	2,003	239	100	NR	60.10	20.05	201
	Armor	3,224	2,306	259	100	NR	49.05	16.05	214

Legend for Table 4-10:
NR=Not Required
Notes:
[1] To correct for tail winds, Distance X must increase by 25m per m/s or 13m per knot of tail wind measured along the line of fire. To correct for cross range winds, the dispersion angle must increase by 0.45 degree per m/s or 0.23 degree per knot of cross range wind measured perpendicular to the line of fire.
[2] Area A applies to cone SDZ only.

n. Table 4–11 contains SDZ data for 5.56mm MK301 Dim Tracer.

Table 4–11.
Surface danger zone data for 5.56mm MK301 Dim Tracer[1]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[2] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	2,324	1,920	190	100	NR	51.30	13.75	158
	Armor	2,324	1,655	145	100	NR	41.70	11.75	100
1000	Earth	2,396	1,973	196	100	NR	51.15	13.85	164
	Armor	2,396	1,708	149	100	NR	41.60	11.85	104
2000	Earth	2,472	2,026	202	100	NR	51.00	13.95	170
	Armor	2,472	1,761	153	100	NR	41.50	11.95	108
3000	Earth	2,550	2,079	208	100	NR	50.85	14.05	176
	Armor	2,550	1,814	157	100	NR	41.40	12.05	112
4000	Earth	2,632	2,132	214	100	NR	50.70	14.15	182
	Armor	2,632	1,867	161	100	NR	41.30	12.15	116
5000	Earth	2,716	2,185	220	100	NR	50.55	14.25	188
	Armor	2,716	1,920	165	100	NR	41.20	12.25	120
6000	Earth	2,804	2,238	226	100	NR	50.40	14.35	194
	Armor	2,804	1,973	169	100	NR	41.10	12.35	124
7000	Earth	2,896	2,291	232	100	NR	50.25	14.45	200
	Armor	2,896	2,026	173	100	NR	41.00	12.45	128

Legend for Table 4-11:
NR=Not Required
Notes:
[1] To correct for tail winds, Distance X must increase by 24m per m/s or 12.50m per knot of tail wind measured along the line of fire. To correct for cross range winds, the dispersion angle must increase by 0.50 degree per m/s or 0.26 degree per knot of cross range wind measured perpendicular to the line of fire.
[2] Area A applies to cone SDZ only.

o. Table 4–12 contains SDZ data for 5.56mm MK318 MOD 0 ball.

Table 4–12.
Surface danger zone data for 5.56mm MK318 MOD 0 ball[1]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[2] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	2,816	2,600	310	100	NR	59.50	14.00	235
	Armor	2,816	2,525	290	100	NR	44.50	16.00	218
1000	Earth	2,903	2,670	321	100	NR	59.40	14.15	242
	Armor	2,903	2,595	299	100	NR	44.30	16.10	224
2000	Earth	2,992	2,740	332	100	NR	59.30	14.30	250
	Armor	2,992	2,665	308	100	NR	44.10	16.20	231
3000	Earth	3,085	2,810	343	100	NR	59.20	14.45	258
	Armor	3,085	2,735	317	100	NR	43.90	16.30	238
4000	Earth	3,181	2,880	354	100	NR	59.10	14.60	266
	Armor	3,181	2,805	326	100	NR	43.70	16.40	245
5000	Earth	3,281	2,950	365	100	NR	59.00	14.75	274
	Armor	3,281	2,875	335	100	NR	43.50	16.50	252
6000	Earth	3,385	3,020	376	100	NR	58.90	14.90	282
	Armor	3,385	2,945	344	100	NR	43.30	16.60	259
7000	Earth	3,493	3,090	387	100	NR	58.80	15.05	291
	Armor	3,493	3,015	353	100	NR	43.10	16.70	267

Legend for Table 4-12:
NR=Not Required
Notes:
[1] To correct for tail winds, Distance X must increase by 26.50m per m/s or 13.50m per knot of tail wind measured along the line of fire. To correct for cross range winds, the dispersion angle must increase by 0.39 degree per m/s or 0.20 degree per knot of cross range wind measured perpendicular to the line of fire.
[2] Area A applies to cone SDZ only.

p. Table 4–13 contains SDZ data for 5.56mm M1037 Short Range Training Ammunition.

Table 4–13.
Surface danger zone data for 5.56mm M1037 Short Range Training Ammunition (SRTA)[1]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A^2 (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	370	345	22	100	NR	16.90	13.00	16
	Armor	370	345	9	100	NR	6.20	3.90	9
1000	Earth	381	355	23	100	NR	16.90	13.30	17
	Armor	381	355	9	100	NR	6.20	3.90	9
2000	Earth	393	365	24	100	NR	16.90	13.60	17
	Armor	393	365	10	100	NR	6.20	3.90	9
3000	Earth	405	385	25	100	NR	17.80	13.80	18
	Armor	405	385	10	100	NR	6.30	3.90	10
4000	Earth	418	395	25	100	NR	18.00	14.00	18
	Armor	418	395	10	100	NR	6.30	3.90	10
5000	Earth	431	405	27	100	NR	18.40	14.20	19
	Armor	431	405	10	100	NR	6.40	3.90	10
6000	Earth	445	414	27	100	NR	18.40	14.50	20
	Armor	445	414	10	100	NR	6.40	3.90	11
7000	Earth	459	424	27	100	NR	18.40	14.80	20
	Armor	459	424	10	100	NR	6.50	3.90	11

Legend for Table 4-13
NR=Not Required
Notes:
[1] To correct for tail winds, Distance X must increase by 10m per m/s or 5m per knot of tail wind measured along the line of fire. To correct for cross range winds, the dispersion angle must increase by 1.10 degree per m/s or 0.55 degree per knot of cross range wind measured perpendicular to the line of fire.
[2] Area A applies to cone SDZ only.

q. Table 4–14 contains SDZ data for 7.62mm weapons.

Table 4–14.
Surface danger zone data for 7.62mm weapons

Ammunition 7.62mm	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A^2 (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
M59 ball, M62 tracer	Earth/ Water	4,100	4,073	1,461	100	NR	43.54	38.90	706
	Steel/ Concrete	4,100	4,053	861	100	NR	20.04	75.54	447
7.62X39mm A102[1] intermediate designed for AK series, SKS, RPK	Earth/ Water	4,100	4,073	1,461	100	NR	43.54	38.90	706
	Steel/ Concrete	4,100	4,053	861	100	NR	20.04	75.54	447
M118 Spec Ball, M85, MK316 MOD 0	Earth/ Water	5,288	4,800	1,545	100	NR	43.81	38.73	752
	Steel/ Concrete	5,288	5,137	990	100	NR	20.17	41.29	490

Legend for Table 4-14:
NR=Not Required
Notes:
[1] For the 7.62mm x 39mm (AK) the only authorized standard Department of Defense identification code (DODIC) to be used is A102.
[2] Area A applies to cone SDZ only.

r. Table 4–15 contains SDZ data for 7.62mm M80 ball.

Table 4–15.
Surface danger zone data for 7.62mm M80 ball[1]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[2] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	3,662	2,875	315	100	NR	45.60	35.20	271
	Armor	3,662	2,775	115	100	NR	13.00	7.00	126
1000	Earth	3,777	2,952	328	100	NR	45.70	34.60	279
	Armor	3,777	2,848	118	100	NR	13.10	7.70	130
2000	Earth	3,897	3,029	341	100	NR	45.80	34.00	288
	Armor	3,897	2,921	121	100	NR	13.20	8.40	134
3000	Earth	4,022	3,106	354	100	NR	45.90	33.40	297
	Armor	4,022	2,994	124	100	NR	13.30	9.10	139
4000	Earth	4,150	3,183	367	100	NR	46.00	32.80	307
	Armor	4,150	3,067	127	100	NR	13.40	9.80	143
5000	Earth	4,284	3,260	380	100	NR	46.10	32.20	317
	Armor	4,284	3,140	130	100	NR	13.50	10.50	147
6000	Earth	4,423	3,337	393	100	NR	46.20	31.60	327
	Armor	4,423	3,213	133	100	NR	13.60	11.20	152
7000	Earth	4,569	3,414	406	100	NR	46.30	31.00	338
	Armor	4,569	3,286	136	100	NR	13.70	11.90	156

Legend for Table 4-15:
NR=Not Required
Notes:
[1] To correct for tail winds, Distance X must increase by 29m per m/s or 14.90m per knot of tail wind, measured along the line of fire. To correct for cross-range winds, the dispersion angle must increase by 0.31 degrees per m/s or 0.16 degrees per knot of cross wind, measured perpendicular to the line of fire.
[2] Area A applies to cone SDZ only.

t. Table 4–16 contains SDZ data for 7.62mm M80A1 Enhanced Performance Round (EPR) ball.

Table 4–16.
Surface danger zone data for 7.62mm M80A1 Enhanced Performance Round (EPR) ball[1]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[2] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	3,951	3,460	650	100	NR	46.00	73.00	473
	Armor	3,951	3,105	335	100	NR	18.00	52.00	368
1000	Earth	4,066	3,560	668	100	NR	45.80	72.00	486
	Armor	4,066	3,185	346	100	NR	18.20	57.00	379
2000	Earth	4,185	3,660	686	100	NR	45.60	71.00	499
	Armor	4,185	3,265	357	100	NR	18.40	62.00	390
3000	Earth	4,308	3,760	704	100	NR	45.40	70.00	512
	Armor	4,308	3,345	368	100	NR	18.60	67.00	399
4000	Earth	4,435	3,860	722	100	NR	45.20	69.00	526
	Armor	4,435	3,425	379	100	NR	18.80	72.00	410
5000	Earth	4,567	3,960	740	100	NR	45.00	68.00	541
	Armor	4,567	3,505	390	100	NR	19.00	77.00	423
6000	Earth	4,703	4,060	758	100	NR	44.80	67.00	555
	Armor	4,703	3,585	401	100	NR	19.20	82.00	436
7000	Earth	4,845	4,160	776	100	NR	44.60	66.00	570
	Armor	4,845	3,665	412	100	NR	19.40	87.00	448

Legend for Table 4-16:
NR=Not Required
Notes:
[1] To correct for tail winds, Distance X must increase by 35m per m/s or 18m per knot of tail wind measured along the line of fire. To correct for cross range winds, the dispersion angle must increase by 0.36 degree per m/s or 0.19 degree per knot of cross range wind.

[2] Area A applies to cone SDZ only.

u. Table 4–17 contains SDZ data for 7.62mm M62A1 enhanced performance round (EPR) tracer.

Table 4–17.
Surface danger zone data for 7.62mm M62A1 Enhanced Performance Round (EPR) tracer[1]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[2] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	3,298	2,825	625	100	NR	51.00	68.00	510
	Armor	3,298	2,680	275	100	NR	14.50	26.50	191
1000	Earth	3,400	2,910	647	100	NR	51.20	68.40	524
	Armor	3,400	2,765	283	100	NR	14.60	26.60	196
2000	Earth	3,505	2,995	669	100	NR	51.40	68.80	538
	Armor	3,505	2,850	291	100	NR	14.70	26.70	202
3000	Earth	3,615	3,080	691	100	NR	51.60	69.20	553
	Armor	3,615	2,935	299	100	NR	14.80	26.80	207
4000	Earth	3,729	3,165	713	100	NR	51.80	69.60	569
	Armor	3,729	3,020	307	100	NR	14.90	26.90	213
5000	Earth	3,847	3,250	735	100	NR	52.00	70.00	585
	Armor	3,847	3,105	315	100	NR	15.00	27.00	218
6000	Earth	3,970	3,335	757	100	NR	52.20	70.40	601
	Armor	3,970	3,190	323	100	NR	15.10	27.10	224
7000	Earth	4,098	3,420	779	100	NR	52.40	70.80	618
	Armor	4,098	3,275	331	100	NR	15.20	27.20	231

Legend for table 4-17
NR = Not Required
Notes:
[1] To correct for tail winds, Distance X must increase by 29m per m/s or 15m per knot of tail wind measured along the line of fire. To correct for cross range winds, the dispersion angle must increase by 0.35 degree per m/s or 0.18 degree per knot of cross range wind.
[2] Area A applies to cone SDZ only.

v. Table 4–18 contains SDZ data for 7.62mm M993 armor piercing ammunition.

Table 4–18.
Surface danger zone data for 7.62mm M993 Armor Piercing (AP)

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[1] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	4,100	4,084	330	100	NR	33.32	5.97	224
	Armor	4,100	4,084	330	100	NR	33.32	5.97	224
1000	Earth	4,195	4,179	338	100	NR	33.51	6.00	229
	Armor	4,195	4,179	338	100	NR	33.51	6.00	229
2000	Earth	4,290	4,274	346	100	NR	33.69	6.03	234
	Armor	4,290	4,274	346	100	NR	33.69	6.03	234
3000	Earth	4,385	4,368	354	100	NR	33.87	6.06	239
	Armor	4,385	4,368	354	100	NR	33.87	6.06	239
4000	Earth	4,480	4,463	362	100	NR	34.04	6.09	244
	Armor	4,480	4,463	362	100	NR	34.04	6.09	244
5000	Earth	4,575	4,558	370	100	NR	34.20	6.12	249
	Armor	4,575	4,558	370	100	NR	34.20	6.12	249
6000	Earth	4,670	4,652	378	100	NR	34.36	6.14	254
	Armor	4,670	4,652	378	100	NR	34.36	6.14	254
7000	Earth	4,765	4,747	386	100	NR	34.51	6.17	259
	Armor	4,765	4,747	386	100	NR	34.51	6.17	259

Legend for Table 4-18:
NR=Not Required
Notes:
[1] Area A applies to cone SDZ only.

w. Table 4–19 contains SDZ data for 7.62mm M276 Dim Tracer.

Table 4–19.
Surface danger zone data for 7.62mm M276 Dim Tracer[1]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[2] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	2,932	1,118	106	100	NR	22.00	15.30	83
	Armor	2,932	2,192	234	100	NR	44.30	11.00	165
1000	Earth	3,032	1,238	114	100	NR	22.20	15.00	84
	Armor	3,032	2,242	238	100	NR	44.20	10.90	170
2000	Earth	3,132	1,242	116	100	NR	22.30	14.80	86
	Armor	3,132	2,342	244	100	NR	44.10	10.90	175
3000	Earth	3,232	1,287	118	100	NR	22.50	14.50	88
	Armor	3,232	2,392	248	100	NR	44.00	10.80	180
4000	Earth	3,332	1,330	122	100	NR	22.70	14.20	90
	Armor	3,332	2,492	258	100	NR	44.00	10.80	186
5000	Earth	3,432	1,382	134	100	NR	22.90	13.90	92
	Armor	3,432	2,542	266	100	NR	43.90	10.70	192
6000	Earth	3,557	1,436	239	100	NR	23.00	13.70	94
	Armor	3,557	2,642	276	100	NR	43.80	10.70	198
7000	Earth	3,677	1,485	144	100	NR	23.20	13.40	96
	Armor	3,677	2,742	286	100	NR	43.70	10.60	204

Legend for Table 4-19:
NR=Not Required
Notes:
[1] To correct for tail wind, Distance X is increased by 36m per m/s or 18.50m per knot of tail wind measured along the line of fire. To correct for cross range winds, the dispersion angle must be increased by 0.30 degree per m/s or 0.16 degree per knot of cross range wind measured perpendicular to the line of fire.
[2] Area A applies to cone SDZ only.

x. Table 4–20 contains SDZ data for 7.62mm MK319 Mod 0 ball.

Table 4-20
Surface danger zone data for 7.62mm Barrier MK319 MOD 0 ball [1]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[2] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	2,788	2,590	305	100	NR	61.00	13.50	232
	Armor	2,788	2,510	285	100	NR	44.50	18.00	215
1000	Earth	2,874	2,665	315	100	NR	61.10	13.65	239
	Armor	2,874	2,575	294	100	NR	44.40	18.10	221
2000	Earth	2,963	2,740	325	100	NR	61.20	13.80	246
	Armor	2,963	2,640	303	100	NR	44.30	18.20	228
3000	Earth	3,055	2,815	335	100	NR	61.30	13.95	254
	Armor	3,055	2,705	312	100	NR	44.20	18.30	235
4000	Earth	3,151	2,890	345	100	NR	61.40	14.10	262
	Armor	3,151	2,770	321	100	NR	44.10	18.40	242
5000	Earth	3,250	2,965	355	100	NR	61.50	14.25	270
	Armor	3,250	2,835	330	100	NR	44.00	18.50	249
6000	Earth	3,353	3,040	365	100	NR	61.60	14.40	278
	Armor	3,353	2,900	339	100	NR	43.90	18.60	257
7000	Earth	3,461	3,115	375	100	NR	61.70	14.55	287
	Armor	3,461	2,965	348	100	NR	43.80	18.70	264

Legend for table 4-20:
NR=Not Required
Notes:
[1] To correct for tail winds, distance X must increase by 26.50 meters per m/s or 13.50 meters per knot of tail wind measured along the line of fire. To correct for cross range winds, the dispersion angle must increase by 0.39 degrees per m/s or 0.20 degree per knot of cross range wind measured perpendicular to the line of fire.
[2] Area A applies to cone SDZ only.

y. Table 4–21 contains SDZ data for M973 Ball and M974 Tracer 7.62mm short range training ammunition. These rounds are designed to be ballistically comparable to 7.62mm M80 Ball and M62 Tracer service ammunition out to 100m.

Table 4–21
Surface danger zone data for 7.62mm M973 Short Range Training (SRTA) Ball and M974 SRTA tracer [1,2]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[3] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	540	500	105	100	NR	38.00	45.00	178
	Armor	540	500	30	100	NR	10.00	20.00	178
1000	Earth	565	520	110	100	NR	38.00	45.00	184
	Armor	565	520	32	100	NR	10.00	20.00	184
2000	Earth	590	540	115	100	NR	38.00	45.00	190
	Armor	590	540	34	100	NR	10.00	20.00	190
3000	Earth	615	560	120	100	NR	38.00	45.00	196
	Armor	615	560	36	100	NR	10.00	20.00	196
4000	Earth	640	580	125	100	NR	38.00	45.00	202
	Armor	640	580	38	100	NR	10.00	20.00	202
5000	Earth	665	600	130	100	NR	38.00	45.00	208
	Armor	665	600	40	100	NR	10.00	20.00	208
6000	Earth	690	620	135	100	NR	38.00	45.00	214
	Armor	690	620	42	100	NR	10.00	20.00	214
7000	Earth	715	640	140	100	NR	38.00	45.00	220
	Armor	715	640	44	100	NR	10.00	20.00	220

Legend for Table 4-21:
NR=Not Required
Notes:
[1] For SDZ construction use figure 4–4, with the following change: Dispersion, use a dispersion angle of 12 degrees.
[2] To correct for cross wind, the dispersion angle is increased by 0.80 degree per m/s or 0.40 degree per knot of cross wind, measured perpendicular to the line of fire.
[3] Area A applies to cone SDZ only.

z. Table 4–22 contains SDZ data for MK 248 MOD 0 .300 caliber Winchester Magnum ammunition.

Table 4–22.
Surface danger zone data for .300 caliber Winchester Magnum MK 248 MOD 0[1]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[2] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	5,919	4,200	390	100	NR	40.00	10.00	322
	Armor	5,919	2,300	180	100	NR	28.00	12.00	128
1000	Earth	6,078	4,336	399	100	NR	40.45	10.30	340
	Armor	6,078	2,358	187	100	NR	27.75	12.15	138
2000	Earth	6,242	4,472	408	100	NR	40.90	10.60	358
	Armor	6,242	2,416	194	100	NR	27.50	12.30	150
3000	Earth	6,411	4,608	417	100	NR	41.35	10.90	382
	Armor	6,411	2,474	201	100	NR	27.25	12.45	160
4000	Earth	6,584	4,744	426	100	NR	41.80	11.20	410
	Armor	6,584	2,532	208	100	NR	27.00	12.60	165
5000	Earth	6,763	4,880	435	100	NR	42.25	11.50	433
	Armor	6,763	2,590	215	100	NR	26.75	12.75	180
6000	Earth	6,947	5,016	444	100	NR	42.70	11.80	457
	Armor	6,947	2,648	222	100	NR	26.50	12.90	194
7000	Earth	7,137	5,152	453	100	NR	43.15	12.10	484
	Armor	7,137	2,706	229	100	NR	26.25	13.05	208

Legend for Table 4-22:
NR=Not Required
Notes:
[1] To correct for tail winds, Distance X must increase by 37m per m/s or 19m per knot of tail wind, measured along the line of fire. to correct for cross range winds, the dispersion angle must increase by 0.28 degree per m/s or 0.15 degree per knot of cross wind, measured perpendicular to the line of fire.

[2] Area A applies to cone SDZ only

aa. Table 4–23 contains surface danger zone data for.300 caliber Winchester Magnum MK 248 MOD 1 ammunition.

Table 4–23.
Surface danger zone data for .300 caliber Winchester Magnum, MK 248 MOD 1[1]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A^2 (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	6,294	4,600	390	100	NR	39.00	14.00	350
	Armor	6,294	3,800	220	100	NR	24.00	10.00	146
1000	Earth	6,462	4,675	402	100	NR	39.15	14.60	372
	Armor	6,462	3,858	227	100	NR	23.75	10.15	155
2000	Earth	6,635	4,750	414	100	NR	39.30	15.20	397
	Armor	6,635	3,916	234	100	NR	23.50	10.30	165
3000	Earth	6,814	4,825	426	100	NR	39.45	15.80	424
	Armor	6,814	3,974	241	100	NR	23.25	10.45	175
4000	Earth	6,998	4,900	438	100	NR	39.60	16.40	440
	Armor	6,998	4,032	248	100	NR	23.00	10.60	187
5000	Earth	7,188	4,975	450	100	NR	39.75	17.00	468
	Armor	7,188	4,090	255	100	NR	22.75	10.75	198
6000	Earth	7,384	5,050	462	100	NR	39.90	17.60	500
	Armor	7,384	4,148	262	100	NR	22.50	10.90	211
7000	Earth	7,587	5,125	474	100	NR	40.05	18.20	533
	Armor	7,587	5,206	269	100	NR	22.25	11.05	223

Legend for Table 4-23:
NR=Not Required
Notes:
[1] To correct for tail winds, Distance X must increase by 40m per m/s or 21m per knot of tail wind, measured along the line of fire. To correct for cross range winds, the dispersion angle must increase by 0.28 degree per m/s or 0.15 degree per knot of cross range wind, measured perpendicular to the line of fire.
[2] Area A applies to cone SDZ only.

bb. Table 4–24 contains surface danger zone data for .338 caliber Lapua Magnum MK330 (300 grain).

Table 4–24.
Surface danger zone data for .338 caliber Lapua Magnum MK 330 (300 grain)[1]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A^2 (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	6,833	3,950	220	100	NR	41.00	52.00	329
	Armor	6,833	4,050	165	100	NR	15.00	18.00	188
1000	Earth	7,015	4,035	228	100	NR	41.25	52.50	341
	Armor	7,015	4,135	172	100	NR	15.30	19.80	193
2000	Earth	7,201	4,120	236	100	NR	41.50	53.00	353
	Armor	7,201	4,220	179	100	NR	15.60	21.60	199
3000	Earth	7,395	4,205	244	100	NR	41.75	53.50	366
	Armor	7,395	4,305	186	100	NR	15.90	23.40	203
4000	Earth	7,593	4,290	252	100	NR	42.00	54.00	378
	Armor	7,593	4,390	193	100	NR	16.20	25.20	208
5000	Earth	7,798	4,375	260	100	NR	42.25	54.50	391
	Armor	7,798	4,475	200	100	NR	16.50	27.00	213
6000	Earth	8,008	4,460	268	100	NR	42.50	55.00	402
	Armor	8,008	4,560	207	100	NR	16.80	28.80	217
7000	Earth	8,227	4,545	276	100	NR	42.75	55.50	414
	Armor	8,227	4,645	214	100	NR	17.10	30.60	223

Legend for Table 4-24:
NR=Not Required
Notes:
[1] To correct for tail winds, Distance X must increase by 42m per m/s or 22m per knot of tail wind, measured along the line of fire. To correct for cross range winds, the dispersion angle must increase by 0.24 degree per m/s or 0.12 degree per knot of cross range wind, measured perpendicular to the line of fire

[2] Area A applies to cone SDZ only.

cc. . Table 4–25 contains SDZ data for .50 caliber weapons

Table 4–25.
Surface danger zone data for .50 caliber weapons

Ammunition .50 Caliber	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[1] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
M8 API, M2 AP, M20, M1	Earth/ Water	6,100	5,142	1,659	100	NR	40.80	69.60	904
	Steel/ Concrete	6,100	4,300	718	100	NR	16.30	33.10	462
M33 Ball, M2 Ball, M17, M10, M17, Spotter Tracer	Earth/ Water	6,500	5,211	1,652	100	NR	38.19	63.35	901
	Steel/ Concrete	6,500	4,147	714	100	NR	16.03	44.13	478
M858 Ball Plastic, M860 Tracer Plastic	Earth/ Water	700	398	20	100	NR	4.28	9.16	41
	Steel/ Concrete	700	415	53	100	NR	11.65	21.14	41
MK322/1 MK322 RRA	Earth/ Water	3,500	3,500	1,659	NR	NR	40.80	69.60	904
	Steel/ Concrete	3,500	3,500	1,659	NR	NR	40.80	69.60	904

Legend for Table 4-25:
AP=Armor Piercing
API=Armor Piercing Incendiary
RRA=Reduced Range Ammunition
NR=Not Required
Notes:
[1] Area A applies to cone SDZ only.

dd. Table 4–26 contains SDZ data for M903 .50 caliber saboted light armor penetrator (SLAP) ammunition.

Table 4–26.
Surface danger zone data for .50 caliber M903 Saboted Light Armor Penetrator (SLAP)

Altitude (ft)	Impact Media	Dist X (m)	Dist W (m)	Dist D (m)	Area A (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Sand/Steel	8,625	1,130	1,074	NR	NR	47.34	NR	1,130
1000	Sand/Steel	8,885	1,155	1,101	NR	NR	47.34	NR	1,155
2000	Sand/Steel	9,145	1,180	1,128	NR	NR	47.38	NR	1,180
3000	Sand/Steel	9,405	1,205	1,155	NR	NR	47.39	NR	1,205
4000	Sand/Steel	9,665	1,230	1,182	NR	NR	47.40	NR	1,230
5000	Sand/Steel	9,925	1,255	1,209	NR	NR	47.42	NR	1,255
6000	Sand/Steel	10,185	1,280	1,236	NR	NR	47.43	NR	1,280
7000	Sand/Steel	10,445	1,305	1,263	NR	NR	47.44	NR	1,305

Legend for Table 4-26:
NR=Not Required

ee. Table 4–27 contains SDZ data for M962 .50 caliber saboted light armor penetrator- tracer (SLAP–T) ammunition.

Table 4–27.
Surface danger zone data for .50 caliber M962 Saboted Light Armor Penetrator-Tracer (SLAP-T)

Altitude (ft)	Impact Media	Dist X (m)	Dist W (m)	Dist D (m)	Area A (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Sand/Steel	9,560	1,240	1,001	NR	NR	48.00	NR	1,240
1000	Sand/Steel	9,870	1,270	1,025	NR	NR	48.00	NR	1,270
2000	Sand/Steel	10,180	1,300	1,049	NR	NR	48.01	NR	1,300
3000	Sand/Steel	10,490	1,330	1,073	NR	NR	48.02	NR	1,330
4000	Sand/Steel	10,800	1,360	1,098	NR	NR	48.03	NR	1,360
5000	Sand/Steel	11,110	1,390	1,122	NR	NR	48.04	NR	1,390
6000	Sand/Steel	11,420	1,420	1,146	NR	NR	48.04	NR	1,420
7000	Sand/Steel	11,730	1,450	1,170	NR	NR	48.04	NR	1,450

Legend for Table 4-27:
NR=Not Required

ff. Table 4–28 contains SDZ data for .50 caliber MK211 MOD 0 and MK211 MOD 1 API small ammunition.

Table 4-28
Surface danger zone data for .50 caliber MK211 MOD 0, MK211 MOD 1 Armor Piercing- Incendiary (AP-I) MK211 Multi-Purpose (MP)[1,2,3]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	7,463	4,700	700	NR	NR	58.00	47.25	508
	Armor	7,463	4,750	460	NR	NR	32.00	28.75	412
1000	Earth	7,648	4,810	725	NR	NR	58.35	46.25	521
	Armor	7,648	4,850	475	NR	NR	32.05	29.75	433
2000	Earth	7,837	4,920	750	NR	NR	58.70	45.25	534
	Armor	7,837	4,950	490	NR	NR	32.10	30.75	453
3000	Earth	8,032	5,030	775	NR	NR	59.05	44.25	548
	Armor	8,032	5,050	505	NR	NR	32.15	31.75	471
4000	Earth	8,232	5,140	800	NR	NR	59.40	43.25	562
	Armor	8,232	5,150	520	NR	NR	32.20	32.75	486
5000	Earth	8,438	5,250	825	NR	NR	59.75	42.25	577
	Armor	8,438	5,250	535	NR	NR	32.25	33.75	499
6000	Earth	8,650	5,360	850	NR	NR	60.10	41.25	592
	Armor	8,650	5,350	550	NR	NR	32.30	34.75	511
7000	Earth	8,869	5,470	875	NR	NR	60.40	40.25	607
	Armor	8,869	5,450	565	NR	NR	32.35	35.75	524

Legend for table 4-28:
NA=Not Required
Notes:
[1] To correct for tail winds, Distance X must increase by 43 meters per m/s or 22 meters per knot of tail wind measured along the
line of fire. To correct for cross range winds, the dispersion angle must increase by 0.22 degree per m/s or 0.11 degree per knot of
wind measured perpendicular to the line of fire
[2] Maximum deflection is maximum horizontal ricochet distance from left to right limits of the dispersion angle.
[3] Warning is issued when engaging hard target less than or equal to 350 meters. The potential for hazardous fragments to impact near the
weapon area may exist.

gg. Table 4–29 contains SDZ data for .50 caliber MK257 MOD 0 Armor Piercing Incendiary Dim Tracer (API-DT).

Table 4-29.
Surface danger zone data for .50 caliber MK257 MOD 0 Armor Piercing Incendiary-Dim Tracer (API-DT)[1,2]

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A[3] (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	6,666	4,450	575	100	NR	57.80	35.00	428
	Armor	6,666	4,500	360	100	NR	34.00	24.00	335
1000	Earth	6,843	4,585	590	100	NR	58.40	33.50	439
	Armor	6,843	4,605	374	100	NR	34.15	24.75	351
2000	Earth	7,026	4,720	605	100	NR	59.00	32.00	450
	Armor	7,026	4,710	388	100	NR	34.30	25.50	368
3000	Earth	7,216	4,855	620	100	NR	59.60	30.50	462
	Armor	7,216	4,815	402	100	NR	34.45	26.25	385
4000	Earth	7,411	4,990	635	100	NR	60.20	29.00	475
	Armor	7,411	4,920	416	100	NR	34.60	27.00	398
5000	Earth	7,612	5,125	650	100	NR	60.80	27.50	488
	Armor	7,612	5,025	430	100	NR	34.75	27.75	409
6000	Earth	7,819	5,260	665	100	NR	61.40	26.00	501
	Armor	7,819	5,130	444	100	NR	34.90	28.50	418
7000	Earth	8,035	5,395	680	100	NR	62.00	24.50	515
	Armor	8,035	5,235	458	100	NR	35.05	29.25	429

Legend for Table 4-29:
NR=Not Required
Notes:
[1]To correct for tail winds, Distance X must increase by 42 meters per m/s or 22 meters per knot of tail wind measured along the line of fire. To correct for cross range winds the dispersion angle must increase by 0.24 degree per m/s or 0.12 degree per knot of cross range wind measured perpendicular to the line of fire.
[2] Warning is issued when engaging hard target less than or equal to 350 meters. The potential for hazardous fragments to impact near the weapon area may exist.
[3] Area A applies to cone SDZ only.

4–3. Small caliber dummy, drill, and inert ammunition

The dummy, drill, and inert (DDI) cartridges are designed to aid in easy identification of inert ammunition to prevent injury caused by any mix-up with live service ammunition during training. The DDI are completely nickel plated with the 9mm DDI having two holes drilled in the cartridge case, while the 5.56mm, 7.62mm, and .50 caliber DDI have fluted cartridge cases to aid tactile identification in darkness. For the Army, the nickel plated DDI will be the only DDI inert small caliber cartridges authorized for classroom training and weapon cycling functioning for weapon maintenance, or other situations when inert cartridges are needed.

Chapter 5
Grenades and Grenade Launchers

5–1. Hand grenades

a. High explosive loaded type grenades. These contain explosive charges that detonate after a short delay (3 to 5 seconds). Every precaution will be taken to prevent injury from blast, concussion, and fragment. For training purposes, fragmentation and offensive hand grenades will be thrown from a trench or barrier equivalent to a screen of sandbags 0.5m (1.65 ft) thick. When throwing bays are used for protection, they will be built to a minimum height of 1.5m (5 ft) high and 2.7m (8.8 ft) wide or enough to accommodate one thrower and one assistant Range Safety Officer (ARSO). Bay height may be reduced to less than 1.5m if approved by the installation commander. However, it must provide positive protection against high-velocity, low-angle fragments. (See FM 3–23.30 and TC 25–8 for other dimensions and additional information.) Throwing bays will be separated from adjacent bays by a distance of 20m; if this requirement cannot be met, then throwing bays may be separated from one another by physical barriers (earthen berms, concrete walls, or wooden revetments) long and high enough to attenuate high-velocity, low-angle fragments. It is recommended that all throwing pits for live grenade training have knee walls at the rear of the bay. Knee walls provide the quickest and safest means of reacting to a dropped grenade. Knee walls should be 0.6m (2 ft) high.

b. Firing conditions for fragmentation and offensive grenades.

(1) Personnel within the 150m danger area when casualty-producing hand grenades are thrown shall wear, at a minimum, PPE Level 1. Refer to table 2–2. Approved single hearing protection is required for all participating personnel when throwing bays are used. Approved single hearing protection is recommended for all personnel participating in tactical exercises.

(2) Safety clips on fragmentation and practice grenades will not be removed until immediately before the safety pin is removed. Once the safety pin has been pulled, the grenade will be thrown. No attempt will be made to reinsert the safety pin or tape the safety lever (spoon). The safety lever will not be released for any reason on HE grenades until the grenade exits the throwing hand.

(3) All personnel must be proficient in the safety precautions for handling and throwing grenades before live grenade training begins. Successful completion of practice grenade training (usually referred to as mock-bay, these pits will replicate the physical layout of live-bay pits) is mandatory prior to live grenade training.

(4) OICs, RSOs, and live-bay ARSOs for live grenade training events must be certified to perform these duties. Certification will include training detailing actions in the event of a dropped grenade, short throw, grenade thrown other than downrange, SDZ, control of observers, misfire/dud grenade procedures, arming, throwing techniques, and pre-live bay requirements. Marine Corps battalion/squadron commanders are responsible for establishing and maintaining a certification program for their OICs and RSOs commensurate to the assigned duties and responsibilities. RSOs and ARSOs must be qualified with the hand grenade prior to assuming their duties.

(5) HE grenades that fail to function (dud) will not be approached except by EOD personnel. During training, if a grenade fails to explode, the throwing of live grenades in any bay within the uninterrupted fragmentation radius of the dud grenade will cease. Dud grenades will be destroyed by EOD personnel only. Unauthorized personnel will not approach, move, touch, or handle dud grenades. All duds will be reported by the OIC to the range operations office (Army), range control office (Marine Corps).

(6) During demonstrations, fragmentation and blast/concussion type grenades will be thrown from a barricaded position so grenades burst at least 150m from unprotected personnel (see fig 5–1).

(7) When direct viewing of hand grenade detonations within the 150m danger area is required the following information is provided:

(a) Viewing positions will be constructed so as to provide positive protection from high-velocity, low-angle fragments and low- velocity high-angle fragments.

(b) Composite (laminated) viewing ports will be constructed using the following criteria or equivalent:

1. 10mm (.40 inch (in)) glass (outside).

2. 7mm (.28 in) polycarbonate.

3. 6mm (.24 in) glass.

4. 6mm (.24 in) polycarbonate.

5. 6mm (.24 in) glass.

6. 6mm (.24 in) polycarbonate.

(c) Alternatives:

1. Provide a single pane of UL 752 Level 1-, Level 2-, or Level 3- rated bullet-resisting laminated glass glazing (with a minimum total thickness of at least 1–3/16 inches). Also, as an alternative, two panes of other

UL 752 Level 1-, Level 2-, or Level 3- rated bullet-resisting glazing types may be used provided each pane contains a minimum of 30 percent glass by thickness. In cases where the protected side of the glazing is made of a glass layer, the interior surface should have a spall shield/film applied to that surface by the manufacturer.

2. These criteria provide minimum essential one-time protection against worst case fragmentation detonated within 6m of the viewing port. Additionally, 12.7mm (.50 in) or equivalent exterior polycarbonate protective sheet (scar shield) should be installed in front of the viewing port. The shield absorbs the majority of damage and is more easily replaced than the entire viewing port.

(8) Live grenades will not be thrown into standing water, deep snow, or dense vegetation which would obscure the grenade (for example, deeper than 5 cm (2 in)).

(9) When training with live grenades in a tire house, trench line, or like environment and a dud grenade is experienced, all activities within the structure or danger area will stop. Personnel will remain within a safe area for a minimum of 5 minutes and then evacuate the structure or area until EOD clears the dud.

(10)Range cadre and commanders are cautioned that multiple employment of grenades in a training scenario significantly increases the difficulty of determining the actual number of grenades that detonated. Dud grenades may be activated by subsequent training, generating an unplanned detonation.

(11)Simultaneous employment of multiple fragmentation grenades into a single impact point is prohibited, as a live grenade could be propelled into the "safe area" by the detonation of another grenade (Marine Corps).

(12)The use of hand grenades during live-fire exercises shall conform to the provisions provided by chapter 17.

c. Firing conditions for chemical and incendiary hand grenades.

(1) Chemical grenades will not be held in the hand after the safety lever is released. The incendiary hand grenade may be taped or tied in place if the incendiary effect is desired at a specified location. In this case, safety pins will not be pulled from the grenade until the desired time of functioning. Remote safety pin removal is preferred.

(2) Burning type grenades (riot control, smoke, illumination, and incendiary) are ignited by pulling the safety pin and releasing the safety lever. After the safety pin has been pulled, the safety lever will not be released until the grenade exits the throwing hand. Once the safety lever is released, there is no way to stop the grenade from functioning. When the burning type grenade is fired in place, the firer will keep their face turned away from the grenade. After releasing the safety lever, the firer will quickly move at least 10m away to avoid contact with incendiary particles and fumes emitted during burning.

(3) Personnel will be instructed on the proper method of holding the M25 bursting type, riot control grenade before commencing training exercises. The arming sleeve will remain depressed until the grenade is thrown. M25 grenades will not be thrown closer than 25m to unprotected personnel.

(4) Burning type grenades burn oxygen. Standard protective masks filter particles but will not supply oxygen. Therefore, burning grenades shall not be used in enclosed or confined spaces (such as occupied tunnels) or in other confined spaces into which personnel will enter until those spaces are ventilated. Specific fuse burning delay times and functioning characteristics are in TM 9–1330–200–12 and TM 43–0001–29.

(5) Burning type CS grenades will not be fired closer than 10m to other personnel or 50m to spectators upwind.

(6) Hexachloroethane (HC) smoke grenade restrictions are the same as those for HC smoke pots. These grenades will ignite combustible materials and cause burns. A separation distance of at least 10m should be maintained from burning grenades. Personnel will wear protective respirators or masks before exposure to any concentration of smoke produced by HC smoke grenades. (See chap 13 for detailed information concerning smoke hazards.)

(7) Burning particles of white phosphorous (WP) are frequently projected from the M15 and M34 grenades to a distance of 40m from the bursting point. Therefore, M15 and M34 WP grenades should be thrown only on standard live grenade ranges during training as prescribed in FM 3–23.30. Trainers should consider use of protective cover when using the M15 and M34. White phosphorous particles cause serious, painful, slow-healing burns. Refer to FM 4–25.11 for appropriate first-aid measures.

(8) Direct viewing of thermite grenades will not be conducted due to the high potential of permanent eye damage.

d. M84 Stun Grenade. All personnel within 1.52m (5 ft) will wear single hearing protection if employing 2 rounds per day. All personnel within this distance will wear double hearing protection if employing 3 to 41 rounds per day.

e. Surface danger zones.

(1) Surface danger zone requirements for hand grenades are provided in figure 5–1.

(2) When developing a hand grenade range the Army will use TC 25-8 for planning guidance

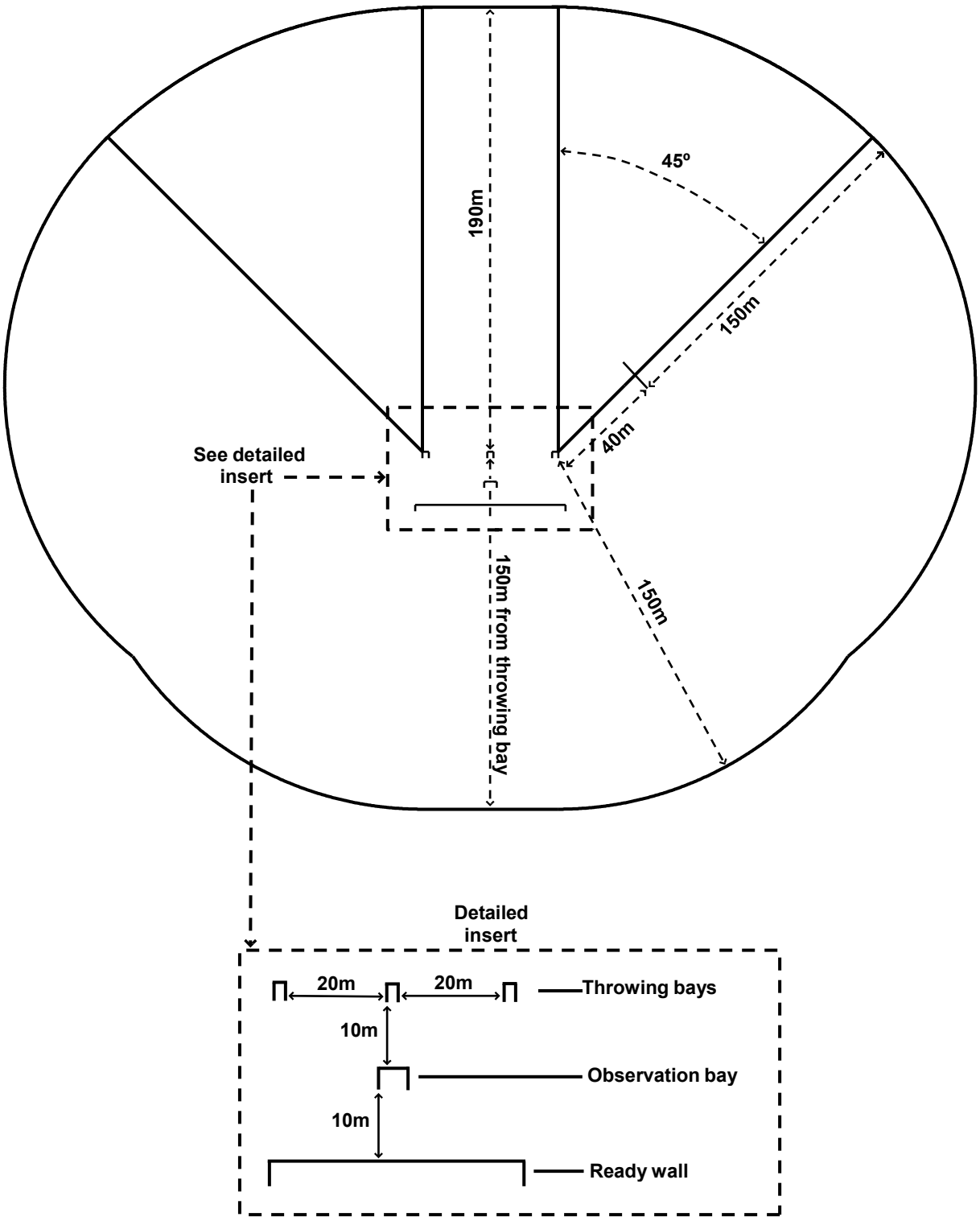


Figure 5–1. Surface danger zone for fragmentation and offensive hand grenade

5–2. Grenade launchers and grenade machine guns

a. General firing conditions.

(1) Personnel will be instructed in the proper use of grenade launchers and grenade machine guns and applicable safety precautions before firing with live ammunition.

(2) PPE Level 1 will be worn when firing HE ammunition. Requirement for eye protection will be determined by the commander as part of the risk management process. Refer to table 2–2.

(a) Hazardous fragmentation from HE grenade ammunition may be experienced up to 165m from the point of detonation. Appropriate HE no-fire lines will be established.

(b) Although the MK32, M79, M203, and M320 40mm grenade launchers are designed to prevent accidental chambering of 40mm high-velocity ammunition, OICs and RSOs will ensure only low-velocity grenade cartridges are fired from MK32, M79, M203, and M320 grenade launchers.

(c) Single hearing protection will be worn within 2m of firing these grenade launchers.

(d) Snow depth of 10cm (4 in) or more and standing water will increase the potential of 40mm duds. These conditions must be considered prior to firing.

(e) Minimum target engagement for MK32, M79, M203, and M320 grenade launchers firing HE ammunition is 130m or 165m, depending on type of ammunition.

(f) For the Marine Corps, minimum target engagement for MK312 Mod 0 (IR) ammunition is 15m.

(3) All duds will be reported by the OIC to the range operations firing desk (Army), range control office (Marine Corps). For the Army, when fired or launched, HE grenades cannot be cleared from an impact area, which must be designated as a dedicated, high-hazard impact area. .

b. General firing precautions. General firing precautions for the MK19 MOD 3 grenade machine gun.

(1) Targets will be engaged only at ranges greater than 75m with training practice (TP) ammunition.

(2) Targets will be engaged only at ranges greater than or equal to 310m with HE ammunition.

(3) Firing through obstructions will be avoided.

(4) Prohibit cross-line firing when using multiple firing points.

(5) Gunners, crew members and other personnel at the firing position will be in PPE Level 1 at all times when firing HE ammunition. Refer to table 2–2.

(6) Range firing procedures and physical setup must be adequate to prevent HE rounds from impacting closer than 310m from the firing position, firing vehicle, other vehicles, or personnel.

(7) Firing over open vehicle hatches is not authorized. Serious injury can result from burns caused by weapon flash or by expended or ejected cartridge cases striking personnel.

(8) Approved single hearing protection and eye protection is required for all personnel within the noise hazard contour of a 20m radius of the weapon system.

(9) Daily exposure limit within the noise hazard contour is 1,000 rounds per day.

(10)Army personnel recovering dud M918 40mm TP projectiles will follow the procedures outlined in TB 9–1310–251–10. The use of protective goggles or face shield, gloves, and tongs while handling M918 TP rounds is mandatory. Marine Corps EOD personnel recovering the same munitions will follow procedures outlined in EODB 60 series publications.

c. Static firing restrictions for vehicle mounted machine gun. Static firing restrictions for vehicle mounted machine gun, MK19 MOD 3 grenade machine gun.

(1) A gunner's quadrant and/ or MK64, MOD 7 mount depression stop will be used to keep the minimum elevation above 30 mil when firing.

(2) M998 High Mobility Multipurpose Wheeled Vehicle (HMMWV) interim squad carrier:

(a) Soft tops must be installed over the driver and passenger compartments for safe operation of the vehicle when firing the MK19.

(b) Visual and physical inspection of the adaptive engineering team collar-mounting bolts must be performed prior to, during, and after firing operations. All bolts must be present with nuts firmly tightened prior to firing.

(3) M113 and M106 series armored carriers:

(a) Firing over open hatches is prohibited.

(b) Driver's hatch must be closed when firing off the left side, forward, or off the right side of the vehicle, or when personnel or objects in hatch areas are forward of the weapon muzzle.

(4) M88A1 Heavy Equipment Recovery Combat Utility Lift and Evacuation System (HERCULES) medium-tracked recovery vehicle:

(a) Operator and mechanic hatches must be closed when firing off the left side, forward, or off the right side of the vehicle.

(b) Personnel doors on the vehicle sides may remain open during firing forward or to the rear, but will be closed when firing to the left or right side of the vehicle.

d. Moving firing restrictions for machine gun. Moving firing restrictions for the MK19 MOD 3 grenade machine gun to preclude unintentional impacts of HE and high explosive dual purpose (HEDP) ammunition at ranges less than 310m —

(1) Restrict speeds to not greater than 20 kilometers per hour (kph) (12 miles per hour (mph)) when firing from the M1025/1026 HMMWV armament carrier and the M998T interim squad carrier over paved and improved roads that are in good condition, and not greater than 10 km per hour (6 mph) over rough roads, trails, and cross-country.

(2) Restrict speeds to not greater than 20 kph (12 mph) when firing from the M113 and M106 family of armored carriers, and the M88A1 tracked recovery vehicle over roads, trails, and cross-country.

e. Surface danger zone.

(1) SDZ requirements for MK32, M79, M203, and M320 grenade launchers are provided in table 5–1 and figures 5–2 and 5–3. A minimum 6m separation distance is required between firing positions when firing HE munitions. Cartridge M433 requires an Area A and B of 165m. All other MK32, M79, M203, and M320 HE cartridges require 130m as illustrated in figure 5–2.

(2) SDZ criteria for the MK19 MOD 3 grenade machine gun are shown in table 5–2 and figure 5–4. Minimum target engagement range for HE cartridges is 310m.

Table 5–1.
Surface danger zone data for 40mm grenade launchers (low velocity) MK32, M79, M203 and M320

Cartridge	Impact Media	Dist X[1] (m)	Minimum Target Engagement (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
M381 HE	Earth	470	130	NA	130	130	NA	NA	216
	Armor	470	130	NA	130	130	NA	NA	216
M433 HEDP	Earth	470	165	NA	165	165	NA	NA	216
	Armor	470	165	NA	165	165	NA	NA	216
M781, M407A1 TP	Earth	470	75	NA	NR	NR	NA	NA	216
	Armor	470	75	NA	NR	NR	NA	NA	216
M576 Multi Projectile	Earth	85	NR	NA	NR	NR	NA	NA	75
	Armor	85	NR	NA	NR	NR	NA	NA	75
M713, M715, M716 Smoke	Earth	470	130	NA	NR	NR	NA	NA	216
	Armor	470	130	NA	NR	NR	NA	NA	216
M651E1 CS[1]	Earth	470	130	NA	NR	NR	NA	NA	216
	Armor	470	130	NA	NR	NR	NA	NA	216
M661, M662, M583A1, M992 Illumination, MK325	NA	470	130	NA	NR	NR	NA	NA	NR
MK312 Mod 0 (IR)	NA	500	15	NA	NR	NR	NA	NA	NR

Legend for Table 5-1:
HE=High Explosive
HEDP=High Explosive Dual Purpose
IR=Infrared
NA=Not Applicable
NR=Not Required
TP=Target Practice
Notes:
[1] For the use of CS see chapter 13.

Table 5–2.
Surface danger zone data for 40mm grenade machine gun (high velocity) MK19 MOD3

Cartridge	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
M383 HE	Earth	2,095	1,250	167	310	310	23	15	See note[1]
	Armor	2,095	1,250	471	310	310	60	28	See note[1]
M385A1 TP	Earth	1,984	1,250	167	NR	NR	23	15	See note[1]
	Armor	1,984	1,250	471	NR	NR	60	28	See note[1]
M430 HEDP	Earth	2,037	1,250	167	310	310	23	15	See note[1]
	Armor	2,037	1,250	471	310	310	60	28	See note[1]
M918 TP	Earth	2,095	1,250	167	NR	NR	23	15	See note[1]
	Armor	2,095	1,250	471	NR	NR	60	28	See note[1]
MK281 MOD 0 TP	Earth	2,200	1,250	167	NR	NR	23	15	See note[1]
	Armor	2,200	1,250	471	NR	NR	60	28	See note[1]
XM1001 Canister	Earth	1,750	1,743	370	NR	NR	35	25	See note[1]
	Armor	1,750	1,743	370	NR	NR	35	25	See note[1]

Legend for Table 5-2:
HE=High Explosive
HEDP=High Explosive Dual Purpose
NA=Not Applicable
NR=Not Required
TP=Target Practice
Notes:
[1] Use the sum of the values of Distance W and Area A (if applicable) until validated test data is available.

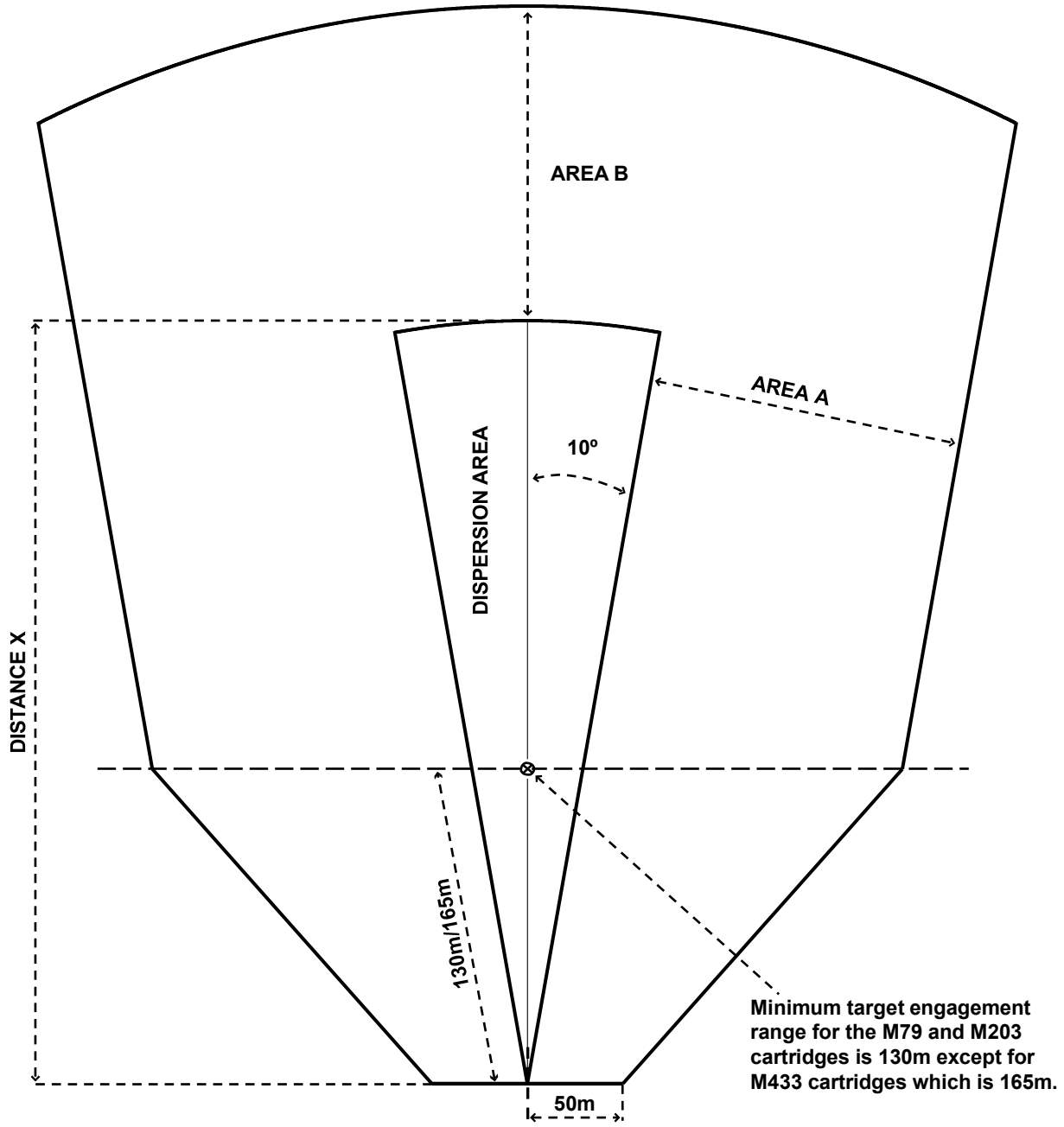


Figure 5–2. Surface danger zone for M79, M203, and M320 grenade launchers

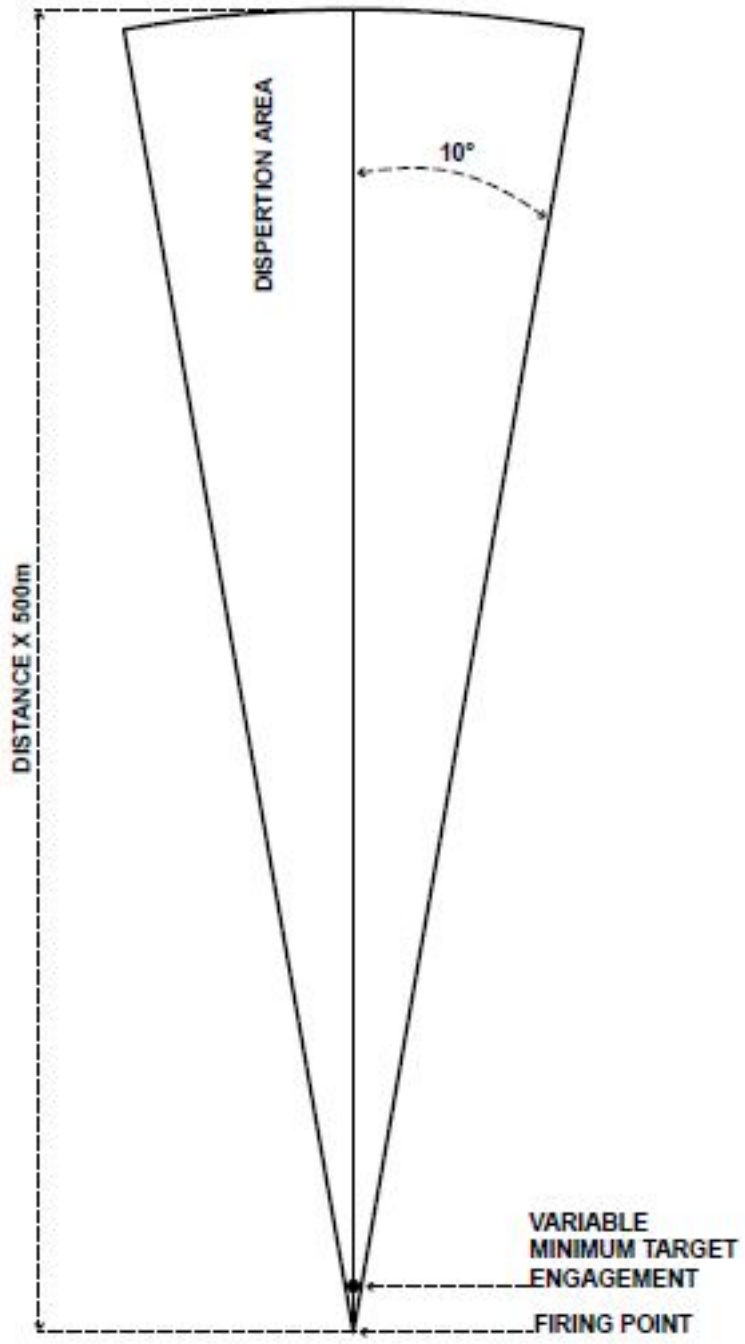


Figure 5–3. Surface danger zone for M781, M407A1, MK312 MOD 0, M576, M713, M715, M716, M661, M662, M583A1, M992, MK325 and M651E1 40mm low velocity ammunition

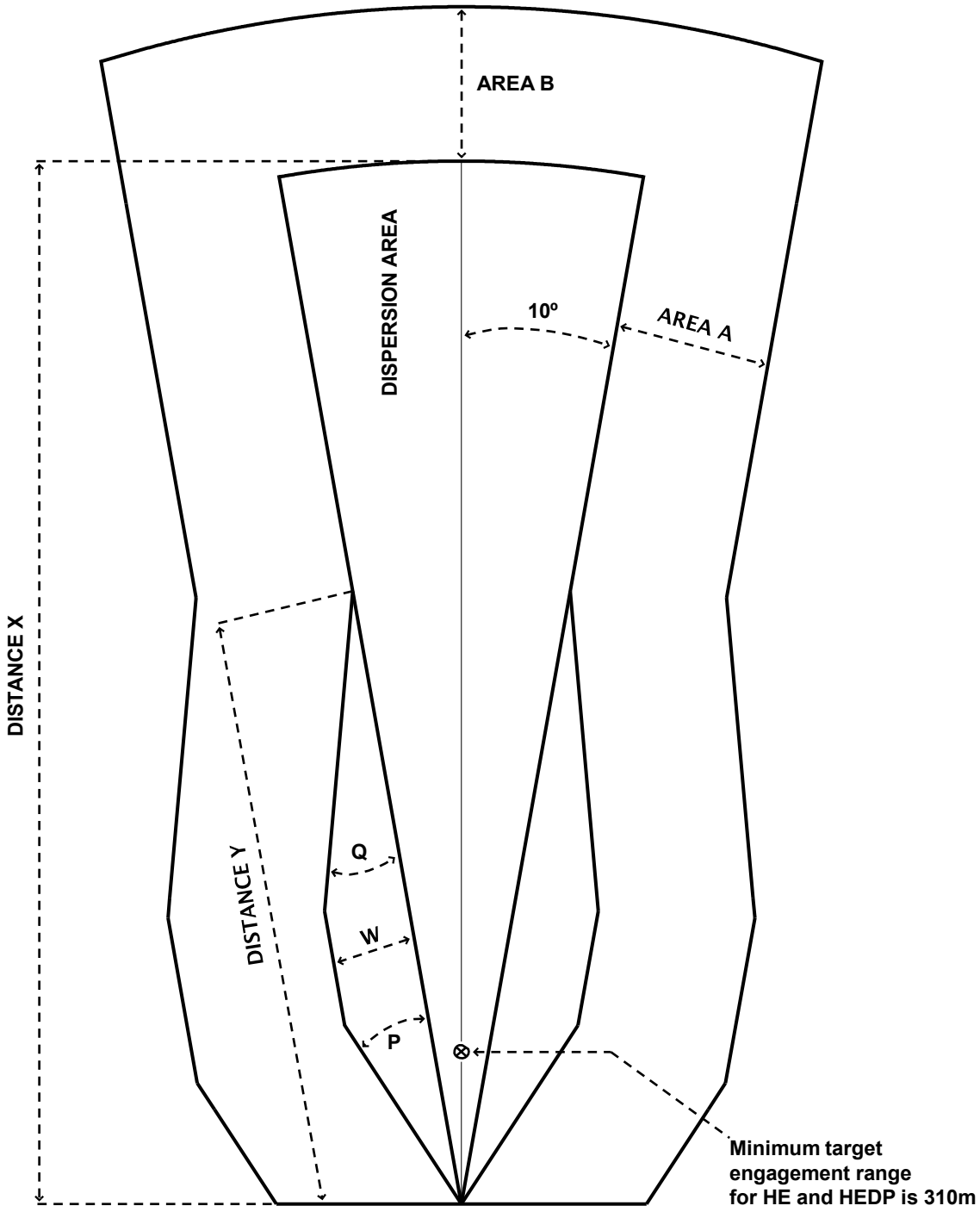


Figure 5–4. Surface danger zone for 40mm machinegun, MK19, MOD3

Chapter 6
Antitank Rockets

6–1. Firing conditions

a. General.

(1) All loading and unloading for separate loading rockets (for example, 35mm training practice rocket and 66mm M74 incendiary rockets) will be on the firing line with the muzzle pointed downrange. Procedures and precautions in TM 3–23.25 and appropriate TMs will be observed in all preparation and firing operations.

(2) Personnel will not stand or have any portion of the body directly in front of or behind a loaded rocket launcher.

(3) Before firing, the SDZ to the rear of the launcher (Area F) will be cleared of personnel, materiel (including expended cartridge cases), and readily combustible vegetation. Area F for antitank rockets is a cone with the apex at the breech and radius corresponding with a rearward extension of the rocket target line.

(4) The use of manned target vehicles is prohibited when firing HE or high-explosive anti-tank (HEAT) ammunition. Moving target vehicles must be operated by remote control. Unprotected operating personnel shall be located outside the SDZ.

(5) Approved single hearing protection will be worn by personnel within 390m of the firing point when firing antitank rockets. Approved single hearing protection will be worn by personnel within 500m of the firing point when firing HE, HEAT, TP, smoke and illumination from the multi-role anti-armor antipersonnel weapons system (MAAWS). The gunner and all other personnel within a 100m radius of the MAAWS must wear properly inserted foam earplugs as well as properly fitting ear muffs (double hearing protection).

(6) Gunners and other personnel within 20m will at a minimum wear PPE Level 1 (see table 2–2). Eye protection is encouraged when firing shoulder-launched multipurpose assault weapons (SMAW).

(7) During training with the SMAW, the gunner and assistant gunner are authorized to fire only five rounds per day because of sound pressure levels.

(8) All personnel are required to wear approved hearing protection when firing the M72AS light anti-tank weapon (LAW) training system.

b. Special firing conditions.

(1) SMAW-common practice round (CPR) HX–07 Areas A and B are not required.

(2) All personnel within 100m of the SMAW launcher will wear, at a minimum, PPE Level 1, Eye protection is encouraged. Refer to table 2–2.

(3) For SMAW MK80 novel explosive (SMAW NE) (DODIC HA34), SMAW–MK6 high explosive anti-armor assault (HEAA) (DODIC HX06), SMAW–MK3 HEDP (DODIC HX05), and SMAW–MK7 CPR (SMAW) (DODIC HX–07), danger zone occupation could result in fatalities or serious casualties including severe burns, eye damage, or permanent hearing loss. The hazards are base plate fragments, debris, fireball, high noise levels, and overpressure.

(4) When the M72 LAW is fired in temperatures below freezing, all back blast areas (Area F) will be doubled. Operating personnel should wear approved face protection during firing.

(5) Extending the M72 weapon system too slowly can result in a failure to cock the weapon.

(6) All M72AS 21mm training system weapons will be visually inspected for damage before firing. Damaged weapons will be destroyed per standard EOD procedures.

(7) Rockets, MAAWS, or the M136 AT4 shoulder-launched munition will not be fired from within buildings unless fired in accordance with ATTP 3–06.11 or within 50m of a vertical or nearly vertical backstop, barrier, or obstacle due to the risk of debris ricochets.

(8) Prone or foxhole firing of HE AT4 (M136) is not authorized. In training, an individual may fire one round from the sitting position or three rounds from the standing or kneeling positions in a 24-hour period.

(9) Prone firing of HE or TP ammunition in the MAAWS is not authorized due to overpressure hazards.

(10) The firing of antitank rockets over unprotected troops from a moving vehicle or aircraft is not authorized.

(11) For HE ammunitions, limit the number of daily firings by any individual (gunner or personnel within 20m) to four. There is no limit for the M72AS 21mm LAW training system.

6–2. Surface danger zone

a. General.

(1) Danger area occupation could result in fatalities or serious casualties, including severe burns or permanent hearing loss. The hazards are base plate fragments, debris, fireball, high noise levels, and overpressure.

(2) Caution area is an extension of the primary danger zone. Occupation of this area could also result in severe casualties due to back blast, debris, high noise levels, eye injuries, and possible base plate fragments.

b. Anti-tank rockets. Surface danger zone requirements including minimum target engagement distances for LAW antitank rockets are in tables 6–1 and 6–2 and figures 6–1 and 6–2. Distance X may be reduced if there is steeply rising terrain behind the target or overhead baffles and positive controls are used to limit elevation of the launcher at the firing position. A formal deviation must be approved to reduce Distance X. For the 35mm M73, see table 6–2. Minimum range to impact (minimum target distance) may be reduced 60 percent when firing non-explosive warhead from unprotected positions or explosive warhead from protected positions. Area F is a 70 degree angle (35 degrees left and right) of rearward extension of launcher target line. When firing from the prone position, the gunner's lower body shall be 45 degrees away from the back blast area. Area F extends rearward of the launcher firing point at 90 degree (45 degree left and right) for the M72A2 and 70 degree (35 degree left and right) for M72A 4, 5, 6, and 7. Area F consists of two primary areas known as danger area and caution area (except for the M72AS, which has only a danger area). The vertical hazard of 950m will be used when firing all HE antitank rockets.

Table 6–1.
Surface danger zone data for Light Ant-Tank Weapon (LAW)

Weapon	Dist X (m)	Minimum Target Engagement (m)	Ricochet Angle (deg)	Area A (m)	Area B (m)	Area F Primary Danger Area (m)	Area F Caution Area (m)
66mm HEAT, M72A2	1,000	75	13	250	250	40	25
66mm Trainer M72AS 21mm sub-caliber	1,000	75	13	NR	NR	50	NR
66mm HEAT M72A 4,5,6,7, and 9	1,400	75	13	250	250	40	30
66mm incendiary, M74	1,000	50	13	100	100	40	38
35mm sub-caliber, M73	1,150	50	13	100	100	40	25

Legend for Table 6-1:
HEAT=High Explosive Anti-Tank
NR=Not Required

Table 6–2.
Maximum ranges at various quadrant elevations for the 35mm M73 practice rocket

Elevation (deg)	Range (m)	Max Ord (m)
5	343	8
10	591	30
15	776	62
30	1,082	203

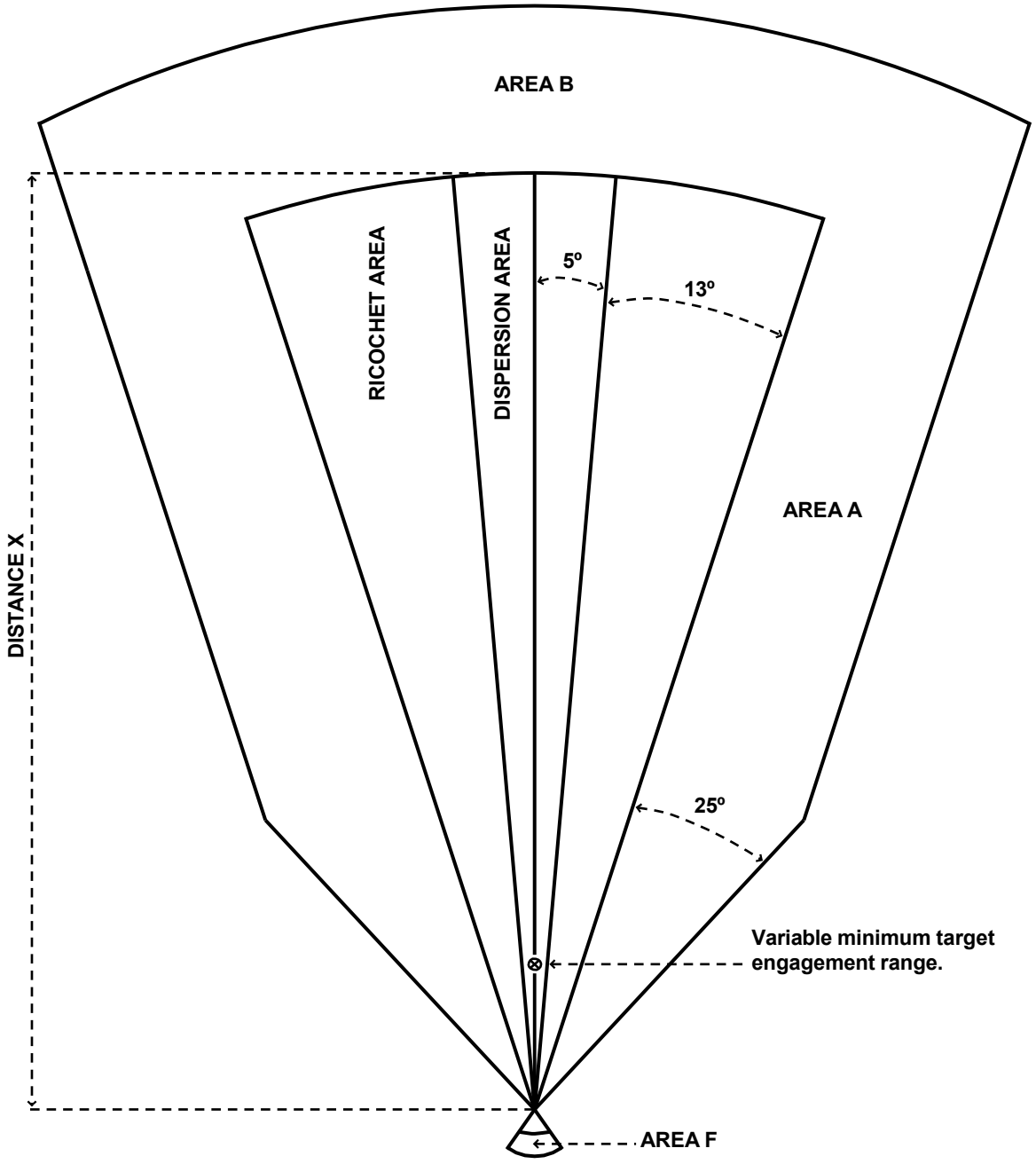


Figure 6–1. Surface danger zone for Light Anti-Tank Weapon (LAW)

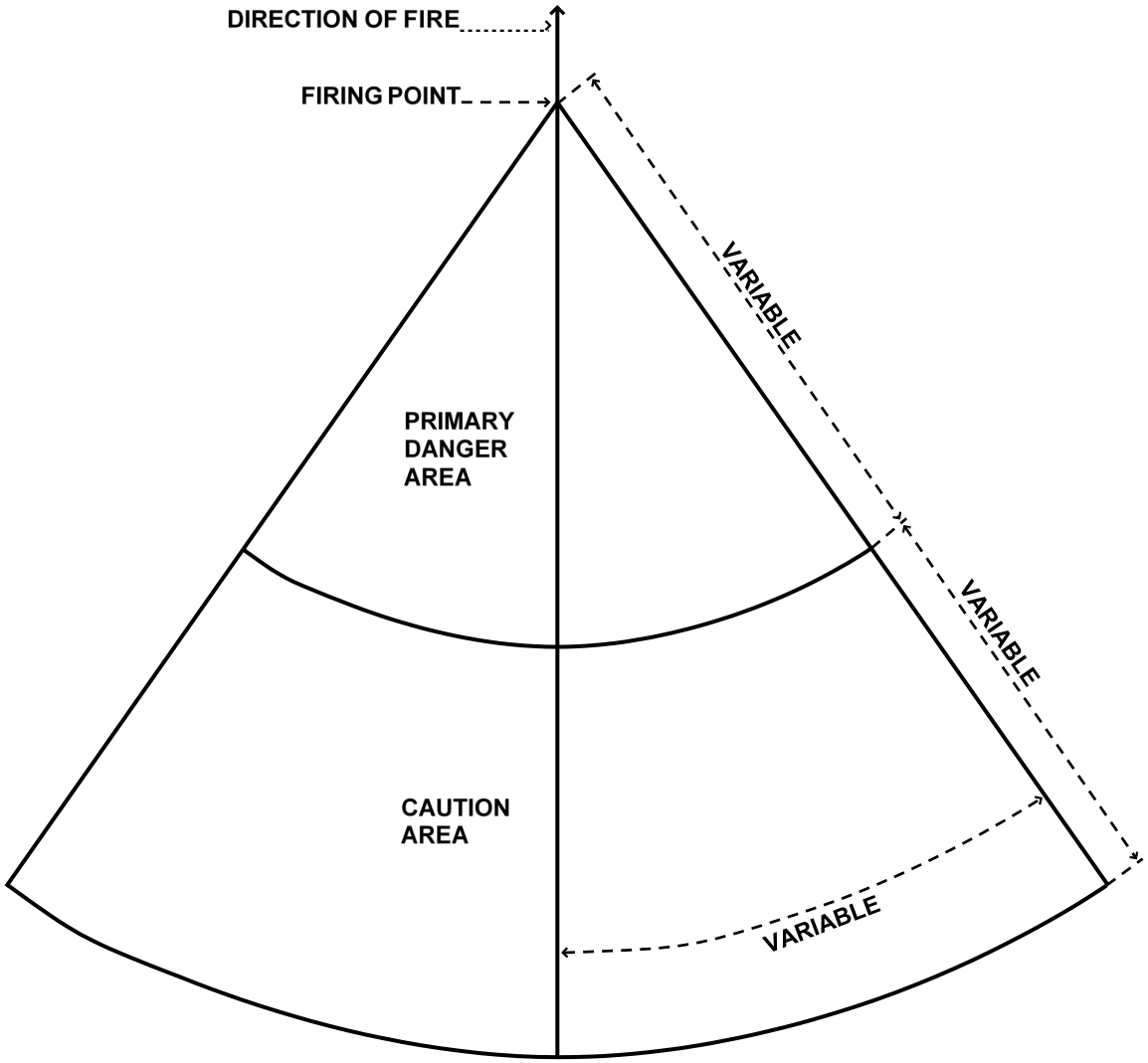


Figure 6–2. Surface danger zone, area F, for Light Anti-Tank Weapon (LAW)

c. SDZ requirements for MAAWS are in table 6–3 and figures 6–3 and 6–4. Minimum Target Engagement may be reduced 60 percent when firing non-explosive projectiles from unprotected firing positions or explosive projectiles from protected positions. Area F is a 90 degree angle (45 degrees left and right) of rearward extension of launcher target line.

Table 6–3.
Surface danger zone data for Multi-role Anti-armor Antipersonnel Weapon Systems (MAAWS)

Munition Type	Dist X (m)	Minimum Target Engagement (m)	Ricochet Angle (deg)	Area A (m)	Area B (m)	Area F Primary Danger Area (m)	Area F Caution Area (m)
HE (441B, 441D RS)	2,600	250	13	400	400	40	60
HEAT (551, 551 MM, 551 C RS)	3,200	50	38	150	150	40	60
HEDP (502, 502 RS)	2,000	150	12	330	330	40	60
TP (552)	3,200	50	13	100	100	40	60
TPT (141)	1,650	200	20	150	150	40	60
Smoke (469B)	2,600	150	13	150	150	40	60
Illumination (545 C)	2,900	NA	NR	100	100	40	60
MT (756)	2,600	300	40	420	420	40	60
7.62mm (FFV553)[1]	4,100	NA	5	100	NR	NR	NR
20mm (CCTS)	2,000	250	45	200	200	40	60

Legend for Table 6-3:
CCTS=Cannon Caliber Training System
HE=High Explosive
HEAT=High Explosive Anti-Tank
HEDP=High Explosive Dual Purpose
MT=Multi-Target
NA=Not Applicable
NR=Not Required
TP=Target Practice
TPT=Target Practice Tracer
Notes:
[1] For SDZ construction refer to small arms chapter 4, figure 4-1

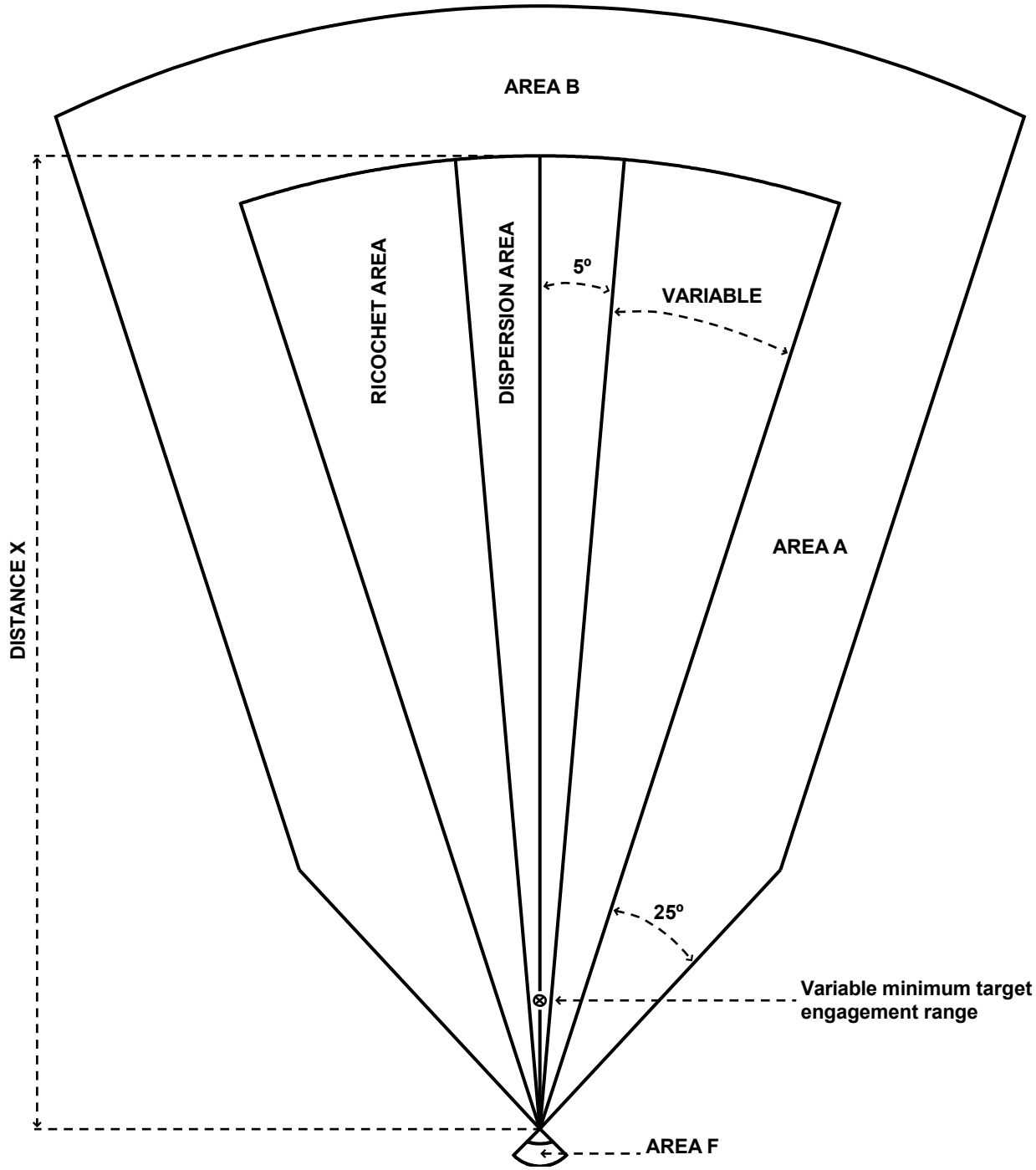


Figure 6–3. Surface danger zone for Multi-role Anti-armor Antipersonnel Weapons System (MAAWS)

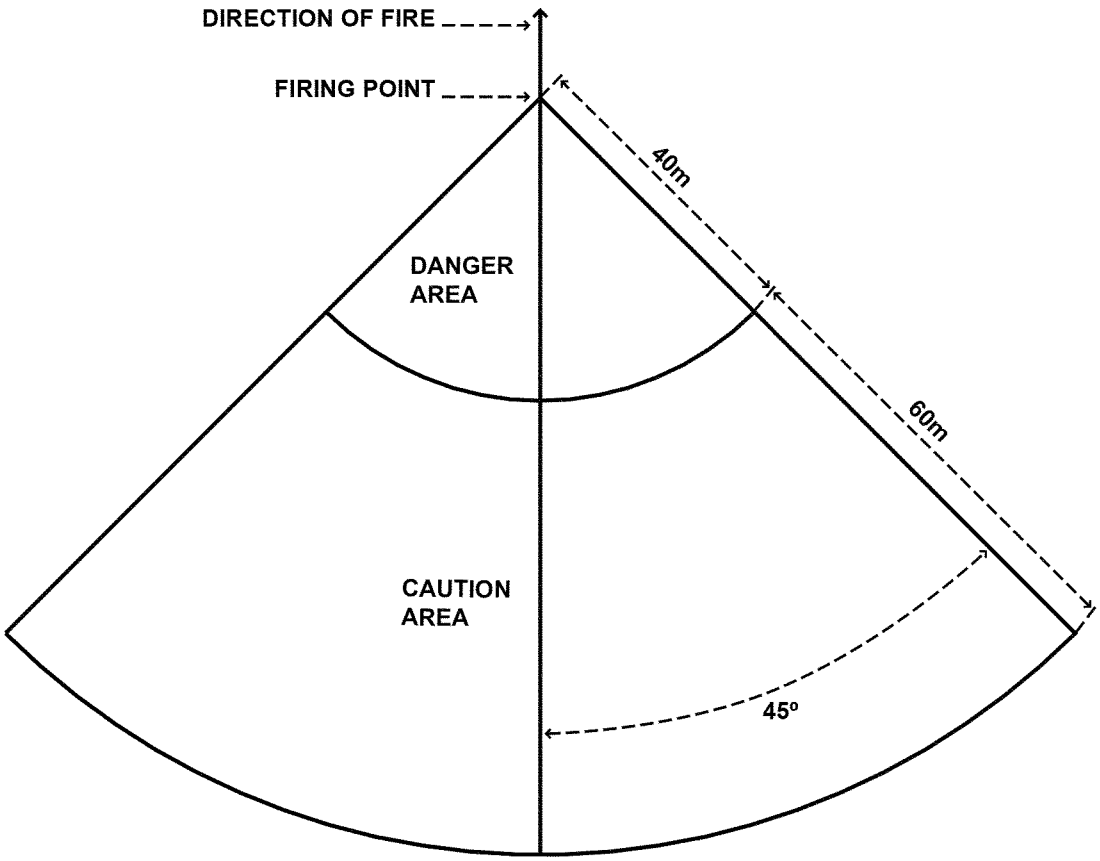


Figure 6–4. Surface danger zone area F for Multi-role Anti-armor Antipersonnel Weapons System (MAAWS)

d. SDZ requirements for the M136 AT4 are in table 6–4 and figures 6–5 and 6–6. Area F is a 90 degree angle (45 degrees left and right) of rearward extension of launcher target line. Increased dud rates may occur when firing HEAT (M136) at impact angles of 10 degrees or less.

Table 6–4.
Surface danger zone data for AT- 4

Weapon	Dist X (m)	Minimum Target Engagement (m)	Ricochet Angle (deg)	Area A (m)	Area B (m)	Area F Primary Danger Area (m)	Area F Caution Area (m)
84mm HEAT M136	2,100	50	13	227	488	5	95
9mmTrainer, M939	1,600	NA	13	NR	NR	NR	NR

Legend for Table 6-4:
HEAT=High Explosive Anti-Tank
NR=Not Required

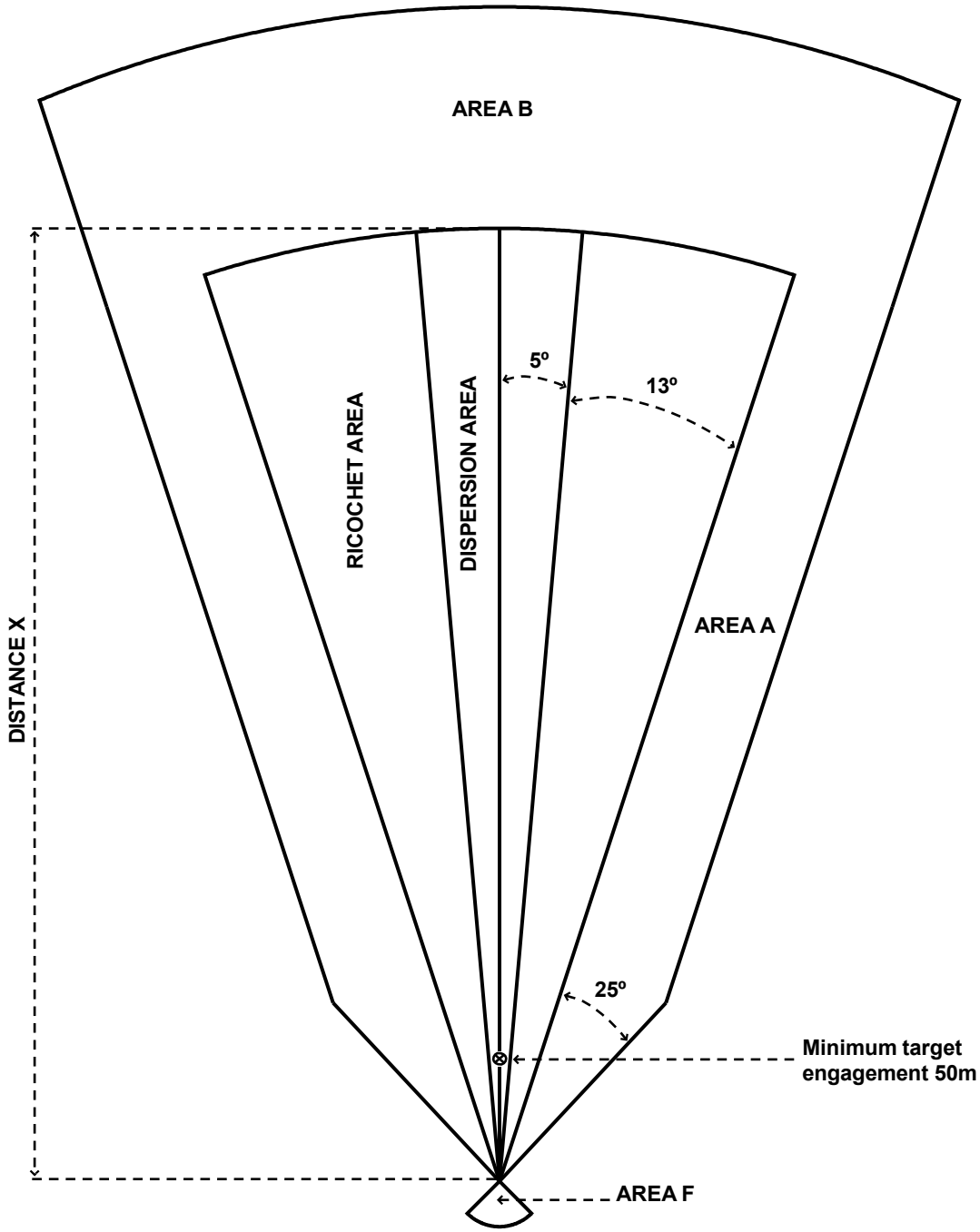


Figure 6–5. Surface danger zone for AT4

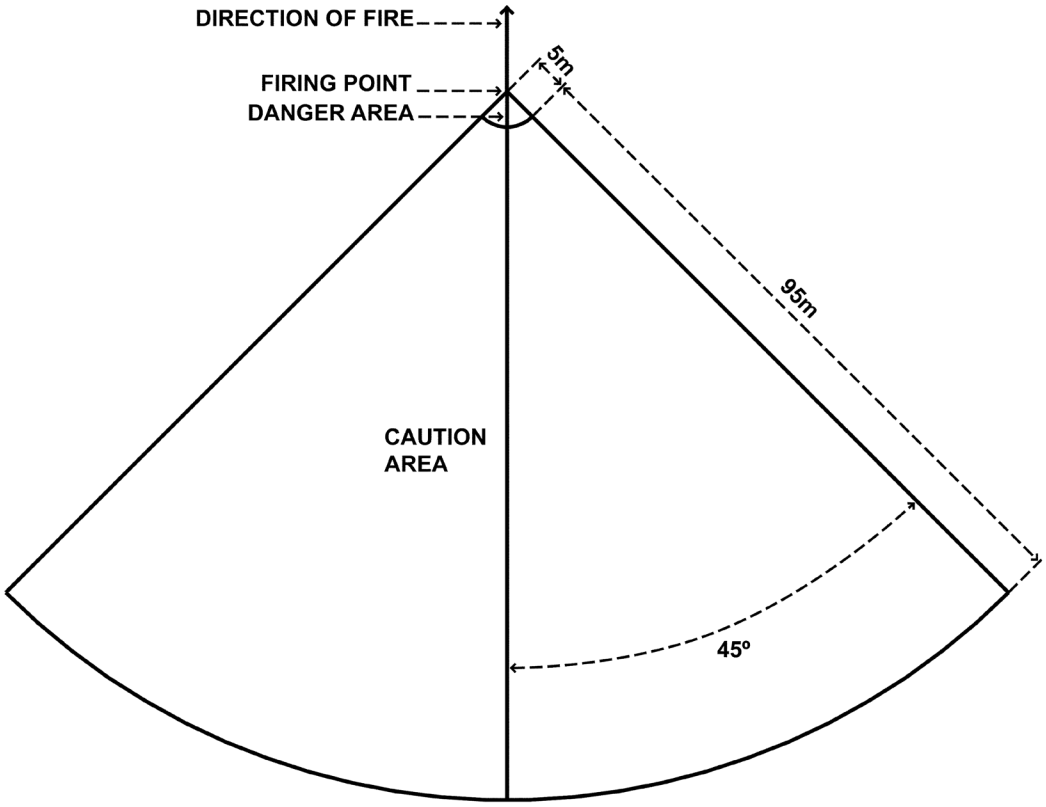


Figure 6–6. Surface danger zone area F for AT-4

e. SDZ requirements for SMAW–NE are in table 6–5 and figures 6–7 and 6–9. SDZ requirements for SMAW–HEAA, -HEDP, and the -CPR are in table 6–5 and figures 6–8 and 6–9. Area F for the SMAW is a 60 degree angle (30 degrees left and right) of rearward extension of launcher target line.

Table 6–5.
Surface danger zone data for Shoulder-launched Multipurpose Assault Weapon (SMAW) Shoulder-launched Multipurpose Assault Weapon Novel Explosive (SMAW-NE)

Munition Type	Dist X (m)	Minimum Target Engagement (m)	Ricochet Angle (deg)	Area A (m)	Area B (m)	Area F Primary Danger Area (m)	Area F Caution Area (m)
SMAW–NE HA34	2,460	100	4	250	250	30	70
SMAW- HEAA HX06	2,500	100	13	500	500	30	60
SMAW- HEDP HX05	2,500	100	13	250	250	30	60
SMAW- CPR HX07	2,500	100	13	NR	NR	30	60

Legend for Table 6-5:
CPR=Common Practice Round
HEAA=High Explosive Anti-Tank Assault
HEDP=High Explosive Dual Purpose
NE=Novel Explosive
NR=Not Required

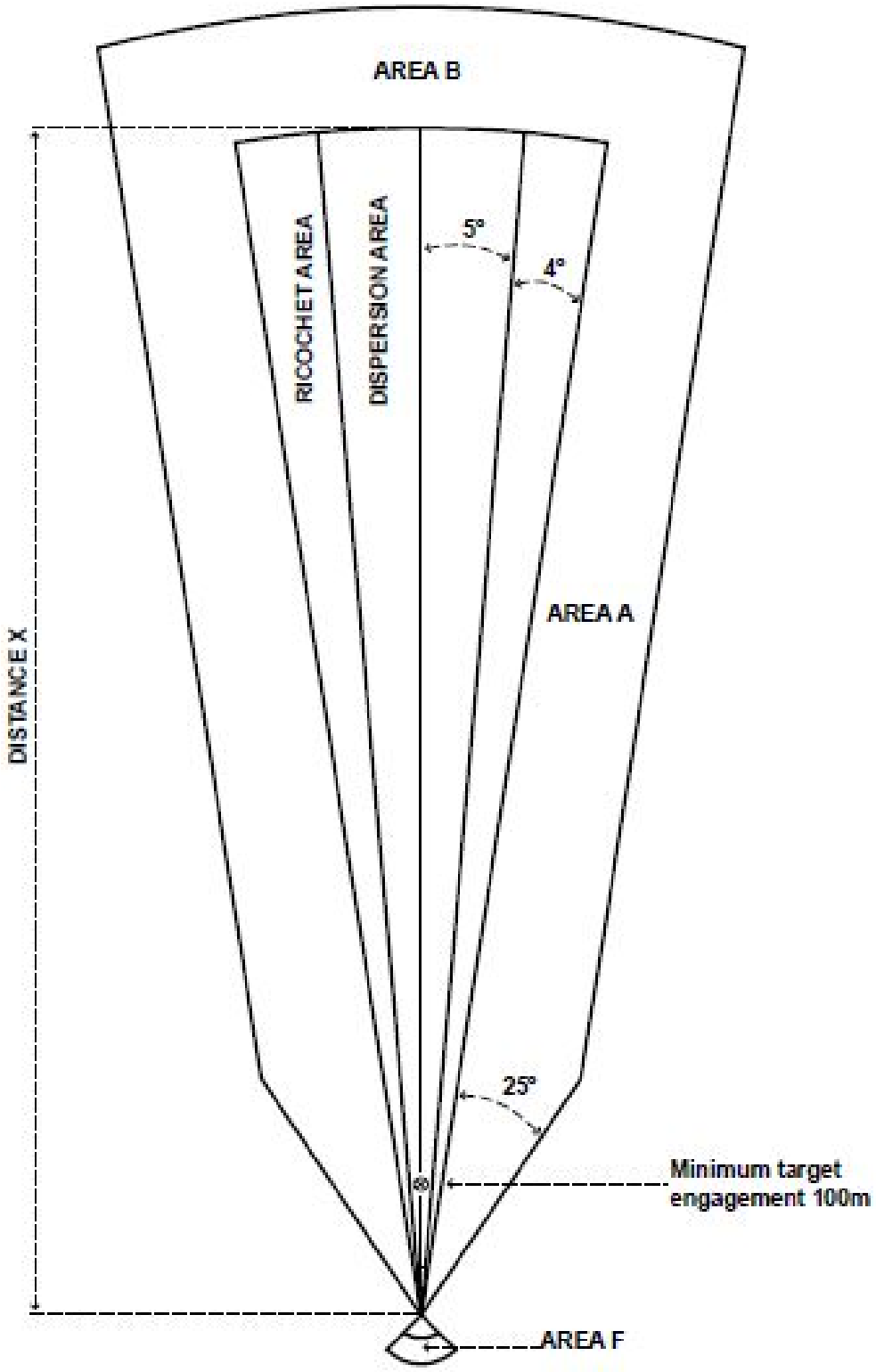


Figure 6–7. Surface danger zone for MK 80 Shoulder-launched Multipurpose Assault Weapon-Novel Explosive (SMAW-NE)

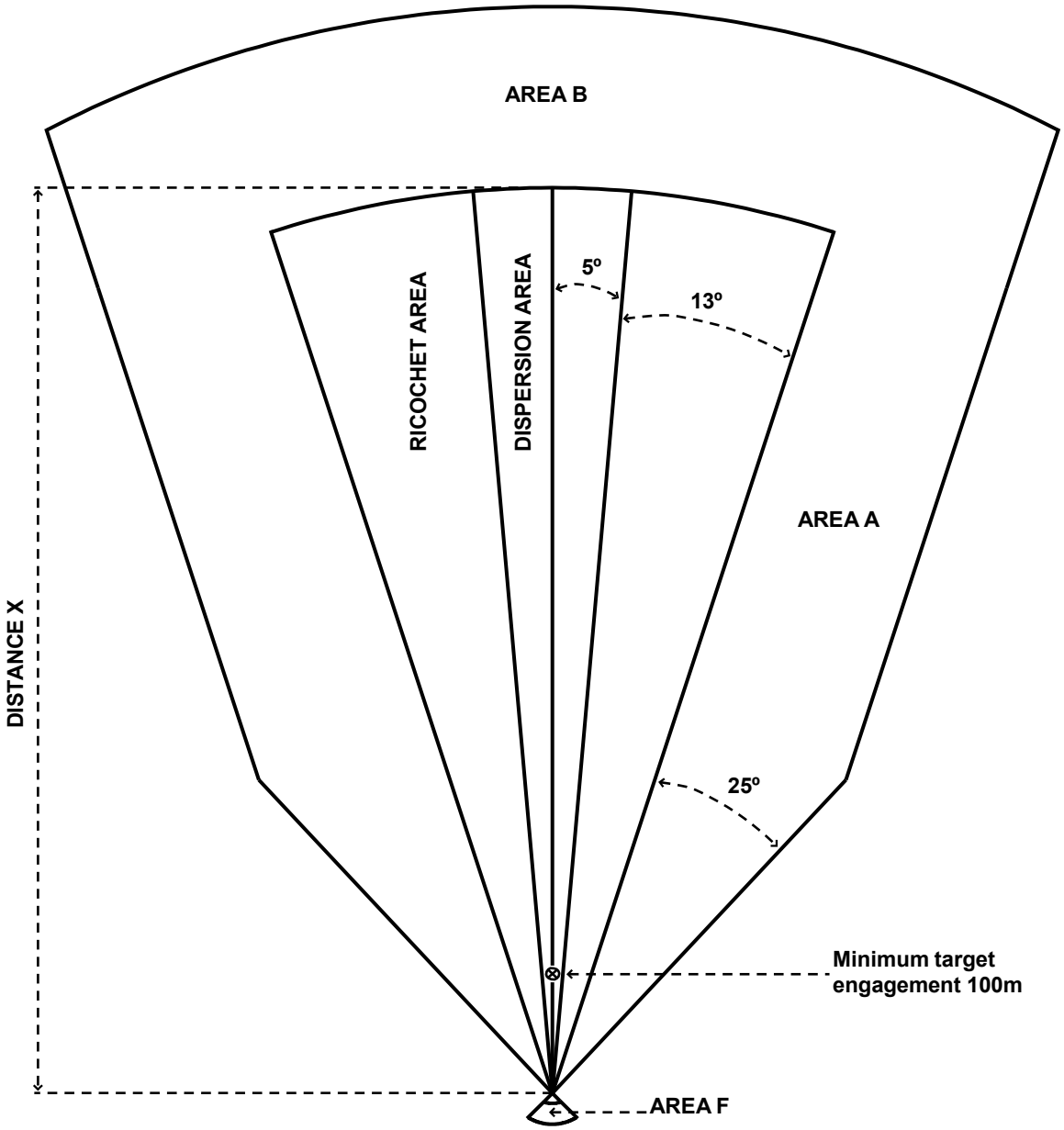


Figure 6–8. Surface danger zone for Shoulder-launched Multipurpose Assault Weapon High Explosive Anti-tank Assault (SMAW-HEAA) High Explosive Dual Purpose (HEDP) Common Practice Round (CPR)

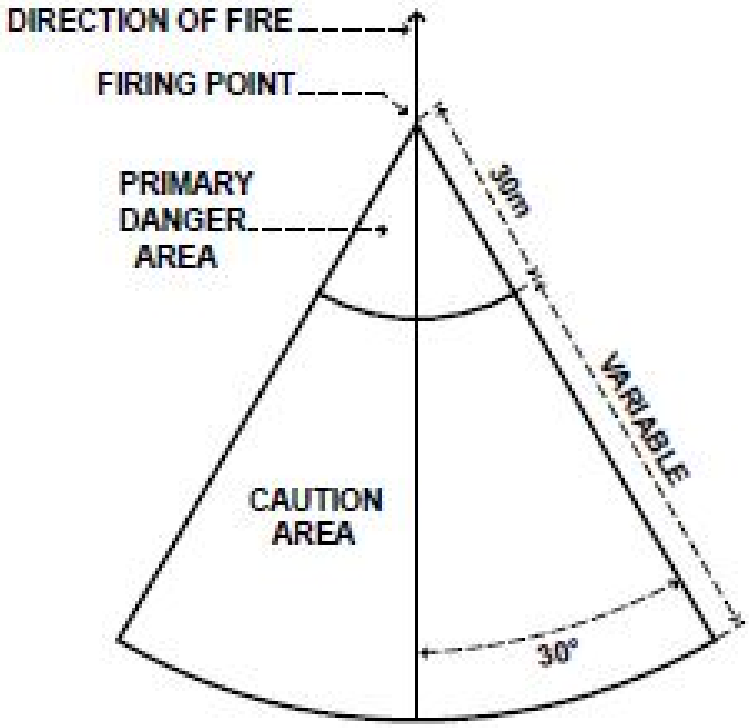


Figure 6–9. Surface danger zone area F for MK 80 Shoulder-launched Multipurpose Assault Weapon-Novel Explosive (SMAW-NE), High Explosive Anti-tank Assault (HEAA), High Explosive Dual Purpose (HEDP) and Common Practice Round (CPR)

Chapter 7
Antitank Guided Missiles

7-1. FGM–148 Javelin guided missile

The Javelin is a shoulder-launched, man-portable, anti-armor weapon system. It fires a passive-imaging infrared (IR) missile with a lock-on before launch guidance system. The Javelin (FGM-148A, B, C or D) antitank missile is the baseline variant. The Javelin FGM-148E antitank missile has extended range capability, enhanced software, and improved warhead. The Javelin FGM-148F is an upgrade to the Javelin FGM-148E, and contains a modernized Control Actuator System (CAS) hardware and software, new missile software, and new multi-Purpose Warhead (MPWH) and Precursor Warhead (PCWH), both designed to improve Insensitive Munitions (IM) performance and performance against non-armor targets.

a. *Firing conditions.*

(1) Before firing any Javelin missile, the entire SDZ will be cleared of non-participating personnel. Only those participating personnel specified in appropriate Training FMs and TMs will be permitted in any part of the SDZ.

(2) Javelin missile firings will be accomplished within predetermined boundaries. Installation RMAs (Army), RCOs (Marine Corps) will ensure that an adequate SDZ exists along the MTL from each anticipated launch position within the predetermined boundaries.

(3) See applicable FMs and TMs for preparation and firing operations.

(4) Personnel will neither stand nor permit any part of their body to be directly behind or in front of the Javelin launcher.

(5) Personnel engaged in firing or supervising Javelin missile training will wear a minimum of PPE Level 1. Refer to table 2–2 for further guidance.

(6) Javelin missile firings during training exercises should be at targets located not less than 500 meters from the launch position. If targets closer than 600 meters are being engaged, an additional circular SDZ of 600 meters from the target should be observed and the gunner and assistant gunner should be in a protected firing position (e.g. sand bags) or an enclosure.

b. Surface danger zone construction for the Javelin antitank missile.

(1) The SDZ for firing the Javelin missile variants at a fixed target is illustrated in figure 7–1, 7-2 and, 7-3.

(2) The Javelin SDZ boundary starts as a specified fan angle (Angle P) extending downrange to a point at which it changes into a cross range (Distance W) boundary, which extends to the maximum kinetic range of the missile (Distance X).

(3) Area A is drawn 600m perpendicular to the 1 in 1 million (10^{-6}) impact fan boundary line for both HE warhead rounds and inert rounds. The remaining downrange portion of Area A is a constant 500m width (FGM-148A-E) and 225m width (FGM-148-F) for HE warhead equipped rounds at the maximum range. Area A values for both HEAT and Inert rounds are found in Table 7-3. Area A will contain missile and warhead debris from impacts on the boundary selected fly out line/trajectory limit and portions of the missile that remain attached to the propulsion section which may continue to be propelled until flight motor burnout.

(4) Area B contains the debris scatter associated with the missile landing at the forward edge of the impact area. This area depth is driven by the fragmentation distance and the width is driven by the maximum cross range of Area A. The depth of Area B is 500 m (FGM-148A-E) and 225m (FGM-148F) for HE warhead equipped rounds at the maximum range. Area B values for both HEAT and Inert rounds are found in Table 7-3.

(5) The launcher danger zone, Area F, is the zone aft of the launcher tube (see fig 7-4) and consists of the primary danger area and cautions areas 1, 2, and 3. Area F dimensions are as described below for all Javelin variants

(a) The primary danger area is a 60 degree angle (30 degree either side of the rearward extension of the MTL) with the apex at the aft end of the missile launch motor. This area has a 25m radius. Additionally, the primary danger area is extended forward to the firing line from a distance of 1 to 5m left and right of the MTL (see fig 7–4).

(b) Caution Area 1 is an extension of the 25m primary danger area arc forward to the firing line on each side of the launcher. Serious hearing impairment or damage from frequent exposure could occur to personnel in this area during firings. Personnel in this area must wear approved hearing protection devices.

(c) Caution Area 2 is an extension to the rear of the primary danger area, 10m beyond the primary danger area.

(d) Caution Area 3 is an extension to the rear of the primary danger area within the 60 degree sector with a 100m radius. This area is affected by the activation of the flight motor pressure relief system. Personnel located

in this area will wear eye protection.

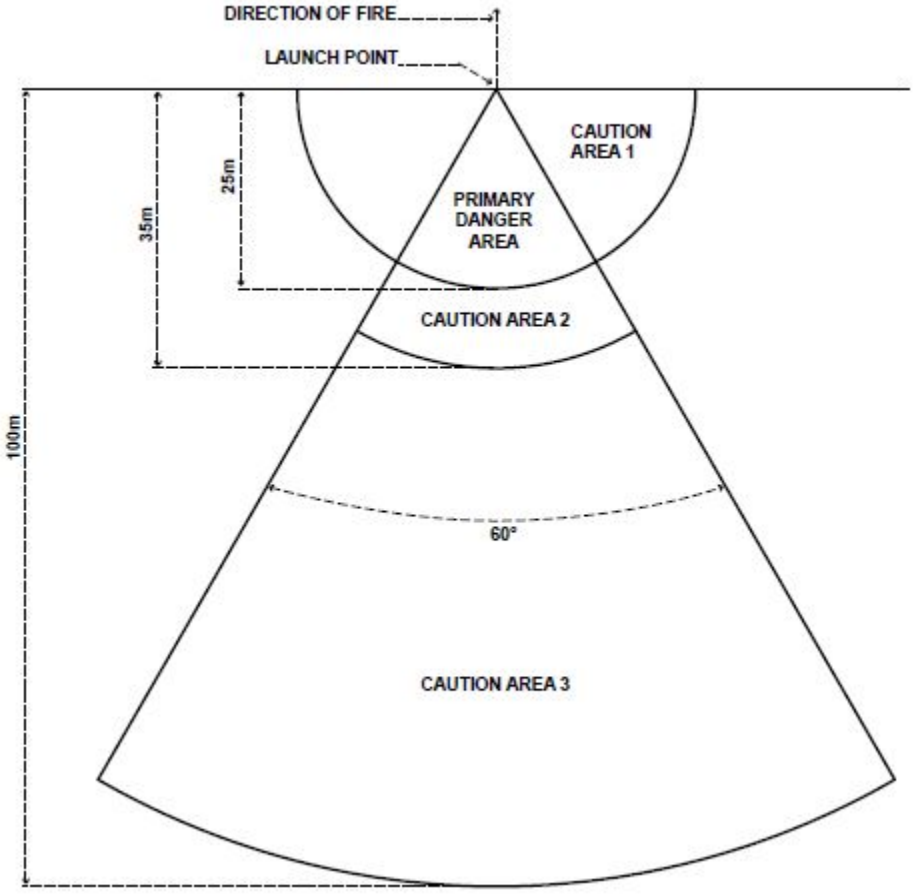


Figure 7–4. Surface danger zone, area F, Javelin missiles, Javelin Block 1 missiles, Javelin FGM-148A, B, C, D High Explosive Anti-Tank (HEAT), Inert, FMG148E HEAT, Inert, FMG 148F HEAT and Inert missiles

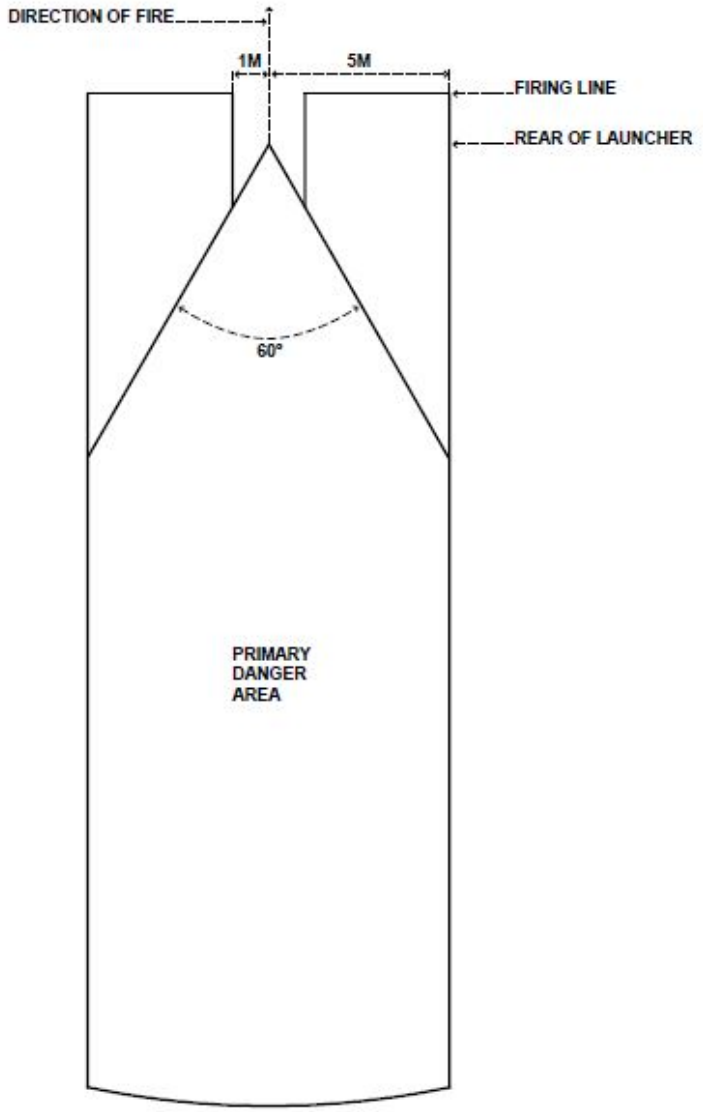


Figure 7–5. Surface danger zone, area F extension, for activation of Javelin missiles, Javelin Block 1 missiles, Javelin FGM-148A, B, C, D High Explosive Anti-Tank (HEAT), Inert, FMG148E HEAT, Inert, FMG 148F HEAT and Inert missiles, flight motor pressure relief system

Table 7-1
Surface danger zone data for Javelin missiles

Javelin Missile	Dist X (m)	Minimum Target Engagement (m)	Area A (m)	Area B (m)	Max ord AGL (m)
HEAT	4,000	500	500/200	500	660
Inert	4,000	500	200/100	500	660

Legend for Table 7-5:
HEAT=High Explosive Anti-Tank

Table 7-2
Surface danger zone data for Javelin Block 1 missiles

Javelin Missile	Dist X (m)	Minimum Target Engagement (m)	Area A (m)	Area B (m)	Max ord AGL (m)
HEAT	6,000	500	500/200	500	660
Inert	6,000	500	200	500	660

Legend for Table 7-7:
HEAT=High Explosive Anti-Tank

Table 7-3
Surface danger zone data for Javelin FGM-148A, B, C, D High Explosive Anti-Tank (HEAT), Inert, FMG148E,F HEAT and Inert

Javelin Missile	Dist X (m)	Minimum Target Engagement Distance (m)	Variable Probability Of Escapement (POE) (deg)	Area A (m)	Area B (m)	Vertical Ricochet Hazard (m)
FGM-148A, B, C, D HEAT	4,300	600	41	600-500	500	660
FGM-148A, B, C, D Inert	4,300	600	41	600-500	200	660
FGM-148E HEAT	6,100	600	37	600-500	500	660
FGM-148E Inert	6,100	600	37	600-200	200	660
FGM-148F HEAT	6,000	600	36	600-225	225	660
FGM-148F Inert	6,000	600	36	600-100	100	660

Legend for Table 7-3:
HEAT=High Explosive Anti-Tank

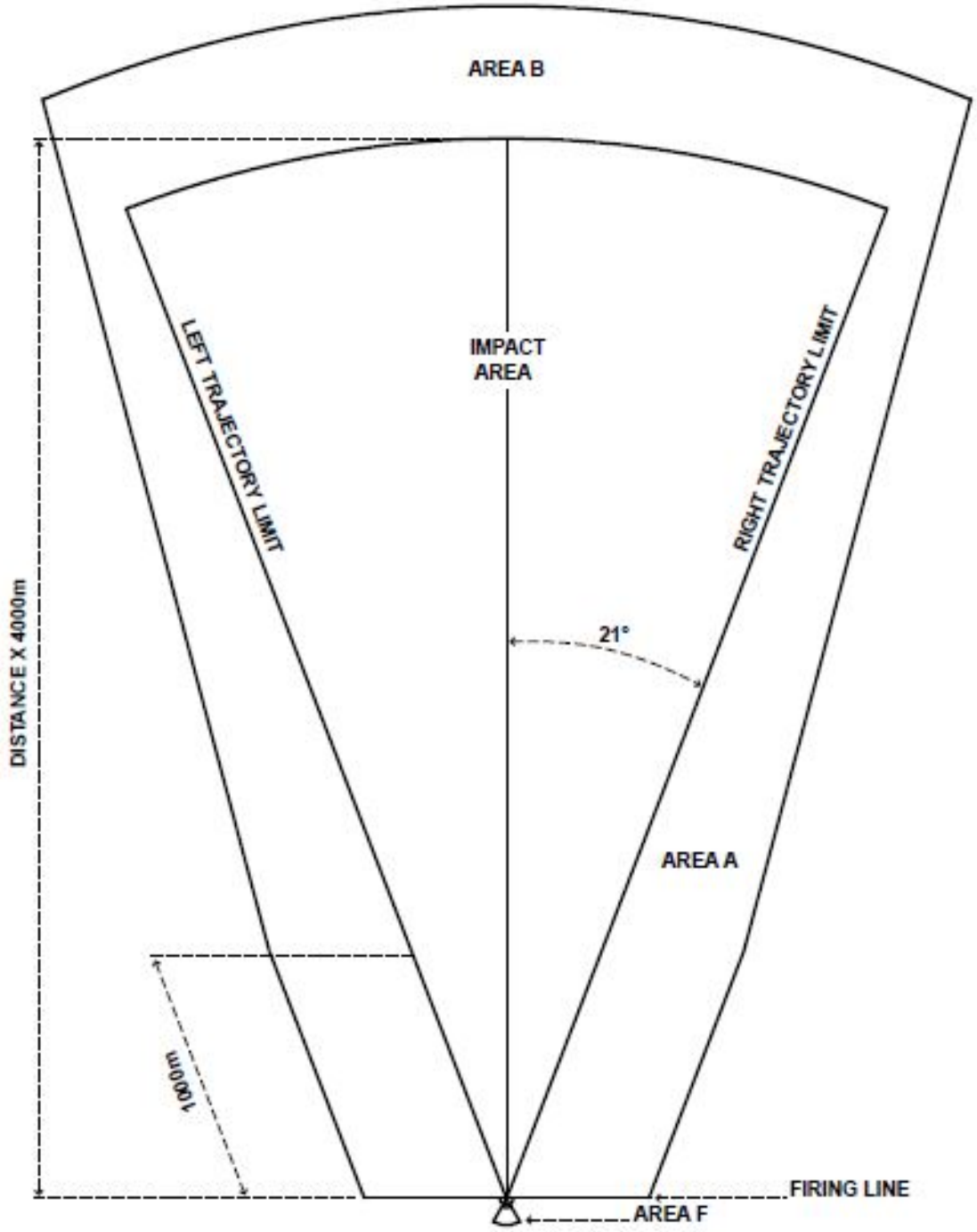


Figure 7–1. Surface danger zone for Javelin missiles

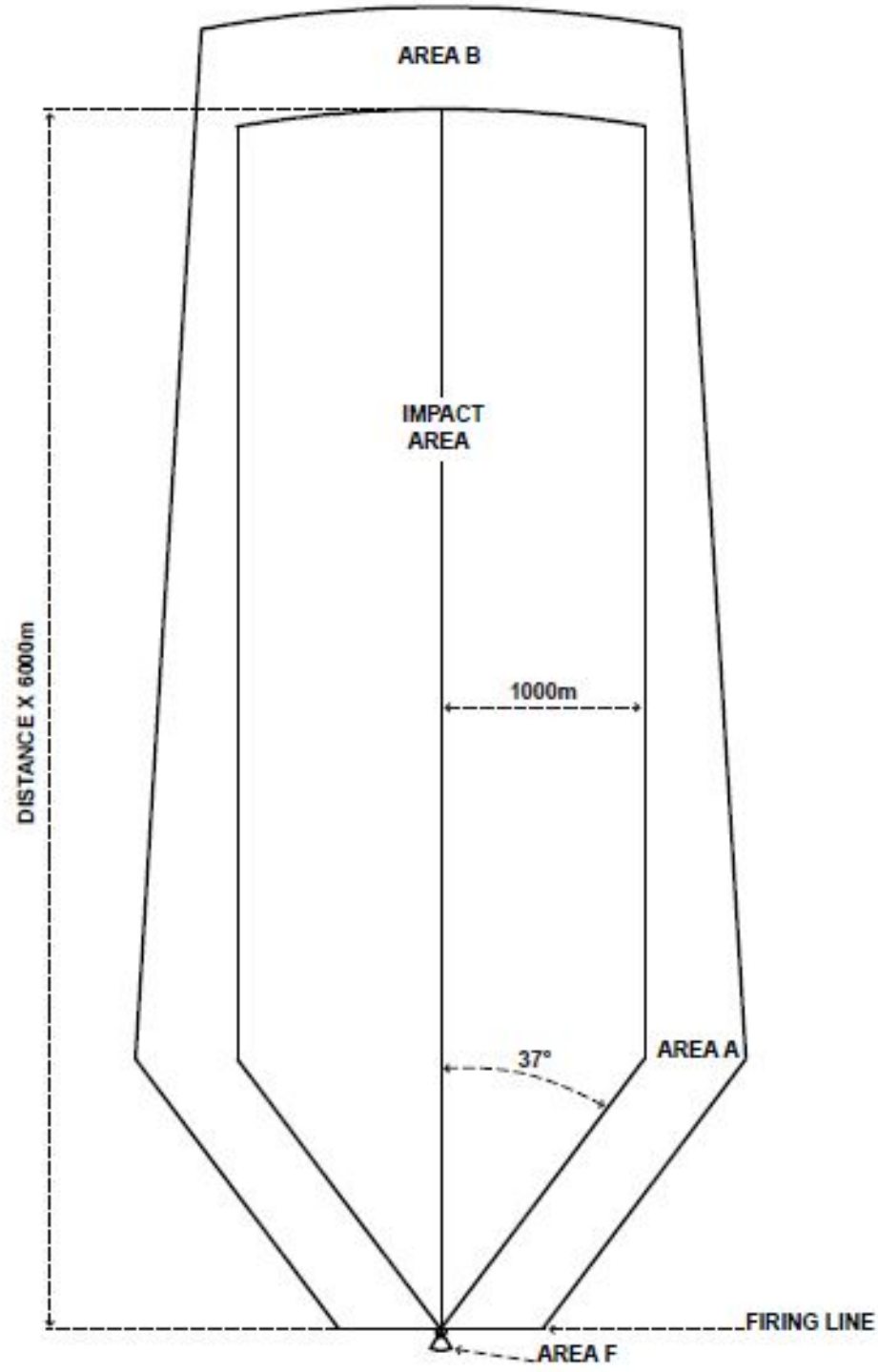


Figure 7–2. Surface danger zone for Javelin Block 1 missiles

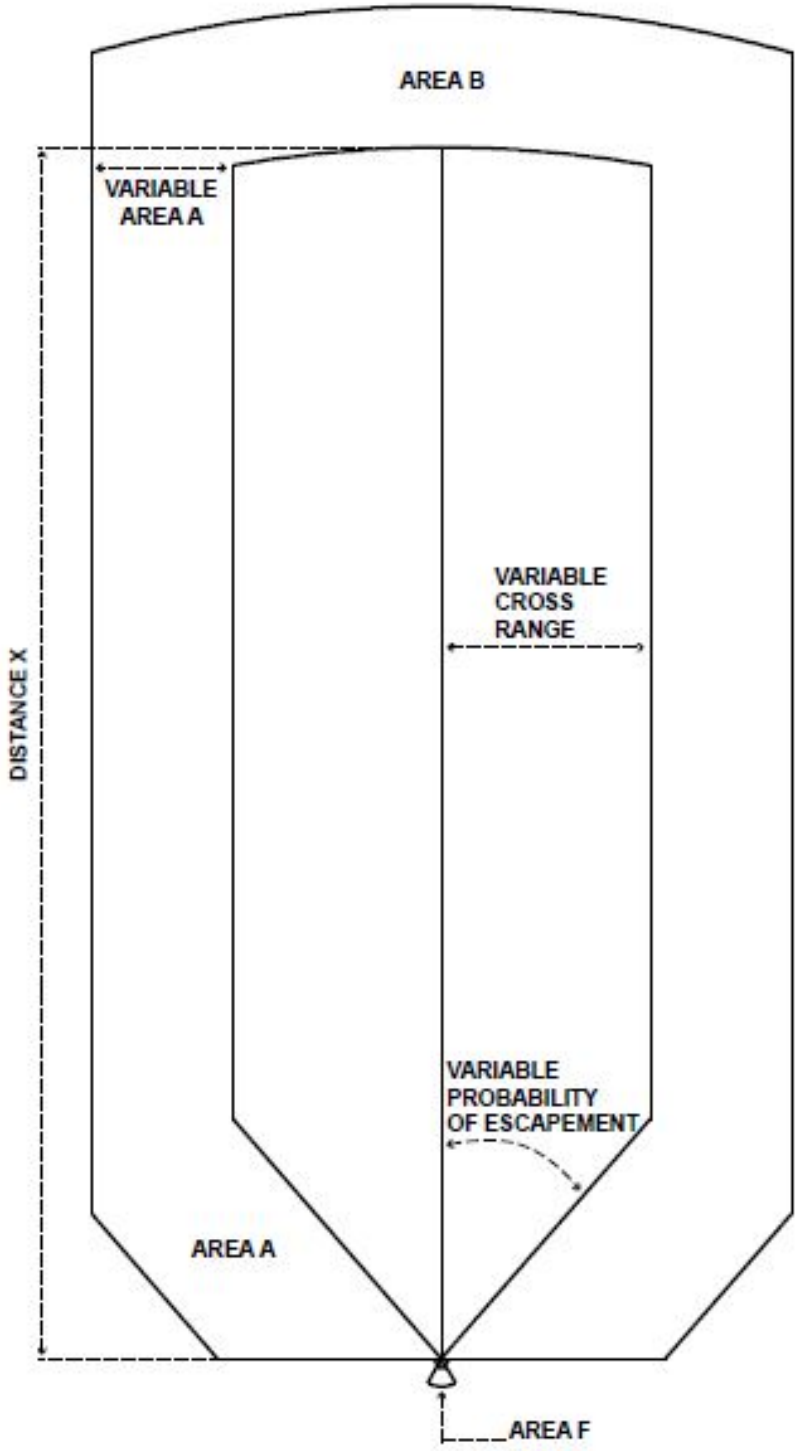


Figure 7–3. Surface danger zone for Javelin FGM-148A, B, C, D High Explosive Anti-Tank (HEAT), Inert, FMG148E HEAT, Inert, FMG 148F HEAT and Inert missiles

7–2. BGM–71 and BTM–71 series tube launched, optically-tracked, wire-guided (TOW) and wireless (TOW RF) missiles

a. Firing conditions.

(1) Before firing any TOW missile, the entire SDZ will be cleared of all non-mission-essential personnel. Essential range safety personnel such as road guards, gate guards, and/or range personnel conducting administrative duties, and so forth, shall be allowed within the SDZ at pre-established locations approved by the installation RMA (Army), RCO (Marine Corps).

(2) TOW missile firings must be accomplished within predetermined boundaries. The installation RMA (Army), RCO (Marine Corps) will ensure that an adequate SDZ exists along the missile target line (MTL) from each anticipated launch position within the predetermined boundaries.

(3) Procedures and precautions in appropriate FMs and TMs will be observed in all preparation and firing operations.

(4) Only those personnel actively engaged in firing and controlling TOW missiles as specified in appropriate FMs and TMs will be permitted in the SDZ. Participating personnel directly associated with but not actively engaged in the firing of TOW missiles may be located at protected sites within Area H, such as behind earthen berms.

(5) Personnel will neither stand nor permit any part of their body to be directly behind or in front of the TOW launcher while a missile is in the launch tube.

(6) TOW missiles should not be fired from any position which will permit the guidance wire to contact electrical power lines or the high power portion of electrically operated targetry. Commanders may deem it mission essential to fire at electrically powered targets where guidance wires may come in contact with the high powered portion of electrically-operated targets. However, the firing commander must first apply a thorough risk management process and have it approved by the installation RMA (Army), RCO (Marine Corps) prior to firing.

(7) For moving targets, TOW missiles should be launched within the left and right limits established by the movement of the target. Missile impact should be as near to the original missile-to-target-line as possible. Large deflection divergences during flight should be avoided.

(8) TOW missiles will not be fired from within buildings or within 100m of any vertical or nearly vertical backstop.

(9) The range will be inspected after TOW firing activities to ensure, to the maximum extent possible, that all guidance wires are removed from the training complex unless approval is granted from installation RMA (Army), RCO (Marine Corps) to abandon wires in place. Recovery of guidance wires will be made by ground personnel. Aircraft will not be used to remove guidance wires. The senior commander (Army)/installation commander (Marine Corps) will determine whether guidance wires will be recovered from dedicated and high hazard impact areas. Access to installation training complexes where command link guidance wires are used will be at the authorization of the installation RMA (Army), RCO (Marine Corps).

(10) Modification of Area I is not authorized. Occupation of Area I by unprotected personnel is prohibited.

(11) All missiles should be tested using the missile test set as part of the overall system pre-fire checks. This will identify the majority of missiles with a potential for operational failures.

(12) For the Marine Corps, participating personnel not in Area F but within a rectangle 100m to either side and 200m to the rear of the TOW firing point will wear a minimum of PPE Level 1, as referenced in table 2–2.

b. Surface danger zone.

(1) The SDZs for basic TOW, practice TOW, Improved TOW (ITOW), TOW 2, TOW 2A, TOW 2B, TOW 2B AERO and TOW 2BB (Bunker Buster) missiles firing at fixed and moving targets are described in figures 7–1 and 7-2 and tables 7-1 and 7-2.

(2) The SDZ for TOW Radio Frequency (RF) Family of Missiles, including TOW 2B Aero RF, TOW 2A RF, TOW 2A RF Practice Missile, and TOW Bunker Buster (BB) RF missiles firing at fixed and moving targets are described in figure 7-3 and tables 7-3 and 7-4.

(3) The SDZs are based on the maximum ballistic range for TOW RF variants since there is no provision for command destruct.

(4) Area F is the danger area extending to the rear of the launcher (see fig 7–3). For ground firings, Area F is divided into a primary danger area and two caution areas.

(a) The primary danger area is a 90 degree included angular cone (45 degree on each side of the rear of the bore axis with a radius of 50m) and with the apex of the cone centered at the rear of the missile launcher. Serious casualties or fatalities are likely to occur to any personnel in the primary danger area during firing. The hazards are launch motor blast, high noise levels, overpressure, and debris.

(b) Caution Area 1 is an area extending radially from each side of the primary danger area to the firing line with a radius of 50m. Permanent hearing damage could occur to personnel in this area during firing. Approved hearing protection will be worn by all personnel occupying this area. The hazards are high noise levels and overpressure.

(c) Caution Area 2 is an extension of the primary danger area with the same associated hazards and personnel protection required. The radius of this area is 75m.

(d) For the Army, at least single hearing protection will be worn by all personnel within the rectangle 100m to either side and 200m to the rear of the TOW firing point.

(5) Area H, a circular sector to the rear of the launch position, is established as an additional buffer zone to protect personnel from the hazards of high velocity fragments and missile debris resulting from detonation of the HE warhead during an "eject only" event (ballistic trajectory upon failure of the flight motor to ignite once the missile has exited the launcher). Each "eject only" event for TOW, Improved TOW, TOW 2, TOW 2A, TOW 2B AERO, and TOW BB is expected to produce about 100 fragments with a maximum range of 1,300m and one slug with a maximum range of 3,200m. The maximum fly-back range for TOW 2B is expected to be 1,000m, and one slug is expected to travel 1,600m. Modification of Area H is authorized by deviation. For the Army, Area H is not required for inert warheads or for HE warheads equipped with missile ordnance inhibit circuits identified by U.S. Army Aviation and Missile Command, as these circuits are designed to prevent "eject only" detonations. These missiles will encompass all Missile Ordnance Inhibit Circuit (MOIC), MOIC Enhancement (MOICE), Improved MOIC (IMOIC), and Digital MOIC (DMOIC) circuitry. For the Marine Corps, Area H is not required for any TOW missile equipped with MOIC.

(6) Area I is a circular sector immediately in front of the launcher position. It is constructed by drawing an arc between the left and right lateral limits of the impact area with a radius of 800m and centered at the launch position.

c. Surface Danger Zone adjustments.

(1) For ground-launched mode, if any point on the edge of the impact area is lower than the elevation of the launch position by more than 30m, extend the impact area at that point by 1m for every meter of drop in elevation greater than 30m. For example, if a point of the SDZ at the edge of the impact area is 65m below the launch position, extend only that portion of the impact area 35m (65m-30m=35m) parallel with the edge of the impact area. For an illustration, see figure 7–4.

(2) When engaging moving or multiple targets, bisect figure 7–1 longitudinally and expand the MTL to accommodate the target array. This will establish the left and right limits of fire.

Table 7-4
Surface danger zone data for Tube-launched Optically-tracked Wire-guided (TOW) missiles

DODIC	Marine Corps/ Army inventory asset	Warhead flight motor safety device	Dist X (m)	Dist D (m)	Area A (m)	Area B (m)	Area H (m)	Max ord AGL (m)
Basic TOW Practice (3,750 m)								
PB99	MC	MOIC	5,000	3,800	100	100	NR	1,832
Basic TOW HEAT (3,750m)								
WF10	MC	IMOIC	5,000	3,800	750	750	NR	1,832
TOW 2 Practice (3,750 m)								
PV02	A		5,000	3,800	100	100	NR	1,832
WH06	MC	IMOIC	5,000	3,800	100	100	NR	1,832
TOW 2A HEAT (3,750 m)								
PD62	A/MC		5,000	3,800	750	750	3,200[1]	1,832
PE96	A/MC		5,000	3,800	750	750	3,200[1]	1,832
WH03	MC	IMOIC	5,000	3,800	750	750	NR	1,832
PV47	A/MC		5,000	3,800	750	750	3,200[1]	1,832
PV83	A		5,000	3,800	750	750	3,200[1]	1,832
PU16	MC		5,000	3,800	750	750	3,200[1]	1,832
PU08	MC		5,000	3,800	750	750	3,200[1]	1,832
WH04	A	IMOIC	5,000	3,800	750	750	NR	1,832
TOW 2A Practice (3,750 m)								
WH05	MC	IMOIC	5,000	3,800	100	100	NR	1,832
PU09	MC		5,000	3,800	100	100	NR	1,832
PV84	A		5,000	3,800	100	100	NR	1,832

TOW BB (Bunker Buster) (3,750 m)								
WH82	A		5,000	3,800	750	750	3,200[1]	1,832
WH50	A/MC		5,000	3,800	750	750	3,200[1]	1,832
TOW 2B HEAT (3,750 m)								
PV18	A/MC		4,400	3,400	600	600	1,600[1]	1.773
PV82	A/MC		4,400	3,400	600	600	1,600[1]	1.773
WF37	A		4,400	3,400	600	600	1,600[1]	1.773
TOW 2B AERO HEAT (4,500 m)								
WF93	A		5,100	3,950	600	600	1,600[1]	1,773
WF94	A		5,100	3,950	600	600	1,600[1]	1,773
WF95	A		5,100	3,950	600	600	1,600[1]	1,773
WG02	A/MC		5,100	3,950	600	600	1,600[1]	1,773

Legend for Table 7-4:
A=Army
DODIC=Department of Defense Identification Code
HEAT= High Explosive Anti-Tank
MC=Marine Corps
MOIC=Missile Ordnance Inhibit Circuit
IMOIC=Improved Missile Ordnance Inhibit Circuit
N/R=Not Required
Notes:
[1] Area H not required for USMC

Table 7-5
Surface danger zone data for Tube launched Optically-tracked Wireless Radio Frequency (TOW-RF) missiles

DODIC	Marine Corps/ Army inventory asset	Warhead flight motor safety device	Dist X (m)	Area A (m)	Area B (m)	Max ord AGL (m)
TOW 2A RF HEAT						
WH54	A	RFMOIC	6,700	750	750	1,855
TOW 2A RF Practice						
WH56	A	RFMOIC	6,700	100	100	1,832
TOW BB (Bunker Buster) RF						
WH51	A/MC	RFMOIC	6,700	750	750	1,888
TOW 2B AERO RF HEAT						
WH53	A/MC	RFMOIC	6,700	600	600	1,773
WJ53	A/MC	RFMOIC	6,700	600	600	1,773
WH52	A	RFMOIC	6,700	600	600	1,773

Legend for Table 7-5:
A=Army
DODIC=Department of Defense Identification Code
MC=Marine Corps
HEAT= High Explosive Anti-Tank
RFMOIC= Radio Frequency Missile Ordnance Inhibit Circuit

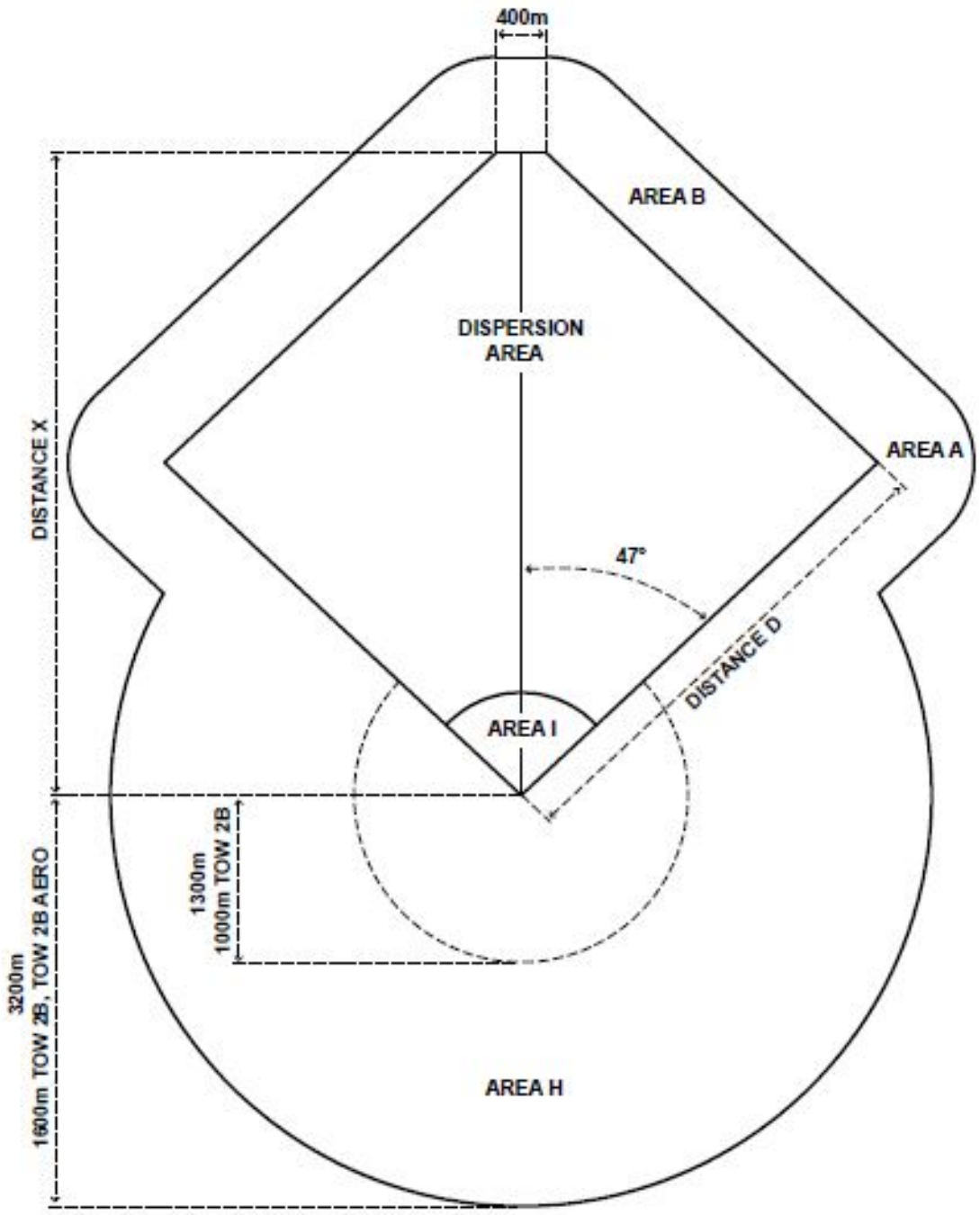


Figure 7–6. Surface danger zone for Tube launched Optically-tracked Wire-guided (TOW) missiles with area H Army

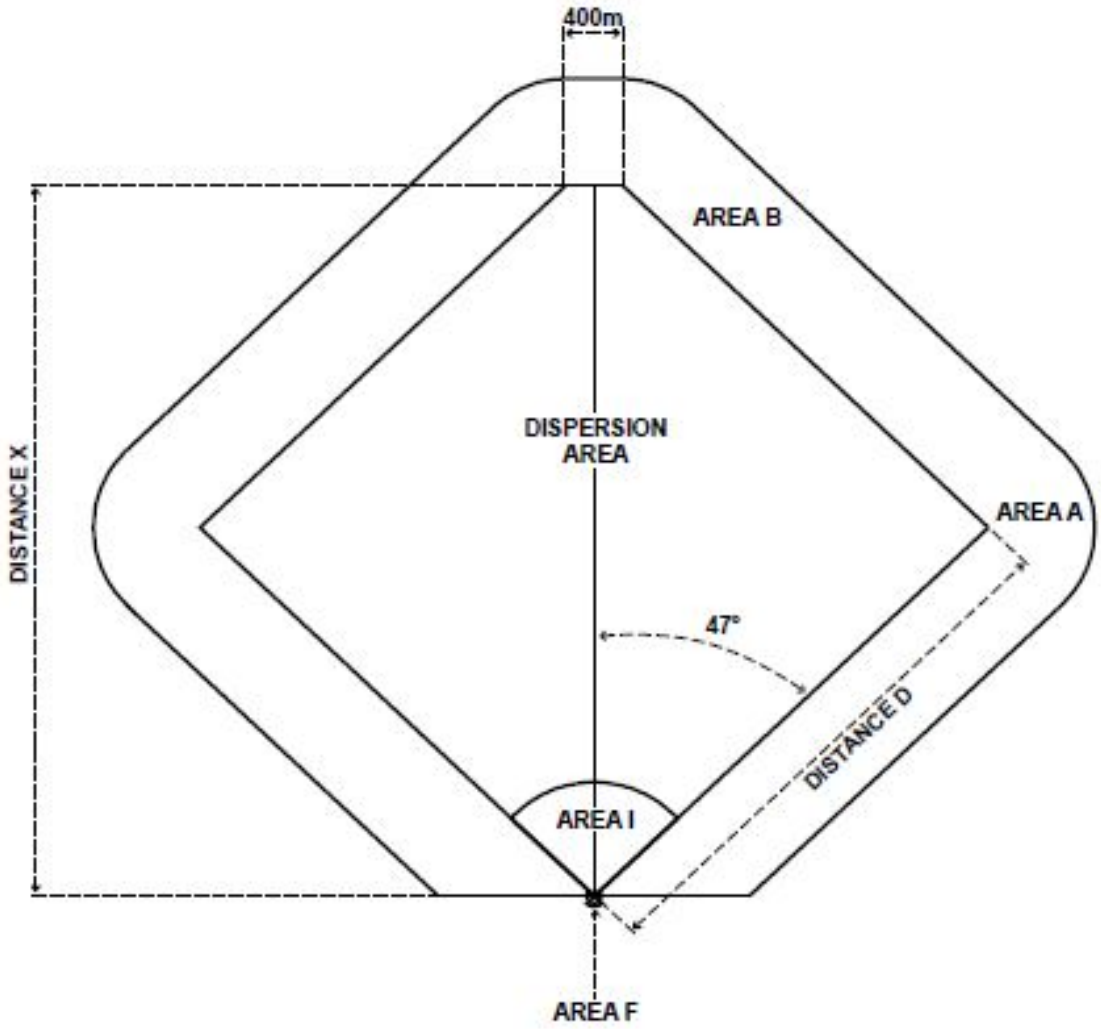


Figure 7–7. Surface danger zone for Tube launched Optically-tracked Wire-guided (TOW) missiles without area H USMC

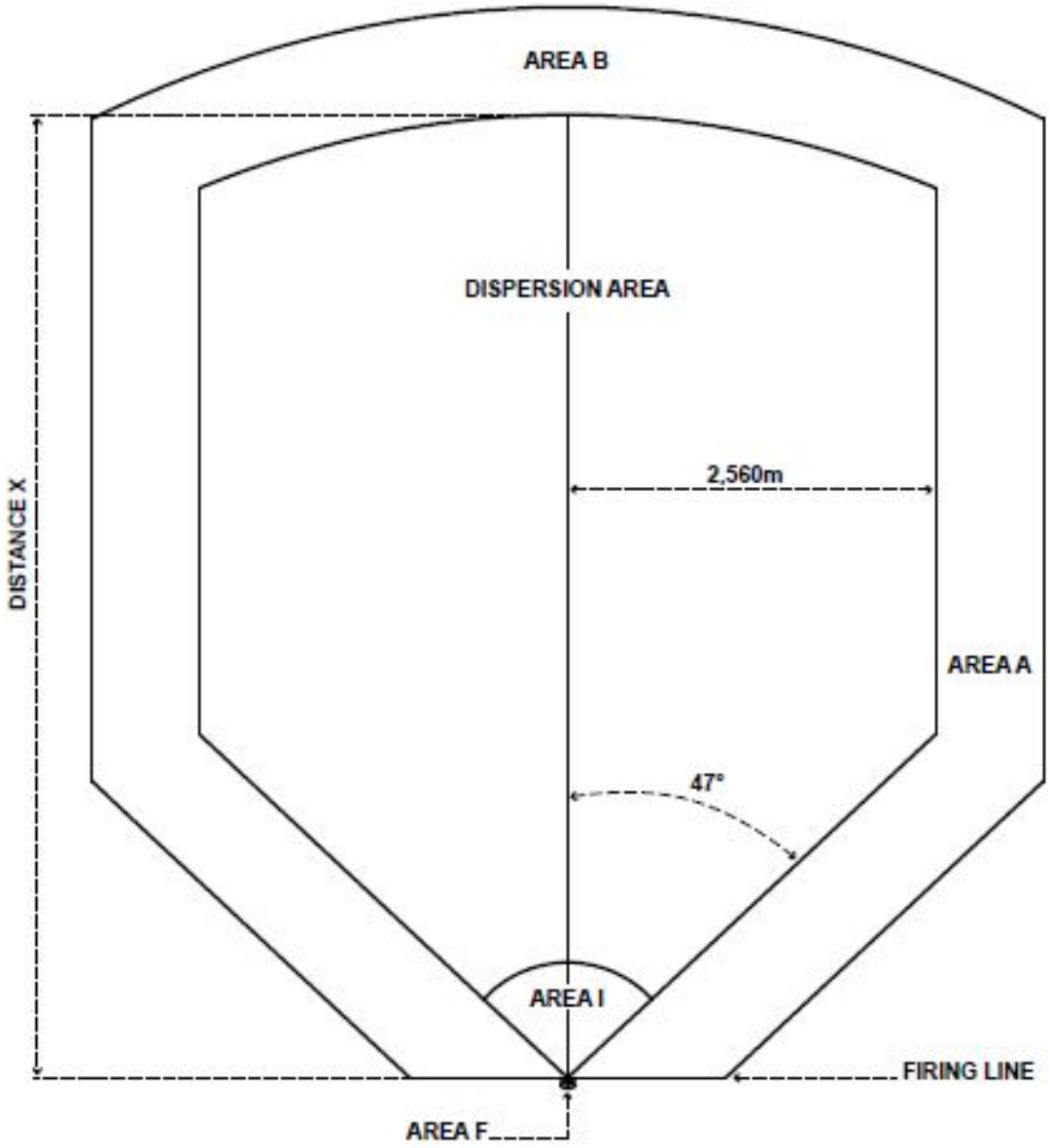


Figure 7–8. Surface danger zone for Tube launched Optically-tracked Wireless Radio Frequency (TOW-RF) missiles

d. Multiple integrated laser engagement system training. The TOW missile uses the anti-tank weapons effect signature simulator (ATWESS) device for a noise simulator. Use the SDZ in figure 7–6 to determine safe limits of use. ATWESS devices must never be armed until ready to fire. A severe jolt to the ATWESS may cause the device to function. Approved single hearing protection is required.

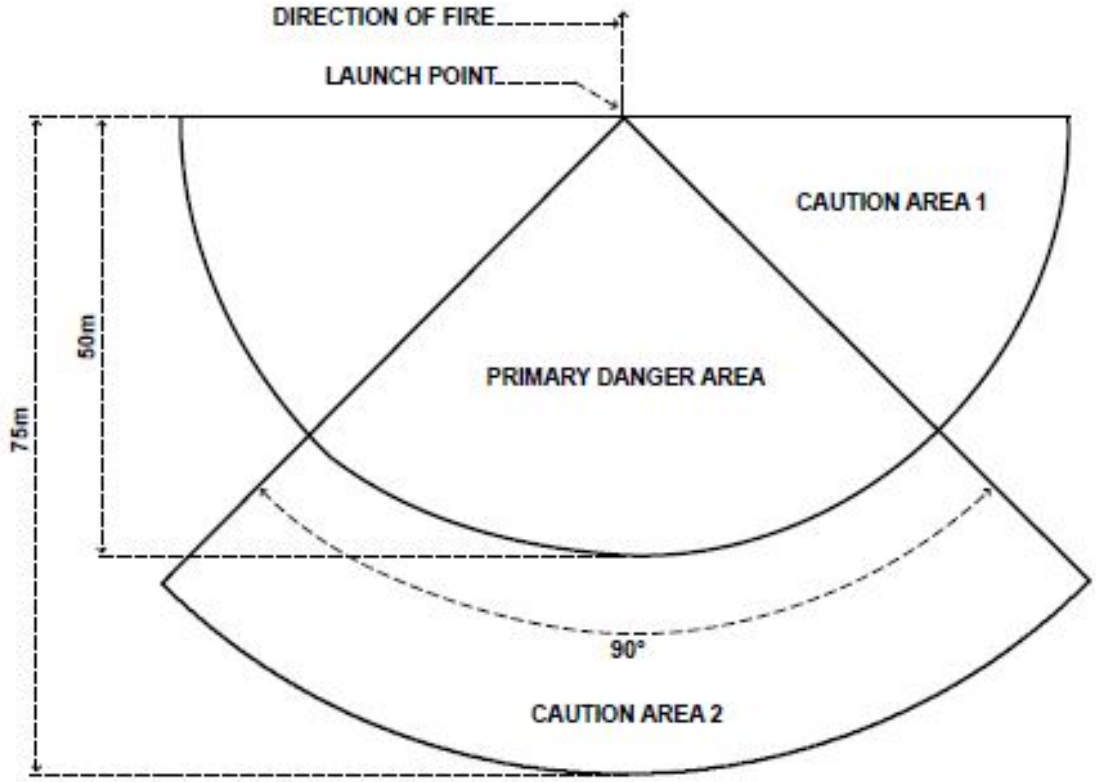


Figure 7–9. Surface danger zone, Area F, for Tube launched Optically-tracked Wire-guided (TOW) and Tube launched Optically-tracked Wireless Radio Frequency (TOW-RF) missiles

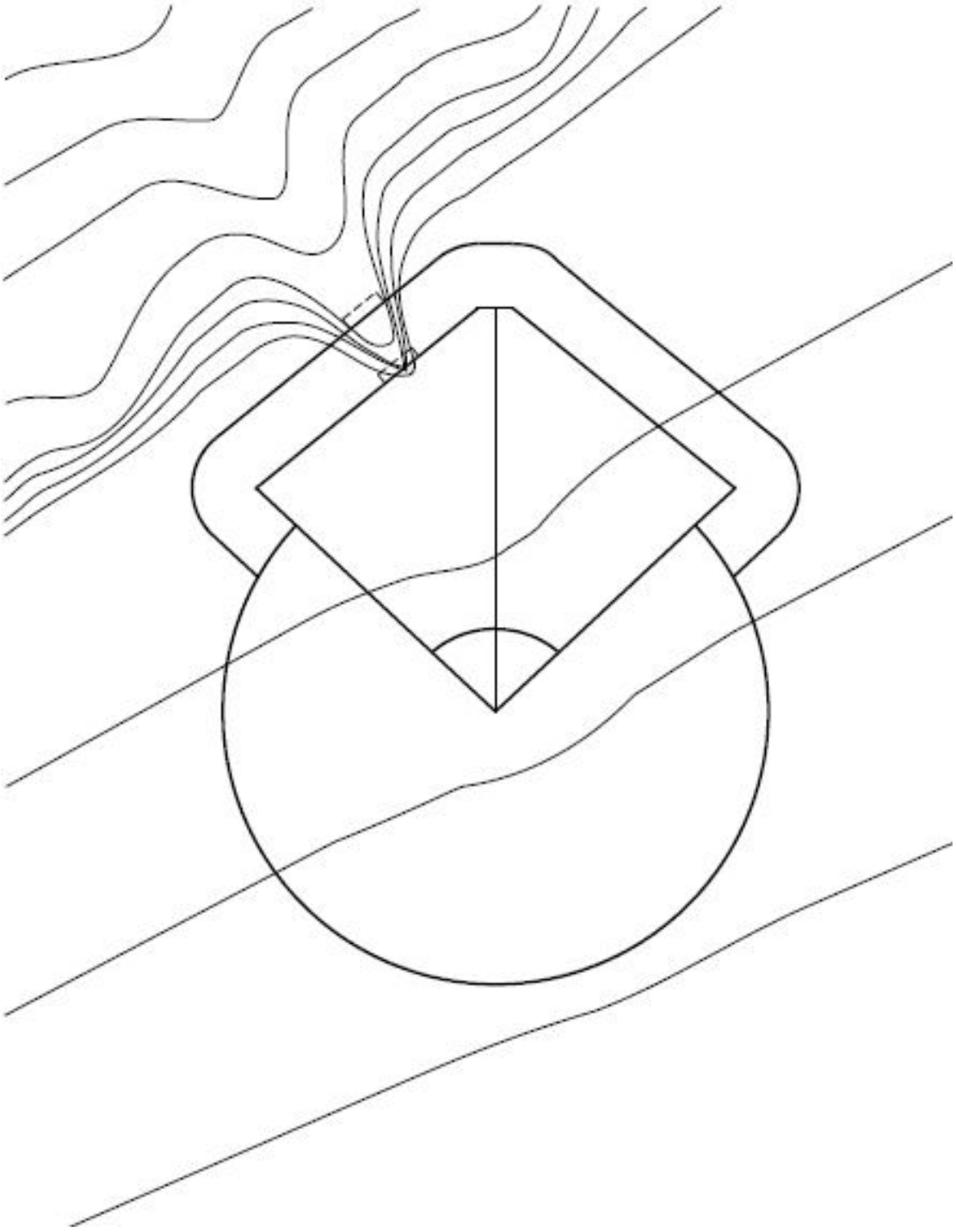


Figure 7–10. Surface danger zone adjustments for firing Tube launched Optically-tracked Wire-guided (TOW) and Tube launched Optically-tracked Wireless Radio Frequency (TOW-RF) missiles

Chapter 8
Tank/Fighting Vehicle Gunnery

8–1. Tank/fighting vehicle firing conditions

a. Tank/fighting vehicle weapon system will not be fired above 5 degrees (89 mils) quadrant elevation (QE) from the firing position to the target (unless otherwise stated in this pamphlet). The following procedures will be employed.

(1) Unit master gunners, in conjunction with range operations (Army), range control (Marine Corps) personnel, will ensure that targets are placed at or less than 5 degrees QE. Tank commanders will ensure that all weapon systems in a firing condition are pointed toward the impact area at or less than 5 degrees QE.

(2) Non-stabilized tank armament will not be fired while the tank/fighting vehicle is moving. This does not include machine guns.

b. When firing ranges and weapons training facilities with less than the prescribed safety limits must be used, existing compensatory terrain features and offsetting control measures will be thoroughly evaluated. An approved deviation is required before firing on reduced SDZs.

c. Hard or soft targetry may be used.

d. Cross-range firing of weapon systems from firing positions at targets or target arrays on the opposite side of the range is permitted if the SDZ falls within allowable limits, and the risk of damage to target systems has been accepted by the RMA (Army), RCO (Marine Corps). Limits of fire, combined dispersion, ricochet areas, and Areas A and B (when required), must be adjusted to compensate for and accommodate such cross-range firing. On ranges that do not permit cross-range firing, internal (inside the range area) left and right limit of fire markers, with both visual and thermal signature, will be used in addition to the left and right external range limit markers.

e. Environmental containment materials (spill kits) shall be available on all mounted ranges, during all refuel operations, and whenever the vehicles involved in the training event are on the range.

8–2. Surface danger zones

Tank/fighting vehicle SDZs for direct fire at fixed or moving ground targets from stationary or moving firing positions are as follows:

a. The dispersion area for tank/fighting vehicle SDZs is 2 degrees with a stabilized weapon system. The dispersion area for tank/fighting vehicle SDZs utilizing non-stabilized weapon systems is 5 degrees.

b. Areas A and B are not required when firing inert/non HE projectiles at soft targets, except spotting charges or frangible projectiles which may eject a hazardous fragment.

c. When engaging armor targets, use the impact media that has the greater value due to the possibility of missing the target.

d. For fighting vehicles the Distance X (maximum range) may be reduced to ricochet range when engaging ground targets at ranges up to 3,500m from stationary firing positions.

e. For fighting vehicles, when firing from a moving vehicle over level terrain at ground targets up to 3,500m, use the 15 degrees QE range, when firing on the move over rough terrain, use Distance X.

f. For fighting vehicles, when firing at aerial targets and the gun elevation is greater than 15 degrees QE, the ricochet area, as defined by Distance W and Angle P, is not required.

g. SDZ requirements for firing port weapon systems are provided in chapter 4 (small arms criteria) and figure 8–5. Firing port weapon systems may be fired selectively or as part of a course provided:

(1) Sufficient terrain is available to accommodate the weapon system's SDZ fired at its extreme elevation and limits of traverse.

(2) An established impact area exists with targets or target arrays.

h. The SDZ data for M1040 105mm and M1028 120mm anti-personnel (APERS) canisters covered in table 8–1 and figure 8–1. SDZ data for M494 105mm APERS–T is covered in table 8–1 and figure 8–1. The flechette dispersion pattern for the M494 is covered in figure 8–3.

i. A deviation is required for standard non-petal producing munitions and requires a separate risk assessment tied to an event.

j. For sabot munitions, no personnel will be allowed within the SDZ.

k. For select tank cannon cartridges use tables 8–1 through 8–3 and figure 8–1.

Table 8-1
Surface danger zone data for select tank cannon cartridges

Ammunition	Impact Media	Dist X (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Ricochet Vertical Hazard (m)
105mm							
M393A1 TP–T	Earth	5,474	1,225	NR	NR	24	1,090
	Steel	5,474	1,125	NR	NR	24	1,090
M393A1/2 HEP–T	Earth	5,474	1,225	615	615	24	1,090
	Steel	5,474	1,125	615	615	24	1,090
M393A3 HEP–T	Earth	8,175	1,225	300	300	24	962
	Steel	7,600	1,125	300	300	20	1,090
M456 HEAT–T	Earth	6,436	1,080	615	615	17	See note 1
	Steel	6,436	600	615	615	12	See note 1
M467A1 TP–T	Earth	8,175	1,225	NR	NR	24	962
	Steel	7,600	1,125	NR	NR	20	1,090
M490 TP–T	Earth	6,445	1,080	NR	NR	17	See note 1
	Steel	6,445	600	NR	NR	12	See note 1
M494 APERS-T	Earth	4,400	550	NR	NR	40	415
	Steel	4,400	850	NR	NR	50	820
M724 TPDS–T	Earth	11,343	1,110	NR	NR	13	See note 1
	Steel	11,343	1,900	NR	NR	11	See note 1
M724A1E1 TPDS-T	Earth	7,234	450	NR	NR	12	See note 1
	Steel	7,234	1,400	NR	NR	16	See Note 1
M735 APFSDS–T	Earth	22,846	1,100	NR	NR	14	See note 1
	Steel	22,846	1,400	NR	NR	16	See note 1
M1040 Canister	Earth	1,300	550	NR	NR	40	415
	Steel	1,300	850	NR	NR	50	820
120mm							
M830 HEAT–MP–T	Earth	6,589	1,080	1,125	1,125	17	See note 1
	Steel	6,589	600	1,125	1,125	12	See note 1
M830A1 HEAT-MP-T	Earth	10,069	1,239	1,377	1,377	22	See note 1
	Steel	10,069	1,061	1,377	1,377	20	See note 1
M831 TP–T	Earth	6,589	1,080	NR	NR	17	See note 1
	Steel	6,589	600	NR	NR	12	See note 1
M865 TPCSDS–T	Earth	7,234	450	NR	NR	12	See note 1
	Steel	7,234	1,400	NR	NR	16	See note
M908 HE–OR–T	Earth	10,069	1,239	1,377	1,377	22	See note 1
	Steel	10,069	1,061	1,377	1,377	20	See note 1
M1028 Canister	Earth	1,650	550	NR	NR	30	550
	Steel	1,650	850	NR	NR	55	1,050

Legend for Table 8-1:
APFSDS–T=Armor Piercing, Fin-Stabilized Discarding Sabot-Tracer
HE=High Explosive
HEAT=High-Explosive Anti-Tank
HEP=High-Explosive Plastic
HEP-T=High-Explosive Plastic-Tracer
MP=Multi-Purpose
NR=Not Required
OR=Obstacle Reduction
T=Tracer
TP–T=Target Practice-Tracer
TPDS–T=Target Practice Discarding Sabot-Tracer
TPCSDS–T=Target Practice, Cone-Stabilized Discarding Sabot-Tracer
Notes:
[1] Use the sum of the values of Distance W and Area A (if applicable) until validated test data is available.

Table 8-2
Surface danger zone data for 120mm M1002 Target Practice Multi-Purpose Tracer (TPMP-T)[1]

Altitude (ft)	Impact Media	Dist X (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Ricochet Vertical Hazard (m)
0	Earth	7,200	975	NR	NR	30	1,252
	Steel	7,200	550	NR	NR	22	816
1000	Earth	7,425	1,010	NR	NR	30	1,288
	Steel	7,425	575	NR	NR	22	842
2000	Earth	7,650	1,045	NR	NR	30	1,325
	Steel	7,650	600	NR	NR	22	868
3000	Earth	7,875	1,080	NR	NR	30	1,363
	Steel	7,875	625	NR	NR	22	869
4000	Earth	8,100	1,115	NR	NR	30	1,402
	Steel	8,100	650	NR	NR	22	924
5000	Earth	8,325	1,150	NR	NR	30	1,444
	Steel	8,325	675	NR	NR	22	954
6000	Earth	8,550	1,185	NR	NR	30	1,486
	Steel	8,550	700	NR	NR	22	985
7000	Earth	8,775	1,220	NR	NR	30	1,530
	Steel	8,775	725	NR	NR	22	1,017

Legend for Table 8-2:
NR=Not Required
Notes:
[1] To correct for cross wind, dispersion angle is increased by 0.15 degree per m/s or 0.075 degree per knot.

Table 8–3
Surface danger zone data for 105mm and 120mm sabot petal discard area[1]

Ammunition	Dist X (m)	Dist y (m)	Dist W (m)	Area R width (m)	Area R depth (m)
M829A4	795	100	385	400	NR
M865 TPCSDS–T M724A1E1 TPDS-T	1,300	200	300	140	NR
M1002 MPAT–TP–T	750	75	250	140	NR

Legend for table 8-3:
TPCSDS–T=Target Practice, Cone-Stabilized Discarding Sabot-Tracer
TPDS-T= Target Practice Discarding Sabot- Tracer
MPAT-TP-T= Multi-Purpose Anti-Tank Target Practice-Tracer
NR=Not Required
Notes:
[1] SDZ holds for constant winds up to 12.5 m/s or 25 knots.

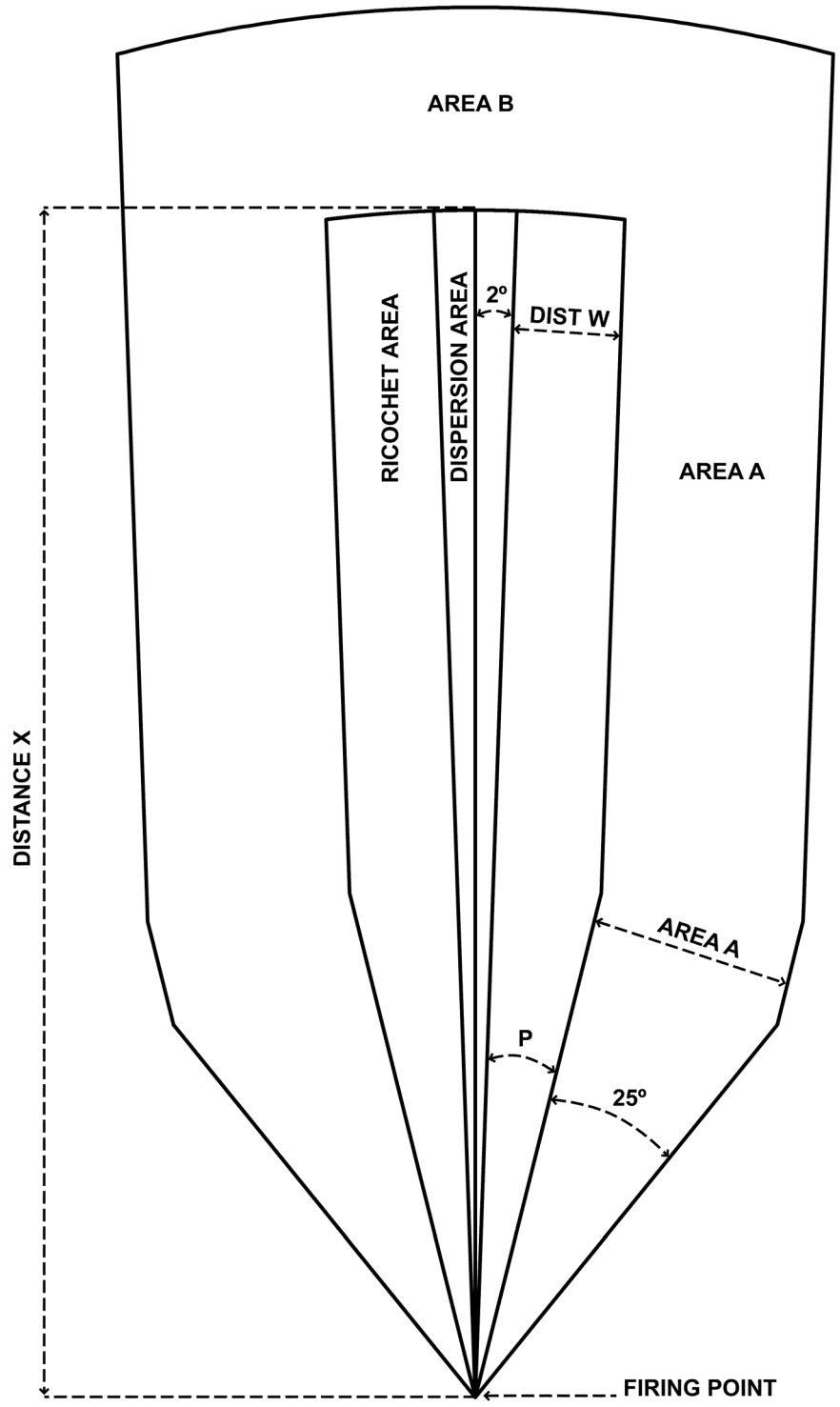


Figure 8–1. Surface danger zone for Select tank cannon cartridges

l. For cartridges M829A4, M865, and M1002 sabot discard hazard, use table 8–3 and figure 8–2.

Table 8–4
Surface danger zone data for 35mm M968 tank precision gunnery inbore device cartridge corresponding to target ranges

Target range (m)	Impact Media	Dist X (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Ricochet Vertical Hazard (m)
100	Earth	5,799	1,786	NR	NR	27	642
	Water	5,722	1,559	NR	NR	30	642
	Concrete	6,051	2,023	NR	NR	37	974
	Steel	5,750	2,301	NR	NR	42	1,133
500	Earth	5,902	1,844	NR	NR	24	622
	Water	5,944	1,528	NR	NR	22	605
	Concrete	6,261	2,068	NR	NR	30	916
	Steel	6,991	2,078	NR	NR	35	1,068
1,000	Earth	6,150	1,752	NR	NR	20	565
	Water	6,195	1,495	NR	NR	20	557
	Concrete	6,797	1,961	NR	NR	27	840
	Steel	6,230	2,191	NR	NR	29	980
1,500	Earth	6,752	1,225	NR	NR	17	505
	Water	6,771	1,487	NR	NR	17	504
	Concrete	6,476	1,180	NR	NR	26	760
	Steel	7,237	2,245	NR	NR	26	876
2,000	Earth	6,995	1,165	NR	NR	14	444
	Water	6,889	1,458	NR	NR	15	437
	Concrete	6,613	1,649	NR	NR	20	671
	Steel	6,776	2,067	NR	NR	23	775
2,500	Earth	7,005	1,211	NR	NR	13	354
	Water	6,934	1,393	NR	NR	13	362
	Concrete	7,144	1,548	NR	NR	17	546
	Steel	7,557	1,735	NR	NR	19	670
3,000	Earth	7,914	1,020	NR	NR	10	279
	Water	7,633	1,268	NR	NR	11	273
	Concrete	7,530	1,298	NR	NR	14	442
	Steel	7,453	1,732	NR	NR	17	527
3,500	Earth	7,713	980	NR	NR	10	193
	Water	8,114	847	NR	NR	9	188
	Concrete	7,816	1,190	NR	NR	11	318
	Steel	7,779	1,600	NR	NR	14	384
4,000	Earth	7,752	748	NR	NR	8	165
	Water	7,380	591	NR	NR	6	162
	Concrete	8,864	1,100	NR	NR	11	217
	Steel	8,190	1,101	NR	NR	10	272
4,500	Earth	7,365	658	NR	NR	6	132
	Water	7,360	495	NR	NR	5	130
	Concrete	8,327	883	NR	NR	8	160
	Steel	8,585	1,126	NR	NR	10	197
5,000	Earth	7,590	434	NR	NR	6	130
	Water	8,299	328	NR	NR	3	98
	Concrete	8,096	670	NR	NR	6	139
	Steel	9,076	995	NR	NR	8	150
5,500	Earth	7,745	307	NR	NR	3	188
	Water	7,047	166	NR	NR	2	51
	Concrete	8,238	751	NR	NR	6	188
	Steel	8,620	629	NR	NR	7	188
6,000	Earth	7,257	68	NR	NR	1	262
	Water	7,027	70	NR	NR	1	29
	Concrete	8,243	405	NR	NR	4	262
	Steel	8,556	622	NR	NR	5	262

Legend for Table 8-4:
NR=Not Required

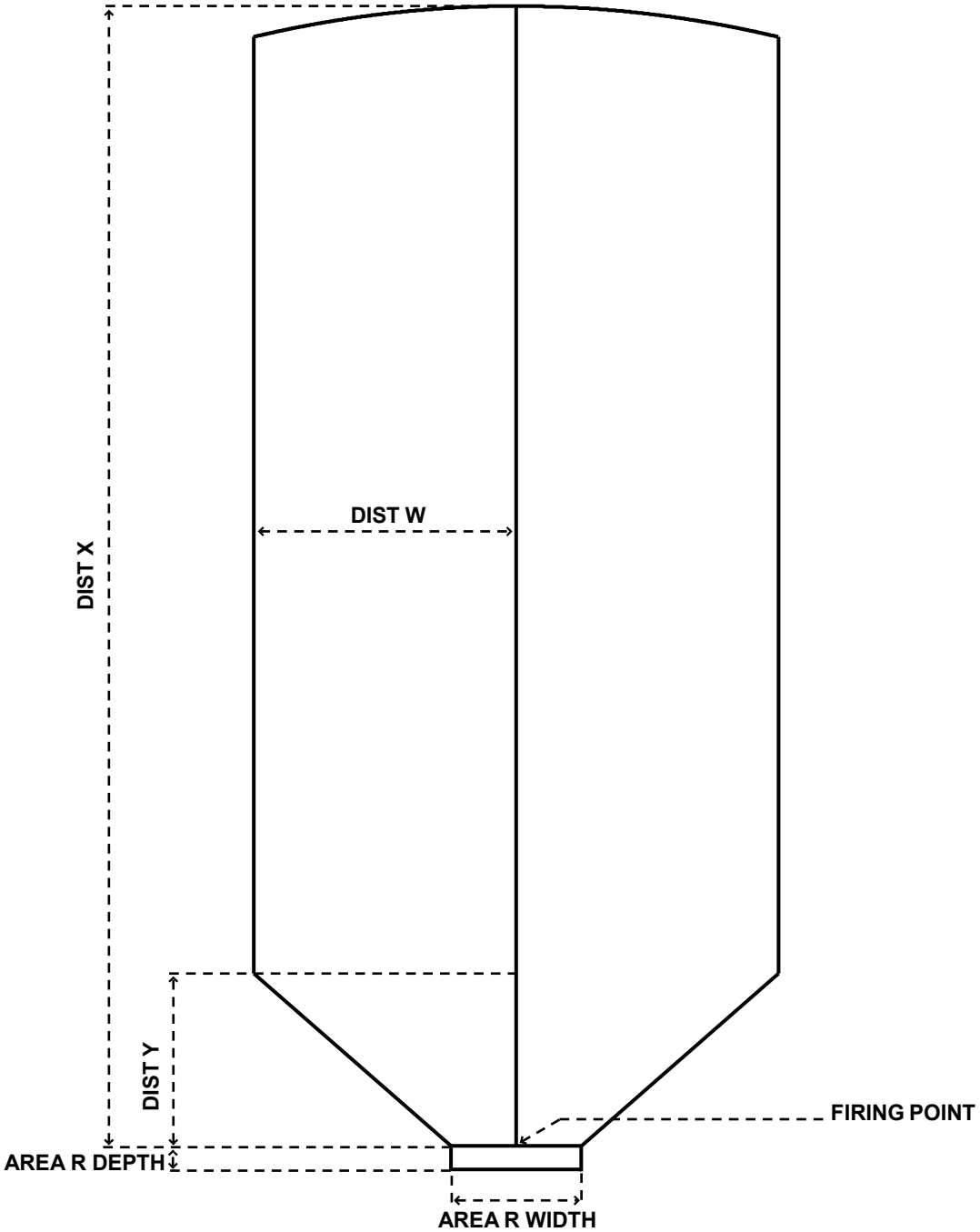


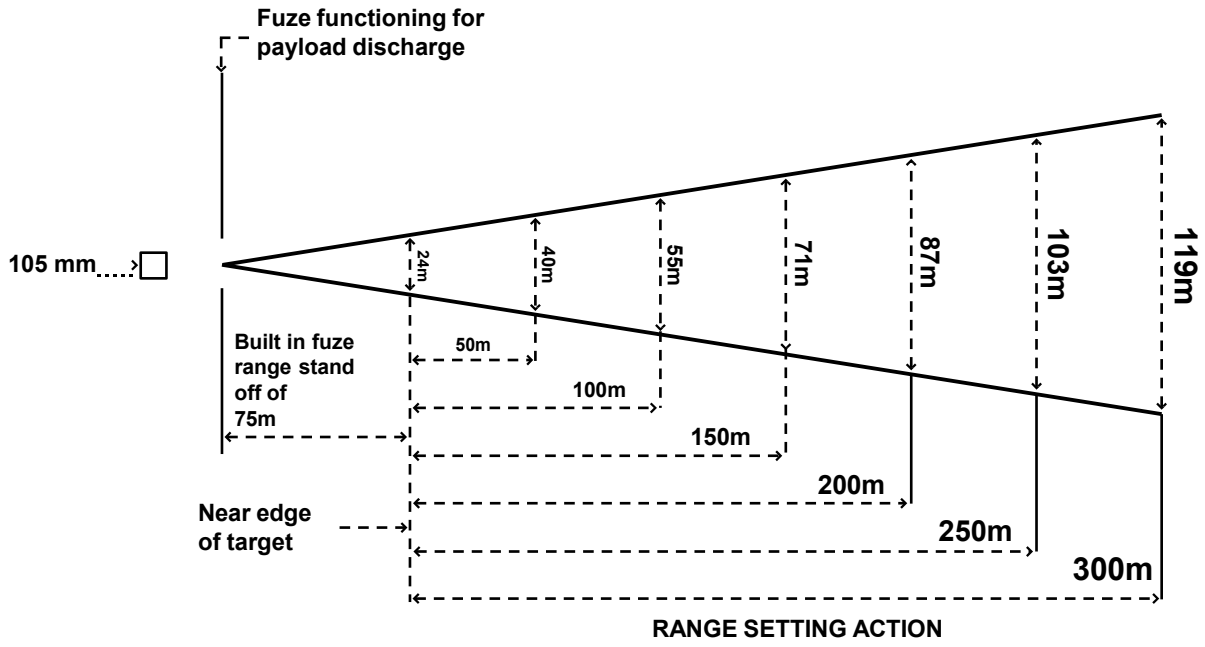
Figure 8–2. Surface danger zone for M865 and M1002 sabot peddle discard area

m. For cartridge M968, 35mm tank/fighting vehicle precision gunnery inbore device, use table 8–5 and figure 8–1.

Table 8–5
Surface danger zone data for 25mm weapons

Ammunition	Impact Media	Dist X (m)	Dist W (m)	Ricochet Range (m)	15 Degree Elevation Range (m)	Angle P (deg)	Ricochet Vertical Hazard (m)
M791 APDS–T	Earth	14,572	1,466	7,402	11,561	18	See note 1
	Water	14,572	263	5,665	11,561	6	See note 1
	Concrete	14,572	2,208	7,622	11,561	34	See note 1
	Steel	14,572	1,510	7,294	11,561	24	See note 1
M792 HEI–T	Earth	6,379	908	4,792	5,249	19	See note 1
	Water	6,379	1,047	4,823	5,249	19	See note 1
	Concrete	6,379	1,290	5,071	5,249	27	See note 1
	Steel	6,379	1,373	5,265	5,249	28	See note 1
M793 TP–T	Earth	6,047	908	4,792	5,114	19	See note 1
	Water	6,047	1,047	4,823	5,114	19	See note 1
	Concrete	6,047	1,290	5,071	5,114	27	See note 1
	Steel	6,047	1,373	5,265	5,114	28	See note 1
M910 TPDS–T	Earth	6,404	734	4,592	5,868	15	See note 1
	Water	6,404	148	3,724	5,868	4	See note 1
	Concrete	6,404	1,143	4,643	5,868	27	See note 1
	Steel	6,404	799	4,472	5,868	20	See note 1

Legend for Table 8-5:
APDS-T=Armor Piercing, Discarding Sabot-Tracer
APFSDS–T=Armor Piercing, Fin-Stabilized Discarding Sabot-Tracer
HEI–T=High Explosive Incendiary-Tracer
NR=Not Required
TP–T=Target Practice-Tracer
TPDS–T=Target Practice, Discarding Sabot-Tracer
Notes:
[1] Use the sum of values of Distance W and Area A (if applicable) until validated test data is available.



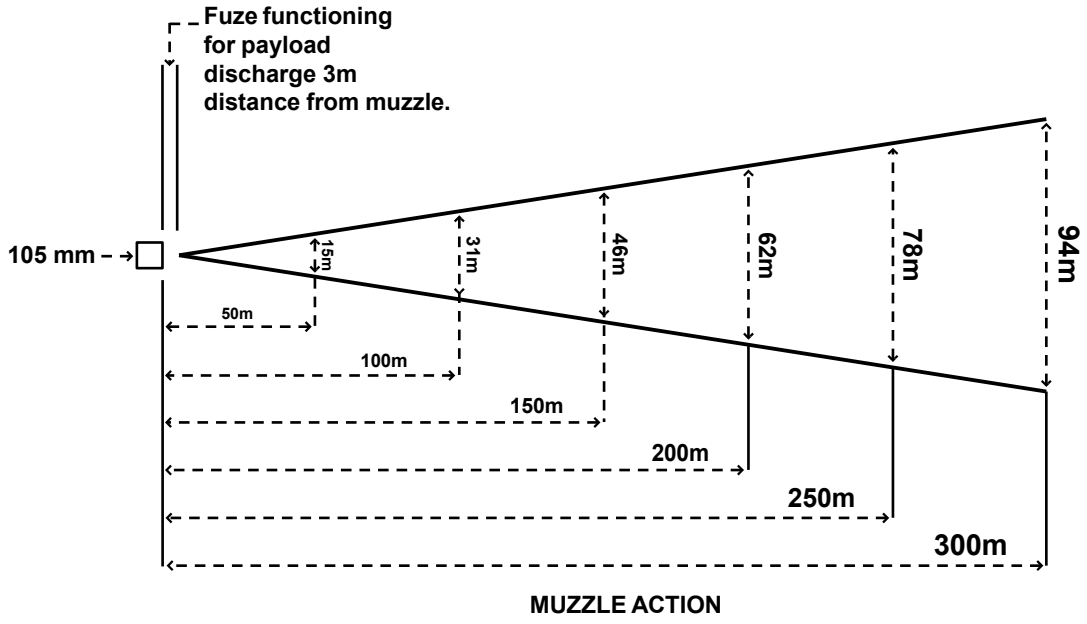


Figure 8–3. Flechette dispersion pattern for 105mm M494 Anti-Personnel-Tracer (APERS-T)

8–3. Fighting vehicles

a. Surface danger zone requirements for the M242 Bushmaster 25mm cannon are provided in table 8–6 and figure 8–4.

Table 8–6
Surface danger zone data for 30mm MK239 Target Practice-Tracer (TP–T) (Fighting Vehicle - Elevation Restriction)

Altitude (ft)	Impact Media	Dist X (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Ricochet Vertical Hazard (m)
0	Earth	6,000	575	NR	NR	8	570
	Armor Plate	6,000	750	NR	NR	17	575
1000	Earth	6,140	590	NR	NR	8	585
	Armor Plate	6,140	765	NR	NR	17	590
2000	Earth	6,280	605	NR	NR	8	600
	Armor Plate	6,280	780	NR	NR	17	605
3000	Earth	6,420	620	NR	NR	8	615
	Armor Plate	6,420	795	NR	NR	17	620
4000	Earth	6,590	640	NR	NR	8	631
	Armor Plate	6,590	825	NR	NR	17	636
5000	Earth	6,760	660	NR	NR	8	647
	Armor Plate	6,760	855	NR	NR	17	652
6000	Earth	6,930	680	NR	NR	8	663
	Armor Plate	6,930	885	NR	NR	17	668
7000	Earth	7,100	700	NR	NR	8	680
	Armor Plate	7,100	915	NR	NR	17	685

Legend for Table 8-6:
NR=Not Required

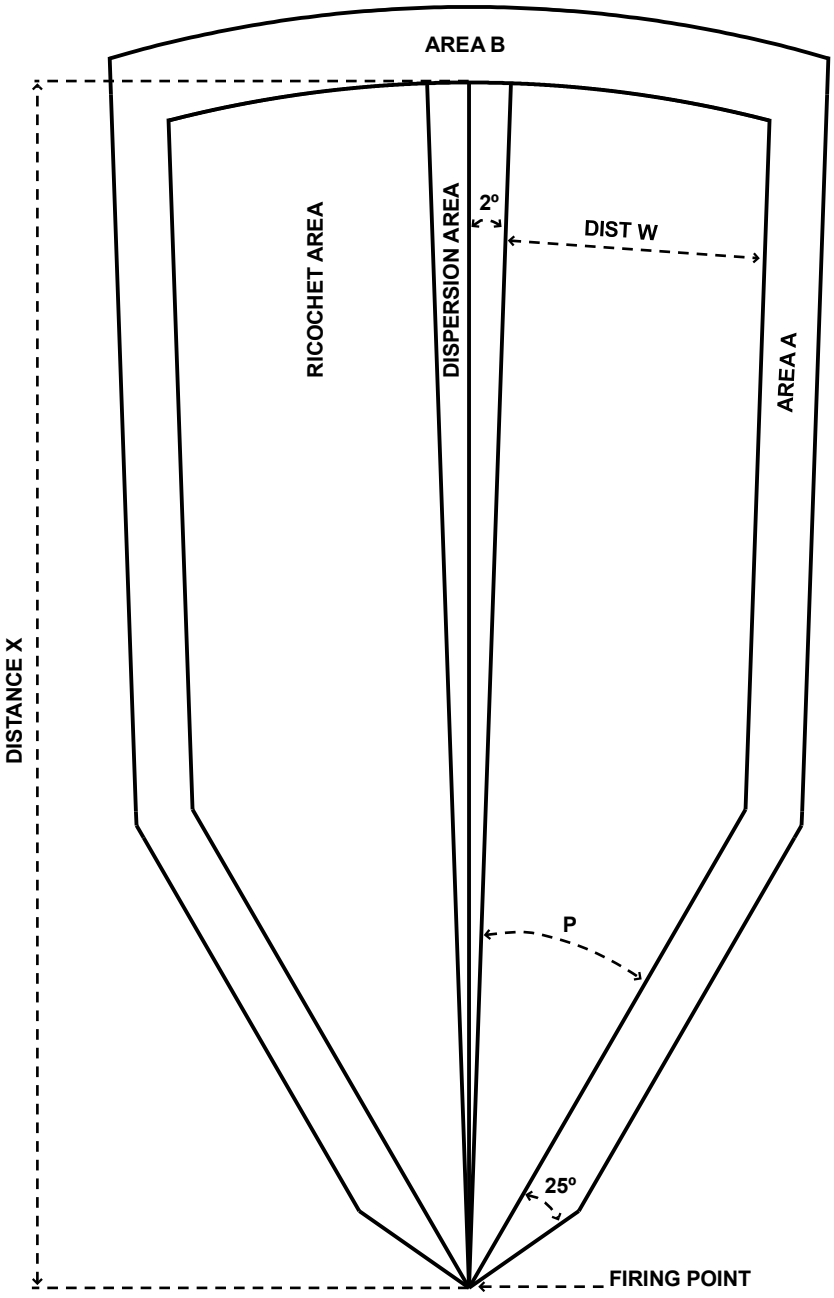


Figure 8–4. Surface danger zone for 25mm, 30mm and 35mm cannons

b. When conducting fighting vehicle training with elevation limitations, use the SDZ template found in figure 8–4 and the data found in tables 8–7 through 8–16. For free gun training, use the batwing SDZ template found in chapter 4, with the data found in tables 8–12 through 8–16. To correct for cross range wind, the dispersion angle of 2 degrees must be increased by 0.1 degree per m/s or 0.05 degree per knot of cross range wind.

(1) For free gun training, to correct for cross range wind the dispersion angle of 5 degrees must be increased by 0.25 degree per m/s or 0.13 degree per knot of cross range wind.

(2) For elevation restriction (5 degrees), to correct for cross range wind the dispersion angle is increased by 0.1 degree per m/s or 0.05 degree per knot of cross range wind.

Table 8–7
Surface danger zone data for 30mm MK238 MOD 1 High Explosive Incendiary-Tracer (HEI–T) and MK266 MOD 1 HEI–T (Fighting Vehicle – Elevation Restriction)

Altitude (ft)	Impact Media	Dist X (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Ricochet Vertical Hazard (m)
0	Earth	6,000	575	175	175	8	570
	Armor Plate	6,000	750	175	175	17	575
1000	Earth	6,140	590	175	175	8	585
	Armor Plate	6,140	765	175	175	17	590
2000	Earth	6,280	605	175	175	8	600
	Armor Plate	6,280	780	175	175	17	605
3000	Earth	6,420	620	175	175	8	615
	Armor Plate	6,420	795	175	175	17	620
4000	Earth	6,590	640	175	175	8	631
	Armor Plate	6,590	825	175	175	17	636
5000	Earth	6,760	660	175	175	8	647
	Armor Plate	6,760	855	175	175	17	652
6000	Earth	6,930	680	175	175	8	663
	Armor Plate	6,930	885	175	175	17	668
7000	Earth	7,100	700	175	175	8	680
	Armor Plate	7,100	915	175	175	17	685

Table 8–8
Surface danger zone data for 30mm MK264 Multi-Purpose Low Drag-Tracer (MPLD-T) (Fighting Vehicle - Elevation Restriction)

Altitude (ft)	Impact Media	Dist X (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Ricochet Vertical Hazard (m)
0	Earth	6,000	575	240	240	8	570
	Armor Plate	6,000	750	240	240	17	575
1000	Earth	6,140	590	240	240	8	585
	Armor Plate	6,140	765	240	240	17	590
2000	Earth	6,280	620	240	240	8	615
	Armor Plate	6,280	780	240	240	17	605
3000	Earth	6,420	620	240	240	8	615
	Armor Plate	6,420	795	240	240	17	620
4000	Earth	6,590	640	240	240	8	631
	Armor Plate	6,590	825	240	240	17	636
5000	Earth	6,760	660	240	240	8	647
	Armor Plate	6,760	855	240	240	17	652
6000	Earth	6,930	680	240	240	8	663
	Armor Plate	6,930	885	240	240	17	668
7000	Earth	7,100	700	240	240	8	680
	Armor Plate	7,100	915	240	240	17	685

Table 8–9
Surface danger zone data for 30mm MK310 Programmable Air Burst Munition-Tracer (PABM-T) (Fighting Vehicle – Elevation Restriction)

Altitude (ft)	Impact Media	Dist X (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Ricochet Vertical Hazard (m)
0	Earth	6,000	575	150	150	8	575
	Armor Plate	6,000	750	150	150	17	570
1000	Earth	6,140	590	150	150	8	585
	Armor Plate	6,140	765	150	150	17	590
2000	Earth	6,280	605	150	150	8	600
	Armor Plate	6,280	780	150	150	17	605
3000	Earth	6,420	620	150	150	8	615
	Armor Plate	6,420	795	150	150	17	620
4000	Earth	6,590	640	150	150	8	631
	Armor Plate	6,590	825	150	150	17	636
5000	Earth	6,760	660	150	150	8	647
	Armor Plate	6,760	855	150	150	17	652

6000	Earth Armor Plate	6,930 6,930	680 885	150 150	150 150	8 17	663 668
7000	Earth Armor Plate	7,100 7,100	700 915	150 150	150 150	8 17	680 685

Table 8–10
Surface danger zone data for 30mm MK258, MK268 Armor Piercing Fin Stabilized Discarding Sabot-Tracer (APFSDS–T) (Fighting Vehicle - Elevation Restriction)

Altitude (ft)	Impact Media	Dist X (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Ricochet Vertical Hazard (m)
0	Earth Armor Plate	13,300 13,450	390 375	NR NR	NR NR	30 17	445 445
1000	Earth Armor Plate	13,700 13,850	405 392	NR NR	NR NR	30 17	452 452
2000	Earth Armor Plate	14,100 14,250	420 409	NR NR	NR NR	30 17	458 458
3000	Earth Armor Plate	14,500 14,650	440 425	NR NR	NR NR	30 17	465 465
4000	Earth Armor Plate	14,875 15,025	455 438	NR NR	NR NR	30 17	471 471
5000	Earth Armor Plate	15,250 15,400	470 451	NR NR	NR NR	30 17	478 478
6000	Earth Armor Plate	15,625 15,775	485 464	NR NR	NR NR	30 17	484 484
7000	Earth Armor Plate	16,000 16,150	500 475	NR NR	NR NR	30 17	490 490

Legend for Table 8-11:
NR=Not Required

Table 8–11
Surface danger zone data for 30mm MK239 Target Practice-Tracer (TP- T) (free gun - no elevation restriction)

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth Armor Plate	8,600 8,600	6,000 6,000	575 750	NR NR	NR NR	8 17	65 65	2,700 2,700
1000	Earth Armor Plate	8,870 8,870	6,140 6,140	590 765	NR NR	NR NR	8 17	65 65	2,770 2,770
2000	Earth Armor Plate	9,140 9,140	6,280 6,280	605 780	NR NR	NR NR	8 17	65 65	2,840 2,840
3000	Earth Armor Plate	9,410 9,410	6,420 6,420	620 795	NR NR	NR NR	8 17	65 65	2,910 2,910
4000	Earth Armor Plate	9,710 9,,710	6,590 6,590	640 825	NR NR	NR NR	8 17	65 65	2,985 2,985
5000	Earth Armor Plate	10,010 10,010	6,760 6,760	660 855	NR NR	NR NR	8 17	65 65	3,060 3,060
6000	Earth Armor Plate	10,310 10,310	6,930 6,930	680 885	NR NR	NR NR	8 17	65 65	3,135 3,135
7000	Earth Armor Plate	10,610 10,610	7,100 7,100	700 915	NR NR	NR NR	8 17	65 65	3,210 3,210

Legend for Table 8-12:
NR=Not Required

Table 8–12
Surface danger zone data for 30mm MK238 MOD 1 High Explosive Incendiary (HEI–T) and MK266 MOD 1 HEI–T (free gun - no elevation restriction)

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Angle Q deg)	Ricochet Vertical Hazard (m)
0	Earth Armor Plate	8,600 8,600	6,000 6,000	575 750	175 175	175 175	8 17	65 65	2,700 2,700
1000	Earth Armor Plate	8,870 8,870	6,140 6,140	590 765	175 175	175 175	8 17	65 65	2,770 2,770

2000	Earth	9,140	6,280	605	175	175	8	65	2,840
	Armor Plate	9,140	6,280	780	175	175	17	65	2,840
3000	Earth	9,410	6,420	620	175	175	8	65	2,910
	Armor Plate	9,410	6,420	795	175	175	17	65	2,910
4000	Earth	9,710	6,590	640	175	175	8	65	2,985
	Armor Plate	9,710	6,590	825	175	175	17	65	2,985
5000	Earth	10,010	6,760	660	175	175	8	65	3,060
	Armor Plate	10,010	6,760	855	175	175	17	65	3,060
6000	Earth	10,310	6,930	680	175	175	8	65	3,135
	Armor Plate	10,310	6,930	885	175	175	17	65	3,135
7000	Earth	10,610	7,100	700	175	175	8	65	3,210
	Armor Plate	10,610	7,100	915	175	175	17	65	3,210

Table 8–13
Surface danger zone data for 30mm MK264 Multi-Purpose Low Drag Tracer (MPLD-T) (free gun - no elevation restriction)

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	8,600	6,000	575	240	240	8	65	2,700
	Armor Plate	8,600	6,000	750	240	240	17	65	2,700
1000	Earth	8,870	6,140	590	240	240	8	65	2,770
	Armor Plate	8,870	6,140	765	240	240	17	65	2,770
2000	Earth	9,140	6,280	605	240	240	8	65	2,840
	Armor Plate	9,140	6,280	780	240	240	17	65	2,840
3000	Earth	9,410	6,420	620	240	240	8	65	2,910
	Armor Plate	9,410	6,420	795	240	240	17	65	2,910
4000	Earth	9,710	6,590	640	240	240	8	65	2,985
	Armor Plate	9,710	6,590	825	240	240	17	65	2,985
5000	Earth	10,010	6,760	660	240	240	8	65	3,060
	Armor Plate	10,010	6,760	855	240	240	17	65	3,060
6000	Earth	10,310	6,930	680	240	240	8	65	3,135
	Armor Plate	10,310	6,930	885	240	240	17	65	3,135
7000	Earth	10,610	7,100	700	240	240	8	65	3,210
	Armor Plate	10,610	7,100	915	240	240	17	65	3,210

Table 8–14
Surface danger zone data for 30mm MK310 Programmable Air Burst Munition Tracer (PABM- T) (free gun - no elevation restriction)

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	8,600	6,000	575	150	150	8	65	2,700
	Armor Plate	8,600	6,000	750	150	150	17	65	2,700
1000	Earth	8,870	6,140	590	150	150	8	65	2,770
	Armor Plate	8,870	6,140	765	150	150	17	65	2,770
2000	Earth	9,140	6,280	605	150	150	8	65	2,840
	Armor Plate	9,140	6,280	780	150	150	17	65	2,840
3000	Earth	9,410	6,420	620	150	150	8	65	2,910
	Armor Plate	9,410	6,420	795	150	150	17	65	2,910
4000	Earth	9,710	6,590	640	150	150	8	65	2,985
	Armor Plate	9,710	6,590	825	150	150	17	65	2,985
5000	Earth	10,010	6,760	660	150	150	8	65	3,060
	Armor Plate	10,010	6,760	855	150	150	17	65	3,060
6000	Earth	10,310	6,930	680	150	150	8	65	3,135
	Armor Plate	10,310	6,930	885	150	150	17	65	3,135
7000	Earth	10,610	7,100	700	150	150	8	65	3,210
	Armor Plate	10,610	7,100	915	150	150	17	65	3,210

Table 8–15
Surface danger zone data for 30mm MK258 Armor Piercing Fin Stabilized Discarding Sabot Tracer (APFSDS- T) and MK268 APFSDS- T (free gun - no elevation restriction)

Altitude (ft)	Impact Media	Dist X (m)	Dist Y (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Angle Q (deg)	Ricochet Vertical Hazard (m)
0	Earth	30,800	18,500	390	NR	NR	30	15	18,705
	Armor Plate	30,800	18,500	375	NR	NR	17	15	18,705
1000	Earth	32,965	18,665	405	NR	NR	30	15	19,625
	Armor Plate	32,965	18,665	392	NR	NR	17	15	19,625
2000	Earth	35,130	18,830	420	NR	NR	30	15	20,545
	Armor Plate	35,130	18,830	409	NR	NR	17	15	20,545
3000	Earth	37,300	19,000	440	NR	NR	30	15	21,465
	Armor Plate	37,300	19,000	425	NR	NR	17	15	21,465
4000	Earth	39,925	19,250	455	NR	NR	30	15	22,530
	Armor Plate	39,925	19,250	438	NR	NR	17	15	22,530
5000	Earth	42,550	19,500	470	NR	NR	30	15	23,595
	Armor Plate	42,550	19,500	451	NR	NR	17	15	23,595
6000	Earth	45,175	19,750	485	NR	NR	30	15	24,660
	Armor Plate	45,175	19,750	464	NR	NR	17	15	24,660
7000	Earth	47,800	20,000	500	NR	NR	30	15	25,730
	Armor Plate	47,800	20,000	475	NR	NR	17	15	25,730

Legend for Table 8-15:
NR=Not Required

Table 8–16
Surface danger zone data for 30mm MK 258 Armor Piecing Fin Stabilized Discarding Sabot Tracer (APFSDS- T) and MK268 APFSDS-T sabot discard area (all firing conditions)

Item	Dist y (m)	Dist W (m)	Angle P (deg)	Angle Q (deg)
MK258	250	30	15	90
MK268	175	40	30	90

Table 8–17
Surface danger zone data for 30mm MK317, Target Practice Frangible Discarding Sabot-Tracer (TPFDS-T)[1]

Altitude (ft)	Impact Media	Dist X (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)	Ricochet Vertical Hazard (m)
0	Earth	5,925	320	NR	NR	22	290
	Armor Plate	6,100	600	NR	NR	21	480
1,000	Earth	6,092	330	NR	NR	22	300
	Armor Plate	6,275	617	NR	NR	21	495
2,000	Earth	6,259	340	NR	NR	22	310
	Armor Plate	6,450	634	NR	NR	21	510
3,000	Earth	6,425	350	NR	NR	22	320
	Armor Plate	6,625	650	NR	NR	21	525
4,000	Earth	6,613	360	NR	NR	22	330
	Armor Plate	6,825	370	NR	NR	21	541
5,000	Earth	6,801	370	NR	NR	22	340
	Armor Plate	7,025	690	NR	NR	21	558
6,000	Earth	6,989	380	NR	NR	22	350
	Armor Plate	7,225	710	NR	NR	21	574
7,000	Earth	7,175	390	NR	NR	22	360
	Armor Plate	7,425	730	NR	NR	21	590

Legend for Table 8-17:
TPFDS-T=Target Practice Frangible Discarding Sabot-Tracer
NR=Not Required
Notes:
[1]To correct for cross range winds, the dispersion angle is increased by 0.10 degree per m/s or 0.05 degree per knot of cross wind.

Table 8–18
Surface danger zone data for Sub-caliber devices

Ammunition/ Device	Impact Media	Dist X at 10 degrees or less (m)	Dist W (m)	Area A (m)	Area B (m)	Ricochet Vertical Hazard (m)
.22 caliber LR DVC–D17–53	Earth/Water	1,073	155	NR	NR	96
caliber .22 in-bore	Concrete/Steel	1,073	386	NR	NR	245
5.56 mm M856 Tracer Brewster	Earth/Water	2,250	260	NR	NR	261
DVC–D17–87	Concrete/Steel	2,250	202	NR	NR	261
7.62 mm M80 Ball DVC–D17–87 (Brewster	Earth/Water	3,100	1,461	NR	NR	706
single shot)	Concrete/Steel	3,100	861	NR	NR	447
.50 caliber M2 Ball, MK211	Earth/Water	4,400	1,652	NR	NR	901
	Concrete/Steel	4,400	714	NR	NR	478
.50 caliber SLAP M962 120 mm	Earth/Water	6,069	1,149	NR	NR	See note 2
in-bore AIMTEST[1]	Concrete/Steel	6,069	1,149	NR	NR	See note 2

Legend for Table 8-18:
NR=Not Required
Notes:
[1] Data based on 7,000ft Mean Sea Level (MSL).
[2] Use value of Distance W until validated test data is available.

Table 8–19
Exposure limits to hazardous impulse noise from 105mm main gun cartridge (per 24 hours)

Cartridge caliber	Cartridge type	Commander exposed	Gunner exposed	Examiner exposed	Commander Adjacent tank
105mm	M490A1	10	10	0	20

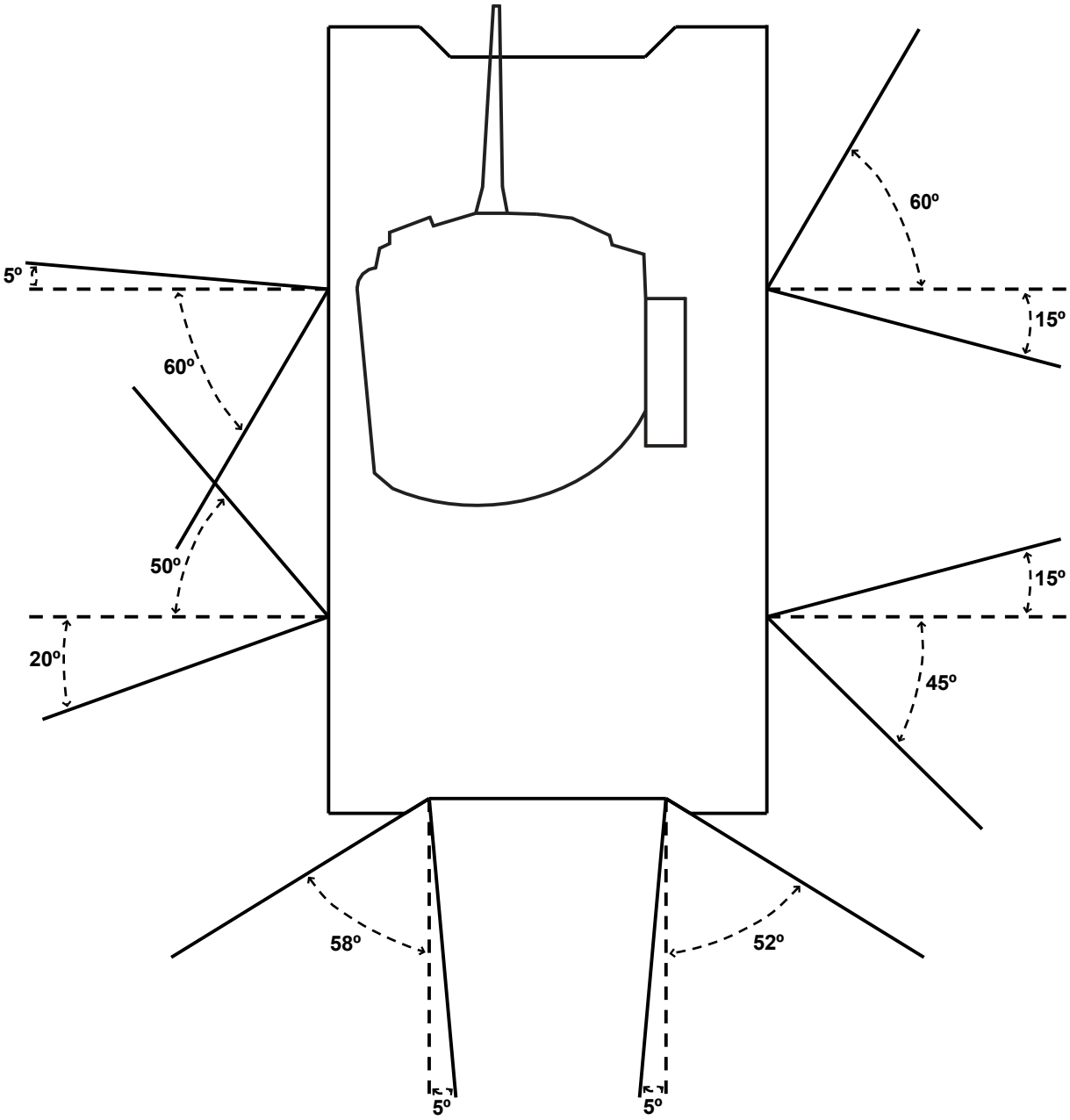


Figure 8–5. Surface danger zone for fighting vehicle firing port weapon systems

c. 25mm and 30mm aluminum and plastic base Sabot discard hazard area information is provided in table 8–17 and figures 8–7, 8–8, and 8–9.

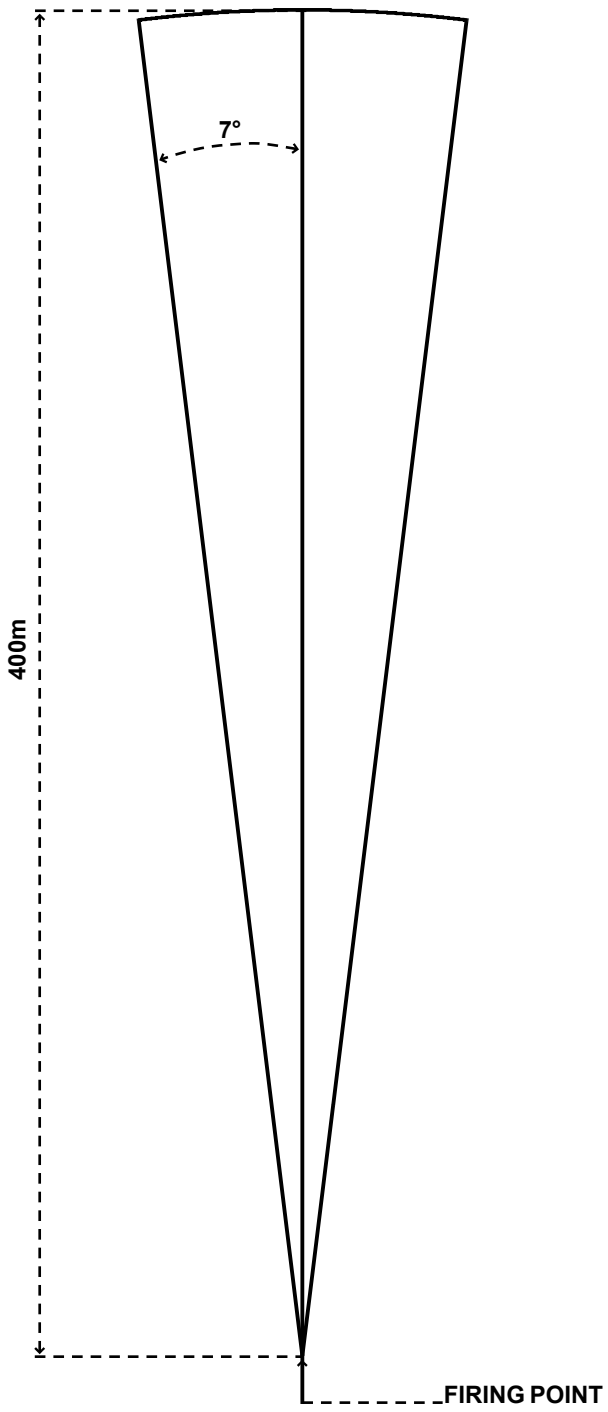


Figure 8–6. Surface danger zone for 25mm aluminum base sabot discard area

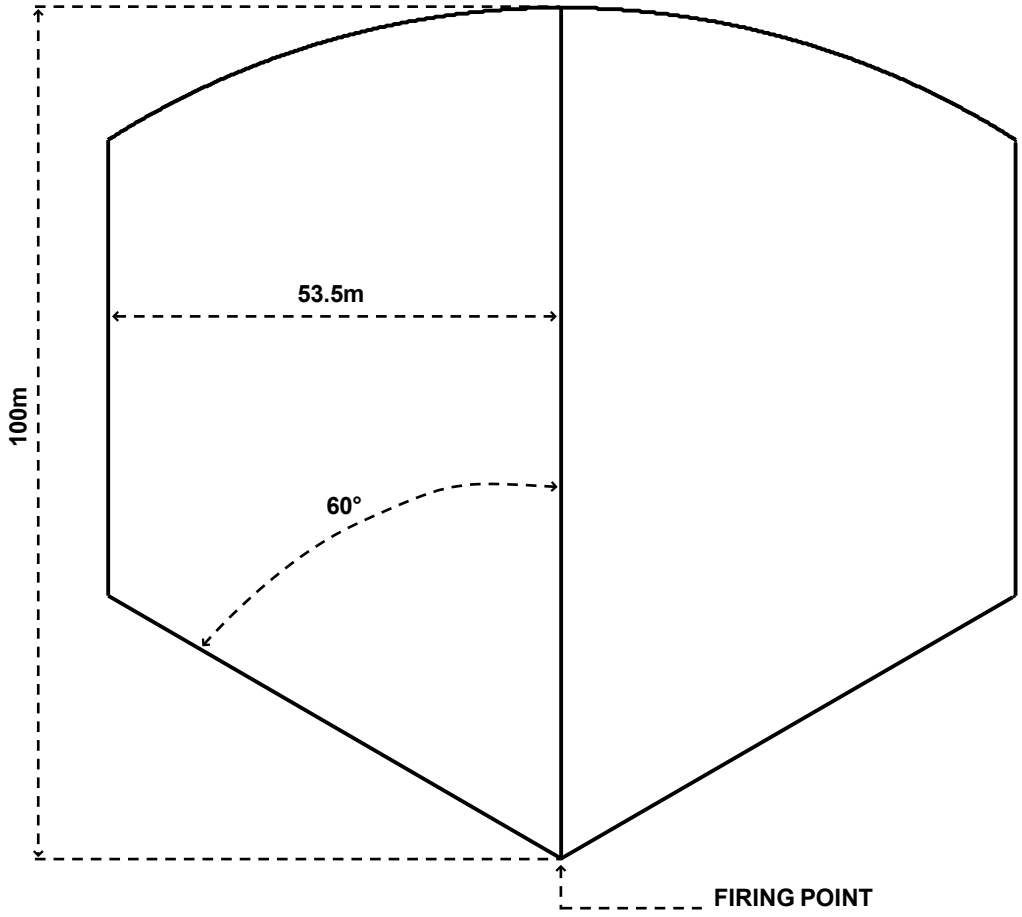


Figure 8–7. Surface danger zone for 25mm plastic base sabot discard area

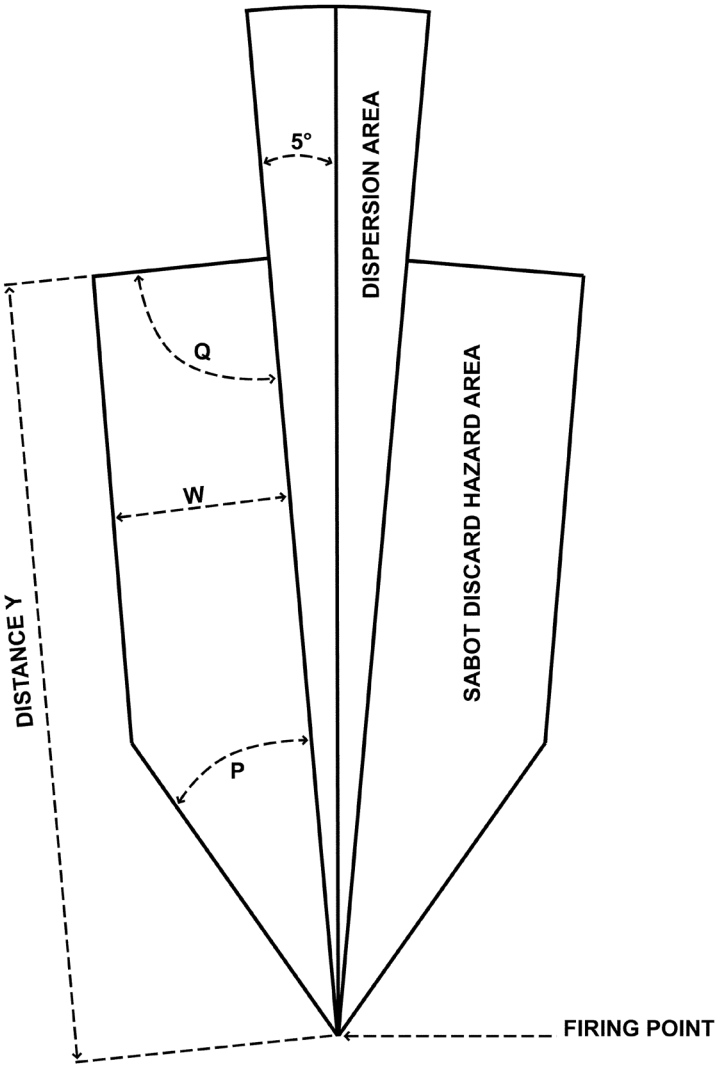


Figure 8–8. Surface danger zone for 30mm discard area

8–4. Firing vehicle status designations

a. Safety precautions for firing vehicle status designations will be determined by appropriate risk authority based on risk assessment and training objectives. Use of flags and lights is an alternative safety precaution to reduce risk of accidental losses during training operations. The following color scheme is recommended when flags and/or lights are used:

(1) Yellow: Vehicle has malfunction. Yellow is used only in conjunction with red or green.

(2) Red and green: Vehicle is preparing to fire or the crew is performing a non-firing exercise. Weapon systems are clear but not elevated.

(3) Red and yellow: Vehicle has a malfunction or misfire. Weapon systems are not clear and are pointed downrange.

(4) Green and yellow: Vehicle has a malfunction. Weapon systems are clear.

(5) Red: Vehicle engaged in firing. Weapons must be pointed at the target area.

(6) Green: All vehicles' weapon systems are clear and elevated. Any live ammunition in the vehicle is properly stowed.

b. Once a firing vehicle begins a battle run and passes the start fire line, all weapon systems, including laser systems, are considered to be loaded and ready to fire. Senior commanders (Army)/installation commanders (Marine

Corps) may require vehicles on a battle run to display status flags or lights or other control measure based on a risk assessment.

c. When the firing vehicle completes a battle run, the tank/fighting vehicle commander will ensure the weapon systems have been cleared. The vehicle commander, RSO, or ARSO will mount the vehicle and verify weapon systems clearance, to include laser systems, before the vehicle moves off the firing line, out of the maneuver box, or out of a battle position to a designated position. Proper flags or lights may be displayed to identify the status of the weapons.

d. Tank/fighting vehicle commanders or RSOs will ensure the weapon systems are aligned within the envelope of the vehicle's width when traveling off-range onto roadways or tank/fighting vehicle trails, unless previously coordinated with range operations (Army), range control (Marine Corps) for purposes of tactical road marches.

8–5. Sub-caliber tank/fighting vehicle gunnery devices

a. SDZ will be constructed as shown in figure 8–1.

b. The dimensions in table 8–19 will be used based on munition caliber.

Table 8–20
Exposure limits to hazardous impulse noise from 120mm tank main gun for selected cartridges (per 24 hours)

Cartridge type	Firing condition	Single hearing protection[1]	Double hearing protection[2]
		Maximum rounds per day	
M831 TP-T	Exposed commander	16	320
M831 TP-T	Exposed leader/evaluator	11	220
M831 TP-T	Rear deck	95	NPL
M831 TP-T	Interior commander (hatch open)	NPL	NPL
M831 TP-T	Interior driver (commander/leader hatch open)	NPL	NPL
M831 TP-T	Exposed commander adjacent tank	15	300
M831 TP-T	Exposed leader adjacent tank	15	300
M831A1 TP-T	Exposed commander	45	894
M831A1 TP-T	Exposed leader/evaluator	20	400
M831A1 TP-T	Rear deck	52	NPL
M831A1 TP-T	Interior commander (hatch open)	215	NPL
M831A1 TP-T	Interior driver (leader/evaluator hatch open)	73	NPL
M831A1 TP-T	Exposed commander adjacent tank	65	NPL
M831A1 TP-T	Exposed leader adjacent tank	66	NPL
M865 TPCSDS-T	Exposed commander	0	0
M865 TPCSDS-T	Exposed leader/evaluator	0	0
M865 TPCSDS-T	Rear deck	13	260
M865 TPCSDS-T	Interior commander (hatch open)	27	549
M865 TPCSDS-T	Interior driver (leader/evaluator hatch open)	NDA	NDA
M865 TPCSDS-T	Exposed leader/evaluator adjacent tank	ENA	0
M865 TPCSDS-T	Exposed leader adjacent tank	0	0

Legend for Table 8-20:
ENA=Exposure Not Allowed
NDA=No Data Available
NPL=No Practical Limit
TP–T=Target Practice-Tracer
TPCSDS–T=Target Practice, Cone-Stabilized Discarding Sabot-Tracer
Notes:
[1] Single hearing protection includes approved earplugs, earmuffs, combat vehicle crewman(CVC) helmet, or headset.
[2] Double hearing protection includes use approved earplugs in combination with earmuffs, CVC helmet, or headset.

8–6. Grenade launchers

a. Firing conditions.

(1) SDZ occupation by unprotected personnel in the open is prohibited.

(2) Grenades will not be fired into strong head winds (19 km per hour (12 mph) and greater).

(3) PPE Level 1 is recommended with hand protection for personnel within the SDZ. See table 2–2.

(4) Clothing will fit snugly to prevent red phosphorous fragments from getting inside clothing, particularly around the neck, ends of sleeves and pockets.

b. Surface danger zone.

(1) The L8A1 and L8A3 grenades are designed to launch out 30m from the vehicle before functioning.

SDZ requirements for firing the L8A1 and L8A3 smoke grenades are provided in figure 8–9. Hazard distances of 125m from the vehicle in the direction of fire, and 50m to the rear will be applied in accordance with figure 8–9.

(2) SDZ requirements for the M176, M226, and M239 grenade launchers are provided in figure 8–10. Dimensions shown in figure 8–10 are for illustrative purposes only.

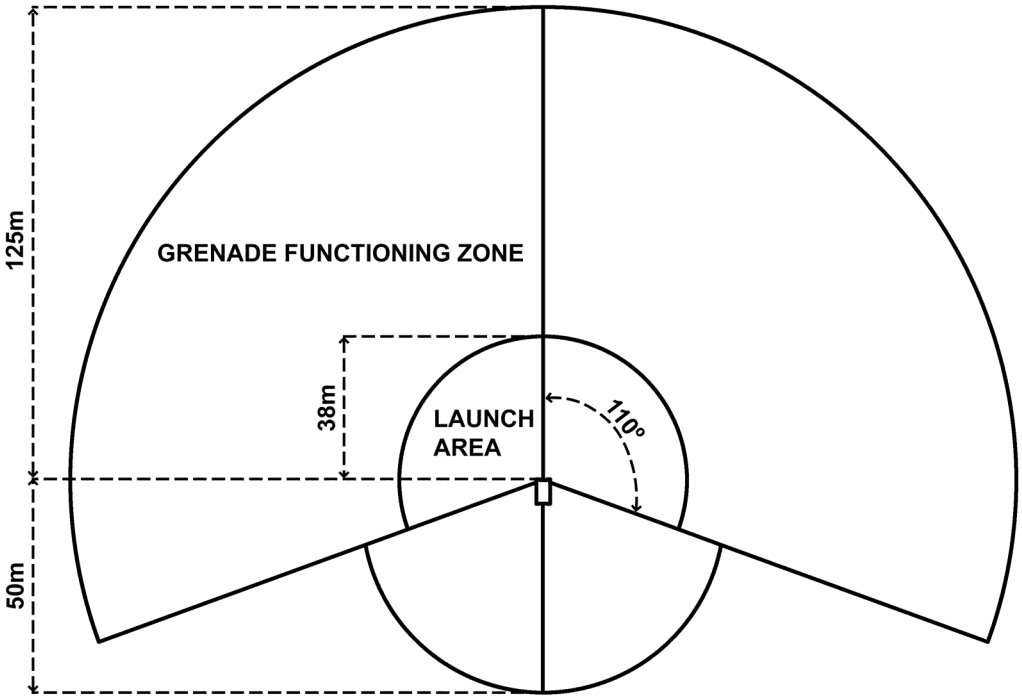


Figure 8–9. Surface danger zone for L8A1 and A3 smoke grenades on armored vehicles

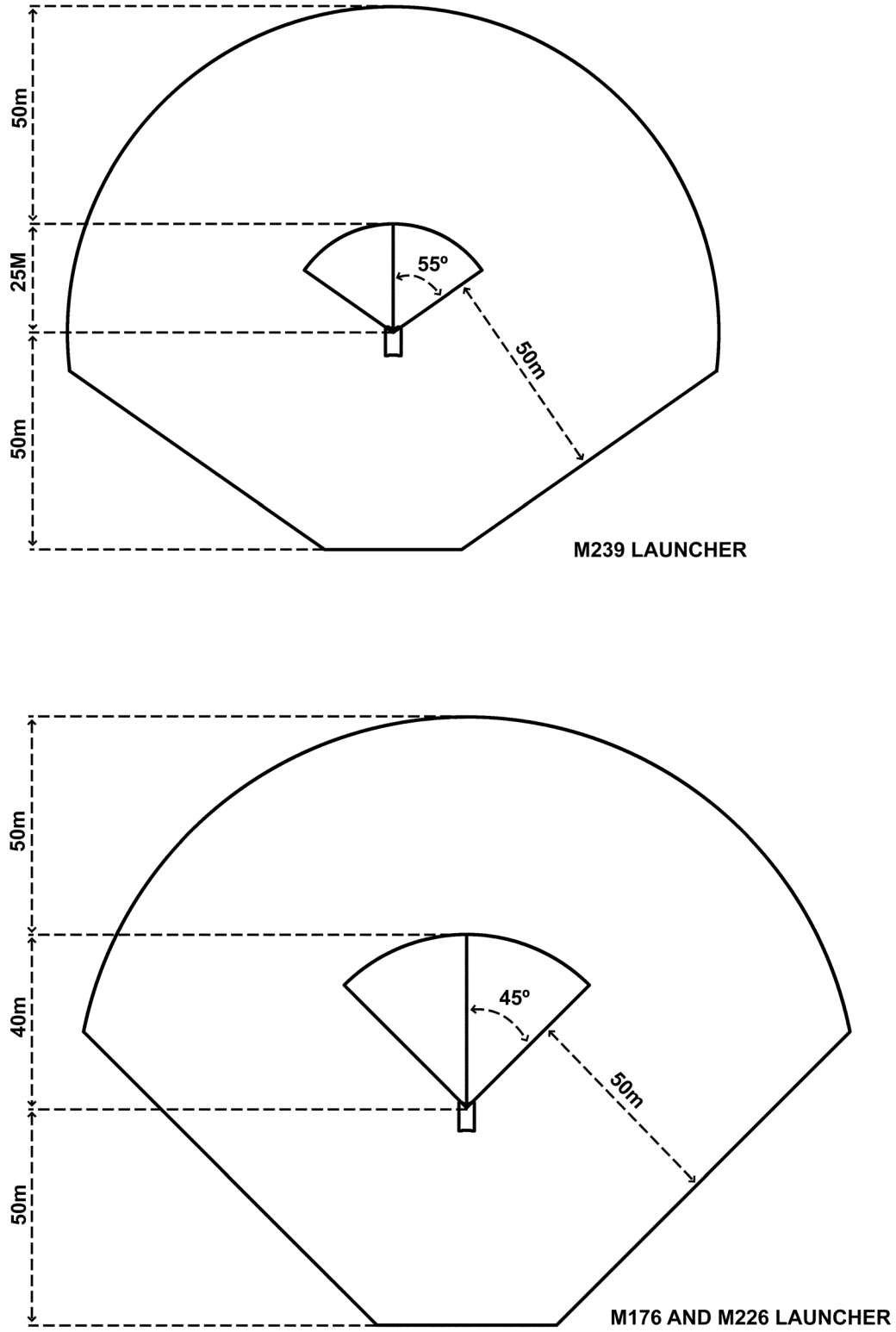


Figure 8–10. Surface danger zone for grenades from M176, M226 and M239 grenade launchers on armored vehicles

(3) SDZ requirements for firing M81 grenades are provided in figure 8–11.

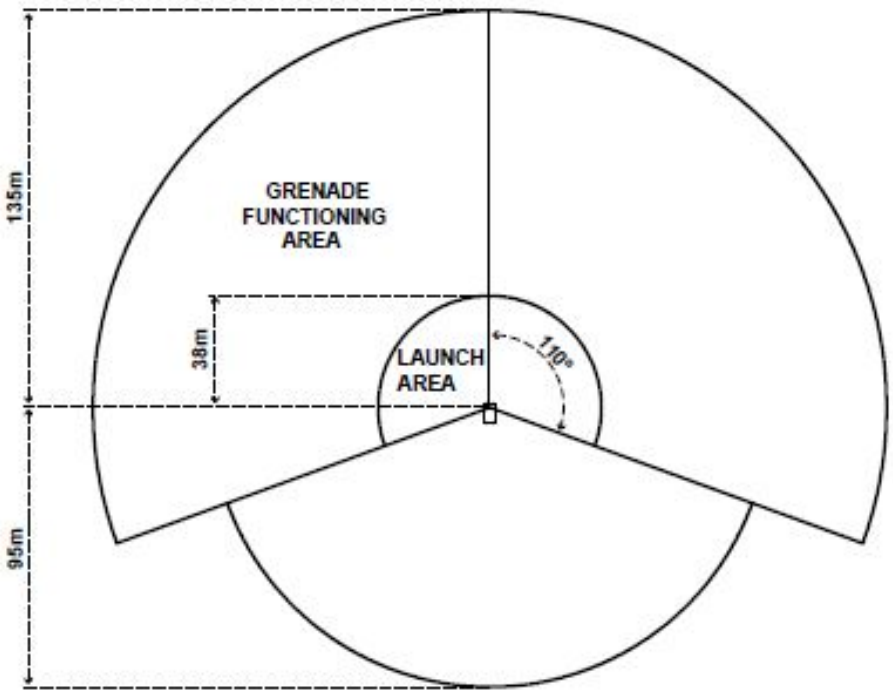


Figure 8–11. Surface danger zone for M81 grenade using standard 66mm launchers on armored vehicles

(4) SDZ requirements for firing M82 grenades are provided in figure 8–12.

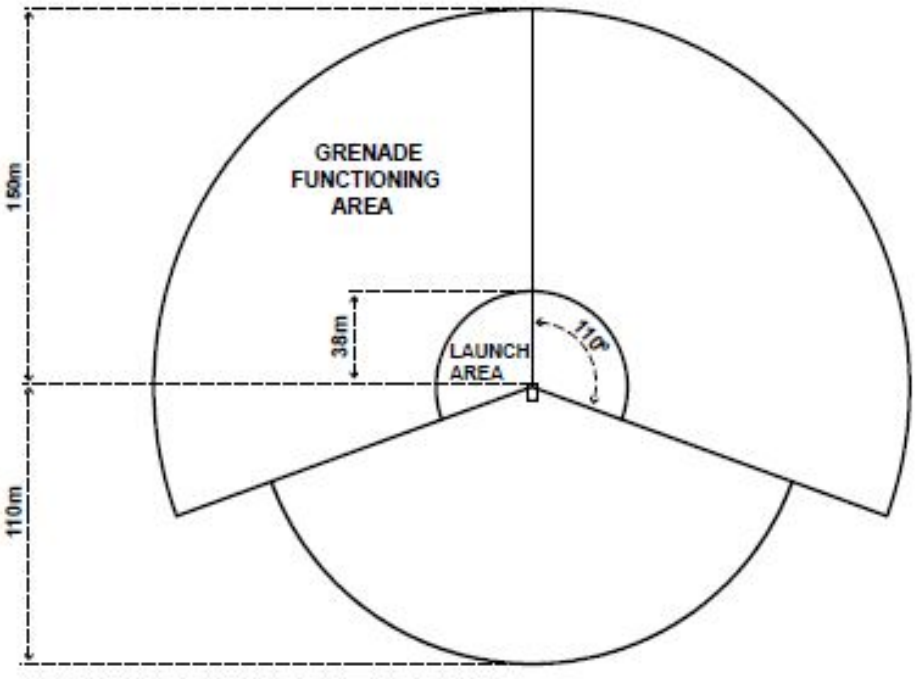


Figure 8–12. Surface danger zone for M82 grenade from 66mm launcher on armored vehicles

8–7. Close support of ground personnel

a. Firing over the heads of unprotected personnel by tank and fighting vehicle main guns is prohibited.

b. Tank/fighting vehicle weapons systems may be used to provide flanking fire if unprotected personnel remain out of the SDZ.

c. Only personnel wearing approved single hearing protection will be allowed within 140 decibels peak (dBP) level contour zones during tank/fighting vehicle main gun firings.

d. Nonparticipating personnel will be restricted from areas 10m to the sides and from all areas forward of tanks/ fighting vehicles.

8–8. Weapons effect signature simulator

Personnel within 25m of the weapons effect signature simulator will wear approved single hearing protection. Eye protection will be worn.

8–9. Hazardous impulse noise exposure

a. The driver's hatch must be closed tight at all times when the main weapon is fired. Exposure limits and contour distances to hazardous impulse noise in excess of 140 dBP from various 105mm and 120mm tank cannon cartridges are based on health hazard assessment reports. Tables 8–19 and 8–20 list exposure limits for tank/fighting vehicle main gun firings.

b. Do not allow tank/fighting vehicle crew examiners or other personnel on the outside of a firing tank/fighting vehicle.

Table 8–21
Hazardous impulse noise contours for various tank/vehicle cannon cartridges

Caliber	Cartridge	Distance to 140 dBP contours (m)		
		90 degrees	135 degrees	180 degrees
105mm	M490	501	NDA	NDA
105mm	M490A1	400	NDA	200
120mm	M831	444	314	152
120mm	M865	501	355	NDA
35mm	M968	130	NDA	NDA
.50 Cal	All	32	16	NDA
7.62mm	All	15	7	NDA

Legend for table 8-21:
NDA=No Data Available

c. Numerous health hazard assessment reports define hazardous impulse noise contours for various tank/fighting vehicle main gun and secondary armament cartridges exceeding 140 dBP. Table 8–21 summarizes these contour requirements and figure 8–13 illustrates the hazardous impulse noise contours in relation to the GTL. Double hearing protection shall be worn when exposure is expected to be in excess of the daily exposure limit. Use of double hearing protection increases the daily exposure limits as determined by The Surgeon General. Loader may not have their head protruding above the open hatch while firing the main gun. Data for locations forward of tank/fighting vehicle weapon systems are not available. Impulse noise levels in front of tank systems are expected to be higher than to the sides and rear.

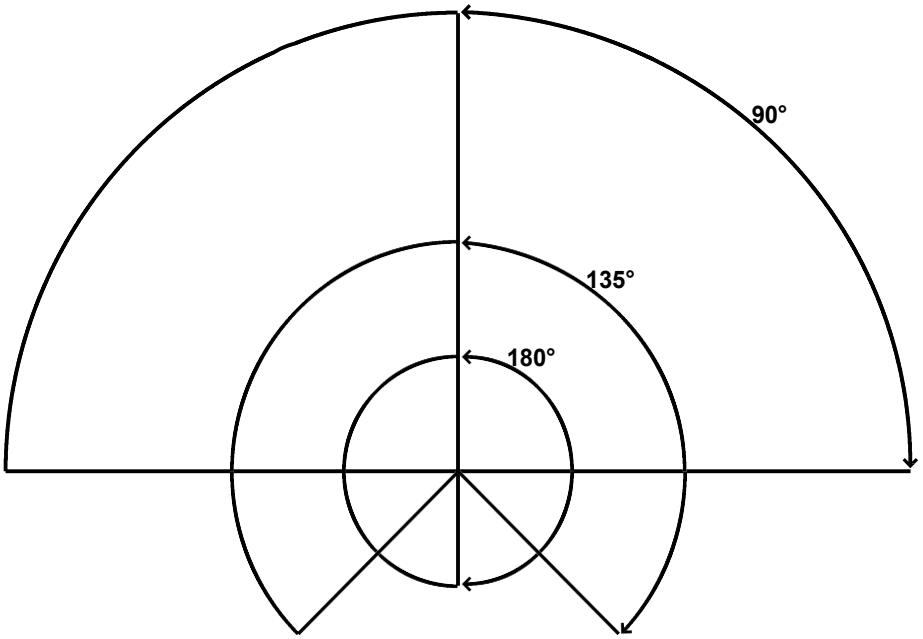


Figure 8–13. Hazardous impulse noise 140 dBP contour zones

Chapter 9
Mortars

9–1. Firing conditions

a. Firing mortars over the heads of unprotected troops by Army units is not recommended. Mortar ammunition must be certified for overhead fire of unprotected troops. The senior commander may approve overhead fire of unprotected troops with certified overhead fire mortar ammunition on the basis of acceptable level of risk. Procedural controls to prevent human error (for example, dedicated observer-controllers with the unprotected troops and firing mortars with dedicated communications) will be included in the risk management process.

b. For the Marine Corps, when firing HE munitions, mortars must be fired at the edge of a high hazard impact area. Illumination and practice rounds may be fired into a dedicated impact area.

c. Firing mortars over the heads of troops by Marine Corps units is not authorized except when firing the Expeditionary Fire Support System (EFSS) M327 120mm rifled towed mortar. Requirements for overhead fire using the 120mm rifled towed mortar can be found in chapter 10.

d. Overhead fire is allowed when Soldiers are in tanks and fighting vehicles with hatches closed 100m or more from the line of fire.

e. All personnel who take part in mortar firing will require PPE Level 1. Refer to table 2–2. At the commander's discretion, the gunner may remove their protective helmet while sighting the mortar. All personnel within the hearing hazard zone for the mortar, cartridge, or charge increment used will wear approved single hearing protection. The hearing hazard zone is usually defined in the manuals for the mortar or cartridges. If the hearing hazard zone information cannot be determined, single hearing protection will be required within 200m.

f. Propellant increments removed from rounds before firing will be placed in metal or wooden covered (water-proofed) containers located outside the firing vehicle or positioned a distance of at least 25m from the firing point when firing dismounted. Unused powder increments must be safeguarded and handled in accordance with installation range and environmental regulations.

g. M720, M721, M722, and M888 cartridges will not be fired above propellant charge 2 in the M2/M19 (60mm) mortar.

h. No mortar cartridges will be fired in the hand-held mode with a charge greater than charge 1.

i. No 800 series cartridges may be fired in the M29 (81mm) mortar except the M880 short-range target practice round. This also applies when using the M303 insert.

j. When firing the 120mm mortar from the carrier, all crew members and personnel inside the carrier must wear double hearing protection. Double hearing protection is required regardless of the carrier ramp position (opened or closed). Double hearing protection is defined as any approved earplugs plus either a CVC helmet or a communication aural protective system/artillery communication aural protective system with personnel armored system for ground troops helmet. Personnel outside the carrier within 200m must wear single hearing protection.

k. Crew members and all personnel within 5m of the 120mm mortar must wear double hearing protection when firing.

l. When firing the 120mm ground mount and carrier mount configuration, using the M933E1 HE cartridge, all personnel within 5m of the mortar are required to wear double hearing protection. Exposure is limited to 140 rounds in any 24 hours.

m. Firing restrictions and limitations in TM 43–0001–28 apply to all cartridges and fuzes. Marine Corps fires will observe restrictions in TM 08655A–10A for light armored vehicle-mortar variants.

n. The target engagement distance will not be less than the distance required for Area B of the respective caliber of mortar to be fired, unless fired from protected positions.

o. Full Range Practice Cartridges (FRPC) M769, M879, and M931 are required to be fired on ranges with full surface danger zones, to include special use airspace restrictions. Recovery of FRPC by mortar crews is not authorized. Only EOD personnel or properly trained range clearance personnel are authorized to recover these cartridges.

9–2. Surface danger zones

a. SDZ requirements for 60mm, 81mm, and 120mm mortars are provided in table 9–1, table 9-2 and figure 9–1. For firing the Cartridge, 120mm, High Explosive, Guided, XM395, Accelerated Precision Mortar Initiative (APMI), use table 9–2 and figure 9–2.

b. Dimensions of Areas A and B may be reduced by 50% when firing illumination cartridges. Cartridges without HE filler do not require Areas A or B.

c. Basic dimensions of the impact area will be computed as specified in table 9–2.

d. Firing table probable errors corresponding to the maximum range of charge employed will be used for this computation. These basic dimensions are based on standard conditions. They do not compensate for errors or nonstandard conditions.

e. To compute the probable errors in range and deflection, multiply the constant (listed in table 9–1 and figure 9–1) by the data found in the tabular firing tables. These data are drawn in meters from the downrange edge of the target area for deflection probable errors ($PE_{D)}$ and from Distance X for range probable errors ($PE_{R)}$. For the XM395 APMI, probable errors are not specified as part of the SDZ template, as the impact area as shown in figure 9–2 includes probable errors for both range and deflection.

f. Minimum range for target engagements will be the distances shown for Area A in table 9-2. The variable Area A angle is 25-degrees but must be increased to 70 degrees when firing HE ammunition at ranges equal to or less than 600m for 60mm mortars; 940m for 81mm mortars; and 1500m for 120mm mortars. Only the personnel required to fire the mortar system are authorized to be within this area.

g. Only the mortar crew is authorized to be in Area A.

h. Quadrant elevation limits must be modified to take into account the distance to the minimum and maximum limits of the impact area. After registration, corrections must be applied to the deflection quadrant elevation limits.

Table 9–1
Mortar Basic impact area dimensions

Limits	Dimensions
Left	Eight PE_D from the left limit of target area
Right	Eight PE_D from the right limit of target area
Far edge	Eight PE_R downrange from distance X

Legend for table 9-1:
PE_D=Deflection Probable Errors
PE_R=Range Probable Errors

Table 9–2
Surface danger zone data for mortars (120mm EFSS M327 rifled towed mortar refer to chapter 10)

Caliber	Area A (m)	Area B (m)
60mm M1061	380	405
60mm (all others)	250	300
81mm	400	400
120mm	600	600

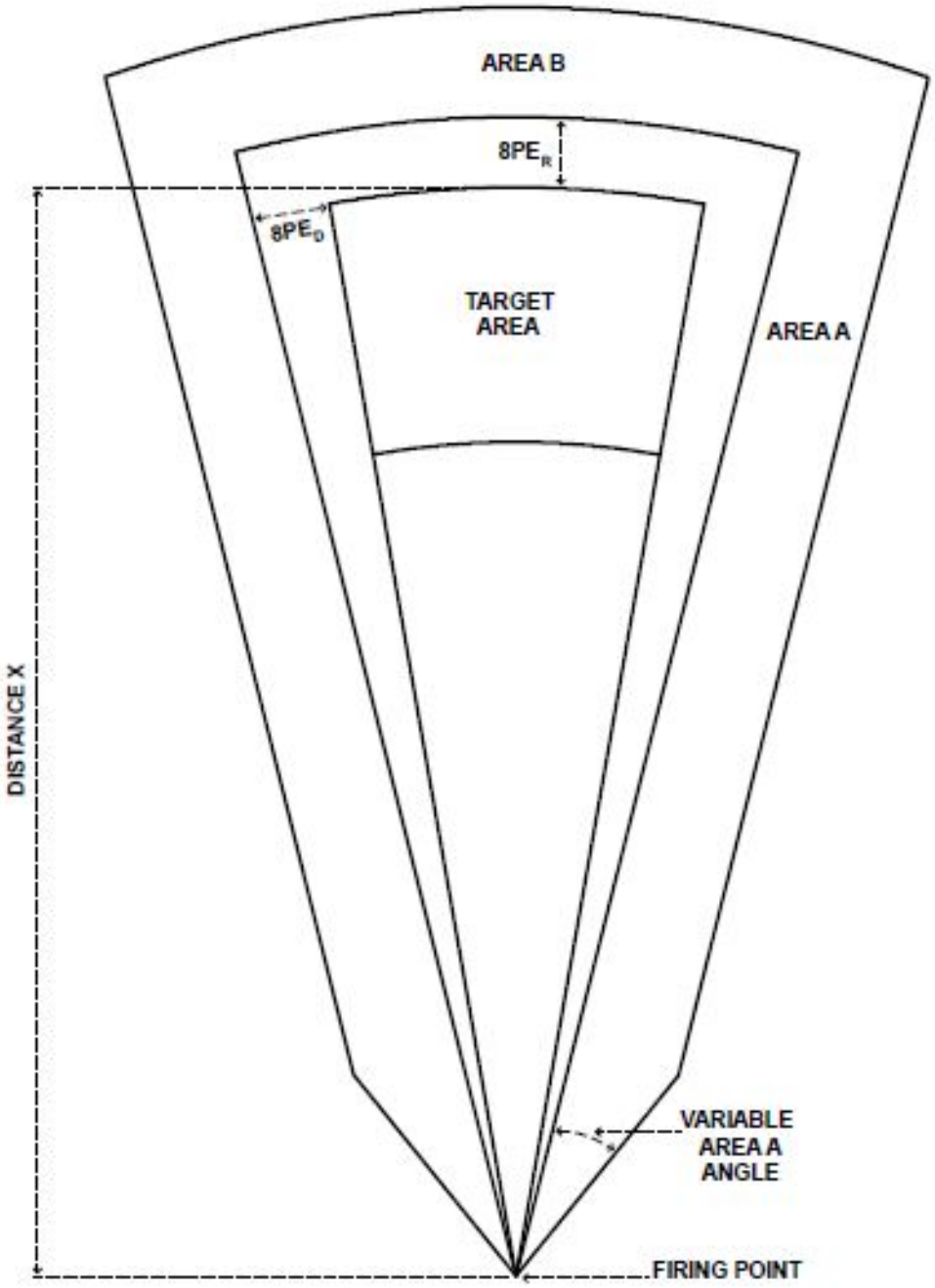


Figure 9-1. Surface danger zone for mortars

Chapter 10
Field Artillery

10–1. Procedures and precautions

This chapter contains procedures and precautions required to fire cannon, rocket field artillery, and the EFSS M327 mortar (spin-stabilized).

10–2. Safety certification program

a. Commanders of field artillery units, battalion and above, will establish and maintain an artillery safety training and annual certification program.

b. Field artillery commanders will determine, select, train, and safety certify personnel necessary to assist them in discharging this responsibility. These personnel will include, but are not limited to, the firing battery commander, executive officer or platoon leader, fire direction officer, chief of firing battery or platoon sergeant, gunnery sergeant, chief fire direction center computer, and howitzer or launcher chief of the section. These positions will be filled by command safety certified individuals. Their duties shall be as described in the appropriate FMs and TCs.

c. A separate battery safety officer is not required during the firing of field artillery, but commanders may appoint one.

10–3. Field artillery cannons

a. Firing conditions.

(1) Procedures will be established for weapon systems producing blast overpressure hazards to reduce the risk to artillery crews from auditory and internal injury caused by blast overpressure from specific charges. Individuals who experience shortness of breath, chest discomfort, bleeding from mouth, nose or ears, or excessive shakiness (tremors) when exposed to weapon system firings may be suffering from a blast overpressure injury. Individuals with any of these symptoms shall be instructed to lie down and remain quiet and immobile. Injured personnel will be transported to the nearest medical facility for immediate evaluation and treatment. Firing procedures for specific weapon systems can be found in appropriate TMs.

(2) Lanyards will not be attached to the firing mechanism of field artillery cannons that use separate loading ammunition until directed by the section chief.

(3) Unused powder increments must be safeguarded and handled in accordance with appropriate TMs and installation range regulations.

(4) All personnel immediately engaged in artillery operations will wear a minimum of PPE Level 1, as referenced in table 2–2.

b. Fuzes.

(1) Alteration of fuzes is not authorized unless authorized by the CG, AMC and supervised by a qualified AMC commissioned officer, WO, or civilian. For the Marine Corps, alteration of fuzes is not authorized unless authorized by Marine Corps System Command.

(2) Protect points of fuzes from blows or damage when handling ammunition because the closing cap may be sufficiently deformed and may activate the percussion primer in the fuze. Personnel inserting rounds of ammunition into cannons will be cautioned to keep each projectile away from the path of cannon recoil until recoil from the previous projectile is complete.

(3) Screw the fuze down by hand and firmly seat with the fuze wrench.

(4) Projectiles removed from cannons with ramming staffs will not be reused.

(5) All projectiles fired during training will be fuzed with bore safe fuzes.

(6) Fuzed projectiles fired during training exercises will be of the type that precludes close-in premature bursts that would present a fragment and debris hazard to the firing crew. Other type fuzes require all personnel within Area A distance from the firing position to be provided positive protection against premature bursts. When only white phosphorous (WP) ammunition is involved, this distance may be reduced to 200m for positive protection from premature bursts. Positive protection at the weapon system position will meet the minimum requirements of four thicknesses of sandbags filled with dry, sifted sand stacked high enough for protection against all calibers of ammunition, or trenches deep enough to provide complete protection, or concrete walls 0.30m thick, or tanks with hatches closed.

(7) Firing projectiles without fuzes is unauthorized.

(8) XM1156 Precision Guidance Kit

(a) The XM1156 Precision Guidance Kit (PGK) fuze uses global positioning system (GPS) and control surfaces to guide the projectile to the target. The PGK is compatible with the M795 and M549A1 155mm projectiles fired

from the M777A2 and M109A6 howitzers.

(b) Steering is carried out by a fixed angle canard section that is spun post-launch in the opposite direction from the projectile body. There is a design constraint within the PGK fuze to preclude arming and subsequent functioning if the round impacts more than 150 meters from the intended aim point/target.

(c) Range Safety Officer (RSO) or assistant RSO (ARSO) will ensure that all PGK fuzes are inspected prior to firing to ensure that canards spin freely with slight resistance by turning canard assembly one full turn (revolution) in each direction. Fuzes should not be used if the canard cannot be spun freely by hand.

c. Malfunctions.

(1) Malfunctions that occur during firing of ammunition will be investigated in accordance with AR 75–1 or MCO 8025.1E.

(2) Procedures to be followed when a misfire or hang-fire occurs, or when the potential for a cook-off exists, are in the appropriate weapon system TMs.

(3) All dud projectiles and their location will be reported to the installation RMA (Army), RCO (Marine Corps).

d. Loading or firing ammunition. Do not load or fire ammunition at bore temperatures higher or lower than the safe limit of firing. After loading, fire the weapon system, or in case of a cease-fire, immediately remove the projectile. If the projectile cannot be removed from the weapon system within five minutes, evacuate all personnel to a distance equivalent to Area A for the munitions. See TM 43–0001–28 and appropriate weapon system TMs.

e. Authorized propellant charge. Use only authorized propellant charges for the specific projectile and weapon system to be fired. Never use more charges than those comprising the full authorized charge.

f. White phosphorous impregnated felt wedges from the M825 and M825A1 155mm projectiles. These may not be totally consumed when the WP burns. Crushing or moving unburned felt wedges would reignite residual WP posing a burn hazard. Personnel will not disturb unburned felt wedges. Personnel discovering unburned felt wedges will notify the range operations firing desk (Army), range control (Marine Corps).

g. Rocket assisted projectiles. Rocket-on firings require a clear zone short of the target area in case the rocket motor fails to function. Rocket-off firings also require a clear zone beyond the target area to allow for accidental (unintended) initiation of the rocket motor. 105mm rocket assisted projectiles require a clear zone of 5,000m short of the target for rocket-on firing and 5,000m beyond the target for rocket-off firing. 155mm rocket assisted projectiles require a 7,000m clear zone short of the target for rocket-on firing and 7,000m beyond the target for rocket-off firing.

h. Salute (blank) firing of 75mm and 105mm projectiles. DODICs B550, B650, C025, C440 produce hazards from muzzle debris and noise. Muzzle closure debris can be expelled 92m forward of the weapon and 10 degrees either side of the bore axis. Hazardous noise levels (140 decibels) are 77m along the bore axis, 49m at 30 degrees each side of the bore axis, 31m at 60 degrees each side of the bore axis, 21m at 90 degrees each side of the bore axis, 14m at 120 degrees each side of the bore axis, 10meters at 150 degrees each side of the bore axis, and 10m directly behind the weapon.

i. Hearing protection. All personnel within the hearing hazard zone shall wear approved single hearing protection. The hearing hazard zone is usually defined in the manuals for the cannon, propellant charges, or cartridge. If the hearing hazard zone information cannot be determined, hearing protection will be required within 800m.

10–4. Field artillery cannon surface danger zones

a. The SDZ requirements for all field artillery cannons firing conventional ammunition (excluding APERS/"beehive" projectiles) are provided in tables 10–1 through 10–4 and figures 10–1 through 10–3.

b. Tactical fire control measures may be substituted for SDZs provided they correspond to figures 10–1, 10–2, or 10-3 as applicable.

c. Installation RMAs (Army), RCOs (Marine Corps) will determine target area boundaries. Left and right limits of the target area determine the left and right limits of fire. The maximum range line (arc) will be the far edge (downrange) of the target area, and the minimum range line (arc) will be the near edge (up range) of the target area. Unprotected personnel are not authorized in the target and associated hazard areas (Areas A, B, C, and E) during firing.

d. Projectile ricochets, empty carrier projectile bodies and debris found outside the Target Area in or beyond Area A and Area B and their locations will be reported to the installation RMA (Army), RCO (Marine Corps).

e. Basic dimensions of the impact area will be computed as specified in table 10–1.

f. Firing table probable errors corresponding to the range for the center of the target area will be used

for this computation. These basic dimensions are based on standard conditions. They do not compensate for errors or nonstandard conditions.

g. When firing the M825 155mm WP smoke projectiles:

(1) Areas A and B may be reduced to 350m.

(2) When firing the M825 projectile at target distances with firing solutions less than 800 mils the information provided in table 10-5 and figure 10-4 will be utilized. The Ricochet Danger Area (RDA) from table 10-5 will be added to the max range arc of the artillery SDZ. A 10 degree ricochet angle is added to the artillery SDZ from the down range arc of area C and outboard of the left and right probable errors in deflection.

h. The PGK control authority maximum divert (CAMDV) area is the danger area immediately surrounding the probable errors (PE) and accounts for GPS and control surface inaccuracies. The SDZ parameters showing the CAMDV area distance, in tables 10-3 and 10-4, are applied to all sides of the impact area as shown in figure 10-3. Area G is located between the CAMDV area and Area C, and accounts for the possibility of a locked PGK canard resulting in a short round. Use figure 10-3 and tables 10-1 through 10-4 to draw the SDZ for firing rounds with PGK fuzes.

Table 10–1
Basic impact area dimensions for field artillery cannons

Limits	Dimensions
Left	Eight PE_D from the left limit of target area
Right	Eight PE_D from the right limit of target area
Far edge	Eight PE_R downrange from distance X
Near edge	Twelve PE_R from the up range edge of target area.

Legend for table 10-1:
PE_D=Deflection Probable Errors
PE_R=Range Probable Errors

Table 10–2
Surface danger zone data for field artillery cannons

Caliber	Area A (m)	Area B (m)	Area C Low angle[1] (m)	Area C High angle, time, VT[2,3] (m)	Area E (m)	Direct fire Mode[4] (m)
105mm howitzer	550	550	300	350	550	650
155mm howitzer	725	725	350	550	725	750

Legend for Table 10-2:
VT=Variable Time
Notes:
[1] When the headings of more than one column above relate in some way to the type of firing to be conducted, the column giving the larger value of Area C will be used.
[2] When using fuze multi-option, XM1156, area C is required to be 550m.
[3] Distances in this column represent minimum target engagement distances when personnel at the firing position are unprotected. When using fuze, multi-option, XM1156, direct fire mode will not be used.

Table 10-3
Surface danger zone data for 155mm HE M796 fired from M777A2 and M109A6 weapon platforms using fuze, multi-option, XM1156 Precision Guidance Kit (PGK) zones 1L, 2L, 3H, 7R, 4H, 8S and 5H

QE (mils)	Zone 1L CAMDIV (m)	Zone 1L Area G (m)	Zone 2L CAMDIV (m)	Zone 2L Area G (m)	Zone 3H CAMDIV (m)	Zone 3H Area G (m)	Zones 7R, 4H CAMDIV (m)	Zones 7R, 4H Area G (m)	Zones 8S, 5H CAMDIV (m)	Zones 8S, 5H Area G (m)
200	0	1,025	25	1,840	175	3,090	200	4,170	225	4,529
300	10	1,650	75	2,910	250	4,465	325	5,680	375	6,172
400	25	2,260	75	3,915	275	5,705	350	7,130	450	7,721
500	25	2,770	75	4,800	250	6,860	375	8,395	475	9,115
600	50	3,150	100	5,440	225	7,770	375	9,445	500	10,235
700	75	3,370	75	6,000	250	8,460	375	10,290	575	11,015
800	50	3,455	100	6,180	175	8,830	375	10,780	600	11,560
900	50	3,480	100	6,145	225	8,830	375	10,840	575	11,810
1,000	50	3,285	100	5,870	225	8,395	400	10,370	550	11,541
1,100	50	2,875	100	5,340	200	7,680	400	9,470	550	10,548
1,200	50	2,455	75	4,570	200	6,490	425	7,915	575	8,799

Table 10-4
Surface danger zone data for 155mm HE M549A1 fired from M777A2 and M109A6 weapon platforms using fuze, multi-option, XM1156 Precision Guidance Kit (PGK) zones 3H-R, 7R-R, 4H-R, 8S-R and 5H-R

QE (mils)	Zone 3H-R CAMDIV (m)	Zone 3H-R Area G (m)	Zones 7R-R, 4H-R CAMDIV (m)	Zones 7R-R, 4H-R Area G (m)	Zones 8S-R, 5H-R CAMDIV (m)	Zones 8S-R, 5H-R Area G (m)
200	275	4,865	325	6,465	425	7468
300	425	6,865	525	8,725	650	10,096
400	525	8,520	625	10,800	775	12,300
500	525	10,095	700	12,475	850	14,300
600	500	11,570	775	13,980	1,025	15,880
700	575	12,580	900	15,125	1,250	17,140
800	650	13,255	1,000	15,915	1,500	17,910
900	700	13,305	1,125	15,955	1,675	18,465
1,000	750	12,990	1,150	15,585	1,775	18,543
1,100	700	12,045	1,125	14,495	1,800	17,619
1,200	675	10,400	1,175	12,530	1,875	15,342

Table 10-5
Ricochet Danger Area (RDA) data for 155mm M825 and M1122 series projectiles

Projectile	Propelling charge/zone	Dist X (m)
M825, M1122	M231 (DA12) – 1L	7,100
M825, M1122	M231 (DA12) – 2L	11,100
M825, M1122	M232 (DA13) – 3H	15,100
M825, M1122	M232 (DA13) – 4H	18,200
M825, M1122	M232 (DA13) – 5H	21,800
M825, M1122	M119 (D533) – 7R	17,600
M825, M1122	M203 (D532) – 8s	21,700

i. Weapon system crews firing from approved tactical configurations are authorized access to Area E. Operational and range operations (Army), range control (Marine Corps) personnel involved in firing exercises with a valid need to enter Area E may do so at the approval of the installation RMA (Army), RCO (Marine Corps).

j. When firing in the direct mode, Distance X will not be less than the range of the weapon system corresponding to a QE of 15 degrees for a given charge.

k. Area C is increased to 2,400m when firing M107 HE ammunitions filled with (trinitrotoluene) TNT.

10–5. Bunkers and fighting vehicles

a. Light field artillery fire, up to and including 105mm howitzer, may impact no closer than 100m to occupied bunkers. Medium and heavy field artillery fire above 105mm may impact no closer than 200m to occupied bunkers. Ammunition certified for overhead fire must be used. Bunkers must have been constructed and approved to protect personnel from a direct hit by the ammunition being fired. Constant communication must be maintained between the firing position and bunkers. Observation from bunkers will be by indirect viewing such as periscopes unless an approved design for direct viewing has been provided.

b. Bunkers to be used in accordance with paragraph 10–5*a* will be designed and constructed using specifications provided by the facility engineer. The installation engineer will review designs before final approval to ensure that structural integrity is maintained against direct hits and penetrating fragments. Direct viewing methods will be designed and constructed according to specifications provided by the facility engineer.

c. Personnel occupation of Areas A, B, and C is not authorized except when bunkers are constructed in accordance with paragraph 10–5*a*. Personnel access to Area C is not authorized unless protective cover exists that is designed in accordance with paragraph 10–5*a*, for positive protection against a direct hit. Tanks and fighting vehicles with hatches closed are permitted in Area C when field artillery ammunition is fired overhead with variable time (VT) or time fuzes. Height of burst data in table 10–6 will be used to provide an adequate degree of safety to protect personnel and materiel from ammunition fired with VT or time fuzes. The following procedures apply when firing over tanks and fighting vehicles:

(1) Use sufficient QE so that if the time element of the fuze fails to function, the projectile will land beyond the tank or fighting vehicle at a distance equal to the predicted height of burst plus four PE_R.

(2) Only certified ammunition (projectiles, propellant/tailcharge, and fuzes) will be fired over the heads of unprotected personnel.

Table 10–6
Heights of burst above occupied fighting vehicles

Vehicle	Distance 105mm (m)	Above vehicle 155mm (m)
Fighting vehicles[1]	125	150
M1/M1A1 Tank	40	55

Notes:
[1]Fighting vehicles include the M106, M109, M113, M125, M577, M2, M3, Stryker, Light Armored Vehicle, and Amphibious Assault Vehicle

10–6. Overhead fire

a. Overhead fire of unprotected personnel located in Area D is authorized during training provided certified ammunition for overhead fire (projectile, propellant/tailcharge, and fuze) is used. (For the Marine Corps' EFSS M327 mortar, only the M1101 HE, M1103 WP, and M1105 Illumination projectiles with M237 tailcharge are authorized for overhead fire.) Senior commanders (Army)/installation commanders (Marine Corps) may authorize nonparticipating personnel access to Area D during indirect field artillery and EFSS 120mm (rifled) mortar firing. When public highways pass through Area D, coordination with appropriate government officials (Federal, State, and/or local) and/or land owner(s) is required. When public roadways and railways pass through Area D, the following precautions apply:

(1) Projectile trajectories must clear unprotected personnel or objects by at least 5m plus two forks. If the minimum range line (arc) is greater than the distance to the near edge of the target area, use the computed minimum range line (arc) for the near edge of the target area.

(2) Unless personnel are provided cover designed to withstand a direct hit, the minimum arming time of the proximity (VT) fuze establishes the near edge of the impact area. The minimum arming time of the proximity (VT) fuze will be the time set on the fuze corresponding to the range to the near limit of the impact area or computed minimum range line, whichever is greater, plus 5.5 seconds.

(3) Forward movement of personnel within Area D requires that the SDZ advance according to the distance and direction of the personnel. If proximity or VT fuzes with adjustable arming times are used, forward movement of personnel is possible. VT fuze time settings will correspond to the range to the near limit of the impact area plus 5.5 seconds.

(4) Warnings that field artillery projectiles may be fired at any time of the day will be posted on public roadways approved for overhead fire that passes through an installation or community.

b. If rocket assisted projectiles will be fired over the heads of unprotected troops during training exercises, ensure compliance with provisions of paragraph 10–3g.

10–7. Expeditionary Fire Support System M327 120mm rifled towed mortar

For the Marine Corps, the EFSS M327 120mm rifled towed mortar uses an SDZ similar to that of an artillery weapon system when firing spin-stabilized ammunition. Table 10–7 and figure 10–1 will be used to construct the SDZ for the EFSS M327 120mm rifled towed mortar. When firing fin-stabilized ammunition from the EFSS M327 120mm rifled towed mortar, use the SDZ in figure 9–1 and the data from table 9–1.

Table 10–7
Surface danger zone data for Expeditionary Fire Support System (EFSS) M327 120mm (rifled) towed mortar (Marine Corps)

Area A (m)	Area B (m)	Area C (m)	Area E (m)
312	312	312	350

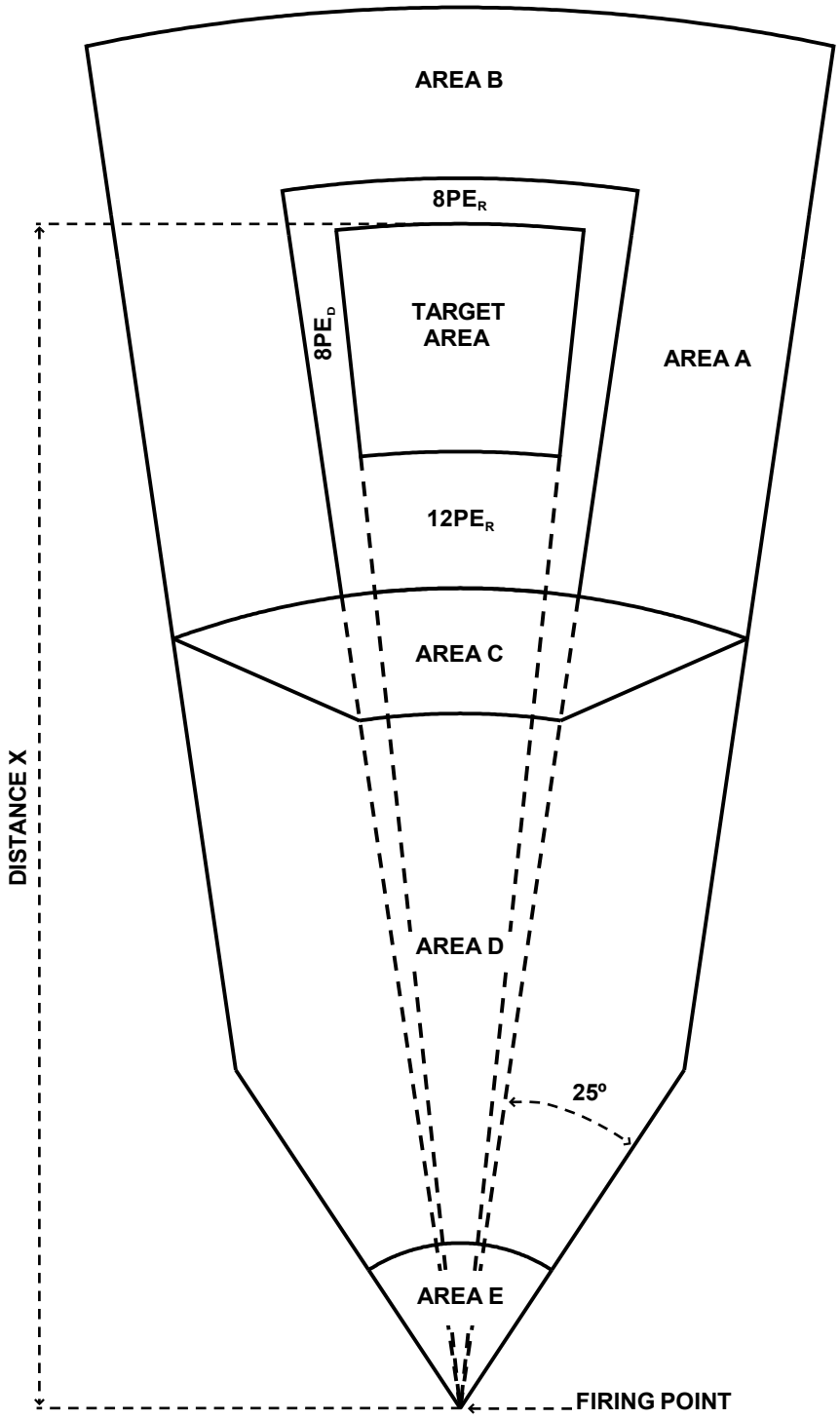


Figure 10–1. Surface danger zone for field artillery cannons and Expeditionary Fire Support System (EFSS) 120mm (rifled) towed mortar firing in the indirect mode at ground, fixed, or moving targets

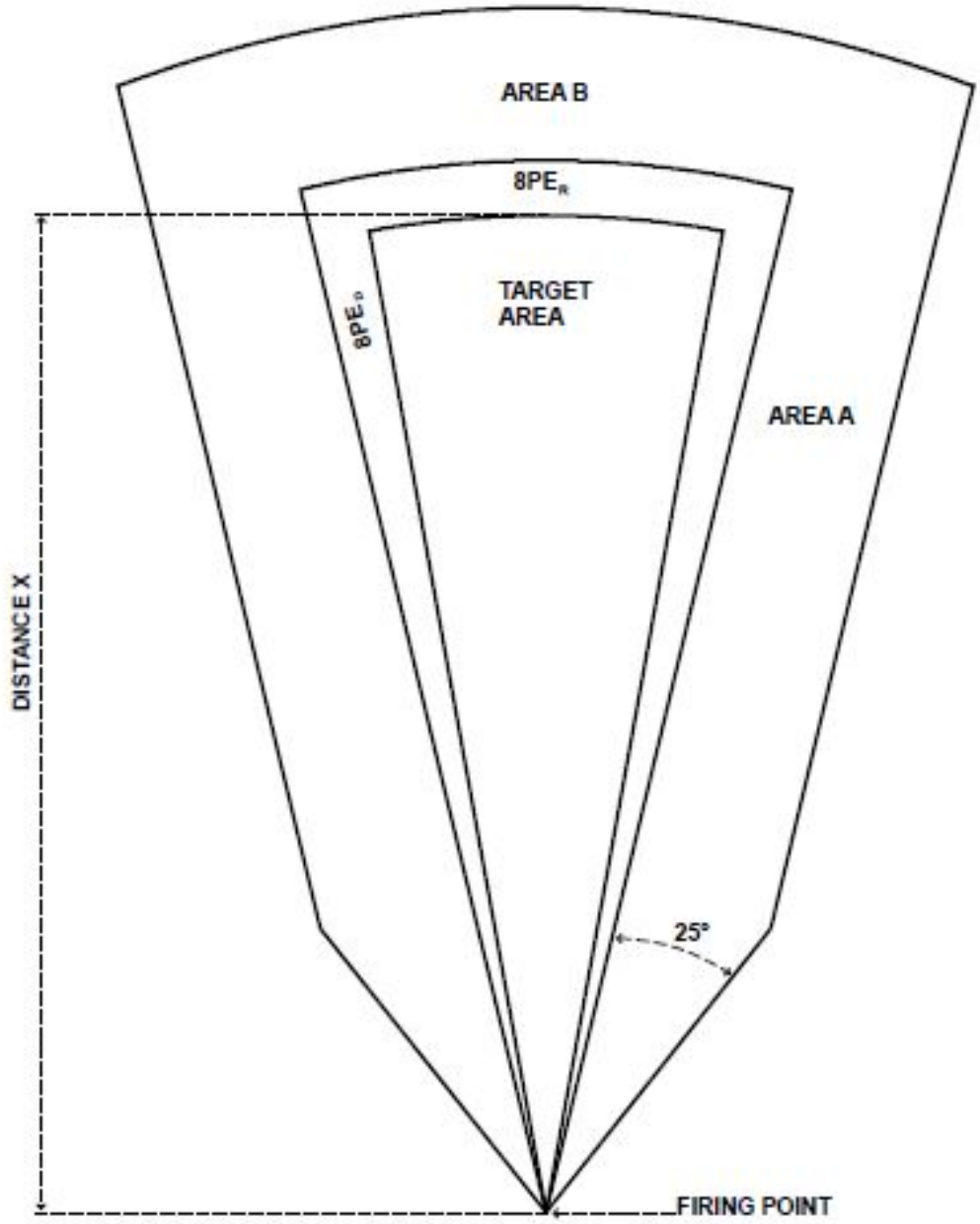


Figure 10–2. Surface danger zone for field artillery cannon firing in the direct mode at ground, fixed, or moving targets

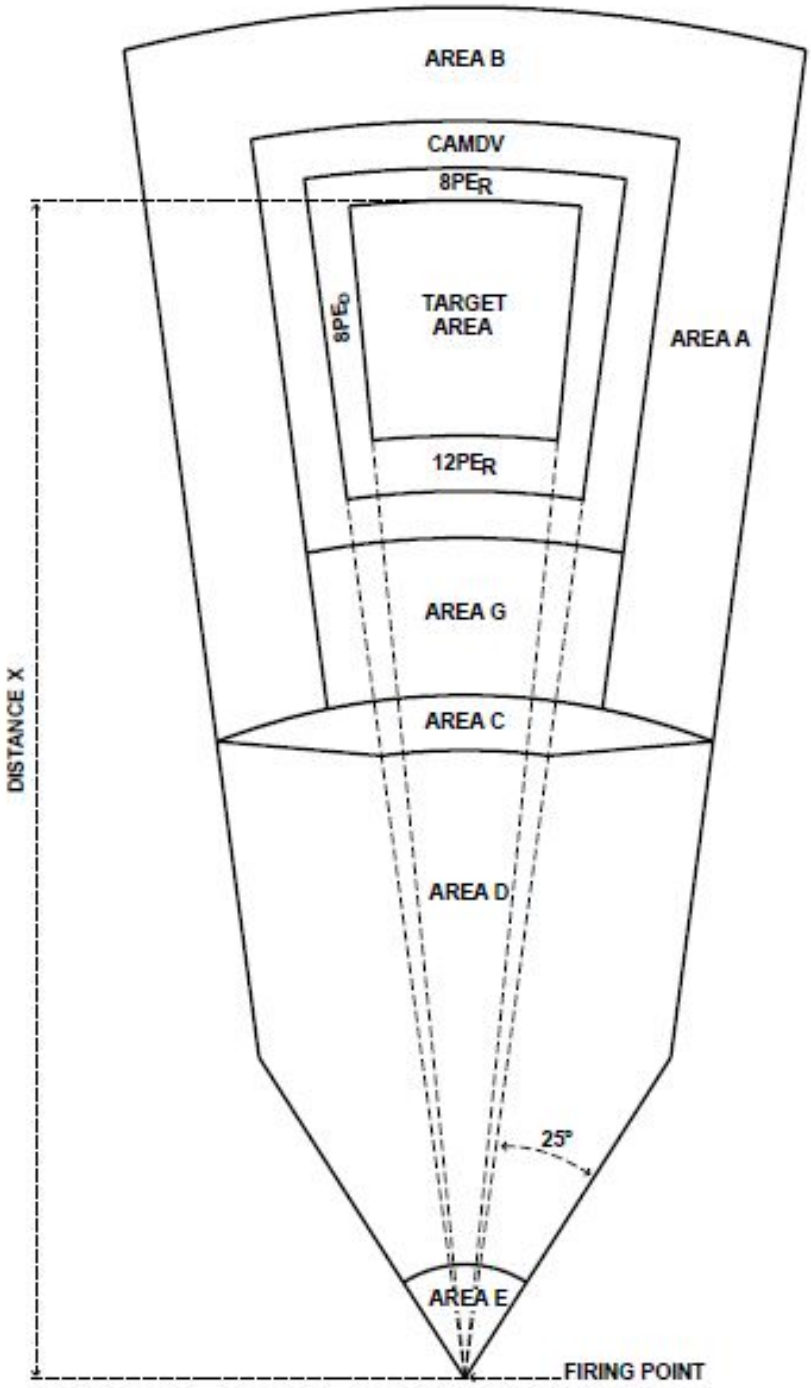


Figure 10-3. Surface danger zone for 155mm HE M795 fired from M777A2 and M109A6 weapon platforms using fuze, multi-option, XM1156 Precision Guidance Kit (PGK) zones 1L, 2L, 3H, 7R, 4H, 8S, 5H, 3H-R, 7R-R, 4H-R, 8S-R and 5H-R

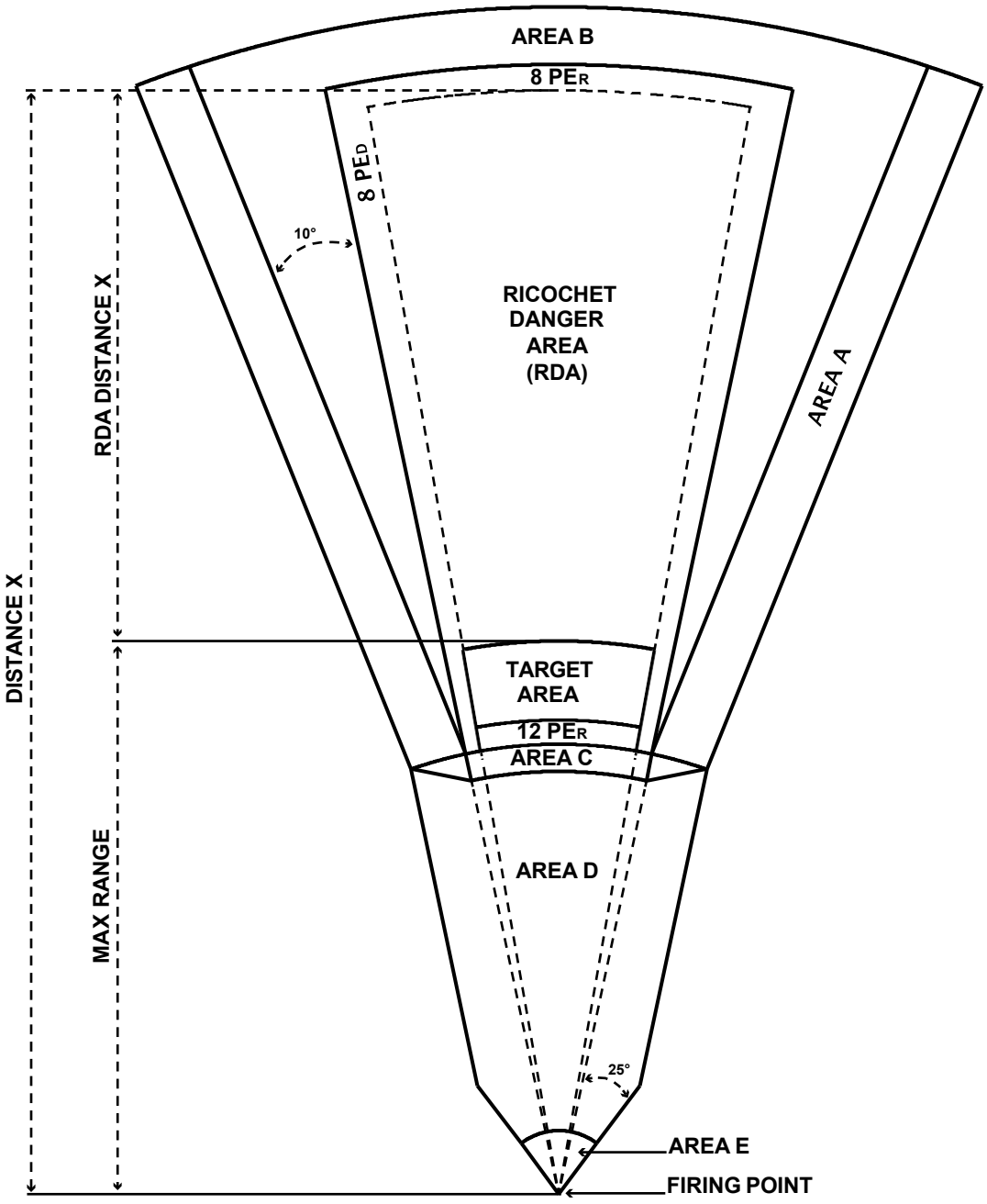


Figure 10-4. Ricochet Danger Area (RDA) for 155mm M825 series and M1122 projectiles

10–8. Anti-personnel ammunition (Army)

a. Firing conditions.

(1) APERS ammunition is available for 105mm cannon artillery. It is designed for use against personnel in direct fire, muzzle action, or direct fire missions with a time setting.

(2) APERS ammunition will not be fired over the heads of unprotected personnel. Hardware discarded by functioning of APERS projectiles presents a potential hazard to personnel to the side and rear of the weapon.

b. Surface danger zone.

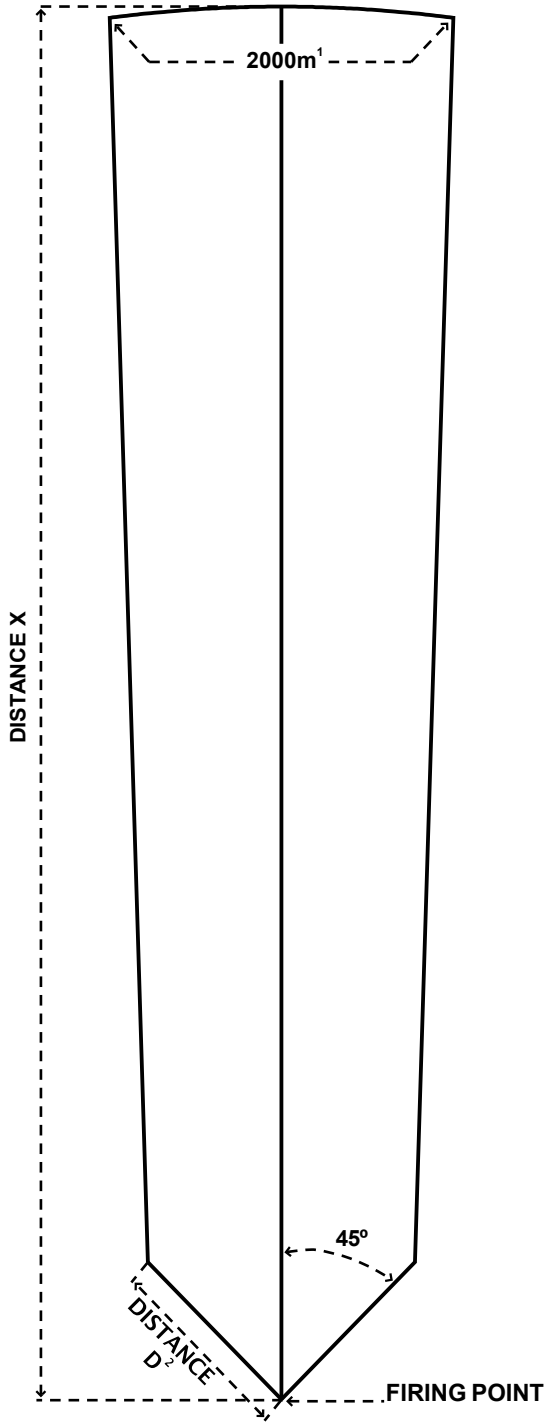
(1) SDZ requirements for APERS ammunition is given in table 10–8 and figure 10–5.

(2) Distance X is based on the range at 15 degrees QE.

(3) For other than muzzle action functioning, begin APERS SDZ construction downrange at a distance equal to the time of fuze setting.

Table 10–8
Maximum range data sources for improved conventional munitions

Model Number	Reference
M444	Standard 105mm Firing Tables for M1
M449	Standard 155mm Firing Tables for M107 w/FT–155–ADD–I–2
M483	Firing Tables FT 155–AN–2 w/C–1



Notes:
[1] WARNING: Hardware discarded by the functioning of the projectile presents a potential hazard to unprotected personnel located to the side and rear of the weapon.
[2] Distance is 2,000m or 1.41D, whichever is greater.
[3] For Distance X and Distance D, see table 10-8.

Figure 10-5. Surface danger zone for 105mm howitzer M102, M119 and M546 field artillery cannon with antipersonnel ammunition (APERS) in the direct fire mode at fixed or moving targets

10–9. Flight corridors (refer to chapter 11 for aviation range safety)

Flight corridors are created to vertically and laterally separate aircraft from surface fires. Aircraft may operate within or pass through artillery cannon danger zones, provided —

a. They are established where the maximum altitude of the aircraft will be below the ordinate corresponding to the minimum QE of the ammunition being fired above the flight corridor and corrected for density altitude. Flight corridors may provide access only through Area D. (See figs 10–1 and 10–6.) Altitudes in flight corridors will be indicated in MSL.

b. Permanent aircraft flight corridors are established under firing corridors. Corridors will be through Area D and outside Areas C and E. Altitude restrictions will be in accordance with paragraph *a*, above. Corridors will follow easily identifiable markers and routes. Flight control points will be established and aircrews briefed on flight navigation procedures. Maps of flight corridors (fig 10–7) will be made available at installation range operations (Army), range control (Marine Corps), facilities base operations, and other locations deemed appropriate by the installation RMA (Army), RCO (Marine Corps).

c. Communications will be maintained among the designated aircraft, range operations firing desk (Army), range control (Marine Corps), and the firing unit on a common communications network. Aircraft will report entry and exit of specific vertical danger zones. This is not applicable to aircraft operating as part of tactical exercises with firing elements provided communication is maintained between participants. A communications failure with aircraft in a flight corridor requires an immediate cease-fire. These procedures will be established by local SOP.

d. Aircraft operating within SDZs as part of an exercise will remain a minimum of 500m from GTLs and outside of Areas C and E.

e. Only ammunition certified for overhead fire will be used when aircraft are operating in or passing over SDZs.

f. Uncontrolled flights within SDZs are not authorized.

g. Computing the stay above (SA) and stay below (SB) distances (for feet AGL) you must —

(1) Determine the GTL and the firing unit range to target.

(2) Determine the munitions type and charge being fired.

(3) Determine the vertical interval (VI) (VI=target altitude - firing unit altitude in meters).

(4) Determine where the final attack heading (FAH) or cone crosses the GTL and the gun target range at those points.

(5) Refer to the appropriate trajectory chart by munitions/charge and determine the arc corresponding to range to target.

(6) Determine the altitude (in meters) corresponding to the ranges where the final attack cone crosses the GTL by tracing the arc to those ranges.

(a) Highest altitude + VI=ALT 1. Multiply by 3.3 to convert to feet. (Note: if the final attack cone straddles the summit of the trajectory, use the Max Ord for ALT 1).

(b) Lowest altitude + VI=ALT 1. Multiply by 3.3 to convert to feet.

(7) Incorporate a 1000 foot buffer for all nonstandard conditions.

(a) ALT 1 + 1,000 ft=SA (expressed to the next highest 100 ft AGL).

(b) ALT 1 - 1,000 ft=SB (expressed safe to the next lowest 100 ft AGL).

h. Computing the SA and SB distances (for feet MSL) you must—

(1) Determine the range to target in meters.

(2) Determine the projectile and charge trajectory.

(3) Determine target altitude in meters.

(4) Plot final attack heading from intersecting point 1 (IP 1) to intersecting point 2 (IP 2)) in degrees magnetic.

(5) Determine where FAH intersects GTL at (IP 1) and (IP 2).

(6) Determine chart ordinate in meters at (IP 1) and (IP 2).

(7) Add target altitude to (IP 1) and (IP 2).

(8) Convert to feet (IP1) X 3.3 and (IP2) X 3.3.

(9) Add 1,000 ft to (IP 1) and subtract 1,000 ft from (IP 2).

i. When computing stay above or stay below the general rule is that if the FAH straddles the Max Ord, compute SA and SB against the Max Ord + or - 1000 ft.

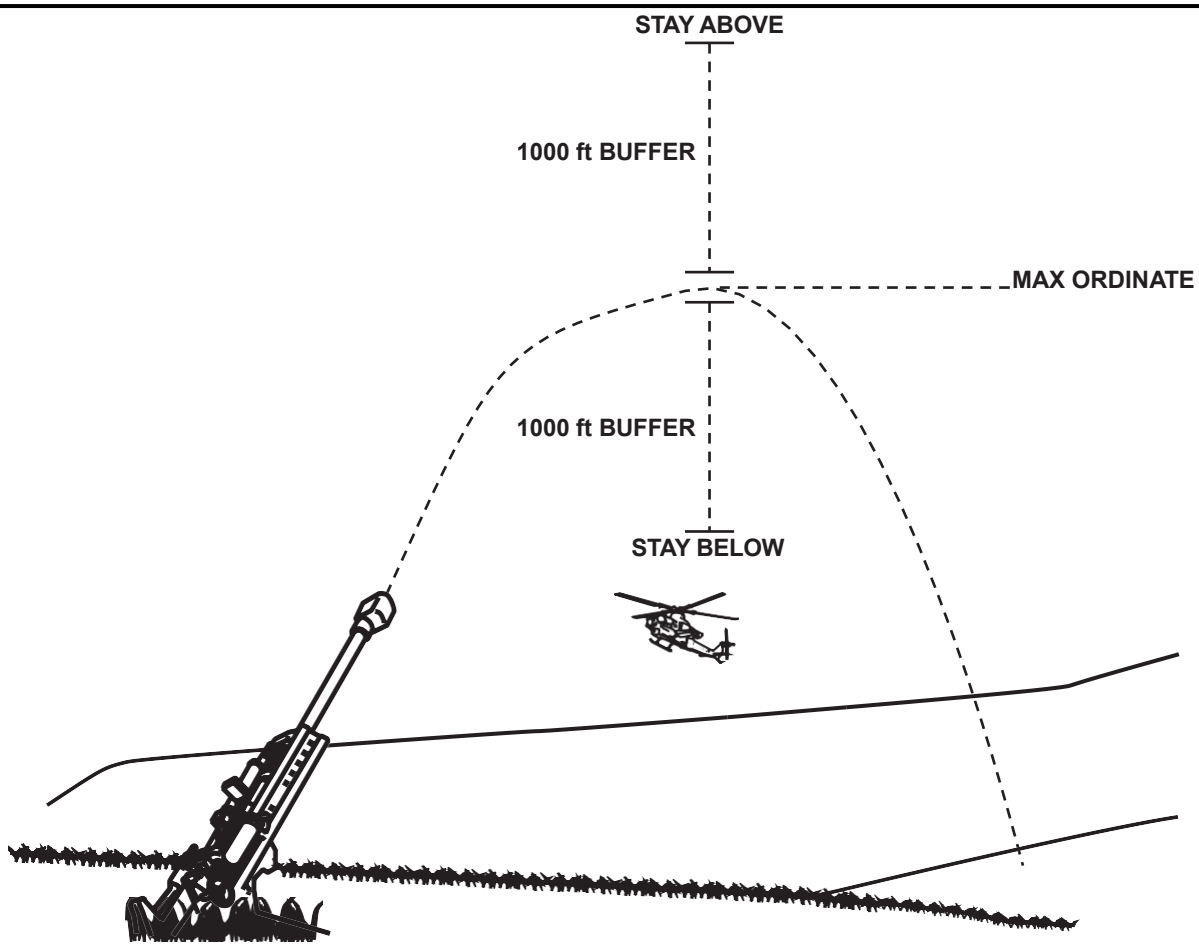


Figure 10–6. Flight corridor for field artillery cannon firing over aircraft

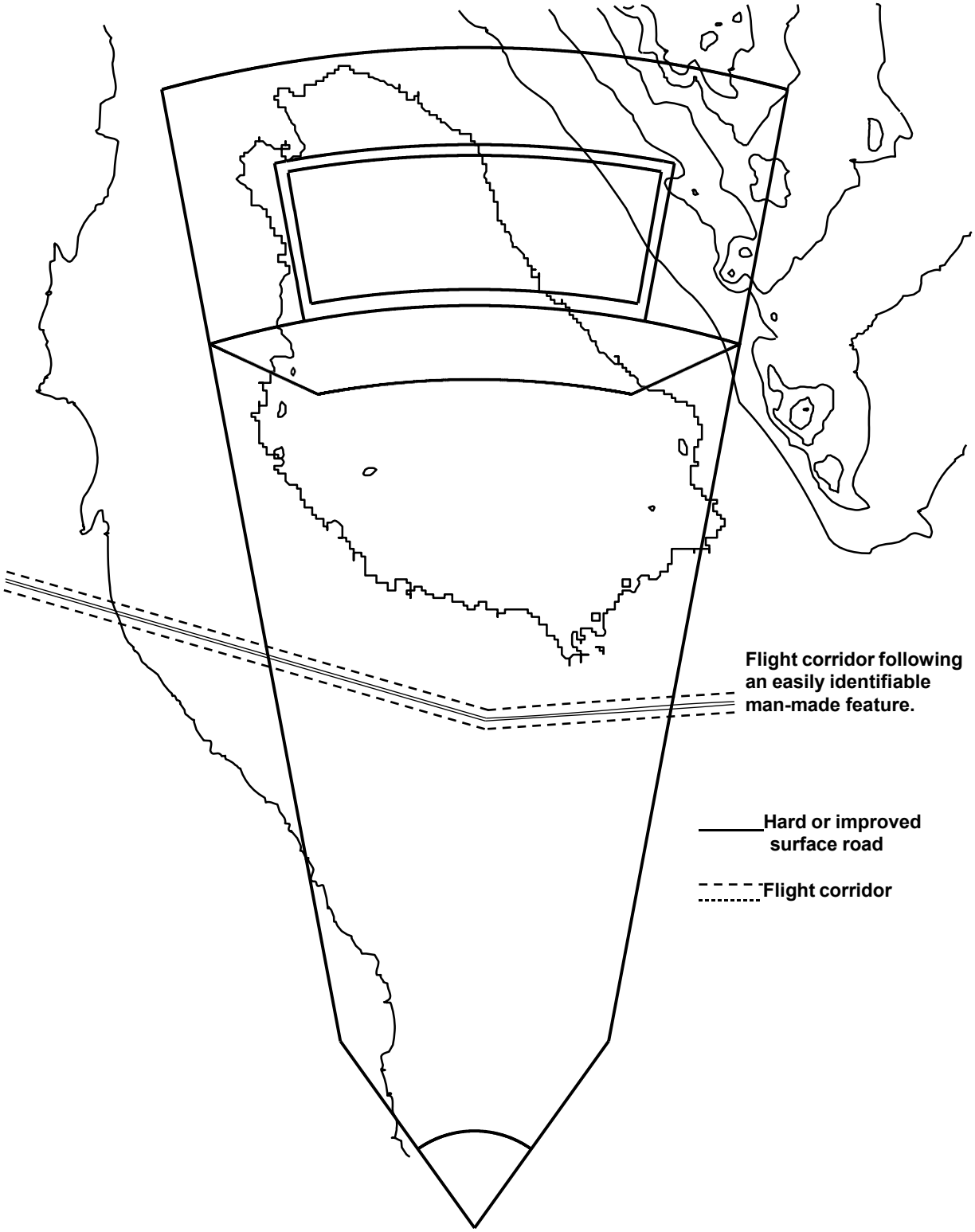


Figure 10–7. An example of an established flight corridor

10–10. Improved conventional munitions

a. Firing conditions.

(1) The firing of live ICM projectiles and dropping of aircraft-delivered live sub-munitions on Army

ranges in training are prohibited.

(2) For the Marine Corps, the firing of dual-purpose improved conventional munitions is authorized in accordance with MCO 8011.4 and current MCBul 8011. Local range SOPs will dictate the specific conditions under which dual-purpose improved conventional munitions may be employed in training.

(3) ICM projectiles will not be fired over the heads of troops in training exercises.

(4) When ICM carriers fail to function and impact on hard surfaces, up range and lateral ricochets of up to 500m may occur.

b. Surface danger zone.

(1) Requirements for field artillery cannon fired ICM are given in figures 10–1. Conventional ballistic tabular firing table data for the particular caliber projectile and weapon system combination will be used to determine maximum range when firing ICM projectiles. (See table 10–9).

(2) The impact area should be relatively flat and free from heavy vegetation.

(3) Danger Areas A and B will be observed for all firings of ICM projectiles. The data necessary to determine each of these are in table 10–10.

(4) The special design of ICM projectiles subjects them to the effects of wind velocity more than standard conventional projectiles. Sub-missile drift factors listed in table 10–11 may be added to or subtracted from the basic trajectory distances presented in respective ballistic tabular firing tables. For example, if the wind is blowing at 50 knots from the gun position toward the target and the gun is being fired at 600mil (33.75 degrees), the maximum range from the firing table will be increased by 150m. If the wind is coming perpendicular (left to right) to the GTL, the right deflection will be increased 160m and the left deflection will be decreased 160m.

Table 10–9
Surface danger zone data for improved conventional munitions areas A, B, and C

Cartridge	Areas A, B, C[1] (M)
M444	440
M449	480
M404	485
M483, M915	650

Notes:
[1]Values for Areas A, B, and C include a maximum wind sub-missile drift of 250m in a 50 knot wind.

Table 10–10
Sub-missile drift factors for improved conventional munitions

Wind velocity (knots)	Elevation (mils)	Maximum range drift (m)	Maximum deflection (m)
50	300	250	250
50	600	150	160
50	1,150	100	100
10	300	50	50
10	600	40	30
10	1,150	20	20

Table 10–11
Surface danger zone data for Multiple Launch Rocket System (MLRS)/High Mobility Artillery Rocket System (HIMARS)

Range to target (m)	Dist X[2] (m)	Dist W (m)
Min to 11,500	See note 2	840
11,501 to 15,000	5,000+H[1]	1,000
15,001 to 20,000	3,700+H[1]	1,300
20,001 to 23,000	1,900+H[1]	1,500
23,001 to 27,000	2,300+H[1]	1,900
27,001 to Max	2,700+H[1]	2,900

Notes:
[1]H is the height of launcher above MSL in meters.
[2]For targets less than 11,500 m from the launcher, Distance X shall vary so that the distance from the launcher to the far edge of the impact area shall be 16,700 + H meters. Adding Area B results in a minimum required distance of 18,000 + H for short shots.

10–11. Multiple Launch Rocket System and High Mobility Artillery Rocket System

a. Firing conditions.

(1) All non-mission-essential personnel will be cleared from the SDZ.

(2) Meteorological data in use at the fire control system will not be more than 4 hours old.

(3) The weapon system navigation unit must be verified as correct. Ensure that the launcher is properly calibrated (M270 only), updated with a verified survey control point (if not using global positioning system navigation, and that startup data is correct.

(4) Fire control system internal tests must be successfully completed.

(5) Firings will not be conducted if:

(a) There is any question of proper operation of the launcher.

(b) The winds have changed dramatically since meteorological data was taken.

(c) Any other sign of abnormal operation is evident.

(6) Safe separation distance between Multiple Launch Rocket System (MLRS) and High Mobility Artillery Rocket System (HIMARS) launchers firing simultaneously is 55m.

b. Surface danger zone.

(1) MLRS/HIMARS safety computations are contained in Army Techniques Publication (ATP) 3–09.60 and Marine Corps Reference Publication (MCRP) 3–1.6.24. Values for Distance W and Distance X in ATP 3–09.60 and MCRP 3–1.6.24 have danger Areas A and B included in their values.

(2) MLRS/HIMARS SDZ requirements for practice and tactical (for combat only with M77 grenade payload) warheads are provided in table 10–12 and figures 10–8 and 10–9. Dimensions of the SDZ vary according to range to target and launcher height above MSL. The SDZ consists of an impact area, Areas A, B, and F and exclusion Areas I, II, and III forming a rectangle around the target with a corresponding flight corridor back toward the launcher.

(3) The rectangular impact area extends X meters beyond the target, Distance W to the left and right of the target, and 2,200m from the target toward the launcher (Distance Y). The construction of the SDZ is completed by connecting the near left and right corners of the rectangle to respective points 350m to the left and right of the launcher. The impact area is designed to contain fragments and debris (payload, warhead skin, and rocket motor) from normal functioning rockets. Distance X is adequate to contain rockets when the fuze fails to function.

(4) Area A is 320m.

(5) Area B is 1,300m.

(6) Exclusion Area I is the 4,700m area that extends forward of the launcher. It is endangered by premature fuze function or failure of the rocket motor during boost phase. Exclusion Area I may be reduced to not less than 1,000m by deviation.

(7) Exclusion Area III is an area 1,800m on the up-range side of the impact area and parallel to Area B. This area is designed to contain fragments and debris from early functioning warheads at the near edge of the impact area.

(8) Exclusion Area II is the remaining area located between Exclusion Areas I and III once these areas are constructed. Occupation of Exclusion Area II by unprotected personnel is authorized only under an approved deviation. Length of Exclusion Area II varies with range to target.

(9) Area F is the area immediately to the rear of the launcher directly exposed to blast overpressure, fragments, and debris from rocket launch. Area F consists of two parts, the launcher danger area (LDA) and the noise hazard area (NHA). The LDA extends 350m to each side of the launcher and 400m to the rear. Personnel are not authorized to occupy the LDA during firing. The NHA extends an additional 300m to 500m past the LDA and may only be occupied by participating personnel wearing approved hearing protection.

(10) Fin release failure impact area is required only for tactical rockets. This area is a sector with an origin at the launcher with a radius of 12,500m. It includes a total angular measurement of 114 degrees centered about the azimuth of fire.

Table 10-12
Guided Multiple Launch Rocket System (GLMRS) variants

Munition	Designator	Warhead
Guided MLRS Rocket	M30	M85 DPICM Bomblets
Guided MLRS with Alternate Warhead	M30A1	Unitary, PBXN-110, Tungsten spheres
Guided Unitary	M31	Unitary, PBXN-109, helical-grooved steel skin
Guided Unitary with Tri-Mode Fuze	M31A1	Unitary, PBXN-109, helical-grooved steel skin

Notes:
[1]H is the height of launcher above MSL in meters.

[2]For targets less than 11,500 m from the launcher, Distance X shall vary so that the distance from the launcher to the far edge of the impact area shall be 16,700 + H meters. Adding Area B results in a minimum required distance of 18,000 + H for short shots.

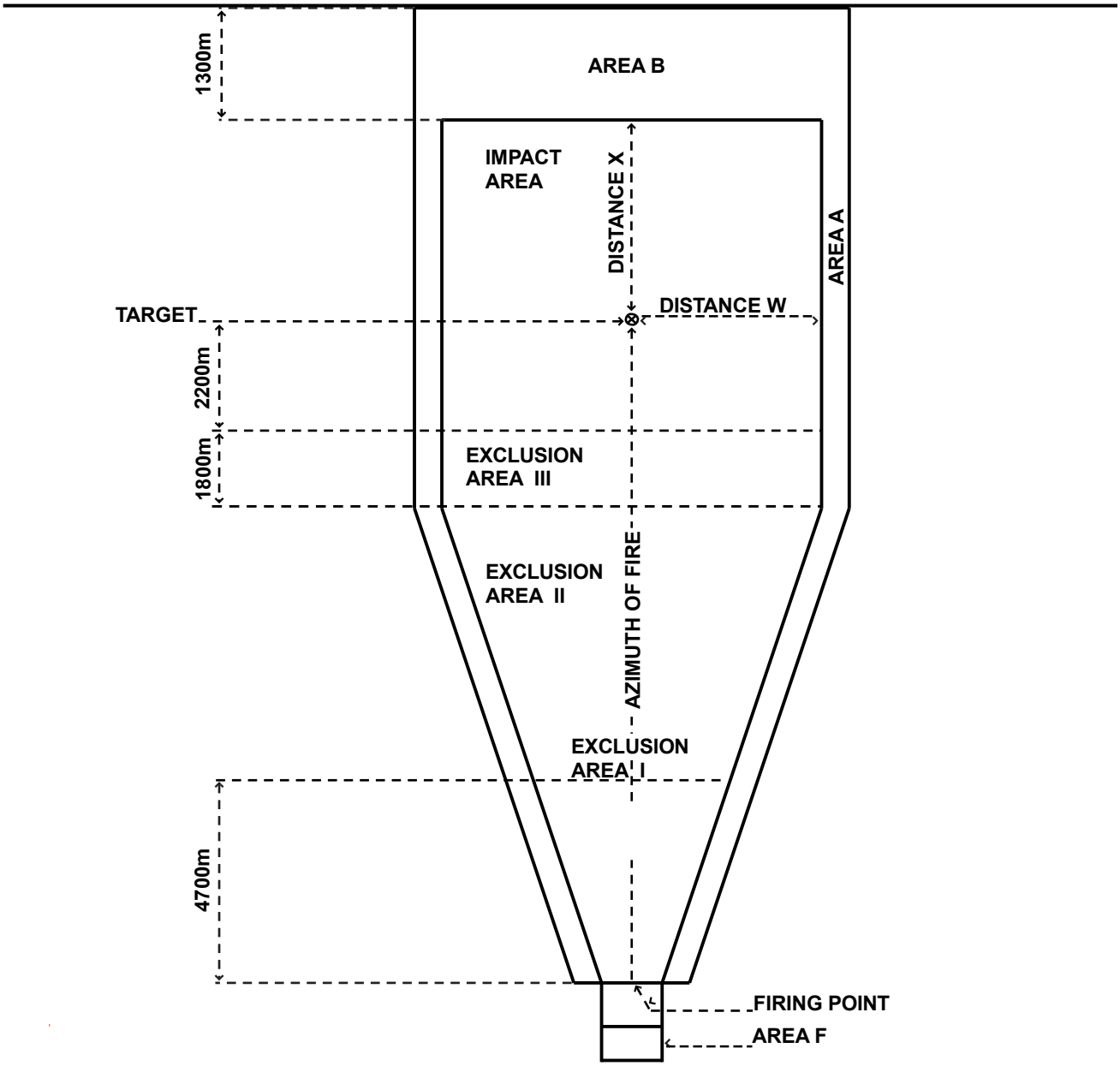


Figure 10–8. Surface danger zone for Multiple Launch Rocket System (MLRS)/High Mobility Artillery Rocket System (HIMARS)

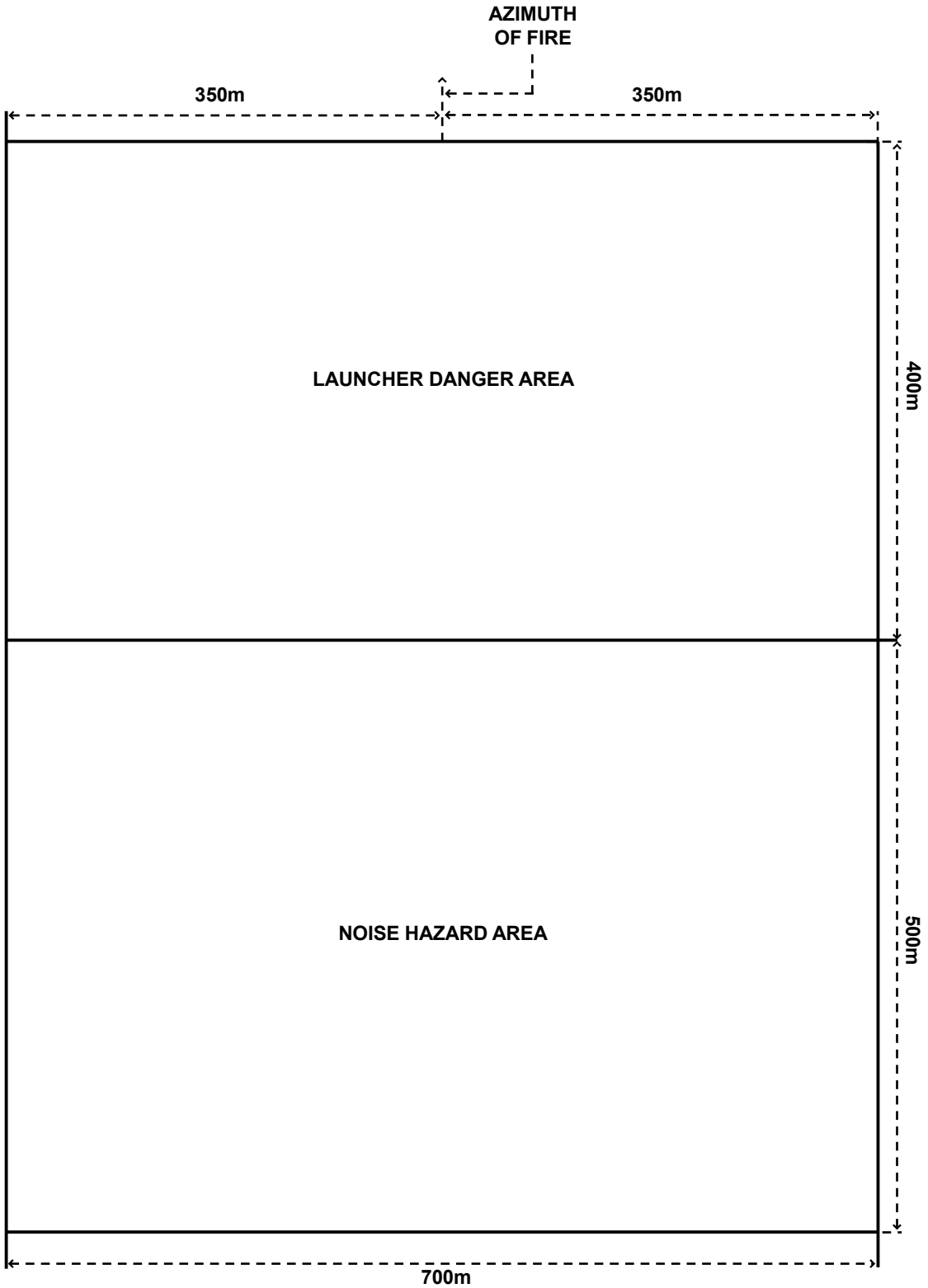


Figure 10–9. Surface danger zone, area F, for Multiple Launch Rocket System (MLRS)/High Mobility Artillery Rocket System (HIMARS)

10–12. Multiple Launch Rocket System/High Mobility Artillery Rocket System reduced range practice rocket

a. Firing conditions for MLRS/HIMARS reduced range practice rocket (RRPR) are the same as for standard MLRS and HIMARS (see para 10–12*a*).

b. Surface danger zone.

(1) MLRS/HIMARS RRPR SDZ requirements are given in table 10–13 and figures 10–10, 10–11, 10–12, 10–13, and 10–14.

(2) The SDZ consists of an impact area, a target area or target point, a safety fan [for firing point to point and operational area (OPAREA) SDZs only], flight corridors, Exclusion Areas I and II, and Area F.

(3) The SDZ impact area is the rectangular area that will contain all but one in one million normally functioning rockets and debris. It is perpendicular to and bisected by the azimuth of fire.

(4) Distances W, X, and Y are buffer distances accounting for debris distribution. Applied inward to determine target areas or outward from a single point, these buffers ensure that less than one in one million normally functioning rockets impact outside prescribed safety limits. With regard to the azimuth of fire, Distance X is beyond the target, Distance Y is short of the target, and Distance W is to the flanks of the target.

(5) For the point-to-point method, the target box is determined by applying the values found in table 10–12, up range, downrange, and laterally from the target location.

(6) The safety fan is defined by range and lateral limits within the target area.

(7) The flight corridors are areas parallel to the limits of the safety fan that extend from the forward corners of Area F to the far edge of the SDZ impact area.

(8) Exclusion Area I is the danger area directly in front of the firing point or OPAREA. This area extends 2,500m toward the impact area (1:10,000 probability of injury). Based on risk estimates, Exclusion Area I may be reduced, by deviation, to not less than 1,000m (1:1000 probability of injury) (see figures 10-11 and 10–12).

(9) Exclusion Area II is the danger area between the forward limit of Exclusion Area I and the SDZ impact area. Exclusion Area II may be occupied by deviation only, per the criteria for overhead fire described in paragraph 10–11*c*.

(10) Area F is the area immediately to the rear of the launcher or OPAREA. Personnel may be exposed to blast overpressure, fragments, and debris from rocket launch. Area F extends 350m to each side of the launcher and 400m to the rear for point to point or firing point safety methods. It extends 400m to each side of the OPAREA and 40m to the rear of the OPAREA for OPAREA firing method. Personnel are not authorized to occupy Area F during firing. The NHA extends an additional 300m past Area F and may only be occupied by mission-essential personnel wearing approved hearing protection.

(11) The target selection box (firing point and OPAREA SDZ only) is the set of all points from which a unit may select targets that will generate safe data regardless of where the launcher is within the OPAREA.

c. Overhead fire.

(1) The RRPR contains the same rocket motor failure potential as the basic rocket. However, because the RRPR does not have an explosive warhead event, the risk of firing over the heads of personnel authorized to occupy the SDZ is less than with the basic practice rocket.

(2) To calculate the risk of injury to personnel during overhead fire of RRPR under deviation, use a short round probability of 1 per 10,000 (.0001) firing when a 2,500m Exclusion Area I is used. If a 1,000m Exclusion Area I is used, a short round probability of 1 per 1,000 firings should be used. This information should be used in conjunction with personnel density and areas occupied to calculate risk to personnel on a per-shot basis.

(3) An evaluation of the RRPR flight corridor is necessary to ensure accurate risk assessment and provide options for improved training and firing flexibility. Two options for assessing probability are as follows:

(a) If a 2,500m Exclusion Area I in front of the launcher is used, a short round probability of 1 per 10,000 firings should be applied.

(b) If a 1,000m Exclusion Area I in front of the launcher is used, a short round probability of 1 per 1,000 firings should be applied.

(4) For both options, the short round hazardous debris area to be used for ranges up to 12 km is 300 x 100m; for ranges from 12.1 km to 15 km, use 100 x 50m.

(5) The calculations in figure 10–15 are provided to assist in determining risk of RRPR overhead fire and should be chosen based on the training mission requirements.

(6) These calculations provide for the ability to estimate a reasonable probability of injury(ies) or vehicle damage. They are estimates and assume a certain level of randomness and uniformity. The probabilities are established so that, although grouping of troops could result in multiple injuries, this grouping would also

realistically result in a lower overall probability of injury.

(7) MLRS/HIMARS safety computations are contained in ATP 3–09.60 and MCRP 3–1.6.24.

Table 10-13
Surface danger zone data for M30, M30A1, M31 and M31A1 Guided Multiple Launch Rocket System (GLMRS)

Range to target (m)	Dist X (m)	Dist W (m)
15,000	47,000+H[1]	20,000
20,000	56,000+H[1]	20,000
25,000	60,000+H[1]	20,000
30,000	55,000+H[1]	20,000
35,000	50,000+H[1]	20,000
40,000	45,000+H[1]	20,000
45,000	40,000+H[1]	20,000
50,000	35,000+H[1]	20,000
55,000	30,000+H[1]	20,000
60,000-95,000	27,000+H[1]	20,000

Notes:
[1]H is the height of launcher above MSL in meters

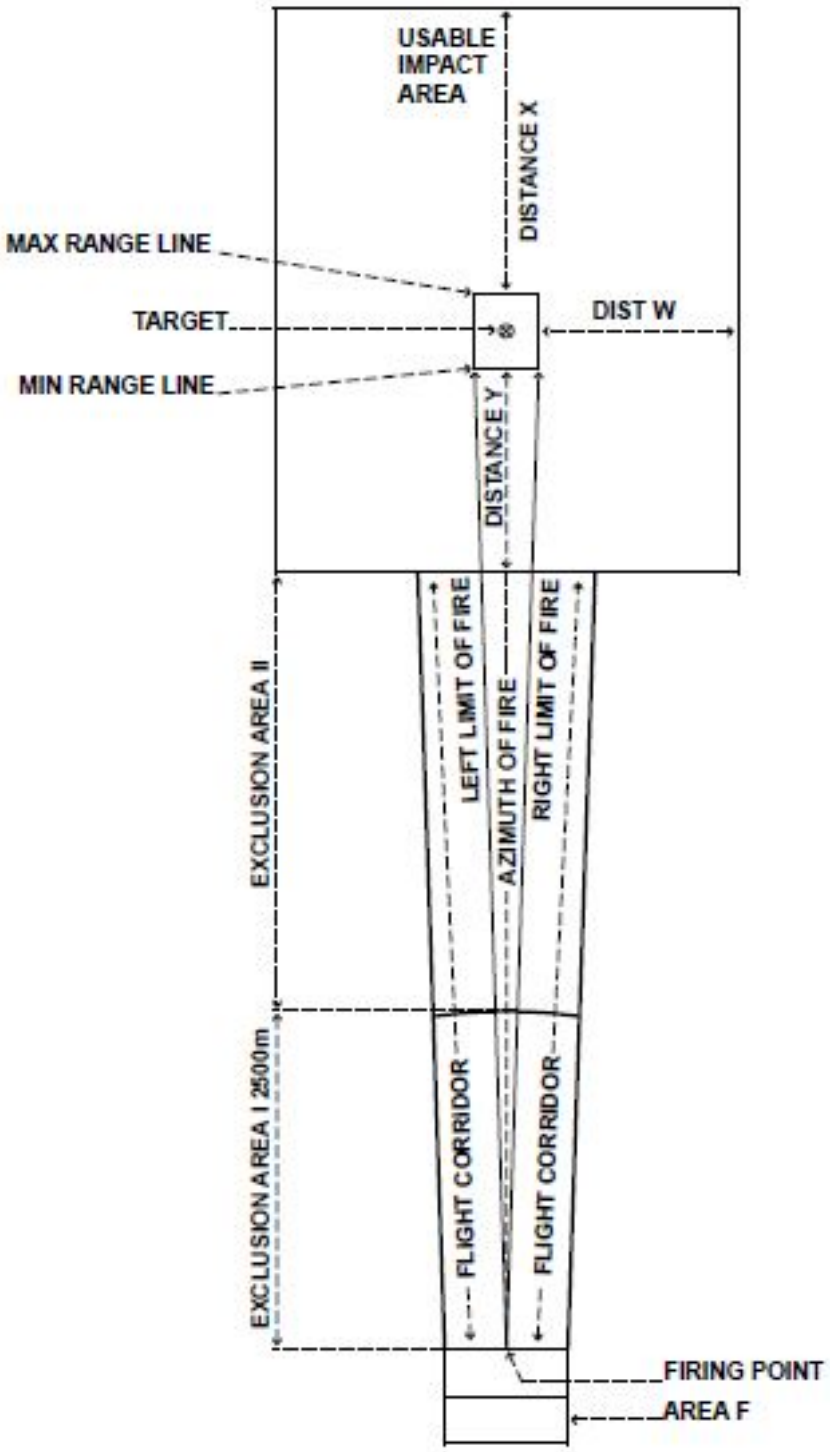


Figure 10–10. Surface danger zone for Multiple Launch Rocket System (MLRS) High Mobility Artillery Rocket Systems (HIMARS) Reduced Range Practice Rocket (RRPR) Guided Multiple Launch Rocket System (GMLRS) point to point

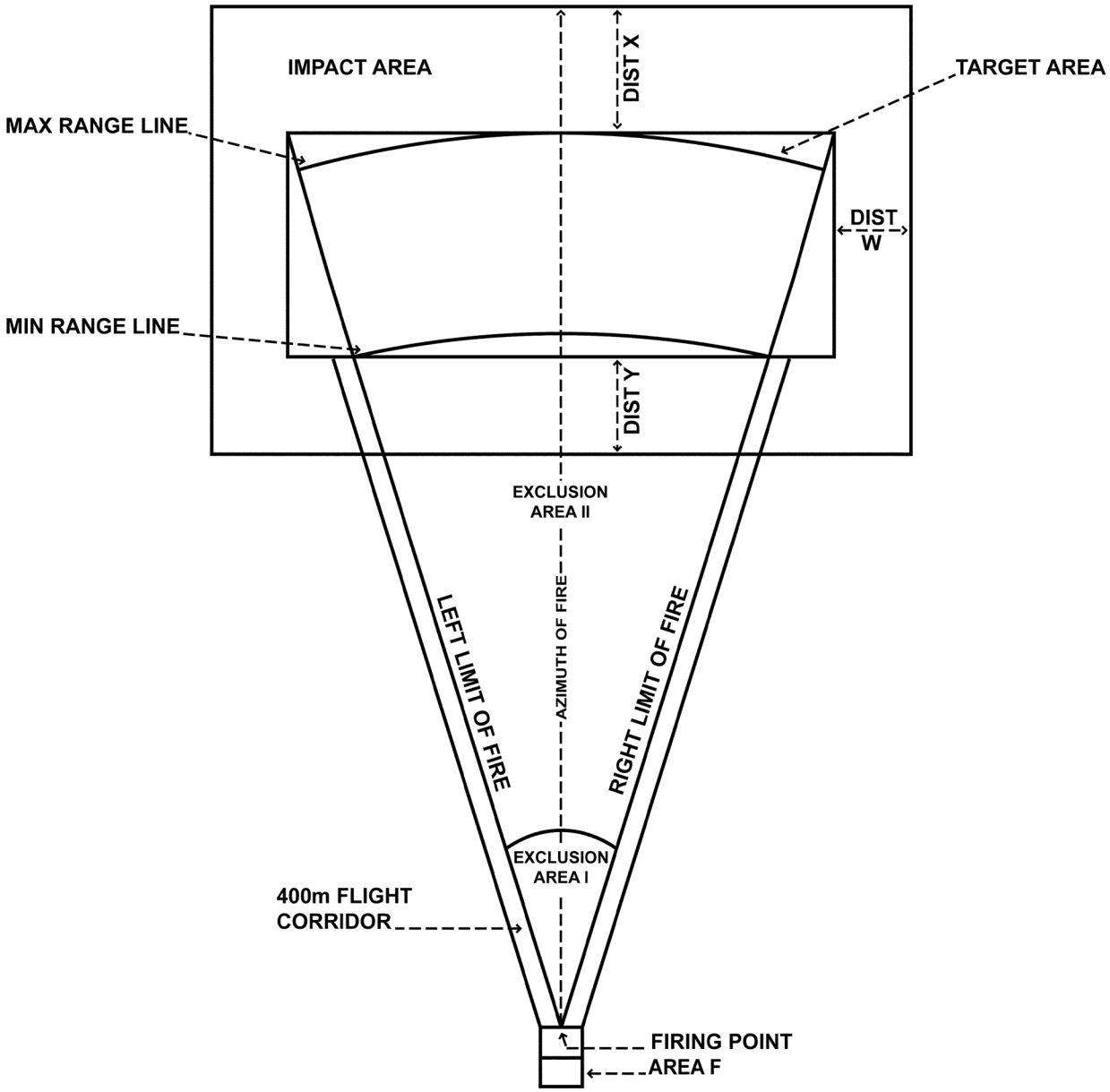
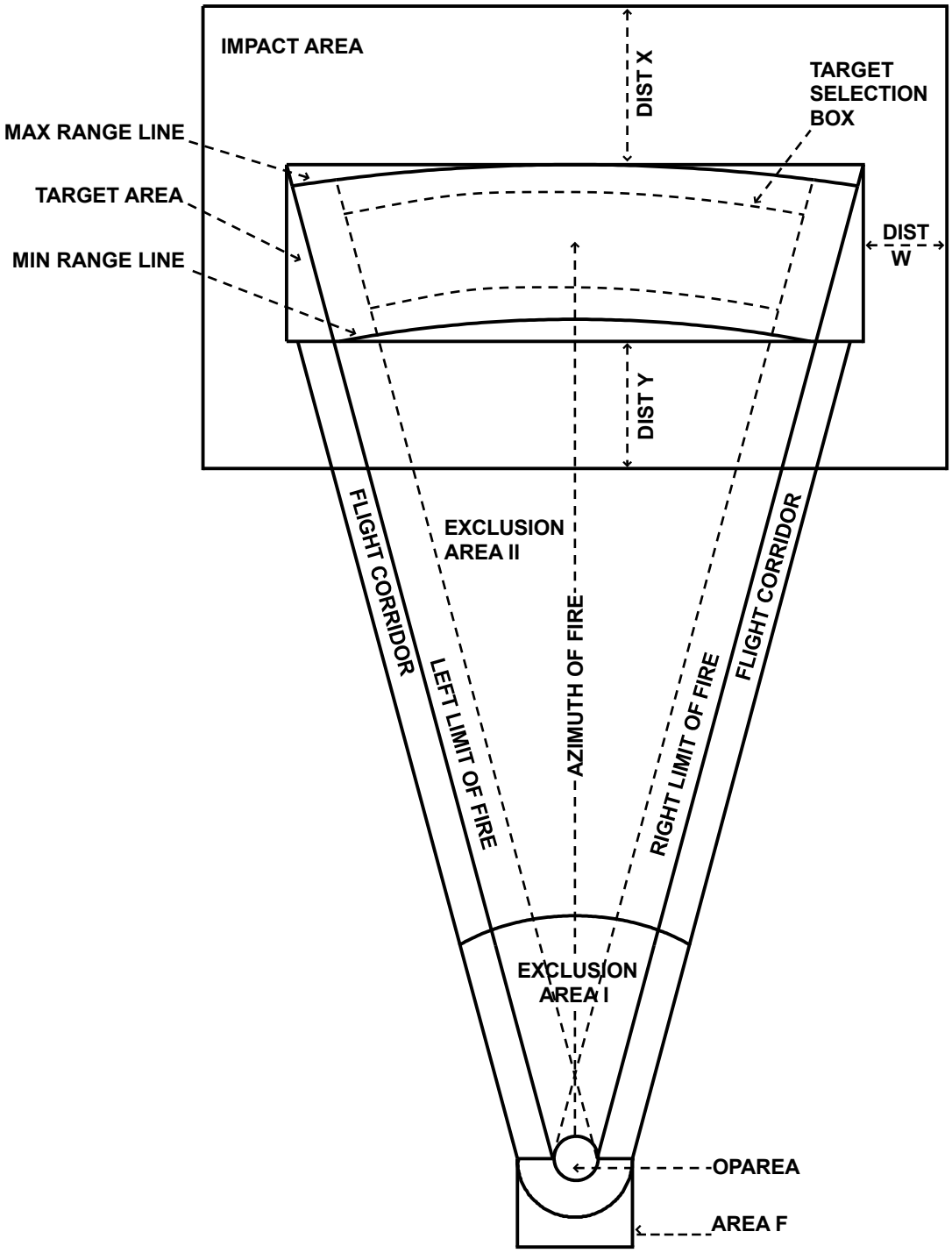


Figure 10–11. Surface danger zone for Multiple Launch Rocket System (MLRS) High Mobility Artillery Rocket Systems (HIMARS) Reduced Range Practice Rocket (RRPR) Guided Multiple Launch Rocket System (GMLRS) point to area



Note:

1. Area F dimensions shown in figure 10–13

Figure 10–12. Surface danger zone for Multiple Launch Rocket System (MLRS) High Mobility Artillery Rocket Systems (HIMARS) Reduced Range Practice Rocket (RRPR) Guided Multiple Launch Rocket System (GMLRS) operations area

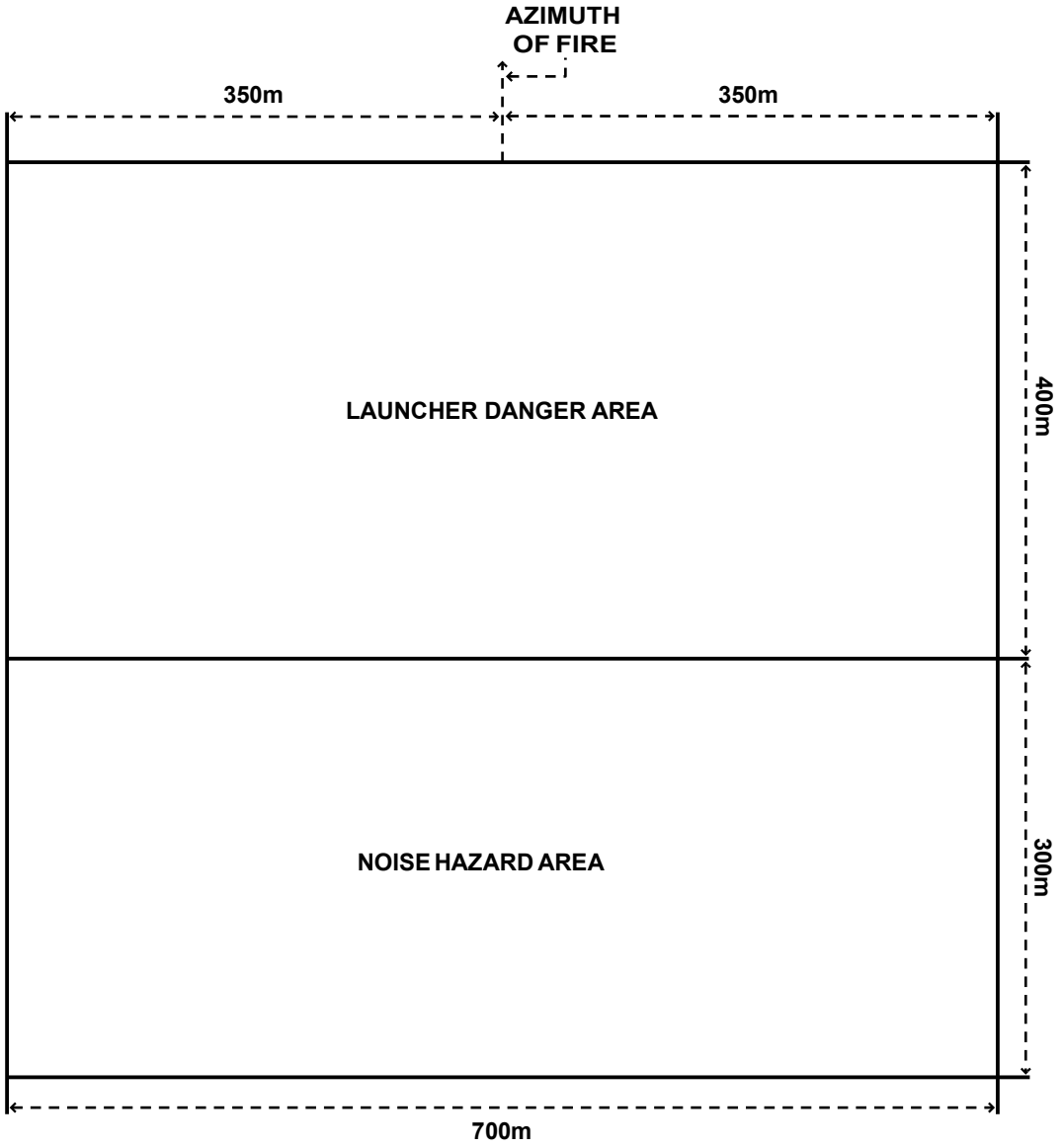


Figure 10–13. Surface danger zone, area F, for Multiple Launch Rocket System (MLRS) High Mobility Artillery Rocket System (HIMARS) Reduced Range Practice Rocket (RRPR) Guided Multiple Launch Rocket System (GMLRS) point to point and point to area

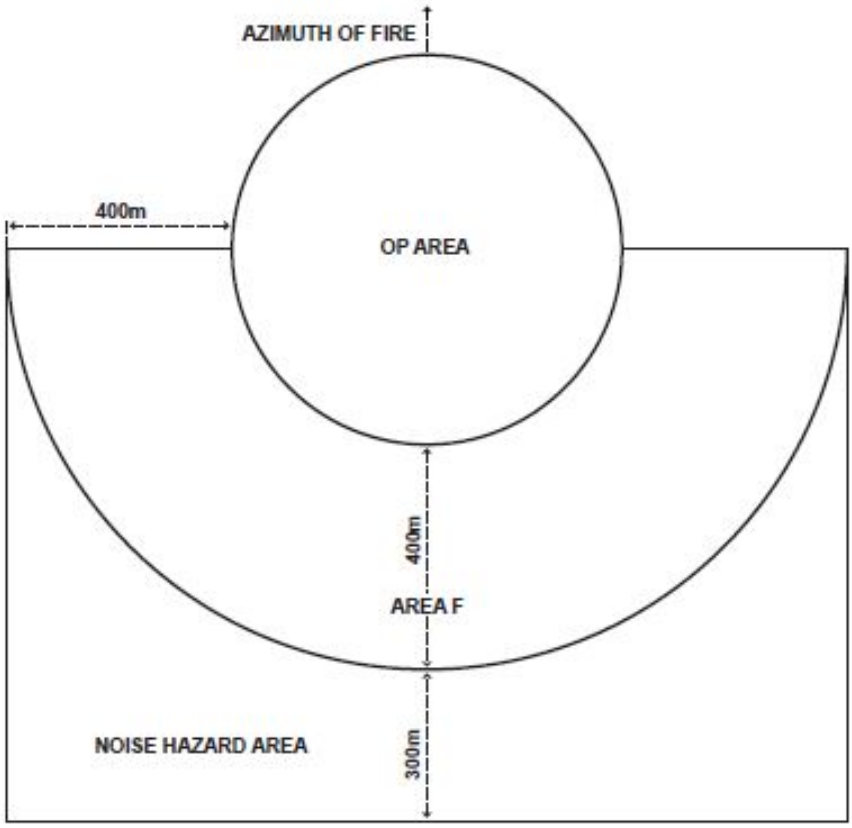


Figure 10–14. Surface danger zone, area F, for Multiple Launch Rocket System (MLRS) High Mobility Artillery Rocket System (HIMARS) Reduced Range Practice Rocket (RRPR) Guided Multiple Launch Rocket System (GMLRS) operations area

Probability of injury(ies) = ABC(E/D)

Probability of injury(ies) = AB(F/D)

Probability of vehicle damage = ABG(E/D)

Probability of injury(ies)/vehicle damage(s) AB(H/I)

A = Probability of short round

B = Number of rockets fired

C = Number of personnel exposed

D = Size of occupiable corridor (based on target distance, in m^2)

E = Estimate of short round impact debris area (300m x 100m or 100m x 50m)

F = Area occupied by tank trail, road, site, etc. (when exact number of personnel/vehicles not known) in m^2 .

G = Number of vehicles exposed

H = (Length of short round impact debris ares) + (width of trail/road), in meters

I = Length of occupiable corridor, in meters.

Figure 10–15. Formulas for determining risk during overhead fire using Multiple Launch Rocket System (MLRS) High Mobility Artillery Rocket System (HIMARS) Reduced Range Practice Rockets (RRPR) overhead fire

10-13 Excalibur, 155mm HE M982

a. General

(1) The Excalibur can be fired from the M777A2 Howitzer or the M109A6 Paladin.

(2) Currently fielded variants are the 1A1 (XM982), 1A2 (M982), and 1B (M982A1). The 1A1 variant has two Operational Flight Software (OFS) configurations, 9.15.1.01 and 9.17.1d.01.

(3) Excalibur utilizes a three-pound hood to protect the base during transportation, handling and gun firing. After exiting the muzzle brake, the hood falls free from the projectile. Death or serious injury can occur from impact of this hood. There is a potential hazard for the gun crew and others in the immediate vicinity that could lead to potentially catastrophic injuries.

b. Surface danger zone.

(1) If the Excalibur SDZ is too large to fit on a particular range, contact the Excalibur Program Manager's office at to obtain a unique Surface Danger Zone tailored to fit on the allowable real estate of the range. The tailored SDZ is produced by restricting firing parameters such as charge levels and gun elevations.

(2) The SDZ for the Excalibur is dependent on the Modular Artillery Charge System (MACS) charge zone. Figures 10-16 through 10-18 show the SDZs for MACS charge zones 3, 4, and 5, and are used with tables 10-14 through 10-16.

(3) The SDZ incorporates the base separation and hood impact hazard areas. These areas are depicted in figure 10-19 and table 10-17, which are valid for surface winds up to 30m/s (67mph).

Table 10–14
Surface danger zone data for M28A1 and M28A2 Multiple Launch Rocket System (MLRS)/High Mobility Artillery Rocket System (HIMARS) Reduced Range Practice Rocket (RRPR)

Range to target (m)	Dist X (m)	Dist W (m)	Dist Y (m)	Target box demention[1] (m)
8,000 to 9,000	2,525	770	1,905	218
9,001 to 10,000	2,155	855	1,635	240
10,001 to 11,000	1,795	945	1,440	264
11,001 to 12,000	1,485	1,045	1,290	288
12,001 to 13,000	1,220	1,155	1,185	312
13,001 to 14,000	1,175	1,290	1,115	336
14,001 to 15,000	1,275	1,475	1,075	360

Notes:
[1]Target box dimensions are applied to point-to-point method only.

Table 10-15
Surface danger zone data for Excalibur 1A1 XM982 Modular Artillery Charge System (MACS) 3 and 4

MACS	Dist EX1 (m)	Dist EX2 (m)	Dist EXR (m)	Dist EW1 (m)	Dist EW2 (m)	Dist EWR (m)	Area A (m)	Area B (m)
3 (OFS 9.15.1.01)	30,000	7,500	6,250	15,500	12,000	3,500	1,000	1,000
3 (OFS 9.17.1d.01)	44,500	16,000	8,000	24,750	16,000	6,500	1,000	1,000
4 (OFS 9.15.1.01)	30,000	10,000	1,500	15,500	5,000	3,000	1,000	1,000
4 (OFS 9.17.1d.01)	44,000	16,000	3,300	24,250	13,500	8,000	1,000	1,000

Table 10-16
Surface danger zone data for Excalibur 1A2 M982 Modular Artillery Charge System (MACS) 3,4 and 5

MACS	Dist EX1 (m)	Dist EX2 (m)	Dist EX3 (m)	Dist EXR (m)	Dist EW1 (m)	Dist EW2 (m)	Dist EW3 (m)	Dist EWR (m)	Min Target Dist (m)	Max Target Dist (m)
3	33,000	11,000	NR	1,400	14,000	4,200	NR	3,000	5,800	26,000
4	46,000	20,000	400	370	21,500	7,000	850	350	8,250	38,000
5	59,000	29,000	1,000	370	28,500	11,000	850	350	12,500	50,100

Legend for Table 10-16:
NR=Not Required

Table 10-17
Surface danger zone data for Excalibur 1B M982A1 Modular Artillery Charge System (MACS) 3,4 and 5

MACS	Dist EX1 (m)	Dist EX2 (m)	Dist EX3 (m)	Dist EXR (m)	Dist EW1 (m)	Dist EW2 (m)	Dist EW3 (m)	Dist EWR (m)	Min Target Dist (m)	Max Target Dist (m)
3	33,000	10,000	Nr	950	16,100	4,600	NR	2,000	5,800	26,000
4	49,000	22,000	Nr	370	23,800	6,300	NR	2,500	8,250	38,000
5	61,000	19,000	2,000	370	29,000	8,500	850	350	12,500	50,100

Legend for Table 10-17:
NR=Not Required

Table 10-18
Surface danger zone data for Excalibur 1A1 XM982, 1B M982A1 and 1B M982A1 Modular Artillery Charge System (MACS) 3, 4 and 5 hood impact and base separation area

Variant	Event	MACS Zone	Dist EXH (m)	Dist EXR (m)	Dist EWH (m)	Dist EWR (m)
All	Hood Impact Area	All	1,230	370	850	350
All	Base Separation Impact Area	3	4,380	410	1,070	870

Legend for Table 10-17:
MACS= Modular Artillery Charge System

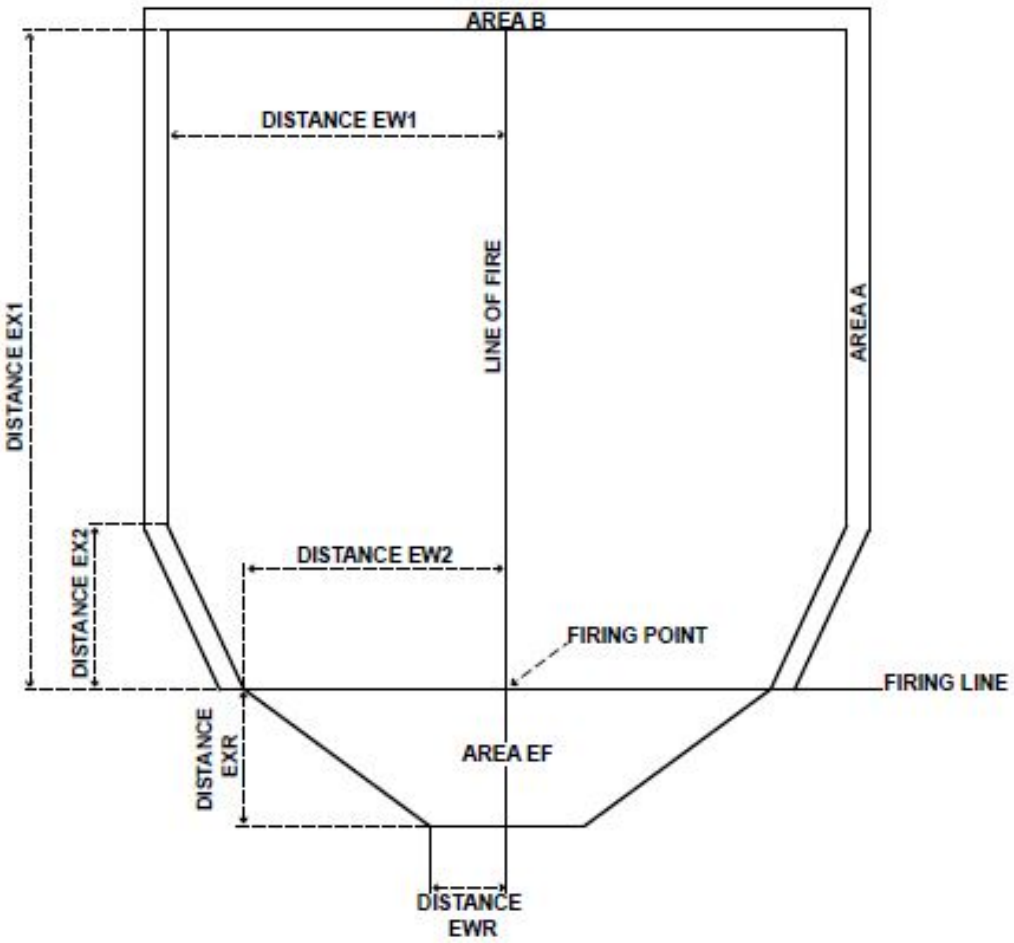


Figure 10-16 Surface danger zone for Excalibur 1A1 XM982 Modular Artillery Charge System (MACS) 3 and 4

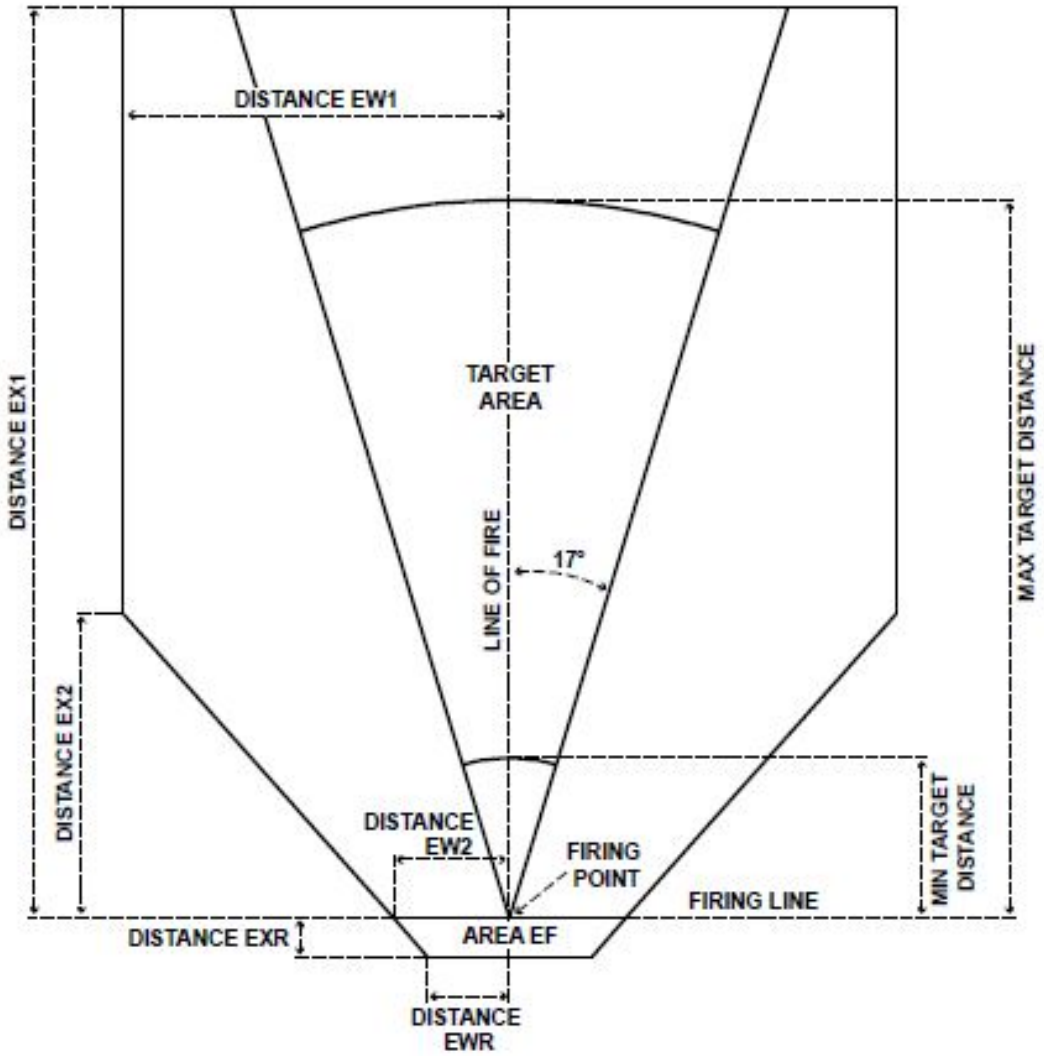


Figure 10-17 Surface danger zone for Excalibur 1A2 M982 Modular Artillery Charge System (MACS) 3 and 1B M982A1 MACS 3 and 4

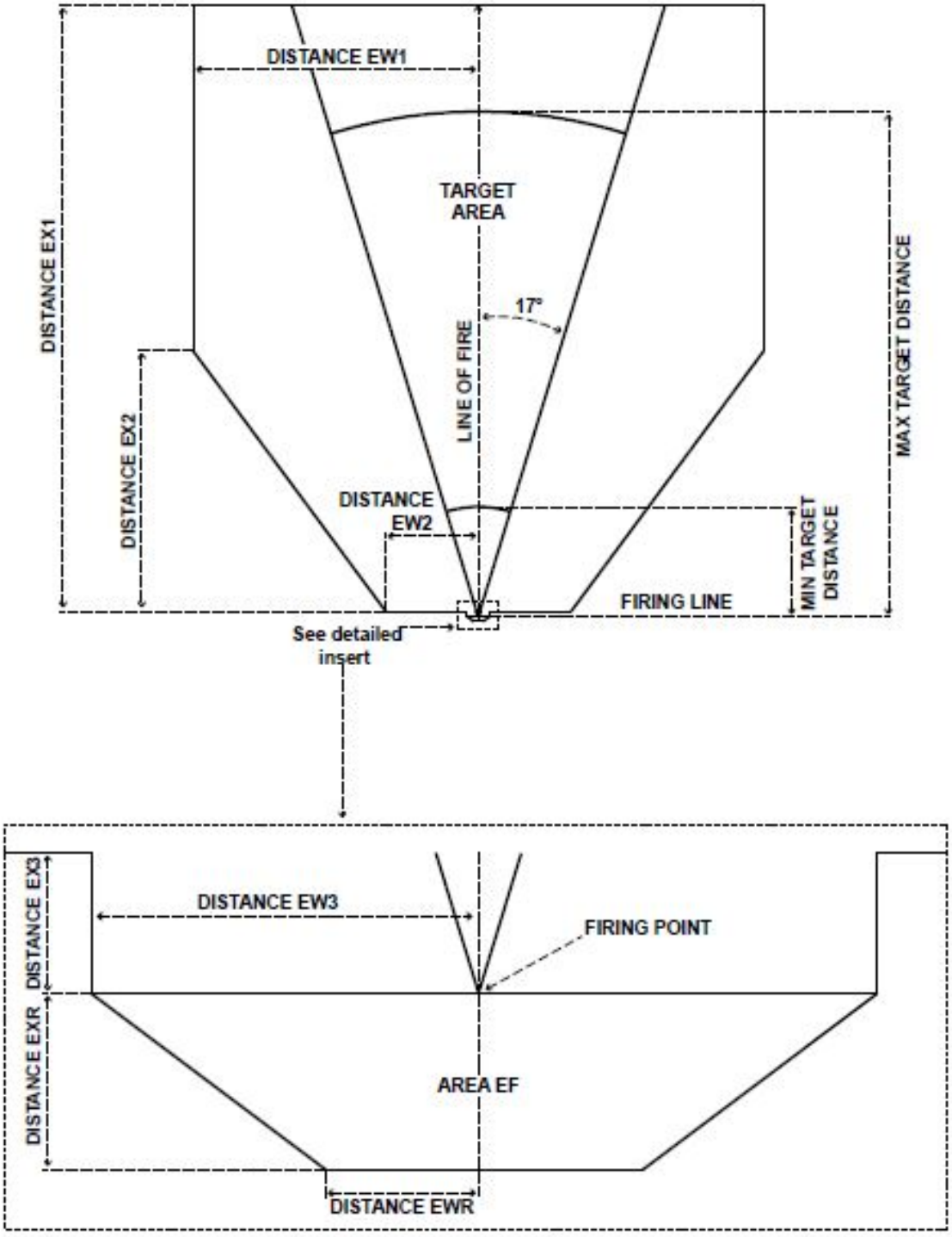


Figure 10-18 Surface danger zone for Excalibur 1A2 M982 Modular Artillery Charge System (MACS) 4 and 5 and 1B M982A1 MACS 5

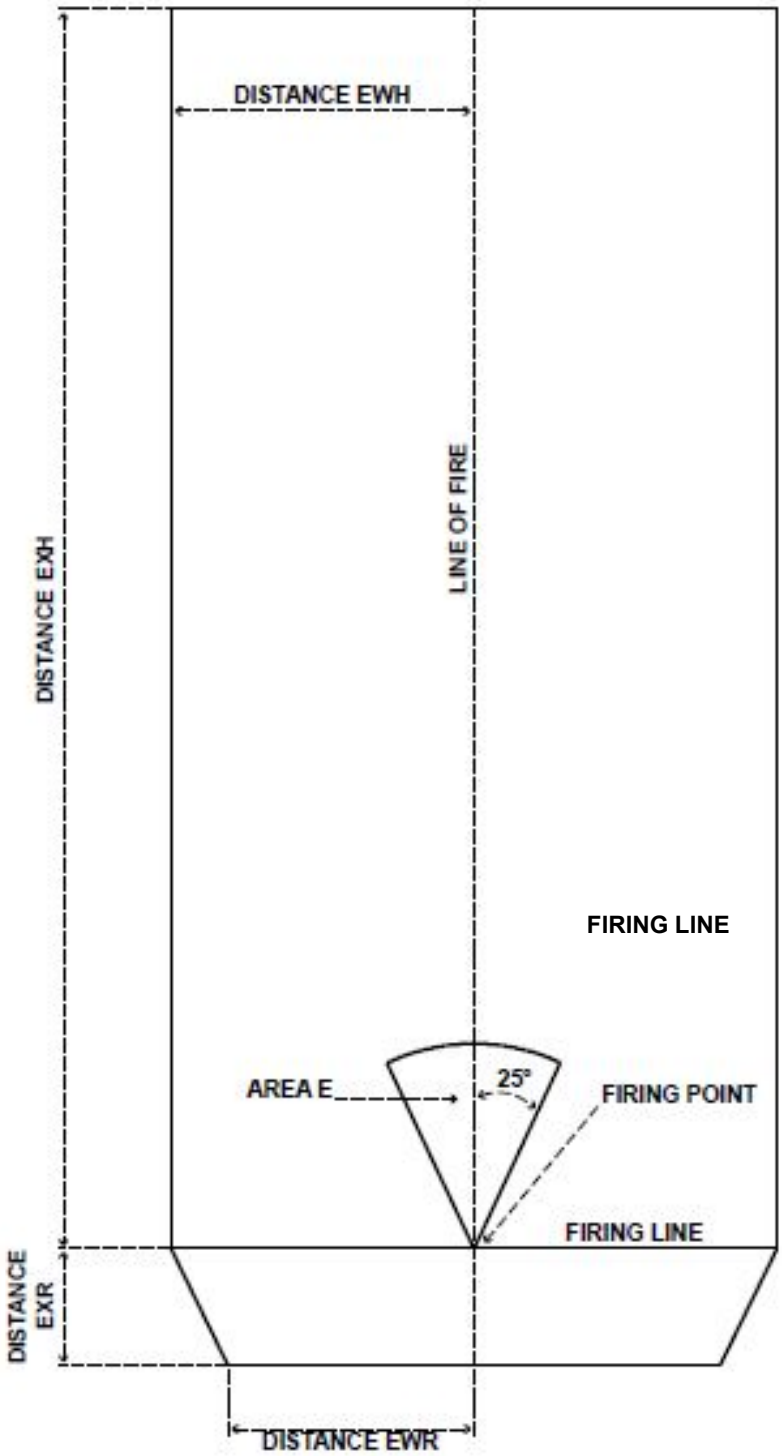


Figure 10-19 Surface danger zone for Excalibur 1A1 XM982, 1A2 M982 and 1B M982A1, Modular Artillery Charge System (MACS) 3, 4 and 5 hood impact and base separation area

Chapter 11
Aviation Range Safety

11–1. General

a. Aircrew requirements.

(1) All aircrews operating within a range/training airspace complex shall participate in a range safety brief and understand installation range regulations prior to operating within the complex.

(2) Aircrews shall take all measures necessary to ensure they conduct training within assigned SUA or other authorized operating areas and that all effects are contained within range complex boundaries.

b. Scheduling.

(1) All aviation operations conducted within a range/SUA shall be scheduled with the scheduling activity.

(2) SUA will be scheduled via the RFMSS when available and designated/ activated in accordance with paragraph 2–4 of this pamphlet for all air-to-ground operations.

c. Communications.

(1) Two-way communication will be maintained between the OIC and the installation range operations firing desk (Army), range control office (Marine Corps).

(2) Range operations firing desk (Army), range control (Marine Corps) must be able to maintain radio contact with all aircraft operating on the range. Communication relays are authorized as long as the RMA (Army), RCO (Marine Corps) has a method (for example, tunable radio) to contact aircraft immediately in the event of an imminent situation.

(3) All aircraft utilizing ranges shall monitor the guard frequency. Range management will have the capability to transmit/receive on the guard frequency (121.5 VHF/243.0 UHF).

d. Weather.

(1) All aviation training shall be conducted in visual meteorological conditions (VMC) unless otherwise approved by the OIC and coordinated with range operations (Army), range control (Marine Corps).

(2) The local weather detachment or command post must advise the OIC and or RMA (Army), RCO (Marine Corps) of any sudden adverse weather changes (watches, warnings, or advisories) that might impact range operations or safety.

(3) The OIC will monitor weather conditions (such as altimeter, wind direction/velocity, and ceiling) and provide general safety and weather updates during range operations as required.

e. Paradrops.

(1) The unit using the drop zone (DZ) is required to survey the DZ 24 hours prior to use.

(2) Paradrop aircrew and DZ personnel shall maintain communications with the range operations firing desk (Army), range control (Marine Corps).

(3) DZs will be confirmed clear before commencement of parachute or paradrop operations.

(4) Joint Precision Airdrop System (JPADS).

(a) The unit dropping the load is responsible for using JPADS mission planning software before they fly the mission.

(b) Range operations (Army), range control (Marine Corps) will approve Improved-Container Delivery System deliveries only if the Precision Airdrop System-Mission Planner derived point of impact, the 3-sigma footprint for chute failure, and the guidance failure footprint overlay on government owned, leased, or otherwise controlled land with no unauthorized personnel present and a collateral damage estimate acceptable to the RMA (Army), RCO (Marine Corps).

(c) Equipment, facilities, and participating personnel are permitted within the 3-sigma success, chute failure, and the guidance failure footprints as long as range management has conducted and approved an operational risk assessment.

(d) RMAs (Army), RCOs (Marine Corps) should note that JPADS users may desire to update weather observations by dropping a sonde (foot-long metal wind sensor) for wind updates in order to revise footprint analyses up until the time of delivery.

f. Countermeasures. The use of chaff/flares will comply with local range regulations/SOPs, FAA requirements, and in accordance with aircraft TMs.

11–2. Firing operations, general requirements

a. Weapon danger zones.

(1) Air-to-ground delivery of munitions can be accomplished from a variety of platforms to include fixed wing (FW), rotary wing (RW), tilt wing (TW), and Unmanned Aircraft Systems (UASs). Danger zones associated with

munitions with program office approved WDZ data shall be generated through the use of the RMTK WDZ Tool that can provide a WDZ for aviation-delivered ordnance. Munitions that do not have a developed WDZ may use an SDZ if available. The WDZ is modeled to represent the distribution of impacts, ricochets/broaches, and the vertical hazard associated with fragmentation and the ricochets (see para 11–6).

(2) The three-dimensional aspect of munitions delivery can present many challenges when determining the safe location of personnel and facilities operating on the ground. The WDZ Tool enables RMAs (Army), RCOs (Marine Corps) to reduce risks to personnel and facilities involved with aviation operations.

(3) RMAs (Army), RCOs (Marine Corps) must employ safe management practices that provide the visibility and control required for the integration of both air and ground operations. The use of the WDZ Tool supplemented with an aggressive risk mitigation program will help reduce the complications and dangers associated with this training.

b. Aircrew currency qualifications for aviation weapons delivery.

(1) Army.

(a) During firing, qualified standardization instructor pilots or instructor pilots having immediate access to positive control of the aircraft and weapon systems being fired will accompany pilots and gunners who are not current and qualified in the aircraft.

(b) Qualified non-rated crew member flight instructors or nonrated crew member unit trainers having immediate access to the weapons systems being fired will accompany door gunners who are not current and qualified.

(2) Marine Corps. Marine pilot and aerial gunners will demonstrate flight and weapons system proficiency in accordance with the appropriate TMs/Training and Readiness manuals.

c. Aircrew weapons qualifications for aviation weapons delivery.

(1) Pilots and gunners will successfully complete an approved qualification course or qualification or transition training in accordance with an approved program of instruction.

(2) Pilots and gunners will demonstrate flight and weapon systems proficiency in accordance with TC 3–04.11, TC 3-04.45, or the appropriate aircrew training manuals.

d. Communications.

(1) All firing elements must maintain positive two-way communications with the OIC.

(2) Firing will be suspended immediately upon loss of communications with the range operations firing desk (Army), range control (Marine Corps), the OIC, or firing elements.

(3) Command and control aircraft may be used at the commander's discretion.

e. Night operations.

(1) Night range operations present unique challenges to both the aircrew and the OIC. Visual cues are greatly reduced, even with the use of night vision devices (NVDs).

(2) OICs should use NVDs during night operations and at a minimum have access to Generation III NVDs.

11–3. Firing conditions, general procedures

a. General.

(1) Pilots and gunners will be familiar with the impact area, firing limits, and safety regulations for the range on which they will fire.

(2) The firing aircraft pilot in command will ensure that firing aircraft are properly oriented with the target and are safe to fire prior to arming.

(3) For FW operations: If the OIC cannot positively determine that the aircraft can release safely, the OIC will delegate ordnance release clearance to a qualified flight lead, individual pilot, forward air controller or other briefed person. The OIC will maintain overall authority on the range for the training event and can abort the release or direct a cease-fire at any time. In all cases the pilot assumes sole responsibility for the safe release of ordnance and confirmation of the approved target.

(4) For UAS operations: The mission commander will maintain the responsibility for the safe operation of payload and platform.

(5) All live-fire training must be observed.

b. Armament safety procedures.

(1) Aircraft weapon systems will be loaded or unloaded only in approved areas. Selection of these areas will ensure total containment in the event of accidental discharge. Use of natural or manmade barriers is encouraged.

(2) Airspace routing used by RW aircraft flying from the ammunition loading site to and from the firing range will be plotted on a map or chart and maintained by both the using unit and the installation range operations office (Army), range control office (Marine Corps). This course will be selected so that accidental firing at any point on the course will minimize risk to life and property, however, aircraft weapon systems will be maintained in a safe

condition until within the range boundary or authorized SUA. RW aircraft routing from the ammunition loading site to the firing range will be published in local SOPs.

(3) When training requirements dictate, commanders (battalion, squadron, or higher) will direct the loading and unloading of ammunition from aircraft while the engines are running. Such operations are authorized when a thorough risk assessment has been conducted, control measures implemented and residual risks identified and accepted by the appropriate commander.

(4) A dry pass or range sweep for the entire range, focusing on the target area, will be accomplished to ensure personnel and equipment are clear from hazardous effects. Aircraft to include UAS may use onboard sensors (such as advance targeting pods, sniper, litening pod, or cameras) in lieu of a dry pass. Terminal controllers observing the target area may waive the dry pass.

(5) Prior to first weapons release/firing for each pass, final switch configuration will not be accomplished until the aircraft is in such a position that accidental activation or release will be contained within the range, and not represent a danger to ground personnel.

(6) Aircraft will be a minimum of one switch position (excluding trigger) away from weapons release/firing when not oriented toward the target area unless approved by range operations (Army), range control (Marine Corps). Switch manipulation shall not occur until after safe recovery of weapons delivery/firing. RW and TW aircraft will be in a safe condition prior to departing an aerial firing point unless otherwise directed.

(7) Prior to leaving a range area, FW aircraft will conduct a hung ordnance check. If hung ordnance remains on board the aircraft, ensure compliance with local restrictions to avoid undue risk for the return flight. For RW and TW aircraft, the pilot in command shall ensure that all weapon systems are clear of ammunition prior to departing the range. Upon completion of training, aircraft weapon systems will be safed in accordance with aircraft TMs before leaving the range.

(8) Crash rescue personnel will be knowledgeable of safety precautions associated with armed aircraft and impact areas and the hazards associated with burned aircraft (for example, radioactive and advanced composite materials).

c. Hung ordnance and jettison areas.

(1) Range operations (Army), range control (Marine Corps) will ensure all aircraft report ordnance expended, hung ordnance, and UXO locations to the range operations firing desk (Army), range control (Marine Corps) prior to departing the range.

(2) Installation SOPs and range directives will designate ordnance jettison and emergency landing areas for use by aircraft experiencing weapons malfunctions or in-flight emergencies.

(3) Jettison areas will be located such that maximum protection is provided to personnel and range facilities in case the jettisoned ordnance detonates.

d. Fuel spill materials (spill kits) will be available at forward arming and refueling points. Fuel tankers used to refuel aircraft will be equipped with sufficient absorbent material to handle small to moderate spills.

e. Commanders will develop and implement an aggressive program to ensure crew coordination and combat identification procedures concurrent with the gunnery training program. Combat identification training will be conducted in accordance with TC 25–8, TC 3–04.11, TC 3-04.45, or appropriate air crew training manuals.

(9) Range operations (Army), range control (Marine Corps) personnel will publish air-to-ground ordnance delivery regulations for each target in the range SOP, specifying ordnance permitted as well as any restrictions (dive angle, airspeed, run-in heading) associated with that target or specific training event. Proper target analysis will include, but is not limited to the following:

a. Approved ordnance for the range target.

b. Type of deliveries allowed.

c. Run-in restriction if required for a specific weapon or delivery.

d. Approved containment boundary.

e. Weather minimums if more restrictive than standard visual flight rules operating requirements.

f. Minimum Safe Lasing Altitude if class 3B or 4 lasers will be used.

g. Any other constraints or restrictions required to allow weapons delivery on the identified target.

h. For deliveries not contained within the SOP, the using unit may submit proposed WDZs and LSDZs as appropriate to the range operations office (Army), range control office (Marine Corps) for consideration.

i. WDZs will be developed and tested as new weapons, aircraft, and delivery parameters are produced and enter the operational inventory or as new testing and lab data becomes available. Appropriate higher headquarters will ensure WDZs are available prior to levying new weapons training requirements or introducing new aircraft and weapons into the DOD inventory.

11–4. Weapon danger zone program methodology

a. WDZs identify the minimum area necessary to contain munitions and hazardous fragments within the installation or range boundary that result from air-to-ground ordnance delivery operations.

b. The principle objective of the WDZ program is to assist range operations (Army), range control (Marine Corps) in executing safe range operations. WDZ program methodology identifies weapon impact point probabilities from a variety of platforms and parameters, thus providing them with a scientific basis for making sound range planning decisions and to facilitate training readiness. It enables range personnel to:

(1) Contain ordnance and fragmentation within range boundaries.

(2) Identify appropriate containment levels and risk associated with the areas identified as needing specific risk analysis, or the Area of Critical Concern (ACC).

(3) Identify possible or improved target locations.

(4) Modify allowable delivery ground tracks to eliminate or reduce hazards.

(5) Identify the best locations for participating personnel, range modifications, or improvements.

(6) Design a new target area/range.

c. The methodology is based on a combination of weapon modeling/simulation data and actual impact data. Each WDZ incorporates a probability distribution function which provides the information necessary to perform a quantitative risk assessment to evaluate the relative risk of an identified profile, based on the size and location within the WDZ.

d. All developed air-to-ground aviation ordnance shall have a WDZ. This WDZ (the weapons footprint) is calculated based on the type of aircraft delivering the weapon (for example, F/A–18 Hornet aircraft or AH-64 helicopter), the delivery parameters of the aircraft (dive angle, airspeed, altitude, and so forth), type of ordnance being delivered (for example, MK–82 bomb and AGM–114 HELLFIRE missile), target and terrain type, and the level of containment desired. Legacy weapon systems that do not have a developed WDZ may still use an SDZ.

e. WDZs may be further affected by terrain, artificial barriers, or other compensating factors such as target type (wood, metal) and soil hardness.

f. Representative examples and descriptions of WDZs are reviewed in chapter 3.

11–5. RMTK Weapon Danger Zone Tool

a. WDZs for FW, RW, TW, and UAS are generated with the WDZ Tool as part of the RMTK suite of tools. The WDZ Tool is a Geographic Information System-based application that is available to operational planners and RMAs (Army), RCOs (Marine Corps) in both desktop and web-based versions.

b. The WDZ Tool will lead the user through the WDZ generation process. It will help range managers determine aircraft type, ordnance, and delivery parameters that are permissible for each target.

c. A record (electronic or hard copy) of the analysis of each target engaged during the training evolution will be maintained at range operations (Army), range control (Marine Corps). The WDZ manager (library software function) may be used to meet this requirement.

11–6. Applying the weapon danger zone tool

a. Containment.

(1) The "containment" of a weapon system's performance envelope, impact footprint, and/or associated debris fields require the surface area (land or sea) to be protected by purchase, lease, or other restriction to exclude personnel from that area. This general policy ensures safety will be maximized and consistent with mission requirements.

(2) The WDZ Tool allows selectable levels for weapons containment based on service policy ranging from 1:10,000 probability to a 1:1,000,000 probability of a munition or munition component escaping the containment area (for inert ordnance) or a live weapon's fragment escaping the containment area (for live ordnance).

(3) The WDZ safety standard for Army and Marine Corps ranges is 1:1,000,000 (99.9999% containment).

(4) For the Army, if the selected containment level is too restrictive to support necessary operations, a less restrictive containment level may be accepted with the completion of an appropriate risk analysis and deviation process referenced in AR 385–63/MCO 3570.1C, ATP 5–19, and paragraph 1-4 of this document. For the Marine Corps, if the selected containment level is too large to support necessary operations, contact Commanding General, Training Education Command, Range and Training Area Management Branch (C465), 3300 Russell Road, Quantico, VA 22134–5001 for assistance in development of the appropriate risk analysis and deviation process referenced in AR 385–63/ MCO 3570.1C, ATP 5–19, and MCO 3500.27B.

(5) Subject to deviation, WDZs may be further reduced by selecting the option to mitigate for terrain.

(6) Deviations approved for WDZs extending beyond installation boundaries must be based on the ability to contain projectiles, hazardous fragments, laser beams, and both vertical and horizontal ricochets sufficiently within the installation boundaries, and area under military control (such as leased land or training areas and facilities acquired through memorandum of understanding or memorandum of agreement). Probability of hazardous fragment escapement must not present a greater than 1:1,000,000 hazard to the public.

b. Mission essential personnel.

(1) Placement of mission essential personnel (MEP) within a WDZ may be authorized by the RMA (Army), RCO (Marine Corps) or the operational commander of the training or exercise.

(2) Mission essential personnel are those personnel directly related to the employment of live/inert ordnance (air, surface, or sea fires) in an exercise or evaluation on a training range in a training/evaluation scenario (all those people that are receiving/giving the training and or receiving/giving the evaluation). This would include JTACs, tactical air control parties (TACPs), maneuver elements, fires elements (air/land/sea), and instructors/evaluators.

c. Risk analysis.

(1) The WDZ Tool risk analysis function can show the probability of impacts within a selectable, defined area of the WDZ. This function will help define the risk associated with a specific location within the WDZ, dependent upon the weapons system employed and the size of the area at risk or area of critical concern. Risk is determined by the WDZ tool for unprotected personnel in the open. An ACC analysis must be performed anytime that participating personnel are located within a WDZ.

(2) ACCs may involve the placement of MEP (such as JTAC or TACPs) or the location of towers or other facilities within the WDZ. For area of critical concerns that contain MEP, the RMA (Army), RCO (Marine Corps), or the OIC will use the WDZ Tool Risk Analysis function and will not accept greater risk than the safety standard of 1:1,000,000 unless a thorough risk assessment, risk management process has been completed IAW ATP 5–19 and MCO 3500.27B.

(3) Risk may be mitigated by moving the location of the personnel or decreasing their vulnerability through the use of terrain features or bunkers.

(4) Non-participating personnel must be outside the WDZ at all times.

11–7. Rotary wing surface danger zones

a. General.

(1) SDZs in this chapter will be used for RW aircraft when WDZ generation is not available.

(2) For firing from a hover, SDZs will be superimposed over the GTL at each firing point. On running fire courses, SDZs will be superimposed over each anticipated firing position along the course. These SDZs will begin at the start-fire line and move along the course to each anticipated firing point to the cease-fire line. SDZs should anticipate that firing may occur across the entire width of the running fire lane.

(3) A range may contain several different hover fire points or running fire courses where multiple aircraft can fire at the same time. The resultant SDZ will be a composite formed by individual SDZs. When multiple aircraft are firing at the same time, controls will be established to ensure the safety of all participating aircraft.

(4) The lateral limits of the target area determine the left and right limits of fire, which will begin at any point beyond the start-fire line provided the minimum safe distance (see figure 11-1 ricochet area, Areas A and B) for the weapon system being fired is maintained from the aircraft to the point of impact. For running fire, Distance X will be measured from the cease-fire line.

b. Guns and Cannons. The WDZ Tool provides for safe firing of 5.56mm, 7.62mm, .50 caliber machine guns, and 20mm and 30mm cannons from RW aircraft.

c. Rockets.

(1) SDZ requirements for the safe firing of the 2.75-inch folding fin aerial rocket weapon systems from rotary-wing aircraft are given in table 11–1 through 11-8 (for hover and running fire), table 11-9 through 11-14 (for diving fire), and figures 11–1 and 11–2 and are the basis for constructing the SDZ.

Table 11-1
Surface danger zone data for M274 TP with MK66 altitude >201 feet AGL, hover and running fire

Launch Angle (deg)	Impact Media	Airspeed (KTAS)	Dist X (m)	Area A (m)	Area B (m)	Ricochet Vertical Hazard (m)
0	All	Hover	4,642	NR	NR	1,524
		90 KTAS	4,644	NR	NR	1,524
2	All	Hover	5,035	NR	NR	1,524
		90 KTAS	5,087	NR	NR	1,524

4	All	Hover 90 KTAS	5,461 5,534	NR NR	NR NR	1,524 1,524
6	All	Hover 90 KTAS	5,828 5,919	NR NR	NR NR	1,524 1,524
8	All	Hover 90 KTAS	6,159 6,292	NR NR	NR NR	1,524 1,524
12	All	Hover 90 KTAS	6,797 6,956	NR NR	NR NR	1,524 1,524
16	All	Hover 90 KTAS	7,327 7,525	NR NR	NR NR	1,524 1,524

Legend for table 11-1:
AGL=Above Ground Level
KTAS=Knots True Airspeed
NR=Not Required
TP=Training Practice

Table 11-2
Surface danger zone data for M274 TP with MK66 altitude >1,001 feet AGL, hover and running fire

Launch Angle (deg)	Impact Media	Airspeed (KTAS)	Dist X (m)	Area A (m)	Area B (m)	Ricochet Vertical Hazard (m)
0	All	Hover 90 KTAS	5,242 5,298	NR NR	NR NR	1,524 1,524
2	All	Hover 90 KTAS	5,604 5,675	NR NR	NR NR	1,524 1,524
4	All	Hover 90 KTAS	5,960 6,063	NR NR	NR NR	1,524 1,524
6	All	Hover 90 KTAS	6,271 6,390	NR NR	NR NR	1,524 1,524
8	All	Hover 90 KTAS	6,606 6,737	NR NR	NR NR	1,524 1,524
12	All	Hover 90 KTAS	7,197 7,371	NR NR	NR NR	1,524 1,524
16	All	Hover 90 KTAS	7,670 7,878	NR NR	NR NR	1,524 1,524

Legend for table 11-2:
AGL=Above Ground Level
KTAS=Knots True Airspeed
NR=Not Required
TP=Training Practice

Table 11-3
Surface danger zone data for M151 HE with MK66 altitude >201 feet AGL, hover and running fire

Launch Angle (deg)	Impact Media	Airspeed (KTAS)	Dist X (m)	Area A (m)	Area B (m)	Ricochet Vertical Hazard (m)
0	All	Hover 90 KTAS	4,642 4,644	300 300	300 300	1,524 1,524
2	All	Hover 90 KTAS	5,035 5,087	300 300	300 300	1,524 1,524
4	All	Hover 90 KTAS	5,461 5,534	300 300	300 300	1,524 1,524
6	All	Hover 90 KTAS	5,828 5,919	300 300	300 300	1,524 1,524
8	All	Hover 90 KTAS	6,159 6,292	300 300	300 300	1,524 1,524
12	All	Hover 90 KTAS	6,797 6,956	300 300	300 300	1,524 1,524
16	All	Hover 90 KTAS	7,327 7,525	300 300	300 300	1,524 1,524

Legend for table 11-3:
AGL=Above Ground Level
HE=High Explosive
KTAS=Knots True Airspeed
Legend for table 11-3:
AGL=above ground level

HE=high explosive
KTAS=knots true airspeed

Table 11-4
Surface danger zone data for M151 HE with MK66 altitude >1,001 feet AGL, hover and running fire

Launch Angle (deg)	Impact Media	Airspeed (KTAS)	Dist X (m)	Area A (m)	Area B (m)	Ricochet Vertical Hazard (m)
0	All	Hover	5,242	300	300	1,524
		90 KTAS	5,298	300	300	1,524
2	All	Hover	5,604	300	300	1,524
		90 KTAS	5,675	300	300	1,524
4	All	Hover	5,960	300	300	1,524
		90 KTAS	6,063	300	300	1,524
6	All	Hover	6,271	300	300	1,524
		90 KTAS	6,390	300	300	1,524
8	All	Hover	6,606	300	300	1,524
		90 KTAS	6,737	300	300	1,524
12	All	Hover	7,197	300	300	1,524
		90 KTAS	7,371	300	300	1,524
16	All	Hover	7,670	300	300	1,524
		90 KTAS	7,878	300	300	1,524

Legend for table 11-4:
AGL=Above Ground Level
HE=High Explosive
KTAS=Knots True Airspeed

Table 11-5
Surface danger zone data for M255 FL with MK66 altitude >201 feet AGL, hover and running fire

Launch Angle (deg)	Impact Media	Airspeed (KTAS)	Dist X (m)	Area A (m)	Area B (m)	Ricochet Vertical Hazard (m)
0	All	Hover	4,286	300	400	1,524
		90 KTAS	4,383	300	400	1,524
2	All	Hover	4,828	300	400	1,524
		90 KTAS	4,975	300	400	1,524
4	All	Hover	5,304	300	400	1,524
		90 KTAS	5,509	300	400	1,524
6	All	Hover	5,779	300	400	1,524
		90 KTAS	6,019	300	400	1,524
8	All	Hover	6,192	300	400	1,524
		90 KTAS	6,461	300	400	1,524
12	All	Hover	6,966	300	400	1,524
		90 KTAS	7,284	300	400	1,524
16	All	Hover	7,670	300	400	1,524
		90 KTAS	8,031	300	400	1,524

Legend for table 11-5:
AGL=Above Ground Level
FL=Flechette
KTAS=Knots True Airspeed

Table 11-6
Surface danger zone data for M255 FL with MK66 altitude >1,001 feet AGL, hover and running fire

Launch Angle (deg)	Impact Media	Airspeed (KTAS)	Dist X (m)	Area A (m)	Area B (m)	Ricochet Vertical Hazard (m)
0	All	Hover	5,062	300	400	1,524
		90 KTAS	5,232	300	400	1,524
2	All	Hover	5,494	300	400	1,524
		90 KTAS	5,686	300	400	1,524
4	All	Hover	5,905	300	400	1,524
		90 KTAS	6,130	300	400	1,524
6	All	Hover	6,319	300	400	1,524
		90 KTAS	6,567	300	400	1,524

8	All	Hover 90 KTAS	6,707 6,989	300 300	400 400	1,524 1,524
12	All	Hover 90 KTAS	7,426 7,749	300 300	400 400	1,524 1,524
16	All	Hover 90 KTAS	8,080 8,451	300 300	400 400	1,524 1,524

Legend for table 11-6:
AGL=Above Ground Level
FL=Flechette
KTAS=Knots True Airspeed

Legend for table 11-6:
AGL=above ground level
FL=flechette
KTAS=knots true airspeed

Table 11-7
Surface danger zone data for M278 IL with MK66 altitude >201 feet AGL, hover and running fire

Launch Angle (deg)	Impact Media	Airspeed (KTAS)	Dist X (m)	Area A (m)	Area B (m)	Ricochet Vertical Hazard (m)
10	NR	80 KTAS	4,423	NR	NR	1,524
12	NR	80 KTAS	4,620	NR	NR	1,524
14	NR	80 KTAS	4,790	NR	NR	1,524
16	NR	80 KTAS	4,937	NR	NR	1,524
18	NR	80 KTAS	5,064	NR	NR	1,524
20	NR	80 KTAS	5,172	NR	NR	1,524
22	NR	80 KTAS	5,263	NR	NR	1,524
24	NR	80 KTAS	5,338	NR	NR	1,524
26	NR	80 KTAS	5,397	NR	NR	1,524

Legend for table 11-7:
AGL=Above Ground Level
IL=Illumination
KTAS=Knots True Airspeed
NR=Not Required

Table 11-8
Surface danger zone data for M278 IL with MK66 altitude >1,001 feet AGL, hover and running fire

Launch Angle (deg)	Impact Media	Airspeed (KTAS)	Dist X (m)	Area A (m)	Area B (m)	Ricochet Vertical Hazard (m)
10	NR	80 KTAS	4,800	NR	NR	1,524
12	NR	80 KTAS	4,959	NR	NR	1,524
14	NR	80 KTAS	5,100	NR	NR	1,524
16	NR	80 KTAS	5,223	NR	NR	1,524
18	NR	80 KTAS	5,330	NR	NR	1,524
20	NR	80 KTAS	5,421	NR	NR	1,524
22	NR	80 KTAS	5,498	NR	NR	1,524
24	NR	80 KTAS	5,561	NR	NR	1,524
26	NR	80 KTAS	5,611	NR	NR	1,524

Legend for table 11-1:
AGL=Above Ground Level
IL=Illumination
KTAS=Knots True Airspeed
NR=Not Required

Table 11-9
Surface danger zone data for M274 TP with MK66 altitude 500 feet AGL, diving fire

Launch Angle (deg)	Impact Media	Airspeed (KTAS)	Dist X (m)	Area A (m)	Area B (m)	Ricochet Vertical Hazard (m)
-5	All	60 120	3,779 3,840	NR NR	NR NR	1,524 1,524
-10	All	60 120	2,887 2,924	NR NR	NR NR	1,524 1,524

-15	All	60 120	2,216 2,231	NR NR	NR NR	1,524 1,524
-20	All	60 120	1,696 1,711	NR NR	NR NR	1,524 1,524
-25	All	60 120	1,356 1,357	NR NR	NR NR	1,524 1,524
-30	All	60 120	1,067 1,055	NR NR	NR NR	1,524 1,524

Legend for table 11-9:
AGL=Above Ground Level
KTAS=Knots True Airspeed
NR=Not Required
TP=Training Practice

Table 11-10
Surface danger zone data for M274 TP with MK66 altitude 1,000 feet AGL, diving fire

Launch Angle (deg)	Impact Media	Airspeed (KTAS)	Dist X (m)	Area A (m)	Area B (m)	Ricochet Vertical Hazard (m)
-5	All	60 120	4,241 4,305	NR NR	NR NR	1,524 1,524
-10	All	60 120	3,315 3,358	NR NR	NR NR	1,524 1,524
-15	All	60 120	2,578 2,605	NR NR	NR NR	1,524 1,524
-20	All	60 120	2,016 2,031	NR NR	NR NR	1,524 1,524
-25	All	60 120	1,640 1,656	NR NR	NR NR	1,524 1,524
-30	All	60 120	1,335 1,345	NR NR	NR NR	1,524 1,524

Legend for table 11-10:
AGL=Above Ground Level
KTAS=Knots True Airspeed
NR=Not Required
TP=Training Practice

Table 11-11
Surface danger zone data for M274 TP with MK66 altitude 1,500 feet AGL, diving fire

Launch Angle (deg)	Impact Media	Airspeed (KTAS)	Dist X (m)	Area A (m)	Area B (m)	Ricochet Vertical Hazard (m)
-5	All	60 120	4,621 4,708	NR NR	NR NR	1,524 1,524
-10	All	60 120	3,703 3,750	NR NR	NR NR	1,524 1,524
-15	All	60 120	2,932 2,953	NR NR	NR NR	1,524 1,524
-20	All	60 120	2,342 2,349	NR NR	NR NR	1,524 1,524
-25	All	60 120	1,907 1,913	NR NR	NR NR	1,524 1,524
-30	All	60 120	1,575 1,575	NR NR	NR NR	1,524 1,524

Legend for table 11-11:
AGL=Above Ground Level
KTAS=Knots True Airspeed
NR=Not Required
TP=Training Practice

Table 11-12
Surface danger zone data for M151 HE with MK66 altitude 500 feet AGL, diving fire

Launch Angle (deg)	Impact Media	Airspeed (KTAS)	Dist X (m)	Area A (m)	Area B (m)	Ricochet Vertical Hazard (m)
-5	All	60	3,779	300	300	1,524
		120	3,840	300	300	1,524
-10	All	60	2,887	300	300	1,524
		120	2,924	300	300	1,524
-15	All	60	2,216	300	300	1,524
		120	2,231	300	300	1,524
-20	All	60	1,696	300	300	1,524
		120	1,711	300	300	1,524
-25	All	60	1,356	300	300	1,524
		120	1,357	300	300	1,524
-30	All	60	1,067	300	300	1,524
		120	1,055	300	300	1,524

Legend for table 11-12:
AGL=Above Ground Level
HE=High Explosive
KTAS=Knots True Airspeed

Table 11-13
Surface danger zone data for M151 HE with MK66 altitude 1,000 feet AGL, diving fire

Launch Angle (deg)	Impact Media	Airspeed (KTAS)	Dist X (m)	Area A (m)	Area B (m)	Ricochet Vertical Hazard (m)
-5	All	60	4,241	300	300	1,524
		120	4,305	300	300	1,524
-10	All	60	3,315	300	300	1,524
		120	3,358	300	300	1,524
-15	All	60	2,578	300	300	1,524
		120	2,605	300	300	1,524
-20	All	60	2,016	300	300	1,524
		120	2,031	300	300	1,524
-25	All	60	1,640	300	300	1,524
		120	1,656	300	300	1,524
-30	All	60	1,335	300	300	1,524
		120	1,345	300	300	1,524

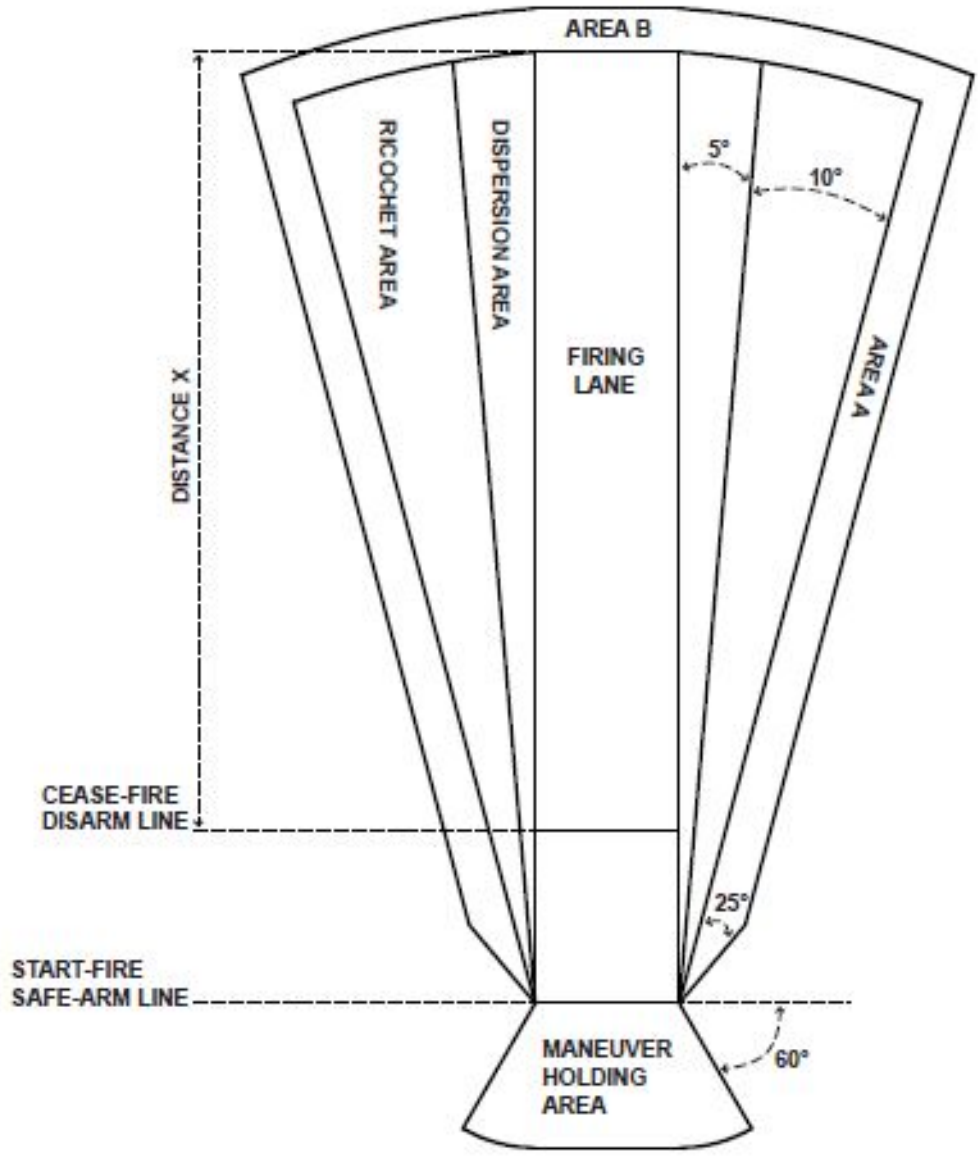
Legend for table 11-13:
AGL=Above Ground Level
HE=High Explosive
KTAS=Knots True Airspeed

Table 11-14
Surface danger zone data for M151 HE with MK66 altitude 1,500 feet AGL, diving fire

Launch Angle (deg)	Impact Media	Airspeed (KTAS)	Dist X (m)	Area A (m)	Area B (m)	Ricochet Vertical Hazard (m)
-5	All	60	4,621	300	300	1,524
		120	4,708	300	300	1,524
-10	All	60	3,703	300	300	1,524
		120	3,750	300	300	1,524
-15	All	60	2,932	300	300	1,524
		120	2,953	300	300	1,524
-20	All	60	2,342	300	300	1,524
		120	2,349	300	300	1,524
-25	All	60	1,907	300	300	1,524
		120	1,913	300	300	1,524
-30	All	60	1,575	300	300	1,524
		120	1,575	300	300	1,524

Legend for table 11-14:
AGL=Above Ground Level
HE=High Explosive

KTAS=Knots True Airspeed



Notes:
1. Normal vertical danger zones with the parameters of tables 11-1 through 11-14 are 5,000 ft AGL. The length and width of the firing lane will be determined by the RMA (Army), OIC (Marine Corps). Minimum recommended width is 50m.
2. The maneuver holding area is not required to be connected to the running fire lane and is not required to be any particular shape or size, except that it must be of sufficient space to accommodate aircraft waiting to enter the running fire lane, without impeding aircraft entering the lane.

Figure 11–1. Surface Danger Zone for aerial rocketry at ground targets

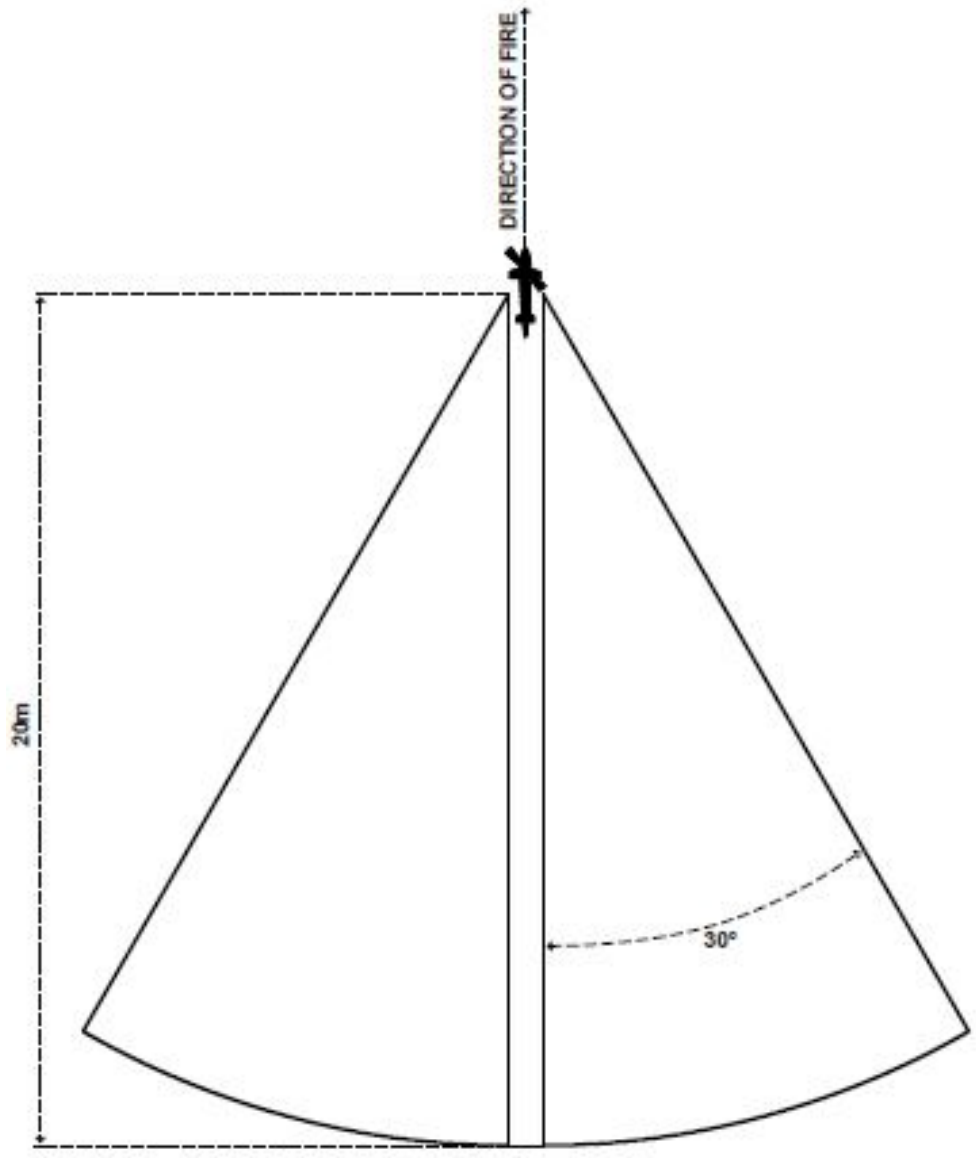


Figure 11–2. Surface danger zone, Area F, rear back blast area for hover firing, loading and unloading aerial rockets

(2) Areas A and B are not required for inert/training munitions. For HE warhead-equipped rockets, Areas A and B are 300m wide. For flechette warhead-equipped rockets, Area A is 300m wide and Area B is 400m wide.

(3) For mixed loads, Distance X is based on the rocket having the greatest range for the highest expected launch angle.

11–8. Firing conditions, specific requirements

a. Running fire. When conducting running fires, cockpit displayed graphics, ground markers, or prominent terrain will be used to mark start and cease fire lines.

b. Hover fire. When conducting hover fire, cockpit displayed graphics, ground markers, or prominent terrain will be used to mark the firing position. If possible, hover fire should be conducted over level terrain free of flight hazards (for example, dust, brush, trees, blowing debris). Natural or manmade features will be used to aid in the establishment of range boundaries and control measures.

c. Markers. When used, markers will be illuminated and/or thermalized when thermal weapons sights are used to ensure proper target area identification at times of limited visibility when required. Additional ground markings will be used at the discretion of the commander or the range OIC. Adjacent ranges within a range complex that support aviation live-fire should be marked or lighted to facilitate aircrew identification of their assigned range.

d. Rotary wing flanking fire.

(1) RW gun and rocket weapon systems may be used to provide flanking fire, as shown in figure 11–3 when a minimum lateral distance of 100m or 15 degrees, whichever is more restrictive, between exposed troops and firing aircraft gun target line is maintained. Additionally, exposed troops must be positioned outside the WDZ/SDZ footprint.

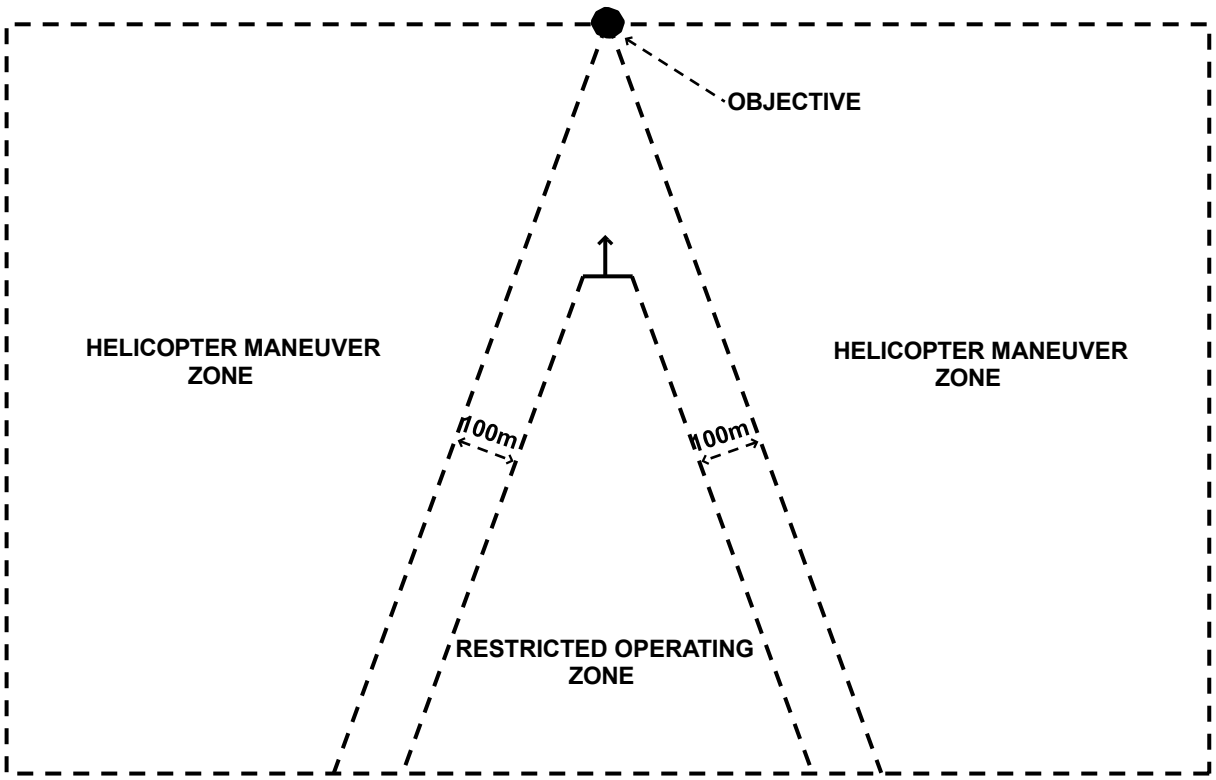


Figure 11–3. Rotary wing gun and rocket flanking fire restrictions

(2) Positive means will be employed to ensure that the firing unit knows the location of the maneuver units while fire support is being provided.

(3) Only non-explosive projectiles will be used for RW flanking fire.

(4) The route and location of maneuver units and the firing aircraft providing flanking fire support will be described and briefed in detail. The use of cockpit displayed graphics, and/or recognizable natural/manmade terrain features, and other means of friendly position marking in accordance with table 11–15 will be used by exposed troops.

Table 11-15
Friendly position marking requirements

Method	Day	Night	NVG	NVS
Smoke	X			
IR Smoke	X			
Signal mirror	X			
IR laser			X	
Glint tape			X	
Combat identification panels	X			X
Strobe		X	X	
IR strobe			X	

IR panel				X
Chem light		X	X	
AN/PAQ-4			X	
VS-17 panel	X			
Spot light		X	X	
MRE heater				X
AN/PEQ-2			X	

(5) Firing aircraft must positively identify the front line trace of exposed troops prior to engagement.

e. Rotary wing/tilt rotor door gunnery operations.

(1) Door gunnery operations will be conducted according to the appropriate gunnery manuals. The Army will use TC 3-04.45. Marine Corps units will follow the procedures established in the Marine Aviation Weapons and Tactics Squadron One (MAWTS–1) Aerial Gunnery Manual and appropriate tactical manuals for the specific type aircraft.

(2) All personnel on the aircraft will wear at least single-hearing protection when firing weapons.

f. Rockets.

(1) *Training operations.* Training operations conducted in conjunction with aerial rocket firing must be suspended if winds or gusts exceed 30 knots.

(2) *Rotary wing aerial rockets.* The launch angle in degrees equals launcher QE in mils divided by 17.7 plus the aircraft pitch in degrees. For articulating launchers, use the maximum articulated QE possible plus the aircraft pitch in degrees.

(a) Firing of the M267 multipurpose sub-munition practice rocket is prohibited if crosswinds exceed 20 knots. The M75 practice sub-munition may be either inert or have an explosive spotting charge. Inert M75 sub-munitions are painted blue and have no ram air decelerator. M75 sub-munitions with explosive spotting charges are painted blue with a brown band and have bright yellow ram air decelerator. A dud M75 has a clean underside. A functioned M75 has soot and burn marks on the underside of the sub-munition body. An armed M231 fuze for the M75 is identified by a slider that sticks out from the sub-munition body about 1.3cm. This slider has a red tip and a "V" notch. Do not use the color as the only means of identification as the colors may change or not be apparent after weathering.

(b) For the Army, firing of the M261 HE multipurpose sub-munition rocket is prohibited in training by units and on Army ranges.

(c) Units using the 2.75" (70mm) aerial rocket are authorized to fire the M255A1 Flechette service munition on range complexes (such as a multipurpose range complex, multipurpose training range, digital multipurpose range complex, digital multipurpose training range, or digital air/ground integration range) that support the WDZ/SDZ. There is no requirement to limit firing of the M255 Flechette into permanently dudded impact areas. The M255A1 presents a hazard similar to the M267 training rocket and if functioned correctly is not a hazard. Flechette rockets that fail to function should be marked upon discovery and referred to EOD personnel for removal. Prudent safety measures and operational practices can minimize risks and burdens to range personnel. RMAs (Army), RCOs (Marine Corps) should identify specific moving and stationary targets for flechette engagements. Aviation crews will typically engage while conducting running fire and close to a range of 1,500m to launch the munition. Selected targets should be in the most downrange third of the range complex. This will minimize expended flechette damage to vehicle tires and risks to range personnel. RMAs (Army), RCOs (Marine Corps) may employ magnetic sweepers to clear expended flechettes from highly travelled service roads.

(3) *The following restrictions apply when firing the 2.75in folding fin aerial rocket with the M278 IR illumination warhead:*

(a) The pilot/gunner will ensure that the M278 IR illumination warhead deployment occurs at least 1,500 ft AGL on training areas. Deployment of the flare below 1500 ft AGL significantly increases the risk of ground fires.

(b) The pilot/gunner will mitigate the hazard of spent rocket motor impact. The spent rocket motor impact point can be approximately 700m to 1200m beyond the point of flare deployment.

(c) When the rocket with the M278 warhead is fired in the vicinity of friendly troops and personnel in an uncovered position, ground personnel are required to be in PPE Level 1.

(d) Pilots must exercise extreme caution when operating in the vicinity of IR illumination flares. Once the flare burns out, the flare container and parachute may not be visible during its descent.

g. Inertial navigation munitions.

(1) Inertial navigation munitions are smart weapons, such as a GBU–38 joint direct attack munition, GBU–44 Viper Strike, or Griffin small tactical munition, that employ Global Positioning System as an inertial aid to acquire target location.

(2) Aircraft employing inertial navigation munitions in a bomb-on-coordinate mode or aircraft employing any ordnance in a system delivery mode on coordinates only will adhere to the following prior to release:

(a) Aircrew will confirm the accuracy of the aircraft navigation and weapon delivery systems via three independent methods (triple check) to confirm GPS accuracy. For the Marine Corps, aircrew will confirm aircraft health, weapon health, and coordinate in accordance with current MAWTS–1 or weapon school technical training procedures.

(b) Aircrew will ensure accurate receipt and entry of target coordinates and that they come from a valid target source. These coordinates will be verified via read-back from target data entry displays or will be cross-checked with mission planning data or range guides but must include one other person, in addition to the pilot, verifying coordinate/ elevation accuracy (either in-flight or during mission planning). Examples of valid target sources include, but are not limited to RMAs (Army), RCOs (Marine Corps), JTACs, range guides, or forward air controller-airborne qualified aircrew.

(c) Aircrew will use all means available to verify accuracy of target coordinates/elevation, and that the coordinates are within the anticipated target area. Examples of available means include but are not limited to forward looking infrared radar, synthetic radar aperture map, heads-up display cueing, other aircraft sensors, terrain pointer, map plots, data links, radio communications, talk-ons with JTACs, RMAs (Army), RCOs (Marine Corps), and other aircrew members.

(d) Aircrew will confirm and adhere to published range operating procedures and restrictions.

h. GBU–44 Viper Strike, Griffin. Both the Viper Strike and Griffin weapon systems have post-launch debris that will fall to the ground after the weapon is launched from the aircraft. This includes aft-launch tube covers, support brackets, and parachutes (Viper Strike). Although the probability of someone being injured by these lightweight items is low, it is recommended that the area below the launch point be cleared of personnel for a radius of 2,000m.

i. AGM–114 HELLFIRE missiles. AGM–114 HELLFIRE missiles shall not be fired if there are tail winds in excess of 20 knots. Further restrictions for HELLFIRE missiles can be found in paragraphs 11–10 thru 11-14.

11–9. Unmanned aircraft systems considerations

a. Operator/air mission commander requirements.

(1) All operators who control UAS platforms/payloads within range complex training airspace shall participate in a range safety brief and become familiar with installation range regulations prior to operating within the complex.

(2) Air mission commanders who oversee UAS operations/training within range complex training airspace shall participate in a range safety brief and become familiar with installation range regulations and range features and boundaries prior to conducting operations within the complex.

(3) Air mission commanders shall take all measures necessary to ensure training/operations are conducted within assigned SUA or other authorized operating area and that UAS and all effects (for example, munitions/laser) are contained within assigned boundaries.

(4) UAS operational unit commanders shall ensure that all UAS performance, air worthiness and related requirements meet system safety standards prior to operating unmanned aerial systems within assigned range space.

b. Operator qualifications for platform/payload operations, aviation weapons delivery/terminal guidance.

(1) Army.

(a) Operators will successfully complete an approved qualification course, or qualification, or transition training in accordance with an approved program of instruction.

(b) Operators will demonstrate platform, payload, and weapon systems proficiency in accordance with TC 3–04.61 and TC 3-04.45.

(2) Marine Corps. Marine operators will demonstrate proficiency in accordance with the appropriate TMS T&R manual.

c. Fielded systems.

(1) Ensure range operations (Army), range control (Marine Corps) personnel are familiar with the flight characteristics of UAS involved in range aviation operations.

(2) Ensure all UAS operations are scheduled and approved by range operations (Army), range control (Marine Corps). Include the coordination radio frequencies, loss of contact procedures, climb/descent corridors, operating altitudes, and proximity to other aircraft and personnel.

(3) UAS operators shall maintain radio contact with the range operations firing desk (Army), range control (Marine Corps) or the OIC at all times.

(4) Unless accomplished during initial coordination, request and receive clearance from the range operations firing desk (Army), range control (Marine Corps) or control agency personnel before changing UAS assigned

position, altitude, or route. If UAS loses uplink for a short period of time, the aircraft will automatically execute return home procedures so that the uplink can be reacquired.

(5) When ordnance is loaded on the UAS, operate UAS in VMC and when the weather is forecast to remain VMC throughout the flight.

(6) If operating with weapons, arm ordnance for delivery only when the aircraft is within the SUA and in a position from which, if released, the ordnance will remain within the designated impact area.

(7) The UAS operator will notify the range operations firing desk (Army), range control (Marine Corps) and the Range OIC when the UAS has completed ordnance delivery, when departing the range, and if any range incidents occur (e.g., misfires, hung ordnance, lost communications, lost UAS, inadvertent or out-of-impact-area firing).

(8) The mission commander will maintain the responsibility for the safe operation of payload and platform.

d. Developmental/experimental unmanned aircraft systems. If the UAS has not yet been fielded, provide range operations (Army), range control (Marine Corps) personnel current reliability information and a "worst case" depiction of potential range, direction and SUA point of departure for developmental/experimental UAS in the event that loss of contact procedures fail.

e. Unmanned aircraft systems operations conducted outside restricted areas and warning areas. UAS operations conducted outside restricted areas and/or warning areas shall comply with the provisions of applicable FAA and Department of Defense Directives (DODDs), notices and current certificates of authorization or waiver.

f. Loss of communications. Firing will be suspended immediately upon loss of communications with the range operations firing desk (Army), range control (Marine Corps), the OIC, or firing elements.

g. Loss of link. For systems with preprogrammed lost link loiter capability, the UAS operator will provide range safety with the location and flight profile of the loiter pattern.

11–10. HELLFIRE missile (semi-active laser) designation criteria

a. Due to the large size of the HELLFIRE WDZ /SDZ and the limited range of the designators, it may be necessary to place designator operators within HELLFIRE WDZs/SDZs during training operations. Remote laser designation will take place from a ground position at least 1000m or 1400m (as depicted below) laterally from the launch aircraft along the target line, while adhering to the designator zone requirements. Three designator zones have been established within the WDZ/SDZ and are depicted in figures 11–4, 11–5, 11–6, and 11–7. (For A thru F models only)

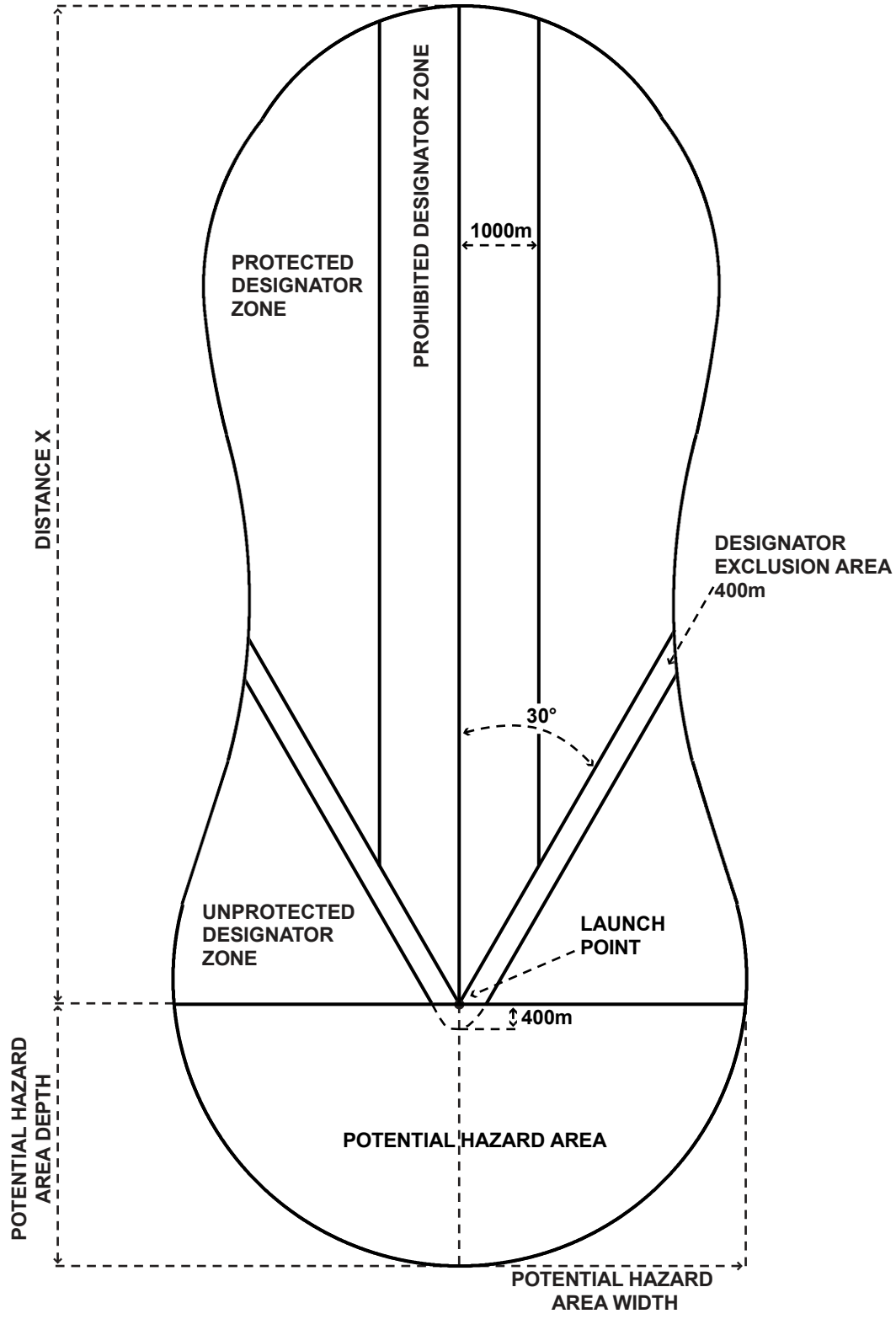


Figure 11–4 Surface Danger Zone for HELLFIRE direct fire A-F models

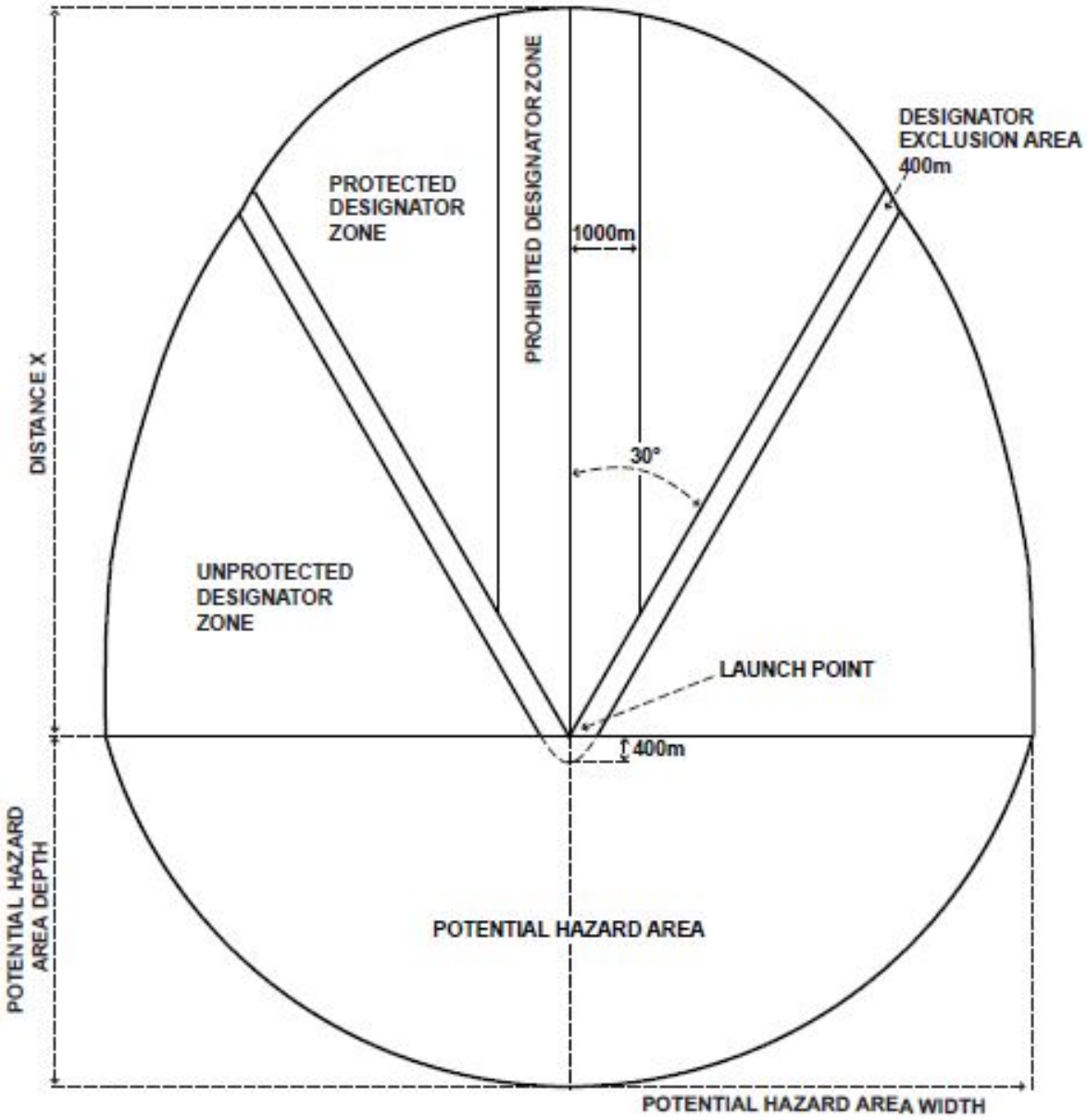


Figure 11–5. Surface Danger Zone for HELLFIRE indirect fire

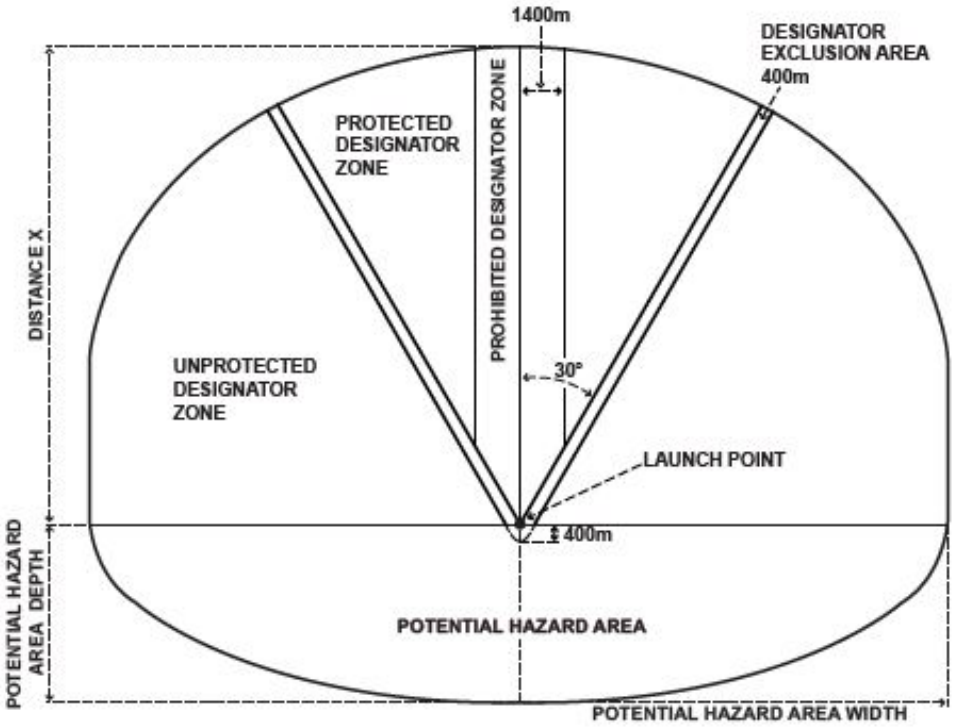


Figure 11–6. Surface Danger Zone for HELLFIRE expanded direct fire

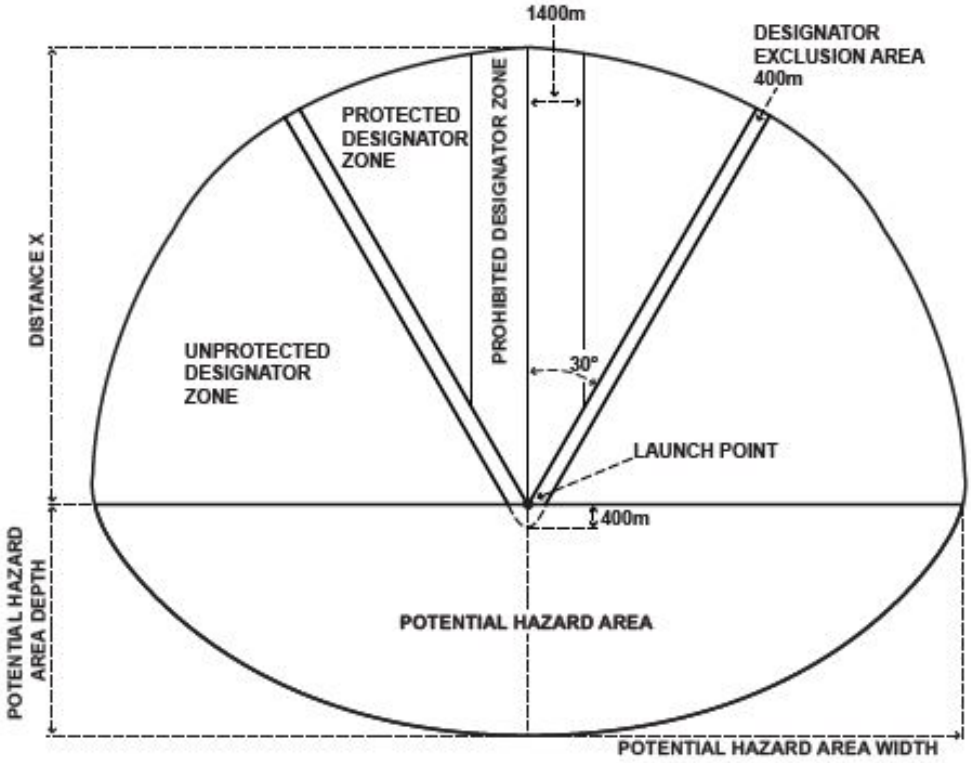


Figure 11–7. Surface Danger Zone for HELLFIRE expanded indirect fire

(1) Prohibited designator zone. No designator operators are allowed in this zone because of the unacceptable probabilities associated with the following hazards:

(a) The missile seeker can track the laser backscatter energy at the exit aperture of the designator or along the path of the laser beam.

(b) The probability of random missile engagement errors is the highest within this zone.

(2) Protected designator zone. Designator operators are not vulnerable to a normally functioning missile tracking the laser backscatter energy in this zone. However, there is a possibility that the missile will track and impact an obstruction such as trees, grass, or hills near the designator operator if it is accidentally illuminated by the laser beam. There is a possibility of a random missile failure impacting at or near the designator operator in this zone. Therefore, the number of personnel in this area must be kept to a minimum consistent with mission requirements.

(a) Only ground designator operators will occupy the protected designator zone. Ground designator operators will be in PPE level 1 and be located in protected positions such as surrounded by sand bags that enclose the designator operator.

(b) The designator will have a clear, unobstructed line of sight to the target. Ensure designator line of sight is unobstructed across the entire path of a moving target during the time of missile flight to impact.

(c) Ground designator operators must ensure that they do not inadvertently lase through battlefield obscurants such as smoke, obstacles, or dust caused by other personnel, vehicles, and so forth.

(3) Unprotected designator zone. Although designator operators are not vulnerable to a normally functioning missile tracking backscatter or false targets in this zone, there is still a possibility of being injured by a random missile failure.

(a) As a minimum, ground designator operators will be in PPE level 1 and laser eye protection. Unprotected ground designators will maintain at least 400m outside of the protected designator zone.

(b) Airborne designator operators must ensure that they are either over ground conditions that do not create dust or are at an altitude where rotor downwash does not create dust.

(c) Ensure designator line of sight is unobstructed across the entire path of a moving target during the time of missile flight to impact.

b. The position of the launch platform and designator operators is critical to the safe use of the HELLFIRE missile weapon system. Controls must be established to ensure proper launcher direction, designator direction, designator boresight, and target coordinate verification prior to missile launch. The angle formed between the designator target line (DTL) and the MTL shall never be greater than 60 degrees. Designator operators will be inside this 60 degree angle (see figure 11-8). For UAS launches, it is desired that the DTL-MTL angle be 45 degrees or less, but never greater than 60 degrees.

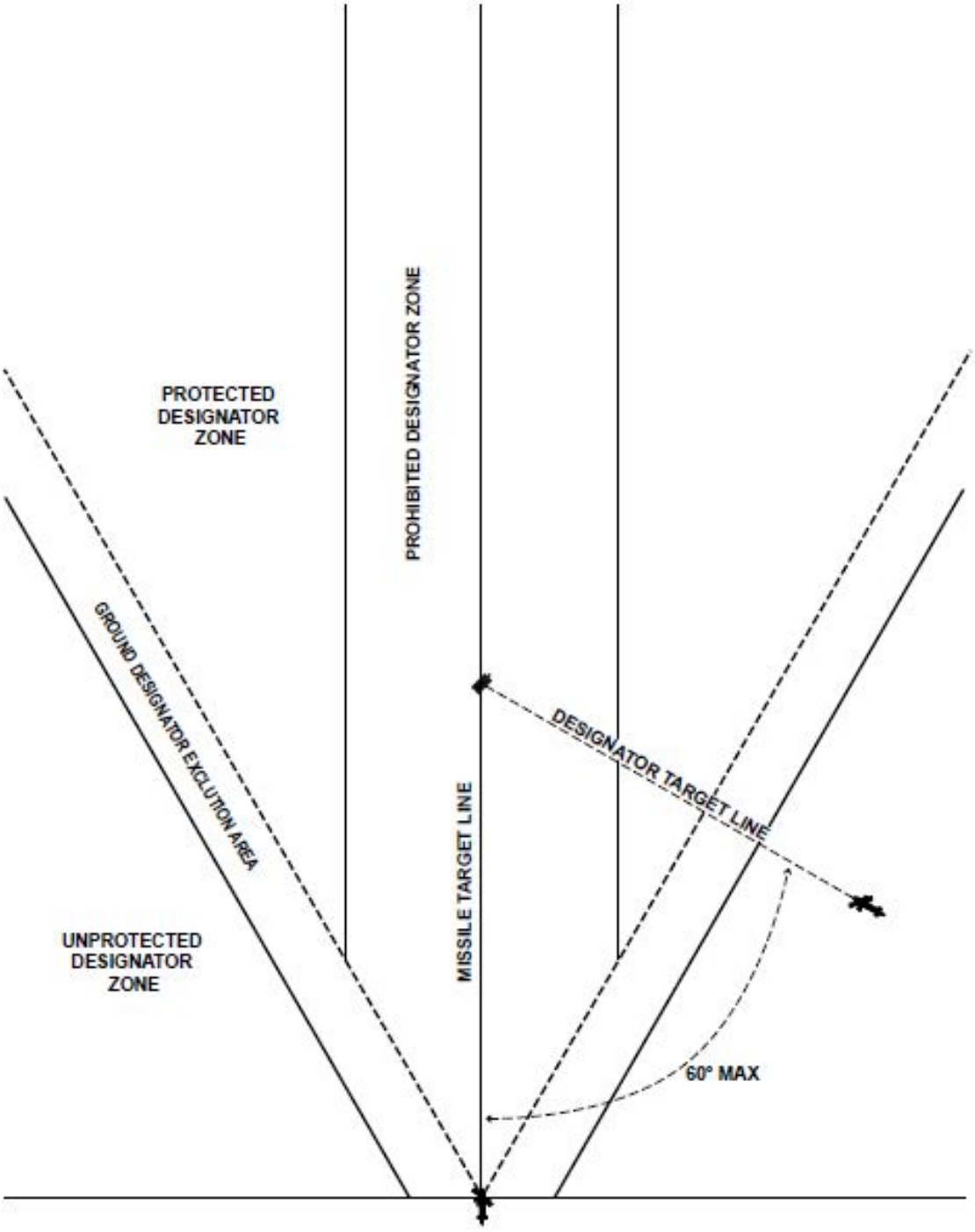


Figure 11-8. Maximum designator angle for AGM-114 HELLFIRE missile laser designators

c. When firing a HELLFIRE in remote designation engagements, the horizontal designator exclusion angle is defined by a ± 30 degree arc centered about the launch platform's missile target line. The launch platform shall be aligned with the target. See figure 11-9. The designator operator must be outside of the horizontal designator exclusion zone (i.e., greater than 30 degrees) and vertical designator exclusion zone. See figure 11-10 for minimum vertical designator exclusion zone. The target must be visible to the launch crew for all Lock On Before Launch (LOBL) and Lock On After Launch (LOAL)-Direct engagements. The aircrew shall ensure aircraft alignment with

the target when using any LOAL remote engagement and the target must be visible to the designating aircraft or designating ground personnel.

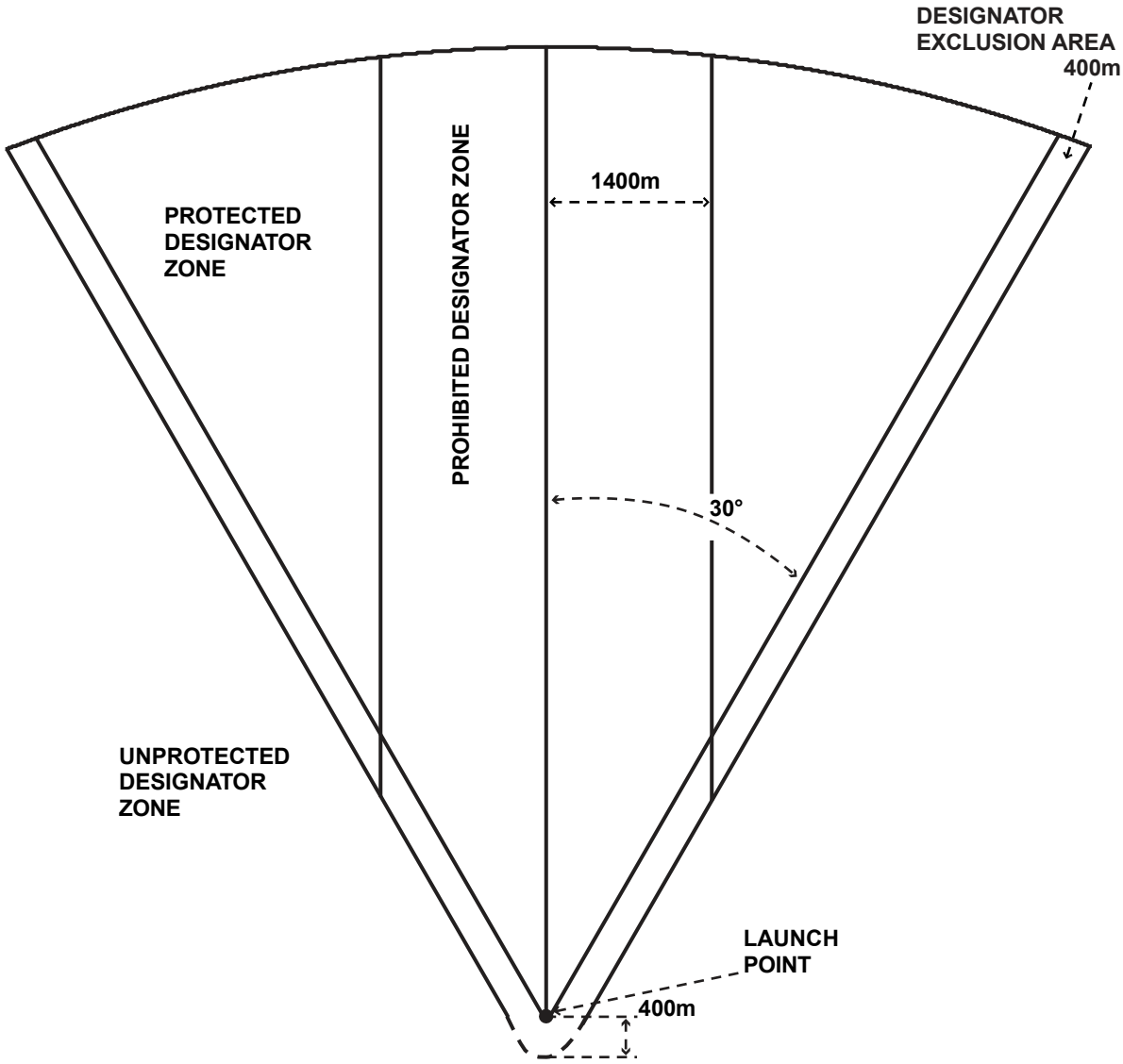


Figure 11-9. Designator zone for HELLFIRE in remote designation engagements

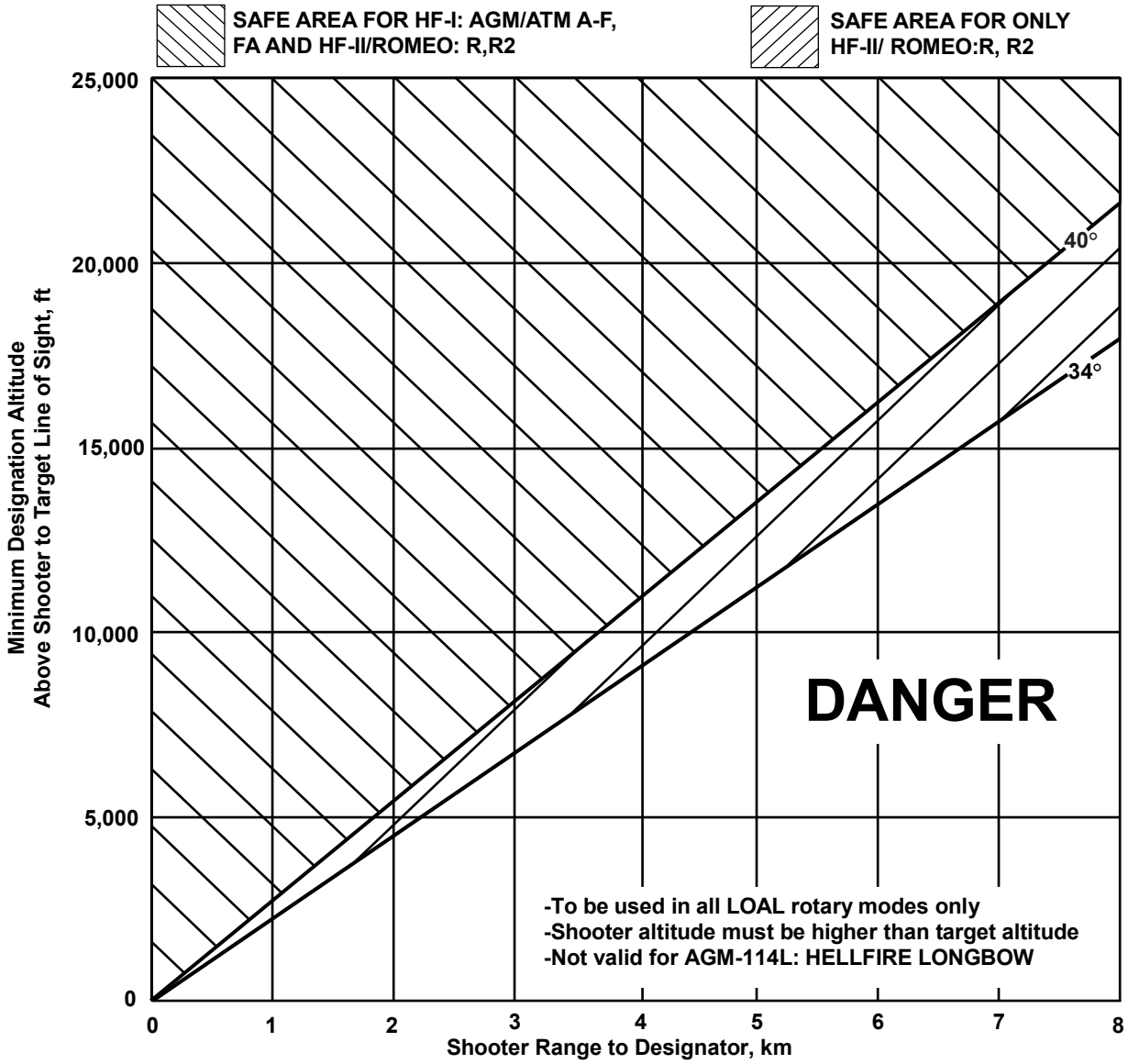


Figure 11-10. Vertical designator zone for HELLFIRE

d. Compliance with the HELLFIRE designator exclusion zones, as described in Joint Publication (JP) 3–09, is required to preclude the designating platform from being targeted by the missile. All HELLFIRE gunnery participants, including UAS operators, must be aware of and comply with JP 3-09's HELLFIRE exclusion zone guidance. Pilots in command are responsible for ensuring missiles are not launched while a designator is in the exclusion zone. UAS pilots must also ensure that cooperative designation engagements comply with their service's TTPs along with overarching JP 3-09's guidance.

e. Ground designator rain hood and port covers must always be used when supplied as a system option to reduce clear air laser energy backscatter (reflected laser energy) emitted from the designator toward the missile.

f. If the missile appears to fly straight up (errant missile), stop lasing.

g. Potential hazard areas depicted in applicable Safety of Use Messages (SOUM) and Army Range Safety Message/Memorandums (ARSMM) identify missile fly-out zones of greater than 1:1,000,000 (99.9999 percent) probability.

h. All non-mission-essential personnel will be located outside HELLFIRE missile WDZs/SDZs.

i. LSDZ parameters outlined in MIL–HDBK–828C apply to designators being used with HELLFIRE missiles. See paragraph 16-2b for use of MIL-HDBK-828C.

11–11. AGM–114 A,B,C,F,K,M,N models HELLFIRE missile weapon danger zones/surface danger zones

a. Direct/indirect HELLFIRE missile weapon danger zones/surface danger zones. The direct and indirect WDZs/SDZs support the AGM–114 A, B, C, F and for K, M, N Indirect only for firing at fixed targets for both Army and Marine Corps RW aircraft. These WDZs/SDZs include the effects of HE warhead functioning at the edge of the impact area.

b. Drawing HELLFIRE WDZ/SDZ. See tables 11-16 through 11-19 for selection criteria and restrictions if a HELLFIRE SDZ is to be constructed. Because of the unique shape and size of the SDZs, the actual scaled safety fans must be created using the WDZ Tool or tables 11-20 through 11-27 using the X-Y coordinates. Depending on the HELLFIRE variant, the appropriate warhead hazard distance (Area A) has been added to the hazard area dimensions of tables 11-16 through 11-19; the appropriate hazard distance for a specific HELLFIRE missile model can be found in the notes of tables 11-20 through 11-27. The alternative is to draw a rectangle using distances provided in tables 11-16 through 11-19 if the training area supports the increased space.

Table 11-16
Surface danger zone data for HELLFIRE Direct SDZ[1,2,3,4]

Ammunition	Restrictions	Configured Restriction defined by SOUM	Launch mode	SDZ	Dist X (m)	Potential hazard area depth (m)	Potential hazard area width (m)
AGM-114 A	Min 3 sec, Max 10 secs; designation delay is calculated for range to target after missile separation, add 1 sec when counting from trigger pull	AH-64 A/D Apache - Yes AH-6 Little Bird - Yes UH-60 IDAP Short Wing Black Hawk - No	LOBL (With Remote Designation Only) LOAL-D (With Remote Designation or Autonomous with proper designation delays)	Figure 11-4	11,450	3,150	3,450
AGM-114 B, C, F (except FA)	Min 3 sec, Max 5 secs; designation delay is calculated for range to target after missile separation, add 1 sec when counting from trigger pull	AH-64 A/D Apache - Yes AH-6 Little Bird - Yes UH-60 IDAP Short Wing Black Hawk - No	LOBL (With Remote Designation Only) LOAL-D (With Remote Designation or Autonomous with proper designation delays)	Figure 11-4	11,450	3,150	3,450

Legend for table 11-16:
AGM=Air Guided Missile
IDAP=Integrated Defensive Armed Penetrator
LOAL=Lock On After Launch
LOBL=Lock On Before Launch
SOUM=Safety Of Use Message

Notes:
[1]Tail winds not to exceed 20 knots
[2]Launch altitude of 300 feet AGL; use larger SDZ for altitudes greater than 300 feet AGL
[3]AGM-114 FA is for operational use only
[4]Minimum clearance airspace 20,000 feet about launch altitude

Table 11-17
Surface danger zone data for HELLFIRE Expanded Direct SDZ[1,2,3,4]

Ammunition	Restrictions	Configured Restriction defined by SOUM	Launch mode	SDZ	Dist X (m)	Potential hazard area depth (m)	Potential hazard area width (m)
AGM-114 A	Min 3 sec, Max 10 secs; designation delay is calculated for range to target after missile separation, add 1	All Army Platforms (to include Army aircraft not defined in SOUM)	LOBL (With Remote Designation Only) LOAL-D (With Remote Designation or	Figure 11-5	12,650	4,900	11,400

	sec when counting from trigger pull		Autonomous with proper designation delays)				
AGM-114 B, C, F (except FA)	Min 3 sec, Max 5 secs; designation delay is calculated for range to target after missile separation, add 1 sec when counting from trigger pull	All Army Platforms (to include Army aircraft not defined in SOUM)	LOBL (With Remote Designation Only) LOAL-D (With Remote Designation or Autonomous with proper designation delays)	Figure 11-5	12,650	4,900	11,400

Legend for table 11-17:
AGM=Air Guided Missile
LOAL=Lock On After Launch
LOBL=Lock On Before Launch
SOUM=Safety Of Use Message

Notes:
[1]Tail winds not to exceed 20 knots
[2]Launch altitude of 300 feet AGL; use larger SDZ for altitudes greater than 300 feet AGL
[3]AGM-114 FA is for operational use only
[4]Minimum clearance airspace 20,000 feet about launch altitude

Table 11-18
Surface danger zone data for HELLFIRE Indirect SDZ[1,2,3,4]

Ammunition	Restrictions	Configured Restriction defined by SOUM	Launch mode	SDZ	Dist X (m)	Potential hazard area depth (m)	Potential hazard area width (m)
AGM-114 A,B,C,F (Except FA) AGM-114 K/K2	LOBL Autonomous - 3 to 5 degree target offset toward the side of the missile being fired	AH-64 A/D Apache - Yes AH-6 Little Bird - Yes UH-60 IDAP Short Wing Black Hawk - No	LOBL (With Remote Designation or Autonomous Designation use defined target offsets) All LOAL (With Remote or Autonomous Designation)	Figure 11-6	13,150	6,650	8,650
AGM-114 KA/K2A AGM-114 M/N/N5 (except M6/N4/N6)	LOBL Autonomous - 3 to 5 degree target offset toward the side of the missile being fired	AH-64 A/D Apache - Yes AH-6 Little Bird - Yes UH-60 IDAP Short Wing Black Hawk - No	LOBL (With Remote Designation or Autonomous Designation use defined target offsets) All LOAL (With Remote or Autonomous Designation)	Figure 11-6	13,400	6,900	8,900

Legend for table 11-18:
AGM=Air Guided Missile
IDAP=Integrated Defensive Armed Penetrator
LOAL=Lock On After Launch
LOBL=Lock On Before Launch
SOUM=Safety Of Use Message

Notes:
[1]Tail winds not to exceed 20 knots
[2]Launch altitude of 300 feet AGL; use larger SDZ for altitudes greater than 300 feet AGL
[3]AGM-114 FA is for operational use only
[4]Minimum clearance airspace 20,000 feet about launch altitude

Table 11-19
Surface danger zone data for HELLFIRE Expanded Indirect SDZ[1,2,3,4]

Ammunition	Restrictions	Configured Restriction defined by SOUM	Launch mode	SDZ	Dist X (m)	Potential hazard area depth (m)	Potential hazard area width (m)
AGM-114 A,B,C,F (Except FA) AGM-114 K/K2	LOBL Autonomous - 3 to 5 degree target offset toward the side of the missile being fired	All Army Platforms (to include Army aircraft not defined in SOUM)	LOBL (With Remote Designation or Autonomous Designation use defined target offsets) All LOAL (With Remote or Autonomous Designation)	Figure 11-7	13,150	6,650	12,480
AGM-114 KA/K2A AGM-114 M/N/N5 (except M6/N4/N6)	LOBL Autonomous - 3 to 5 degree target offset toward the side of the missile being fired	All Army Platforms (to include Army aircraft not defined in SOUM)	LOBL (With Remote Designation or Autonomous Designation use defined target offsets) All LOAL (With Remote or Autonomous Designation)	Figure 11-7	13,400	6,900	12,730

Legend for table 11-19:
AGM=Air Guided Missile
LOAL=Lock On After Launch
LOBL=Lock On Before Launch
SOUM=Safety Of Use Message
Notes:
[1]Tail winds not to exceed 20 knots
[2]Launch altitude of 300 feet AGL; use larger SDZ for altitudes greater than 300 feet AGL
[3]AGM-114 FA is for operational use only
[4]Minimum clearance airspace 20,000 feet about launch altitude

Table 11-20
Surface danger zone data for Army rotary wing HELLFIRE, direct and indirect, Cross Range (CR) and Down Range (DR) point plots when fired 300 feet above the target[1]

Direct 300 ft	Direct 300 ft	Direct 300 ft	Direct 300 ft	Indirect 300 ft	Indirect 300 ft	Indirect 300 ft	Indirect 300 ft
150m	150m	400m	400m	150m	150m	400m	400m
CR (m)	DR (m)	CR (m)	DR (m)	CR (m)	DR (m)	CR (m)	DR (m)
0	-3,153	0	-3,409	0	-6,651	0	-6,902
830	-2,975	889	-3,218	1,819	-6,485	1,869	-6,732
1,654	-2,752	1,762	-2,982	3,638	-5,907	3,737	-6,138
2,495	-2,164	2,678	-2,341	5,461	-4,914	5,614	-5,115
3,322	-916	3,556	-1,015	7,278	-3,016	7,479	-3,168
3,429	-420	3,678	-453	8,137	-1,563	8,366	-1,667
3,451	10	3,702	27	8,651	-22	8,902	-58
3,228	890	3,533	941	8,560	2,644	8,809	2,673
3,088	1,753	3,332	1,809	8,018	5,294	8,259	5,363
2,889	2,612	3,133	2,668	7,024	7,947	7,249	8,060
2,691	3,471	2,935	3,527	5,304	10,604	5,496	10,768
2,500	4,297	2,757	4,297	3,581	12,128	3,717	12,342
2,690	5,119	2,933	5,057	1,831	12,883	1,900	13,126
2,929	5,981	3,173	5,925	0	13,152	0	13,404
3,092	6,861	3,342	6,838	-1,831	12,883	-1,900	13,126
3,092	7,744	3,342	7,762	-3,581	12,128	-3,717	12,342
2,971	8,620	3,217	8,666	-5,304	10,604	-5,496	10,768
2,764	9,514	2,996	9,617	-7,024	7,947	-7,249	8,060
2,140	10,414	2,326	10,585	-8,018	5,294	-8,259	5,363
1,587	10,873	1,732	11,078	-8,560	2,644	-8,809	2,673
847	11,314	934	11,554	-8,651	-22	-8,902	-58

0	11,452	0	11,705	-8,137	-1,563	-8,366	-1,667
-847	11,314	-934	11,554	-7,278	-3,016	-7,479	-3,168
-1,587	10,873	-1,732	11,078	-5,461	-4,914	-5,614	-5,115
-2,140	10,414	-2,326	10,585	-3,638	-5,907	-3,737	-6,138
-2,764	9,514	-2,996	9,617	-1,819	-6,485	-1,869	-6,732
-2,971	8,620	-3,217	8,666	0	-6,651	0	-6,902
-3,092	7,744	-3,342	7,762				
-3,092	6,861	-3,342	6,838				
-2,929	5,981	-3,173	5,925				
-2,690	5,119	-2,933	5,057				
-2,500	4,297	-2,757	4,297				
-2,691	3,471	-2,935	3,527				
-2,889	2,612	-3,133	2,668				
-3,088	1,753	-3,332	1,809				
-3,288	890	-3,533	941				
-3,451	10	-3,702	27				
-3,429	-420	-3,678	-453				
-3,322	-916	-3,556	-1,015				
-2,495	-2,164	-2,678	-2,341				
-1,654	-2,752	-1,762	-2,982				
-830	-2,975	-889	-3,218				
0	-3,153	0	-3,409				

Notes:
[1] Use 150m columns for AGM-114 A, B, C, F, K, K2 and 400m columns for AGM-114 FA, KA, K2A, M, N and N5

Table 11-21
Surface danger zone data for Army rotary wing HELLFIRE, expanded direct and expanded indirect, Cross Range (CR) and Down Range (DR) point plots when fired 300 feet above the target[1]

Expanded direct 300 ft	Expanded direct 300 ft	Expanded direct 300 ft	Expanded direct 300 ft	Expanded indirect 300 ft	Expanded indirect 300 ft	Expanded indirect 300 ft	Expanded indirect 300 ft
150m	150m	400m	400m	150m	150m	400m	400m
CR (m)	DR (m)	CR (m)	DR (m)	CR (m)	DR (m)	CR (m)	DR (m)
0	-4,900	0	-5,150	0	-6,650	0	-6,901
2,312	-4,800	2,333	-5,049	2,611	-6,489	2,645	-6,737
3,953	-4,598	3,991	-4,846	5,233	-5,914	5,304	-6,154
5,053	-4,396	5,107	-4,641	7,851	-4,923	7,970	-5,146
6,958	-3,892	7,038	-4,130	10,482	-3,041	10,653	-3,227
8,791	-3,133	8,910	-3,354	11,727	-1,583	11,937	-1,721
10,303	-2,112	10,474	-2,297	12,482	-31	12,735	-83
11,138	-1,068	11,367	-1,182	12,349	2,655	12,597	2,698
11,400	-18	11,650	-49	11,559	5,308	11,791	5,404
11,400	4,006	11,650	4,016	10,113	7,969	10,317	8,116
11,319	5,024	11,566	5,063	7,615	10,627	7,775	10,823
11,073	6,046	11,312	6,122	5,141	12,138	5,244	12,369
10,665	7,067	10,889	7,178	2,619	12,888	2,668	13,134
10,053	8,087	10,257	8,232	0	13,151	0	13,402
9,208	9,105	9,388	9,279	-2,619	12,888	-2,668	13,134
8,060	10,120	8,211	10,321	-5,141	12,138	-5,244	12,369
6,452	11,132	6,571	11,353	-7,615	10,627	-7,775	10,823
5,345	11,640	5,437	11,872	-10,113	7,969	-10,317	8,116
3,841	12,144	3,910	12,385	-11,559	5,308	-11,791	5,404
2,989	12,347	3,038	12,593	-12,349	2,655	-12,597	2,698
1,736	12,549	1,764	12,798	-12,482	-31	-12,735	-83
0	12,650	0	12,901	-11,727	-1,583	-11,937	-1,721
-1,736	12,549	-1,764	12,798	-10,482	-3,041	-10,653	-3,227
-2,989	12,347	-3,038	12,593	-7,851	-4,923	-7,970	-5,146
-3,841	12,144	-3,910	12,385	-5,233	-5,914	-5,304	-6,154
-5,345	11,640	-5,437	11,872	-2,611	-6,489	-2,645	-6,737
-6,452	11,132	-6,571	11,353	0	-6,650	0	-6,901
-8,060	10,120	-8,211	10,321				
-9,208	9,105	-9,388	9,279				
-10,053	8,087	-10,257	8,232				

-10,665	7,067	-10,889	7,178				
-11,073	6,046	-11,312	6,122				
-11,319	5,024	-11,566	5,063				
-11,400	4,006	-11,650	4,016				
-11,400	-18	-11,650	-49				
-11,138	-1,068	-11,367	-1,182				
-10,303	-2,112	-10,474	-2,297				
-8,791	-3,133	-8,910	-3,354				
-6,958	-3,892	-7,038	-4,130				
-5,053	-4,396	-5,107	-4,641				
-3,953	-4,598	-3,991	-4,846				
-2,312	-4,800	-2,333	-5,049				
0	-4,900	0	-5,150				

Notes:
[1] Use 150m columns for AGM-114 A, B, C, F, K, K2 and 400m columns for AGM-114 FA, KA, K2A, M, N and N5

Table 11-22
Surface danger zone data for Army rotary wing HELLFIRE, direct and indirect, Cross Range (CR) and Down Range (DR) point plots when fired 1,000 feet above the target[1]

Direct 1,000 ft 150m CR (m)	Direct 1,000 ft 150m DR (m)	Direct 1,000 ft 400m CR (m)	Direct 1,000 ft 400m DR (m)	Indirect 1,000 ft 150m CR (m)	Indirect 1,000 ft 150m DR (m)	Indirect 1,000 ft 400m CR (m)	Indirect 1,000 ft 400m DR (m)
0	-3,869	0	-4,125	0	-7,353	0	-7,605
995	-3,655	1,054	-3,898	1,959	-7,176	2,008	-7,422
1,955	-3,396	2,063	-3,626	3,914	-6,554	4,013	-6,785
3,006	-2,661	3,188	-2,839	5,891	-5,477	6,045	-5,678
3,978	-1,193	4,212	-1,292	7,840	-3,442	8,040	-3,594
4,125	-512	4,374	-545	8,778	-1,855	9,007	-1,959
4,154	57	4,405	74	9,355	-124	9,606	-160
3,973	1,032	4,218	1,083	9,258	2,727	9,507	2,756
3,770	1,911	4,014	1,967	8,693	5,488	8,934	5,558
3,571	2,769	3,815	2,826	7,653	8,263	7,878	8,376
3,373	3,628	3,617	3,685	5,840	11,065	6,031	11,229
3,218	4,297	3,475	4,297	3,961	12,727	4,097	12,940
3,369	4,947	3,611	4,885	2,023	13,562	2,092	13,805
3,612	5,824	3,856	5,768	0	13,859	0	14,112
3,792	6,797	4,042	6,774	-2,023	13,562	-2,092	13,805
3,792	7,793	4,042	7,810	-3,961	12,727	-4,097	12,940
3,660	8,748	3,906	8,793	-5,840	11,065	-6,031	11,229
3,415	9,802	3,648	9,905	-7,653	8,263	-7,878	8,376
2,660	10,892	2,846	11,062	-8,693	5,488	-8,934	5,558
1,992	11,446	2,137	11,651	-9,258	2,727	-9,507	2,756
1,091	11,984	1,179	12,223	-9,355	-124	-9,606	-160
0	12,161	0	12,414	-8,778	-1,855	-9,007	-1,959
-1,091	11,984	-1,179	12,223	-7,840	-3,442	-8,040	-3,594
-1,992	11,446	-2,137	11,651	-5,891	-5,477	-6,045	-5,678
-2,660	10,892	-2,846	11,062	-3,914	-6,554	-4,013	-6,785
-3,415	9,802	-3,648	9,905	-1,959	-7,176	-2,008	-7,422
-3,660	8,748	-3,906	8,793	0	-7,353	0	-7,605
-3,792	7,793	-4,042	7,810				
-3,792	6,797	-4,042	6,774				
-3,612	5,824	-3,856	5,768				
-3,369	4,947	-3,611	4,885				
-3,218	4,297	-3,475	4,297				
-3,373	3,628	-3,617	3,685				
-3,571	2,769	-3,815	2,826				
-3,770	1,911	-4,014	1,967				
-3,973	1,032	-4,218	1,083				
-4,154	57	-4,405	74				
-4,125	-512	-4,374	-545				
-3,978	-1,193	-4,212	-1,292				
-3,006	-2,661	-3,188	-2,839				
-1,955	-3,396	-2,063	-3,626				
-995	-3,655	-1,054	-3,898				

0,	-3,869	0	-4,125				

Notes:
[1] Use 150m columns for AGM-114 A, B, C, F, K, K2 and 400m columns for AGM-114 FA, KA, K2A, M, N and N5

Table 11-23
Surface danger zone data for Army rotary wing HELLFIRE, expanded direct and expanded indirect, Cross Range (CR) and Down Range (DR) point plots when fired 1,000 feet above the target[1]

Expanded direct 1,000 ft	Expanded direct 1,000 ft	Expanded direct 1,000 ft	Expanded direct 1,000 ft	Expanded indirect 1,000 ft	Expanded indirect 1,000 ft	Expanded indirect 1,000 ft	Expanded indirect 1,000 ft
150m	150m	400m	400m	150m	150m	400m	400m
CR (m)	DR (m)	CR (m)	DR (m)	CR (m)	DR (m)	CR (m)	DR (m)
0	-5,601	0	-5,851	0	-7,352	0	-7,602
2,370	-5,498	2,391	-5,747	2,708	-7,184	2,743	-7,433
4,059	-5,291	4,096	-5,538	5,433	-6,587	5,504	-6,827
5,206	-5,080	5,260	-5,324	8,184	-5,546	8,303	-5,768
7,183	-4,557	7,263	-4,795	10,959	-3,561	11,129	-3,746
9,125	-3,752	9,244	-3,974	12,317	-1,969	12,528	-2,107
10,783	-2,632	10,954	-2,818	13,190	-176	13,443	-228
11,780	-1,386	12,009	-1,500	13,044	2,774	13,292	2,817
12,100	-105	12,350	-135	12,209	5,578	12,441	5,674
12,100	4,034	12,350	4,044	10,684	8,382	10,889	8,530
12,012	5,134	12,260	5,173	8,061	11,176	8,220	11,371
11,742	6,258	11,981	6,334	5,428	12,783	5,531	13,014
11,294	7,379	11,519	7,490	2,755	13,578	2,804	13,824
10,625	8,493	10,830	8,638	0	13,854	0	14,106
9,712	9,593	9,892	9,768	-2,755	13,578	-2,804	13,824
8,481	10,683	8,632	10,883	-5,428	12,783	-5,531	13,014
6,785	11,749	6,904	11,970	-8,061	11,176	-8,220	11,371
5,603	12,291	5,695	12,524	-10,684	8,382	-10,889	8,530
4,034	12,818	4,103	13,059	-12,209	5,578	-12,441	5,674
3,126	13,034	3,175	13,279	-13,044	2,774	-13,292	2,817
1,813	13,246	1,840	13,495	-13,190	-176	-13,443	-228
0	13,351	0	13,602	-12,317	-1,969	-12,528	-2,107
-1,813	13,246	-1,840	13,495	-10,959	-3,561	-11,129	-3,746
-3,126	13,034	-3,175	13,279	-8,184	-5,546	-8,303	-5,768
-4,034	12,818	-4,103	13,059	-5,433	-6,587	-5,504	-6,827
-5,603	12,291	-5,695	12,524	-2,708	-7,184	-2,743	-7,433
-6,785	11,749	-6,904	11,970	0	-7,352	0	-7,602
-8,481	10,683	-8,632	10,883				
-9,712	9,593	-9,892	9,768				
-10,625	8,493	-10,830	8,638				
-11,294	7,379	-11,519	7,490				
-11,742	6,258	-11,981	6,334				
-12,012	5,134	-12,260	5,173				
-12,100	4,034	-12,350	4,044				
-12,100	-105	-12,350	-135				
-11,780	-1,386	-12,009	-1,500				
-10,783	-2,632	-10,954	-2,818				
-9,125	-3,752	-9,244	-3,974				
-7,183	-4,557	-7,263	-4,795				
-5,206	-5,080	-5,260	-5,324				
-4,059	-5,291	-4,096	-5,538				
-2,370	-5,498	-2,391	-5,747				
0	-5,601	0	-5,851				

Notes:
[1] Use 150m columns for AGM-114 A, B, C, F, K, K2 and 400m columns for AGM-114 FA, KA, K2A, M, N and N5

Table 11-24
Surface danger zone data for Army rotary wing HELLFIRE, direct and indirect, Cross Range (CR) and Down Range (DR) point plots when fired 5,000 feet above the target[1]

Direct 5,000 ft	Direct 5,000 ft	Direct 5,000 ft	Direct 5,000 ft	Indirect 5,000 ft	Indirect 5,000 ft	Indirect 5,000 ft	Indirect 5,000 ft
150m	150m	400m	400m	150m	150m	400m	400m
CR	DR	CR	DR	CR	DR	CR	DR

(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
0	-7,961	0	-8,217	0	-11,370	0	-11,621
1,939	-7,544	1,998	-7,787	2,755	-11,120	2,804	-11,366
3,675	-7,074	3,783	-7,304	5,491	-10,250	5,590	-10,481
5,921	-5,503	6,103	-5,681	8,350	-8,692	8,504	-8,893
7,728	-2,775	7,962	-2,874	11,048	-5,875	11,249	-6,027
8,104	-1,039	8,353	-1,072	12,438	-3,523	12,667	-3,628
8,172	325	8,423	341	13,377	-706	13,628	-743
7,890	1,848	8,135	1,898	13,244	3,198	13,493	3,228
7,667	2,813	7,911	2,869	12,549	6,597	12,790	6,667
7,468	3,670	7,712	3,726	11,247	10,073	11,471	10,186
7,324	4,296	7,581	4,296	8,900	13,698	9,092	13,862
7,324	4,296	7,581	4,296	6,133	16,147	6,268	16,360
7,324	4,296	7,581	4,296	3,124	17,443	3,193	17,686
7,514	4,925	7,757	4,868	0	17,902	0	18,155
7,792	6,430	8,042	6,408	-3,124	17,443	-3,193	17,686
7,792	8,068	8,042	8,086	-6,133	16,147	-6,268	16,360
7,597	9,475	7,843	9,520	-8,900	13,698	-9,092	13,862
7,139	11,451	7,372	11,554	-11,247	10,073	-11,471	10,186
5,636	13,621	5,822	13,791	-12,549	6,597	-12,790	6,667
4,308	14,722	4,453	14,927	-13,244	3,198	-13,493	3,228
2,486	15,810	2,573	16,049	-13,377	-706	-13,628	-743
0	16,213	0	16,467	-12,438	-3,523	-12,667	-3,628
-2,486	15,810	-2,573	16,049	-11,048	-5,875	-11,249	-6,027
-4,308	14,722	-4,453	14,927	-8,350	-8,692	-8,504	-8,893
-5,636	13,621	-5,822	13,791				
-7,139	11,451	-7,372	11,554				
-7,597	9,475	-7,843	9,520				
-7,792	8,068	-8,042	8,086				
-7,792	6,430	-8,042	6,408				
-7,514	4,925	-7,757	4,868				
-7,324	4,296	-7,581	4,296				
-7,324	4,296	-7,581	4,296				
-7,324	4,296	-7,581	4,296				
-7,468	3,670	-7,712	3,726				
-7,667	2,813	-7,911	2,869				
-7,890	1,848	-8,135	1,898				
-8,172	325	-8,423	341				
-8,104	-1,039	-8,353	-1,072				
-7,728	-2,775	-7,962	-2,874				
-5,921	-5,503	-6,103	-5,681				
-3,675	-7,074	-3,783	-7,304				
-1,939	-7,544	-1,998	-7,787				
0	-7,961	0	-8,217				

Notes:
[1] Use 150m columns for AGM-114 A, B, C, F, K, K2 and 400m columns for AGM-114 FA, KA, K2A, M, N and N5

Table 11-25
Surface danger zone data for Army rotary wing HELLFIRE, expanded direct and expanded indirect, Cross Range (CR) and Down Range (DR) point plots when fired 5,000 feet above the target[1]

Expanded direct 5,000 ft	Expanded direct 5,000 ft	Expanded direct 5,000 ft	Expanded direct 5,000 ft	Expanded indirect 5,000 ft	Expanded indirect 5,000 ft	Expanded indirect 5,000 ft	Expanded indirect 5,000 ft
150m	150m	400m	400m	150m	150m	400m	400m
CR (m)	DR (m)	CR (m)	DR (m)	CR (m)	DR (m)	CR (m)	DR (m)
0	-9,605	0	-9,855	0	-11,359	0	-11,610
2,701	-9,487	2,722	-9,736	3,263	-11,158	3,297	-11,406
4,664	-9,246	4,701	-9,494	6,575	-10,432	6,646	-10,672
6,079	-8,987	6,134	-9,231	10,088	-9,102	10,207	-9,325
8,465	-8,355	8,546	-8,593	13,685	-6,529	13,855	-6,715
11,029	-7,293	11,148	-7,514	15,691	-4,178	15,901	-4,316
13,526	-5,606	13,698	-5,792	17,236	-1,003	17,488	-1,055
15,448	-3,203	15,678	-3,317	17,015	3,453	17,263	3,496
16,100	-597	16,350	-628	15,923	7,121	16,156	7,217

16,100	4,194	16,350	4,204	13,953	10,745	14,157	10,893
15,974	5,764	16,222	5,803	10,607	14,308	10,766	14,504
15,564	7,474	15,803	7,550	7,068	16,469	7,170	16,699
14,889	9,162	15,113	9,274	3,531	17,520	3,580	17,766
13,898	10,813	14,103	10,958	0	17,874	0	18,126
12,594	12,385	12,774	12,559	-3,531	17,520	-3,580	17,766
10,887	13,895	11,038	14,095	-7,068	16,469	-7,170	16,699
8,692	15,275	8,811	15,496	-10,607	14,308	-10,766	14,504
7,078	16,016	7,170	16,249	-13,953	10,745	-14,157	10,893
5,136	16,668	5,205	16,908	-15,923	7,121	-16,156	7,217
3,909	16,960	3,958	17,205	-17,015	3,453	-17,263	3,496
2,248	17,227	2,275	17,476	-17,236	-1,003	-17,488	-1,055
0	17,358	0	17,609	-15,691	-4,178	-15,901	-4,316
-2,248	17,227	-2,275	17,476	-13,685	-6,529	-13,855	-6,715
-3,909	16,960	-3,958	17,205	-10,088	-9,102	-10,207	-9,325
-5,136	16,668	-5,205	16,908				
-7,078	16,016	-7,170	16,249				
-8,692	15,275	-8,811	15,496				
-10,887	13,895	-11,038	14,095				
-12,594	12,385	-12,774	12,559				
-13,898	10,813	-14,103	10,958				
-14,889	9,162	-15,113	9,274				
-15,564	7,474	-15,803	7,550				
-15,974	5,764	-16,222	5,803				
-16,100	4,194	-16,350	4,204				
-16,100	-597	-16,350	-628				
-15,448	-3,203	-15,678	-3,317				
-13,526	-5,606	-13,698	-5,792				
-11,029	-7,293	-11,148	-7,514				
-8,465	-8,355	-8,546	-8,593				
-6,079	-8,987	-6,134	-9,231				
-4,664	-9,246	-4,701	-9,494				
-2,701	-9,487	-2,722	-9,736				
0	-9,605	0	-9,855				

Notes:

[1] Use 150m columns for AGM-114 A, B, C, F, K, K2 and 400m columns for AGM-114 FA, KA, K2A, M, N and N5

Table 11-26

Surface danger zone data for Army rotary wing HELLFIRE, direct and indirect, Cross Range (CR) and Down Range (DR) point plots when fired 10,000 feet above the target[1]

Direct 10,000 ft 150m CR (m)	Direct 10,000 ft 150m DR (m)	Direct 10,000 ft 400m CR (m)	Direct 10,000 ft 400m DR (m)	Indirect 10,000 ft 150m CR (m)	Indirect 10,000 ft 150m DR (m)	Indirect 10,000 ft 400m CR (m)	Indirect 10,000 ft 400m DR (m)
0	-13,075	0	-13,331	0	-16,391	0	-16,642
3,118	-12,405	3,177	-12,648	3,750	-16,050	3,799	-16,297
5,825	-11,672	5,933	-11,902	7,462	-14,870	7,561	-15,101
9,565	-9,056	9,747	-9,233	11,425	-12,711	11,578	-12,912
12,416	-4,753	12,650	-4,852	15,059	-8,916	15,260	-9,068
13,077	-1,697	13,326	-1,730	17,013	-5,609	17,242	-5,713
13,195	659	13,446	676	18,405	-1,435	18,656	-1,471
12,787	2,867	13,032	2,918	18,227	3,788	18,476	3,818
12,538	3,941	12,782	3,997	17,369	7,984	17,610	8,053
12,457	4,296	12,713	4,296	15,738	12,335	15,963	12,448
12,457	4,296	12,713	4,296	12,726	16,989	12,917	17,153
12,457	4,296	12,713	4,296	8,847	20,421	8,983	20,635
12,457	4,296	12,713	4,296	4,500	22,295	4,569	22,538
12,457	4,296	12,713	4,296	0	22,956	0	23,208
12,792	5,972	13,042	5,949	-4,500	22,295	-4,569	22,538
12,792	8,413	13,042	8,430	-8,847	20,421	-8,983	20,635
12,519	10,384	12,765	10,429	-12,726	16,989	-12,917	17,153
11,794	13,512	12,027	13,615	-15,738	12,335	-15,963	12,448
9,355	17,032	9,541	17,202	-17,369	7,984	-17,610	8,053
7,203	18,817	7,348	19,022	-18,227	3,788	-18,476	3,818
4,230	20,592	4,317	20,832	-18,405	-1,435	-18,656	-1,471

0	21,279	0	21,532	-17,013	-5,609	-17,242	-5,713
-4,230	20,592	-4,317	20,832	-15,059	-8,916	-15,260	-9,068
-7,203	18,817	-7,348	19,022	-11,425	-12,711	-11,578	-12,912
-9,355	17,032	-9,541	17,202	-7,462	-14,870	-7,561	-15,101
-11,794	13,512	-12,027	13,615	-3,750	-16,050	-3,799	-16,297
-12,519	10,384	-12,765	10,429	0	-16,391	0	-16,642
-12,792	8,413	-13,042	8,430				
-12,792	5,972	-13,042	5,949				
-12,457	4,296	-12,713	4,296				
-12,457	4,296	-12,713	4,296				
-12,457	4,296	-12,713	4,296				
-12,457	4,296	-12,713	4,296				
-12,457	4,296	-12,713	4,296				
-12,538	3,941	-12,782	3,997				
-12,787	2,867	-13,032	2,918				
-13,195	659	-13,446	676				
-13,077	-1,697	-13,326	-1,730				
-12,416	-4,753	-12,650	-4,852				
-9,565	-9,056	-9,747	-9,233				
-5,825	-11,672	-5,933	-11,902				
-3,118	-12,405	-3,177	-12,648				
0	-13,075	0	-13,331				

Notes:
[1] Use 150m columns for AGM-114 A, B, C, F, K, K2 and 400m columns for AGM-114 FA, KA, K2A, M, N and N5

Table 11-27
Surface danger zone data for Army rotary wing HELLFIRE, expanded direct and expanded indirect, Cross Range (CR) and Down Range (DR) point plots when fired 10,000 feet above the target[1]

Expanded direct 10,000 ft	Expanded direct 10,000 ft	Expanded direct 10,000 ft	Expanded direct 10,000 ft	Expanded indirect 10,000 ft	Expanded indirect 10,000 ft	Expanded indirect 10,000 ft	Expanded indirect 10,000 ft
150m	150m	400m	400m	150m	150m	400m	400m
CR (m)	DR (m)	CR (m)	DR (m)	CR (m)	DR (m)	CR (m)	DR (m)
0	-14,609	0	-14,860	0	-16,369	0	-16,619
3,115	-14,474	3,136	-14,723	3,956	-16,124	3,991	-16,373
5,420	-14,191	5,458	-14,438	8,003	-15,237	8,074	-15,478
7,172	-13,870	7,226	-14,114	12,467	-13,548	12,586	-13,770
10,069	-13,103	10,149	-13,341	17,091	-10,240	17,262	-10,425
13,410	-11,719	13,529	-11,940	19,908	-6,939	20,119	-7,077
16,956	-9,323	17,127	-9,509	22,293	-2,038	22,546	-2,090
20,035	-5,475	20,264	-5,588	21,979	4,302	22,228	4,345
21,100	-1,213	21,350	-1,243	20,566	9,049	20,798	9,145
21,100	4,393	21,350	4,403	18,038	13,699	18,242	13,847
20,927	6,551	21,175	6,591	13,789	18,223	13,948	18,419
20,341	8,994	20,580	9,070	9,117	21,076	9,220	21,306
19,382	11,391	19,607	11,502	4,502	22,448	4,550	22,694
17,990	13,712	18,194	13,857	0	22,900	0	23,151
16,195	15,874	16,375	16,049	-4,502	22,448	-4,550	22,694
13,895	17,910	14,046	18,110	-9,117	21,076	-9,220	21,306
11,076	19,683	11,195	19,903	-13,789	18,223	-13,948	18,419
8,921	20,672	9,013	20,904	-18,038	13,699	-18,242	13,847
6,513	21,479	6,582	21,720	-20,566	9,049	-20,798	9,145
4,888	21,866	4,936	22,112	-21,979	4,302	-22,228	4,345
2,793	22,204	2,820	22,453	-22,293	-2,038	-22,546	-2,090
0	22,367	0	22,617	-19,908	-6,939	-20,119	-7,077
-2,793	22,204	-2,820	22,453	-17,091	-10,240	-17,262	-10,425
-4,888	21,866	-4,936	22,112	-12,467	-13,548	-12,586	-13,770
-6,513	21,479	-6,582	21,720	-8,003	-15,237	-8,074	-15,478
-8,921	20,672	-9,013	20,904	-3,956	-16,124	-3,991	-16,373
-11,076	19,683	-11,195	19,903	0	-16,369	0	-16,619
-13,895	17,910	-14,046	18,110				
-16,195	15,874	-16,375	16,049				
-17,990	13,712	-18,194	13,857				
-19,382	11,391	-19,607	11,502				

-20,341	8,994	-20,580	9,070				
-20,927	6,551	-21,175	6,591				
-21,100	4,393	-21,350	4,403				
-21,100	-1,213	-21,350	-1,243				
-20,035	-5,475	-20,264	-5,588				
-16,956	-9,323	-17,127	-9,509				
-13,410	-11,719	-13,529	-11,940				
-10,069	-13,103	-10,149	-13,341				
-7,172	-13,870	-7,226	-14,114				
-5,420	-14,191	-5,458	-14,438				
-3,115	-14,474	-3,136	-14,723				
0	-14,609	0	-14,860				

Notes:
[1] Use 150m columns for AGM-114 A, B, C, F, K, K2 and 400m columns for AGM-114 FA, KA, K2A, M, N and N5

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(1) Direct WDZ/SDZ (see fig 11–4). This WDZ/SDZ will be used for AGM-114 A/F HELLFIRE missiles with the following launch modes and conditions (see tables 11-16 through 11-19):

(a) Lock-on before launch with remote designation.

(b) Lock-on after launch with remote designation.

(c) Lock-on after launch with autonomous designation and proper designation delay:

1. For AGM–114A missiles, use a minimum delay of 3 seconds and a maximum delay of 10 seconds.

2. For AGM–114B/F missiles, use a minimum delay of 3 seconds and a maximum delay of 5 seconds.

3. For designation delay as calculated for range to target after missile separation, always add 1 second to the designation (separation) delay times when counting from trigger pull.

(2) Indirect WDZ/SDZ (see fig 11–5). This WDZ/SDZ will be used for AGM–114 A/F and AGM–114 K/N HELLFIRE missiles with the following launch modes and conditions:

(a) This WDZ/SDZ will be used with all HELLFIRE missiles identified in tables 11-16 through 11-19 and with remote or autonomous designation. The HELLFIRE operational mode launch parameters and performance envelopes are described in TC 3-04.45 and the latest SOUM.

(b) To minimize backscatter for LOBL autonomous engagements use the following target offsets:

1. 3 to 5 degree target offset.

2. Always offset the missile launch angle toward the side of the launch platform on which the missile resides to reduce the chance of interference with autonomous tracking.

3. No offset is necessary when using remote designation.

(3) Expanded direct/expanded indirect weapon danger zones/surface danger zones - Army rotary wing aircraft. Due to excessive missile roll rates induced by interactions between specific Army RW aircraft and their associated launchers, two additional WDZs/SDZs have been established to compensate for possible missile error (roll tip-off error). The expanded direct (AGM–114 A/F) and expanded indirect (AGM–114 A/F and K/N) WDZs/SDZs (see figs 11–6 and 11–7) are required for all Army RW aircraft. However, based on specific aircraft launcher configurations and firing modes, certain Army RW aircraft may be allowed to use the standard direct/indirect WDZs/SDZs as indicated in figures 11–4 and 11–5. Refer to tables 11-16 through 11-19 and the latest Army HELLFIRE Safety of Use Message to determine which aircraft and under which configurations and firing modes are acceptable for firing under the standard direct/indirect WDZs/SDZs.

c. Altitude restrictions. HELLFIRE WDZs/SDZs as depicted in figures 11–4, 11–5, 11–6, and 11–7 and tables 11-20 and 11-21 are based on a launch altitude of 300 ft AGL. If firing above 300 ft AGL then the 'Radial' extent (i.e., centered on the launch point) of the WDZ/SDZ is increased by approximately 1m per additional foot of launch altitude. These increases are depicted in tables 11-22 through 11-27. Minimum clearance airspace will be 20,000 ft above launch altitude. For the HELLFIRE models listed in tables 11-16 through 11-19, refer to the latest SOUM (such as AMCOM-07-001) or ARSMM associated with HELLFIRE delivery to ensure appropriate parameters are met.

d. Area F. An area to the rear of the launch point 30m wide (15m to each side of the launcher) and 50m long when aircraft are at or below 300ft AGL. See figure 11-11. Hazards are launch motor blast, hazardous noise levels, overpressure, and debris. Serious casualties or fatalities may occur to personnel occupying Area F; therefore, occupation of it is not authorized.

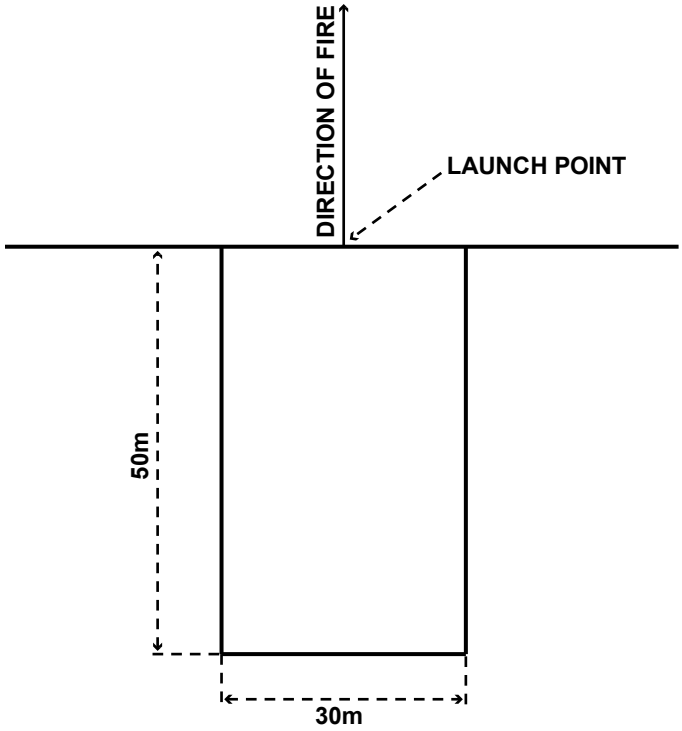

Figure 11-11. Surface Danger Zone, area F, for HELLFIRE missile launches

11–12. AGM–114 L/L-5 Longbow HELLFIRE missile

AGM–114L/L-5 WDZ/SDZ. These missiles will be fired in accordance with all applicable HELLFIRE SOUMs and ARSMMs. For further information contact the US Army Project Manager, Joint Attack Munitions Systems (PM-JAMS) Project Office.

11–13. AGM–114 P/P+ HELLFIRE missile

AGM–114 P/P+ WDZ/SDZ. For USMC platforms, WDZs/SDZs will be developed using the RMTK WDZ Tool. For Army platforms, contact the US Army PM-JAMS Project Office. These missiles are authorized for high altitude firings in order to support additional platforms such as UAS and AC–130 Hercules aircraft in accordance with all applicable HELLFIRE SOUMs and ARSMMs.

11-14. AGM-114 R/R2 HELLFIRE missile

AGM–114 R/R2 WDZ/SDZs. These missiles will be fired in accordance with all applicable SOUMs and ARSMMs.

a. AGM-114 R/R2 HELLFIRE can be fired in accordance with the SDZ guidance below if no WDZ is available. As shown in table 11-28, AGM-114 R/R2 SDZs are platform-specific and have configuration restrictions for rotary wing LOBL engagements until further guidance is issued that provides relief for high roll-rate inducing loadouts. An additional requirement to the SDZ restrictions is that the target be placed no closer to the range boundary than 2km. Ensure designators comply with the location restrictions depicted in figure 11-9.

Table 11-28
Army UAS and rotary wing AGM-114 R/R2 HELLFIRE missile firing modes and restriction requirements

Aircraft	Launch mode	Configuration restrictions	SDZ	Alternate SDZ construction
UAS	LOAL	NO	Figure 11-12	Table 11-29
AH-64 Apache (R09)	LOBL	YES	Figure 11-13	Table 11-30
AH-64 Apache (R09)	LOAL	NO	Figure 11-14	Table 11-31
AH-64 Apache (Target Reference)	LOBL	YES	Figure 11-15	Table 11-32
AH-64 Apache (Target Reference)	LOAL	NO	Figure 11-14	Table 11-31
MH-6 MELB Little Bird	LOBL	YES	Figure 11-16	Table 11-33
UH-60 IDAP Short Wing Black Hawk	LOBL	NO	Figure 11-16	Table 11-33
UH-60 IDAP Short Wing Black Hawk/ MH-6 MELB Little Bird	LOAL	NO	Figure 11-14	Table 11-31

Legend for table 11-28:
IDAP=Integrated Defensive Armed Penetrator
LOAL=Lock On After Launch
LOBL=Lock On Before Launch
MELB=Mission Enhanced Little Bird
UAS=Unmanned Aircraft System

b. Rotary Wing LOBL configuration restrictions. Configuration restrictions for rotary wing LOBL engagements are:

(1) AH-64 Apache

(a) Apache aircraft must be outfitted with HELLFIRE launchers (M299) on the inboard pylons and M261 Hydra-70 rocket launchers on the outboard pylons with or without rockets or another M299 HELLFIRE launcher with or without missiles.

(b) HELLFIRE missiles may be fired from only two rails- left and right inboard pylons, upper inboard rails. The users may load/fire missiles on both rails or on just one rail.

(c) The other inboard pylon rails must contain either live tactical HELLFIRE missiles or M34 dummy HELLFIRE missiles.

(d) HELLFIRE missiles may be fired from approved configurations for hover and forward flight.

(2) MH-6 Mission Enhanced Little Bird (MELB) Little Bird

(a) HELLFIRE missiles shall be fired from only two rails during forward flight - left and right inboard rails.

(b) The outboard rails must contain either live tactical HELLFIRE missiles or M34 dummy HELLFIRE missiles.

(c) HELLFIRE missiles may be fired from approved configurations for hover and forward flight.

c. Use of AGM-114 R/R2 SDZs for aviation platforms. Use of AGM-114 R/R2 SDZs shall be constrained to launch conditions used in the generation of the SDZs and should not be extrapolated beyond the dataset.

(1) UAS Platforms: AGM-114 R/R2 HELLFIRE SDZ contours have been generated for LOAL R09 target message-enhanced mode engagement altitudes from 5,000 ft to 25,000 ft MSL and airspeeds up to 160 Knots True Airspeed (KTAS). UAS platform offsets and launch airspeeds shall not exceed AGM-114 R/R2 design constraints. HELLFIRE weapon engagement zone (WEZ) guidance should be followed to ensure good performance of the missile. The UAS LOAL SDZ contours are depicted in figure 11-12. No UAS LOBL SDZ contours are provided since LOBL capability is currently not implemented on UAS platforms.

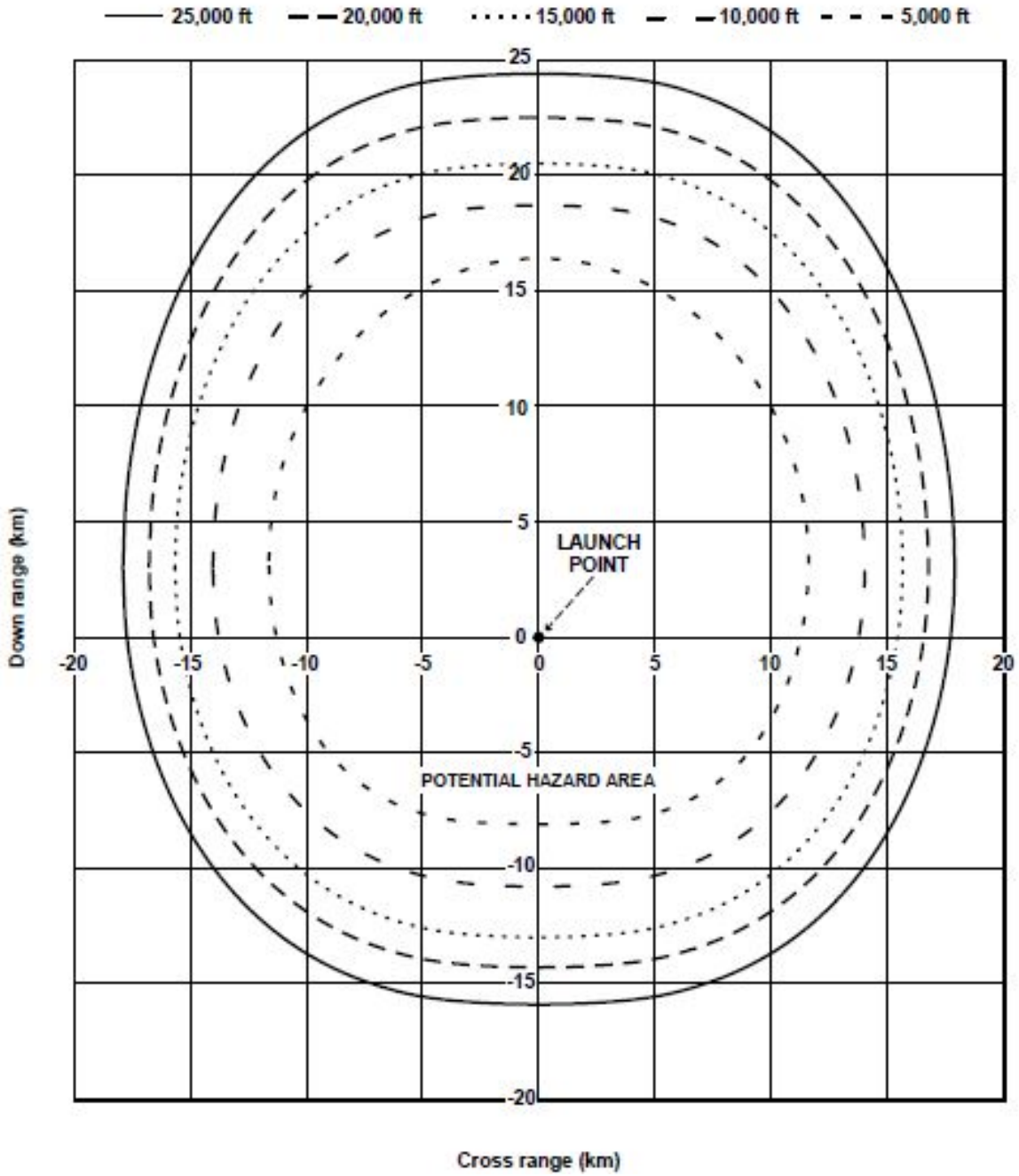

Figure 11–12. Surface Danger Zone for AGM-114 R/R2 Unmanned Aerial System (UAS) Lock On After Launch (LOAL) only

Table 11-29
Surface danger zone contours data for AGM-114-R UAS (LOAL only) Cross Range (CR) and Down Range (DR) point plots

25,000 ft CR (m)	25,000 ft DR (m)	20,000 ft CR (m)	20,000 ft DR (m)	15,000 ft CR (m)	15,000 ft DR (m)	10,000 ft CR (m)	10,000 ft DR (m)	5,000 ft CR (m)	5,000 ft DR (m)
-17,900	3,000	-16,780	3,000	-15,660	3,000	-14,040	3,000	-11,620	3,300
-17,730	6,348	-16,621	6,050	-15,511	5,738	-13,907	5,456	-11,477	5,349
-17,222	9,613	-16,145	9,026	-15,067	8,408	-13,508	7,852	-11,051	7,348
-16,379	12,715	-15,355	11,853	-14,330	10,945	-12,847	10,128	-10,353	9,247
-15,207	15,579	-14,256	14,462	-13,304	13,286	-11,928	12,228	-9,401	11,000
-13,711	18,132	-12,853	16,789	-11,995	15,374	-10,754	14,102	-8,217	12,563
-11,894	20,313	-11,150	18,776	-10,406	17,158	-9,329	15,702	-6,830	13,898
-9,751	22,068	-9,141	20,375	-8,531	18,593	-7,648	16,989	-5,275	14,972
-7,253	23,353	-6,799	21,546	-6,346	19,643	-5,689	17,932	-3,591	15,759
-4,296	24,137	-4,028	22,260	-3,759	20,285	-3,370	18,507	-1,818	16,239
0	24,400	0	22,500	0	20,500	0	18,700	0	16,400
4,296	24,137	4,028	22,260	3,759	20,285	3,370	18,507	1,818	16,239
7,253	23,353	6,799	21,546	6,346	19,643	5,689	17,932	3,591	15,759
9,751	22,068	9,141	20,375	8,531	18,593	7,648	16,989	5,275	14,972
11,894	20,313	11,150	18,776	10,406	17,158	9,329	15,702	6,830	13,898
13,711	18,132	12,853	16,789	11,995	15,374	10,754	14,102	8,217	12,563
15,207	15,579	14,256	14,462	13,304	13,286	11,928	12,228	9,401	11,000
16,379	12,715	15,355	11,853	14,330	10,945	12,847	10,128	10,353	9,247
17,222	9,613	16,145	9,026	15,067	8,408	13,508	7,852	11,051	7,348
17,730	6,348	16,621	6,050	15,511	5,738	13,907	5,456	11,477	5,349
17,900	3,000	16,780	3,000	15,660	3,000	14,040	3,000	11,620	3,300
17,730	43	16,621	294	15,511	497	13,907	841	11,524	1,517
17,222	-2,840	16,145	-2,346	15,067	-1,944	13,508	-1,264	11,238	-223
16,379	-5,580	15,355	-4,854	14,330	-4,264	12,847	-3,265	10,760	-1,875
15,207	-8,109	14,256	-7,169	13,304	-6,405	11,928	-5,111	10,089	-3,401
13,711	-10,364	12,853	-9,233	11,995	-8,314	10,754	-6,758	9,223	-4,761
11,894	-12,290	11,150	-10,996	10,406	-9,944	9,329	-8,164	8,154	-5,923
9,751	-13,840	9,141	-12,414	8,531	-11,256	7,648	-9,296	6,864	-6,857
7,253	-14,975	6,799	-13,453	6,346	-12,217	5,689	-10,125	5,311	-7,542
4,296	-15,667	4,028	-14,087	3,759	-12,803	3,370	-10,630	3,374	-7,960
0	-15,900	0	-14,300	0	-13,000	0	-10,800	0	-8,100
-4,296	-15,667	-4,028	-14,087	-3,759	-12,803	-3,370	-10,630	-3,374	-7,960
-7,253	-14,975	-6,799	-13,453	-6,346	-12,217	-5,689	-10,125	-5,311	-7,542
-9,751	-13,840	-9,141	-12,414	-8,531	-11,256	-7,648	-9,296	-6,864	-6,857
-11,894	-12,290	-11,150	-10,996	-10,406	-9,944	-9,329	-8,164	-8,154	-5,923
-13,711	-10,364	-12,853	-9,233	-11,995	-8,314	-10,754	-6,758	-9,223	-4,761
-15,207	-8,109	-14,256	-7,169	-13,304	-6,405	-11,928	-5,111	-10,089	-3,401
-16,379	-5,580	-15,355	-4,854	-14,330	-4,264	-12,847	-3,265	-10,760	-1,875
-17,222	-2,840	-16,145	-2,346	-15,067	-1,944	-13,508	-1,264	-11,238	-223
-17,730	43	-16,621	294	-15,511	497	-13,907	841	-11,524	1,517
-17,900	3,000	-16,780	3,000	-15,660	3,000	-14,040	3,000	-11,620	3,300
-17,900	3,000	-16,780	3,000	-15,660	3,000	-14,040	3,000	-11,620	3,300

(2) AH-64 Apache (Enhanced Rotary Wing Mode-R09): AH-64 Apache missile firings that utilize enhanced rotary wing mode's R09 targeting message shall use the SDZ restrictions shown in figures 11-13 and 11-14. The launch thresholds for the LOBL and LOAL SDZs shall be constrained to a maximum launch altitude of 10,000 ft MSL and a maximum platform airspeed of 120 KTAS. Missile launches less than 1,000 ft height above target shall utilize the 1,000 ft SDZ contours for LOBL and LOAL engagements.

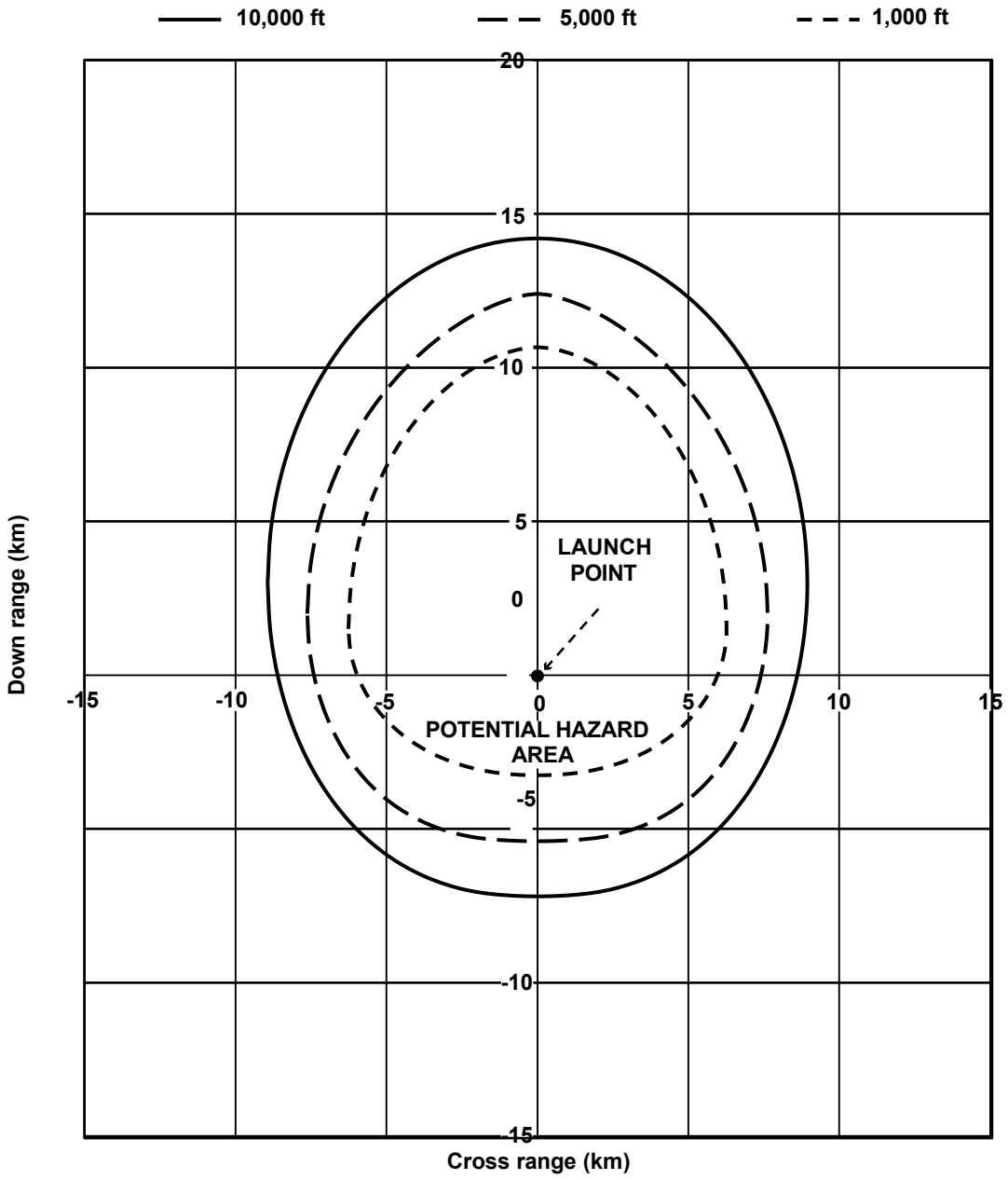

Figure 11–13. Surface Danger Zone for Army AH-64 Apache enhanced mode R09 AGM-114 R/R2 Lock On Before Launch (LOBL) R09 only

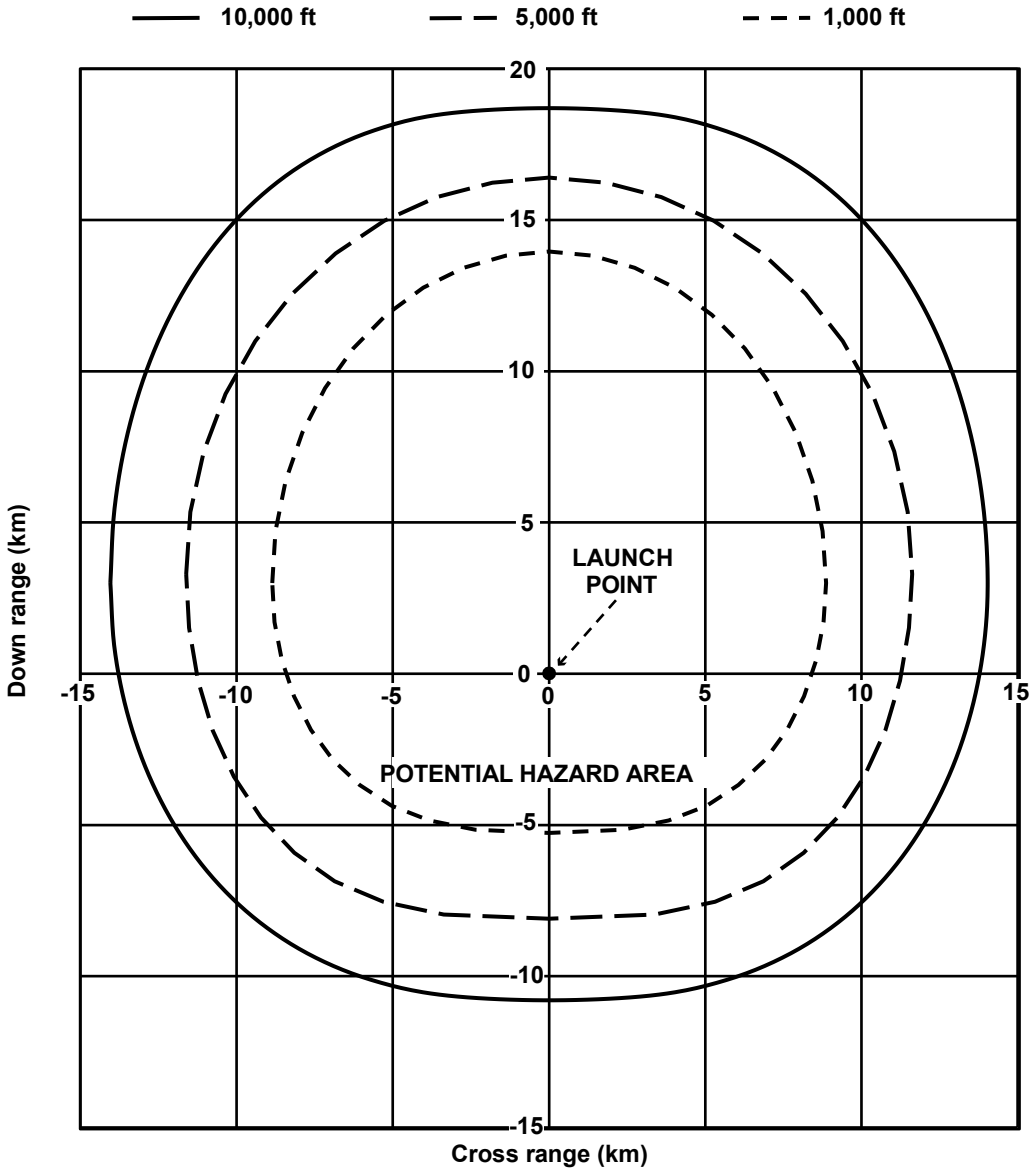

Figure 11–14. Surface danger zone for Army rotary wing AGM-114 R/R2 Lock On After Launch (LOAL)

Table 11-30
Surface danger zone contours data for Army AH-64 Apache Enhanced Mode-R09 AGM-114 R/R2 (LOBL R09 only) Cross Range (CR) and Down Range (DR) point plots

10,000 ft	10,000 ft	5,000 ft	5,000 ft	1,000 ft	1,000 ft
CR (m)	DR (m)	CR (m)	DR (m)	CR (m)	DR (m)
-8,940	3,000	-7,620	2,000	-6,264	1,500
-8,830	4,752	-7,503	3,627	-6,178	2,933
-8,502	6,461	-7,157	5,214	-5,924	4,331
-7,966	8,085	-6,596	6,722	-5,510	5,659
-7,233	9,583	-5,847	8,113	-4,950	6,884
-6,322	10,920	-4,941	9,354	-4,262	7,977
-5,255	12,061	-3,922	10,414	-3,471	8,911
-4,059	12,979	-2,840	11,266	-2,605	9,662

-2,763	13,652	-1,756	11,891	-1,699	10,212
-1,399	14,062	-750	12,272	-797	10,547
0	14,200	0	12,400	0	10,660
1,399	14,062	750	12,272	797	10,547
2,763	13,652	1,756	11,891	1,699	10,212
4,059	12,979	2,840	11,266	2,605	9,662
5,255	12,061	3,922	10,414	3,471	8,911
6,322	10,920	4,941	9,354	4,262	7,977
7,233	9,583	5,847	8,113	4,950	6,884
7,966	8,085	6,596	6,722	5,510	5,659
8,502	6,461	7,157	5,214	5,924	4,331
8,830	4,752	7,503	3,627	6,178	2,933
8,940	3,000	7,620	2,000	6,264	1,500
8,848	1,404	7,548	842	6,194	755
8,574	-152	7,331	-287	5,985	29
8,120	-1,631	6,973	-1,360	5,640	-661
7,493	-2,995	6,474	-2,350	5,166	-1,298
6,697	-4,212	5,837	-3,233	4,571	-1,866
5,741	-5,252	5,063	-3,987	3,864	-2,351
4,630	-6,088	4,151	-4,593	3,055	-2,741
3,360	-6,701	3,088	-5,038	2,154	-3,027
1,905	-7,074	1,829	-5,309	1,160	-3,201
0	-7,200	0	-5,400	0	-3,260
-1,905	-7,074	-1,829	-5,309	-1,160	-3,201
-3,360	-6,701	-3,088	-5,038	-2,154	-3,027
-4,630	-6,088	-4,151	-4,593	-3,055	-2,741
-5,741	-5,252	-5,063	-3,987	-3,864	-2,351
-6,697	-4,212	-5,837	-3,233	-4,571	-1,866
-7,493	-2,995	-6,474	-2,350	-5,166	-1,298
-8,120	-1,631	-6,973	-1,360	-5,640	-661
-8,574	-152	-7,331	-287	-5,985	29
-8,848	1,404	-7,548	842	-6,194	755
-8,940	3,000	-7,620	2,000	-6,264	1,500

Table 11-31
Surface danger zone contours data for Army Rotary Wing AGM-114 R/R2 LOAL Cross Range (CR) and Down Range (DR) point plots

10,000 ft	10,000 ft	5,000 ft	5,000 ft	1,000 ft	1,000 ft
CR (m)	DR (m)	CR (m)	DR (m)	CR (m)	DR (m)
-14,040	3,000	-11,620	3,300	-8,864	3,000
-13,907	5,456	-11,477	5,349	-8,755	4,715
-13,508	7,852	-11,051	7,348	-8,430	6,387
-12,847	10,128	-10,353	9,247	-7,898	7,976
-11,928	12,228	-9,401	11,000	-7,171	9,442
-10,754	14,102	-8,217	12,563	-6,268	10,750
-9,329	15,702	-6,830	13,898	-5,210	11,867
-7,648	16,989	-5,275	14,972	-4,024	12,765
-5,689	17,932	-3,591	15,759	-2,739	13,424
-3,370	18,507	-1,818	16,239	-1,387	13,825
0	18,700	0	16,400	0	13,960
3,370	18,507	1,818	16,239	1,387	13,825
5,689	17,932	3,591	15,759	2,739	13,424
7,648	16,989	5,275	14,972	4,024	12,765
9,329	15,702	6,830	13,898	5,210	11,867
10,754	14,102	8,217	12,563	6,268	10,750
11,928	12,228	9,401	11,000	7,171	9,442
12,847	10,128	10,353	9,247	7,898	7,976
13,508	7,852	11,051	7,348	8,430	6,387
13,907	5,456	11,477	5,349	8,755	4,715
14,040	3,000	11,620	3,300	8,864	3,000
13,907	841	11,524	1,517	8,786	1,708
13,508	-1,264	11,238	-223	8,552	448
12,847	-3,265	10,760	-1,875	8,163	-750
11,928	-5,111	10,089	-3,401	7,619	-1,855

10,754	-6,758	9,223	-4,761	6,920	-2,841
9,329	-8,164	8,154	-5,923	6,064	-3,682
7,648	-9,296	6,864	-6,857	5,043	-4,360
5,689	-10,125	5,311	-7,542	3,831	-4,856
3,370	-10,630	3,374	-7,960	2,356	-5,158
0	-10,800	0	-8,100	0	-5,260
-3,370	-10,630	-3,374	-7,960	-2,356	-5,158
-5,689	-10,125	-5,311	-7,542	-3,831	-4,856
-7,648	-9,296	-6,864	-6,857	-5,043	-4,360
-9,329	-8,164	-8,154	-5,923	-6,064	-3,682
-10,754	-6,758	-9,223	-4,761	-6,920	-2,841
-11,928	-5,111	-10,089	-3,401	-7,619	-1,855
-12,847	-3,265	-10,760	-1,875	-8,163	-750
-13,508	-1,264	-11,238	-223	-8,552	448
-13,907	841	-11,524	1,517	-8,786	1,708
-14,040	3,000	-11,620	3,300	-8,864	3,000

(3) AH-64 Apache (Modified Legacy Mode-Target Reference): Rotary wing AH-64 Apache missile firings that do not utilize enhanced rotary wing mode's R09 targeting message shall adhere to the SDZ boundaries shown in figures 11-14 and 11-15. The launch thresholds for the LOBL and LOAL SDZs shall be constrained to a maximum launch altitude of 10,000 ft height above target and maximum platform airspeed of 120 KTAS. Missile launches less than 1,000 ft height above target shall utilize the 1,000 ft SDZ contours for LOBL and LOAL engagements.

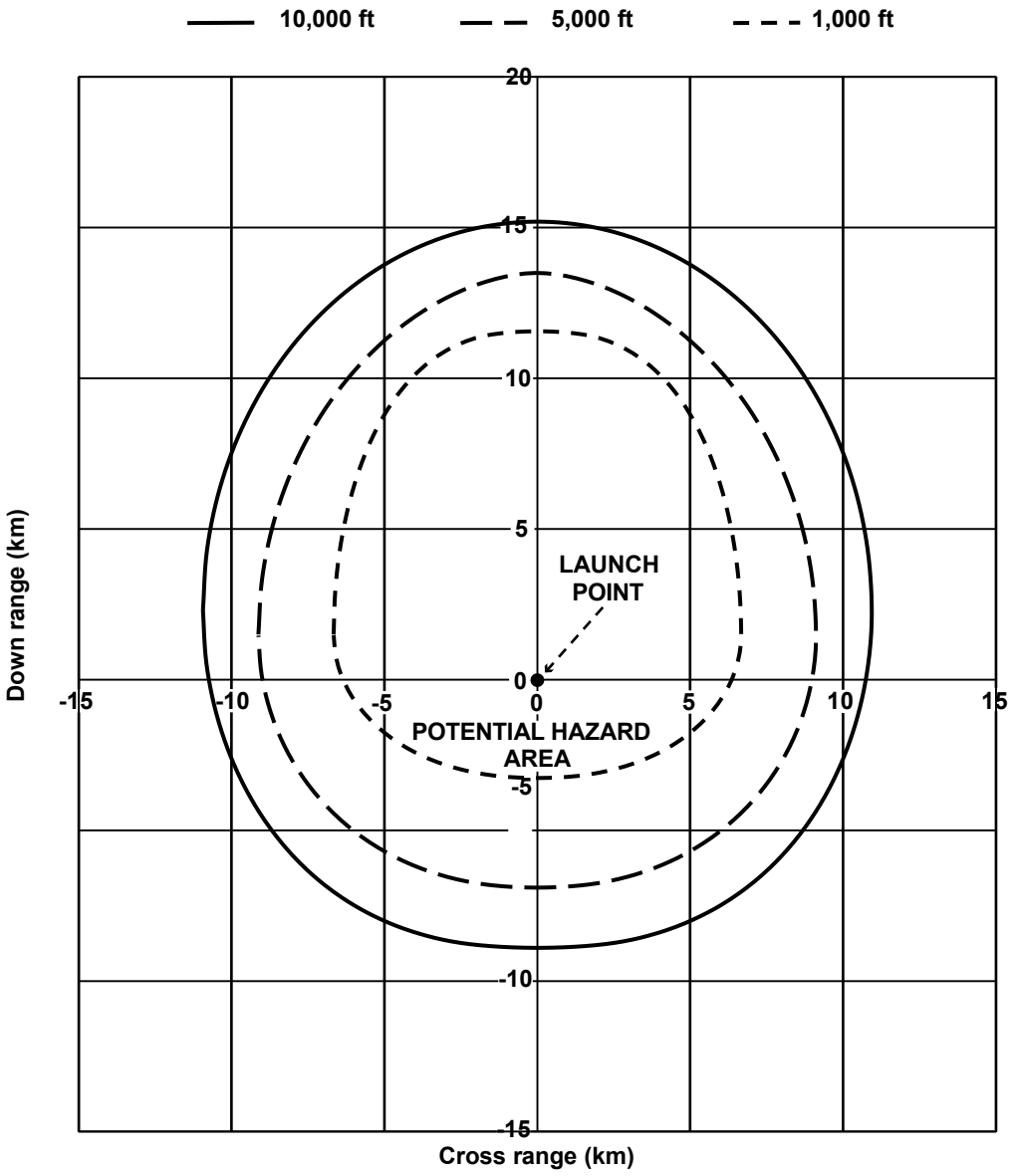

Figure 11–15. Surface danger zone for Army AH-64 Apache Target Reference AGM-114 R/R2 Lock On Before Launch (LOBL)

Table 11-32
Surface danger zone contours data for Army AH-64 Apache (Target Reference) AGM-114 R/R2 LOBL Cross Range (CR) and Down Range (DR) point plots

10,000 ft	10,000 ft	5,000 ft	5,000 ft	1,000 ft	1,000 ft
CR (m)	DR (m)	CR (m)	DR (m)	CR (m)	DR (m)
-10,940	2,300	-9,120	1,500	-6,664	1,500
-10,805	4,318	-8,995	3,377	-6,601	3,074
-10,405	6,286	-8,625	5,208	-6,412	4,609
-9,748	8,156	-8,022	6,948	-6,098	6,067
-8,851	9,882	-7,207	8,553	-5,662	7,413
-7,736	11,422	-6,205	9,985	-5,105	8,613
-6,430	12,736	-5,053	11,208	-4,428	9,639
-4,967	13,794	-3,793	12,192	-3,630	10,464
-3,381	14,569	-2,473	12,913	-2,700	11,068
-1,711	15,041	-1,161	13,352	-1,600	11,436
0	15,200	0	13,500	0	11,560
1,711	15,041	1,161	13,352	1,600	11,436
3,381	14,569	2,473	12,913	2,700	11,068
4,967	13,794	3,793	12,192	3,630	10,464
6,430	12,736	5,053	11,208	4,428	9,639
7,736	11,422	6,205	9,985	5,105	8,613
8,851	9,882	7,207	8,553	5,662	7,413
9,748	8,156	8,022	6,948	6,098	6,067
10,405	6,286	8,625	5,208	6,412	4,609
10,805	4,318	8,995	3,377	6,601	3,074
10,940	2,300	9,120	1,500	6,664	1,500
10,828	548	9,018	186	6,589	755
10,492	-1,161	8,713	-1,096	6,367	29
9,937	-2,785	8,212	-2,314	6,000	-661
9,169	-4,283	7,522	-3,437	5,496	-1,298
8,196	-5,620	6,655	-4,440	4,863	-1,866
7,026	-6,761	5,626	-5,296	4,111	-2,351
5,665	-7,679	4,449	-5,984	3,251	-2,741
4,112	-8,352	3,136	-6,489	2,291	-3,027
2,331	-8,762	1,689	-6,797	1,234	-3,201
0	-8,900	0	-6,900	0	-3,260
-2,331	-8,762	-1,689	-6,797	-1,234	-3,201
-4,112	-8,352	-3,136	-6,489	-2,291	-3,027
-5,665	-7,679	-4,449	-5,984	-3,251	-2,741
-7,026	-6,761	-5,626	-5,296	-4,111	-2,351
-8,196	-5,620	-6,655	-4,440	-4,863	-1,866
-9,169	-4,283	-7,522	-3,437	-5,496	-1,298
-9,937	-2,785	-8,212	-2,314	-6,000	-661
-10,492	-1,161	-8,713	-1,096	-6,367	29
-10,828	548	-9,018	186	-6,589	755
-10,940	2,300	-9,120	1,500	-6,664	1,500

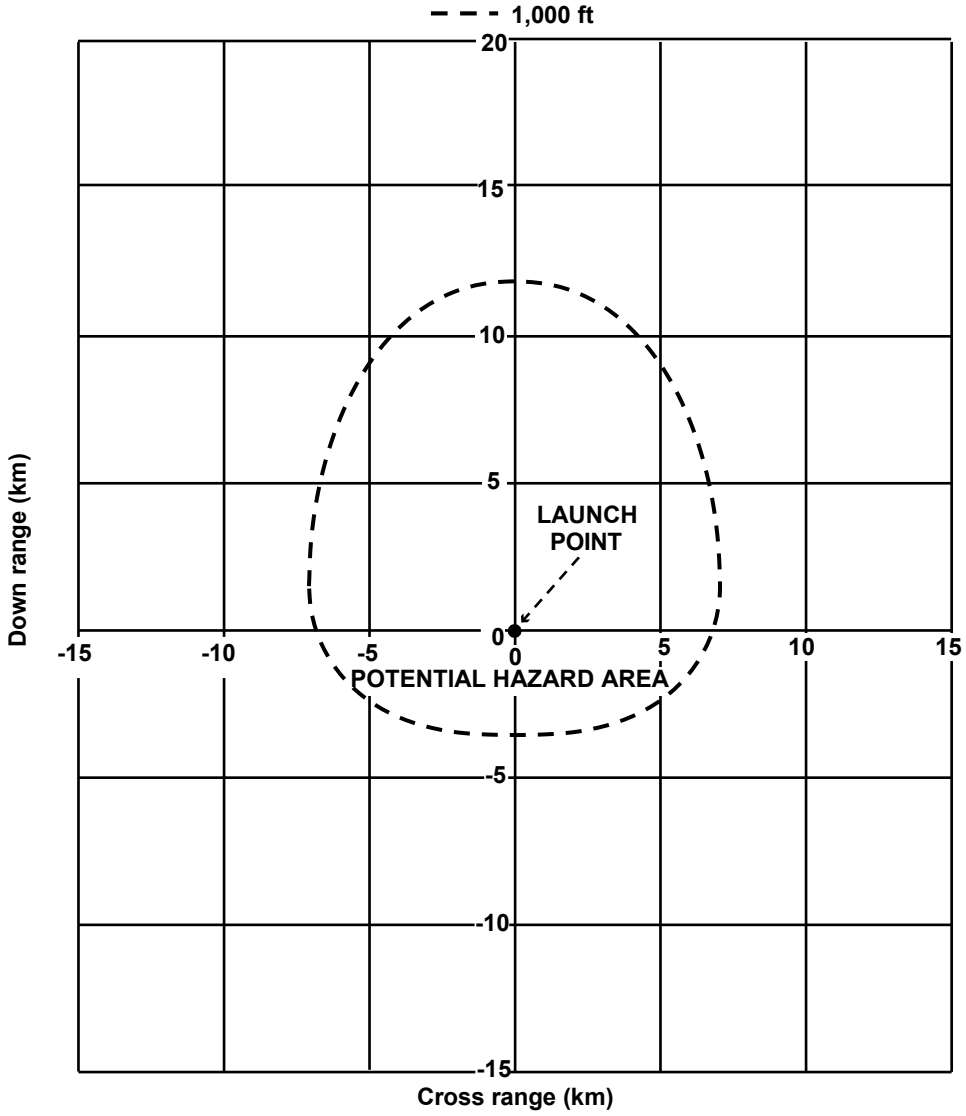

Figure 11–16. Surface Danger Zone for Army Little Bird/Black hawk AGM-114 R/R2 Lock On Before Launch (LOBL)

Table 11-33
Surface danger zone data for Army Little Bird/Black Hawk AGM-114 R/R2 LOBL R-Missile MH-6/UH-60 Cross Range (CR) and Down Range (DR) point plots

1,000 ft	1,000 ft
CR (m)	DR (m)
-7,064	1,500
-6,985	3,121
-6,749	4,701
-6,360	6,203
-5,826	7,589
-5,155	8,826
-4,358	9,881
-3,446	10,731
-2,429	11,353
-1,308	11,732
0	11,860
1,308	11,732
2,429	11,353

3,446	10,731
4,358	9,881
5,155	8,826
5,826	7,589
6,360	6,203
6,749	4,701
6,985	3,121
7,064	1,500
6,997	708
6,797	-64
6,464	-797
6,001	-1,474
5,411	-2,078
4,694	-2,594
3,848	-3,008
2,862	-3,312
1,696	-3,498
0	-3,560
-1,696	-3,498
-2,862	-3,312
-3,848	-3,008
-4,694	-2,594
-5,411	-2,078
-6,001	-1,474
-6,464	-797
-6,797	-64
-6,997	708
-7,064	1,500

d. Cooperative remote designation engagements with AGM-114 R/R2. Improvements designed into AGM-114 R/R2 have expanded HELLFIRE's operational envelope on rotary wing and UAS aircraft. For rotary wing platforms using modified legacy missile mode (i.e., without enhanced mode's R09 targeting message), the minimum ground designator operator keep-away distance about the 30° designator exclusion cone is 400m.

Chapter 12
Air Defense Artillery Weapon Systems

12–1. General

a. An SOP will be established to prevent accidents during the firing of guided missiles and rockets. The SOP will—

(1) Expand the specific duties and responsibilities of the range OIC, RSO, and trajectory officer (if appropriate).

(2) Relate to the special characteristics of the specific missile or rocket to be fired and the physical characteristics of the firing area.

(3) Specify procedures for conducting operations involving the use of high-pressure air (or compressed gases). Operations will be supervised by well-trained personnel who are knowledgeable of the Air Defense Artillery Weapons System.

b. Changes in the type of missile or rocket to be fired or changes in local conditions make it mandatory that the SOP be revised or a new SOP prepared prior to firing.

12–2. Firing conditions-general requirements

The following safety precautions will be observed for firing guided missiles and heavy rockets:

a. When units are firing at independent locations in the same general area, a commissioned OIC will be responsible for each independent firing location (Marine Corps).

(1) Safety at each firing location is the responsibility of the SRSO. A RSO and trajectory safety officer will be designated to assist the SRSO. Additional personnel may be detailed to assist the SRSO, as required.

(2) Situations may arise that are not addressed in this pamphlet, but in the opinion of the SRSO, may result in an unsafe condition. Conversely, situations may arise in which firing a missile or rocket, rather than destroying a missile or rocket in flight, is considered the safest course of action. The decision must be made locally based upon prevailing conditions.

(3) Guided missiles and rockets will not be launched on a trajectory that allows the missile or rocket to pass over personnel or materiel, except as specifically authorized by the installation RMA (Army), RCO (Marine Corps), this pamphlet, and the appropriate TM.

(4) Guided missiles and rockets will be fired within a time limitation (window) established by the installation range operations organization (Army), range control organization (Marine Corps). If firings cannot be accomplished within the prescribed window, a new firing schedule will be obtained.

(5) Intermediate and high altitude guided missiles (such as the MIM–23B Improved Hawk (Army) or MIM–104 PATRIOT) fired for training will be equipped with self-destruct systems capable of destroying the missile during flight or terminating the trajectory in a safe area.

(6) Missiles equipped with inert or practice warheads will be provided with a system capable of terminating the powered trajectory or destroying the aerodynamic characteristics of the missile to ensure its destruction.

(7) When a flight termination system is used to control a system's SDZ, the trajectory safety officer will have the capability to command destruct missiles independently of all actions of firing and trajectory control crews.

(8) The number of personnel engaged in handling, assembling, or firing guided missiles and heavy rockets will be kept to the minimum required to maintain efficient operations and mission accomplishment.

(9) Shorting plugs and other safety devices will be removed only to conduct tests or in final preparation for firing.

(10) Smoking is prohibited at firing pads, ready storage sites, and assembly sites. No-smoking signs will be prominently displayed. Smoking is also prohibited on any vehicle used to transport propellants or explosives. The possession of matches or any other flame producing devices while working with or transporting propellants or explosives is prohibited.

(11) Suitable firefighting equipment as determined by the installation fire marshal will be readily available during all firings.

(12) Personnel engaged in handling hazardous materials or exposed to hazardous operations or conditions will use protective clothing and equipment as prescribed by appropriate TMs and FMs. Approved hearing protection will be worn by all personnel within the hearing hazard zones defined in the manuals for each system.

(13) Except for the use of approved testing equipment in accordance with established procedures, guided missiles and heavy rockets will be isolated from sources of electrical energy (such as, sparks, static discharges, or stray current) that may cause ignition of the propellant or electro-explosive devices.

(14) Decontamination equipment appropriate for the type of propellants, oxidizers, active chemicals, batteries, or hazardous fuels at the site will be readily available during firing operations.

b. Firing and support personnel will not occupy positions within any portion of the SDZ except as specifically authorized by this pamphlet.

c. When occupation of the SDZ is authorized, protective shelters will be used which have been inspected by the installation safety director and facility engineer.

Fire control personnel will employ positive protection, such as keyed firing panels, to prevent premature firing of a guided missile or heavy rocket.

12–3. FIM–92 Stinger guided missile

a. Firing conditions.

(1) The entire Stinger guided missile SDZ will be cleared of all personnel except those actively engaged in the missile firing. This number will be held to the minimum compatible with efficient operations.

(2) Stinger weapon systems will not be fired over the heads of unprotected personnel because of the hazards from launch motor impact and the sustainer motor plume.

(3) All training firings will be limited to a maximum elevation angle of 50 degrees (40 degrees target elevation angle plus 10 degrees super elevation) to minimize the possibility of a malfunctioning missile traveling to the rear of the launch position.

(4) Procedures and precautions in appropriate TMs and FMs will be followed during Stinger firings. No firings will be made on directly incoming targets which normally pass over the launch area allowing targets or target debris to

impact in the area upon intercept. Instructors and any other personnel exposed to the rocket motor blast will wear personal protective equipment as required for the gunner in the appropriate TMs.

b. Surface danger zone.

(1) Stinger guided missile SDZ requirements given in figures 12 – 1 and 12–2 apply to both air-to-air and ground-to-air launched missiles. This SDZ, based upon maximum ballistic range of the missile, consists of an impact area and Areas A, B, and F. Self-destruct features designed to terminate missile flight within the SDZ were not considered in establishing range safety requirements. Maximum ballistic range (Distance X) for Stinger in each launch mode is given below.

(a) Ground-to-air guided missiles.

1. Basic Stinger: 11,900m.

2. Stinger Tracking and Launch Simulator (STLS): 250m

3. Reprogrammable microprocessor Stinger: 13,000m.

4. Reprogrammable microprocessor block 1 Stinger: 14,000m.

(b) Air-to-air guided missiles, same as ground-to-air except Distance X increases 0.60m for every 0.30m of altitude AGL at time of launch.

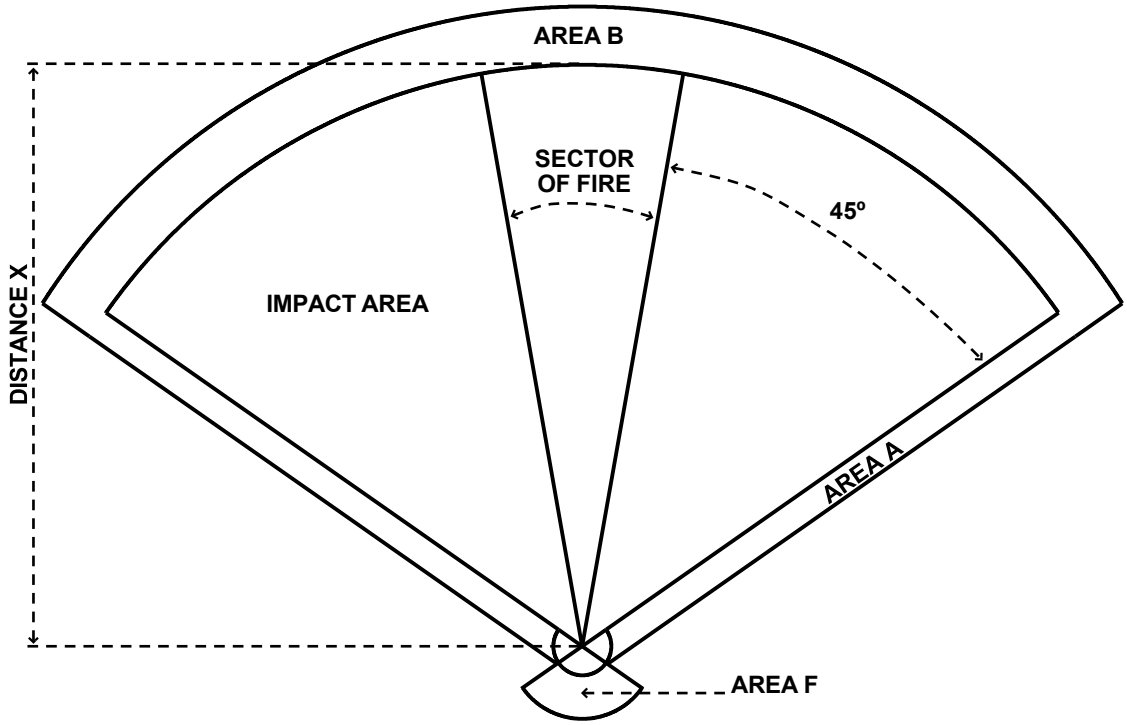

Figure 12–1. Surface danger zone for Stinger guided missiles at moving targets

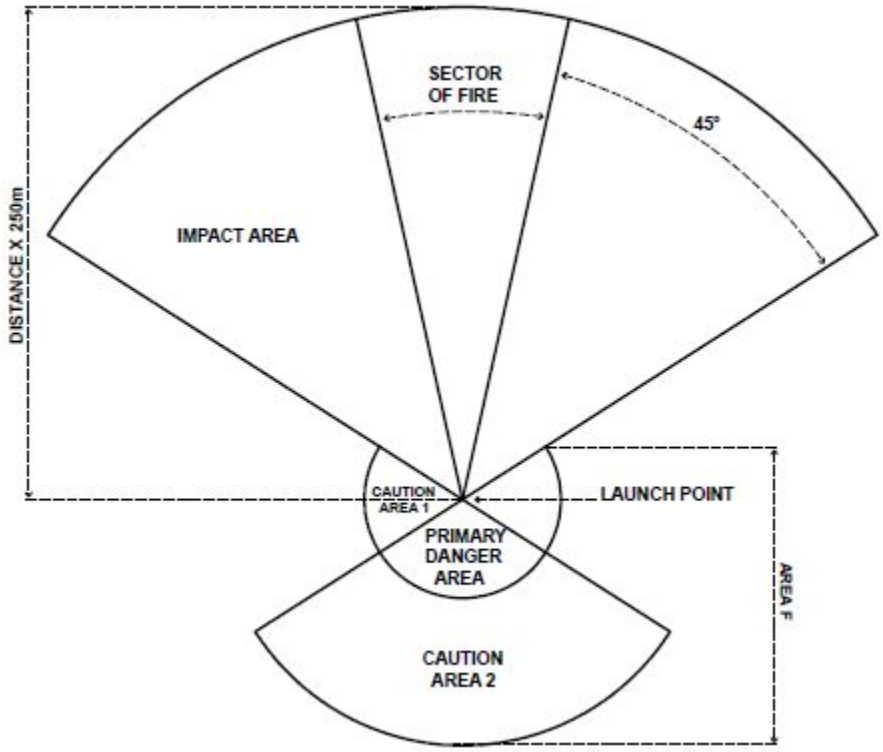

Figure 12–2. Surface danger zone for Stinger Tracking Launch Simulator (STLS) at moving targets

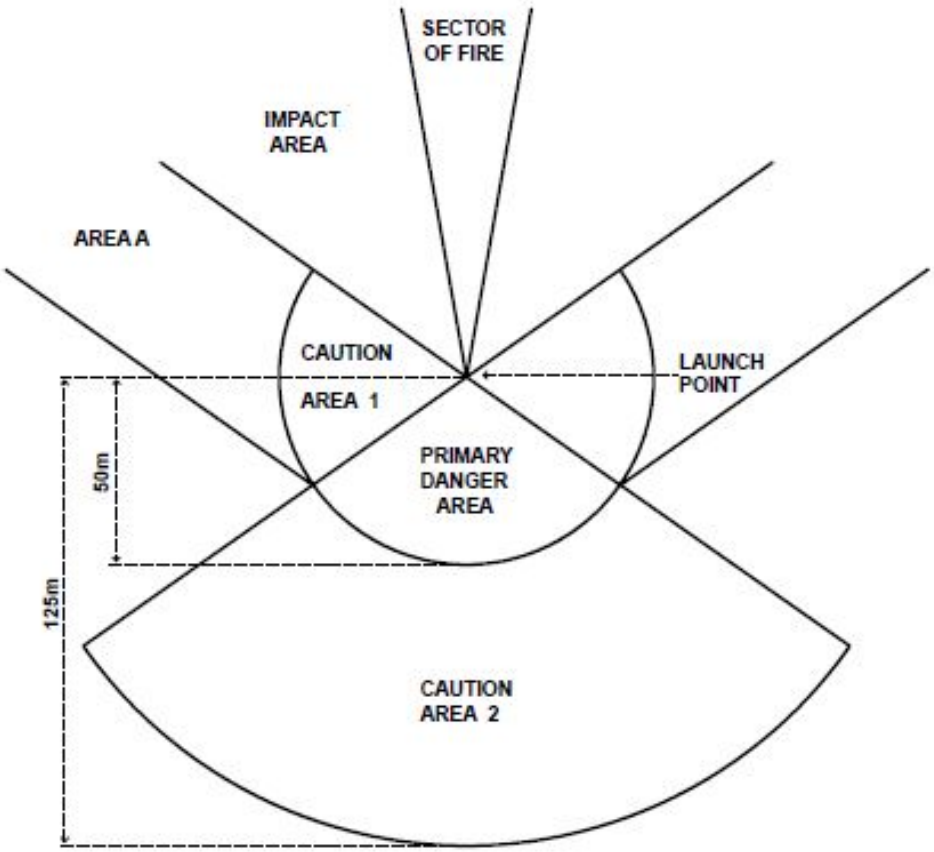

Figure 12–3. Surface danger zone, area F, for Stinger guided missiles and Stinger Tracking Launch Simulator (STLS) at moving targets

(2) Impact areas will normally contain fragments and debris from missiles launched within its sector of fire. The sector of fire is that portion of the impact area in which targets may be engaged. The boundaries of the sector will be designated by positioning azimuth limit markers forward of the launcher position. All firings must be accomplished within these limit markers. The impact area for moving targets consists of an area 45 degrees to each side of the sector of fire and extending downrange to the maximum ballistic range of the missile. For stationary (hovering) and directly outbound moving targets the impact area may be reduced to 40 degrees on each side of the sector of fire.

(3) Area A is the lateral secondary danger zone that is adequate to contain the effects of warheads functioning at the edge of the impact area. It consists of areas 50m wide on each side of the impact area and extending downrange to the maximum ballistic range capability of the missile. Area A is not required for the STLS.

(4) Area B is the far secondary danger zone that is adequate to contain the effects of a warhead functioning at the downrange edge of the impact area. It consists of an area 100m in depth beyond the impact area and Area A. Area B is not required for the STLS.

(5) Area F shown in figure 12–3 is the launcher danger zone extending to the rear of the firing position. It is further divided into a primary danger area and two caution areas.

(a) The primary launcher danger area has a radius of 50m boundaries that lie along rearward extensions of the impact area boundaries. Personnel are not permitted in this area during firings.

(b) Caution Area 1 also has a radius of 50m. Its boundaries are the primary launcher danger area and the impact area. Any personnel in this area must be protected from hazardous noise levels and flying ground

debris.

(c) Caution Area 2 extends to the rear of the launcher with a radius of 125m. Its boundaries are straight lines drawn between the rearward extension of the impact area boundaries and the intersection of the 125m radius. Occupation of Caution Area 2 is permitted when all personnel are wearing approved single hearing protection.

(6) The Stinger SDZ does not ensure protection from aerial targets that may be used for training firings. Target SDZs must be incorporated into overall Stinger firing operations by the RSO.

c. Stinger surface danger zone criteria. These apply to the AN/TWQ–1 Avenger, M6 Linebacker, man-portable air defense systems, and Light Armored Vehicle launch platforms, both stationary and on the move. When firing on the move, extend the Stinger/Avenger SDZ along the route of maneuver. The target flight path establishes left and right limits of fire.

12–5. MIM–72 Chaparral guided missile

a. Firing conditions.

(1) The entire SDZ will be cleared of all personnel prior to firing a missile except as authorized below.

(2) Procedures and precautions outlined in appropriate Chaparral TMs and FMs will be followed during firings. Only the minimum personnel required to fire and maintain safety surveillance of the firing will be permitted in the SDZ at the time of missile firing. All personnel, except the fire unit gunner, will occupy appropriate protective shelters that have been located and constructed in accordance with USACE drawings and will protect against any fragments or debris that may be expected from the missile as a result of warhead functioning. The protective shelters must be examined by the installation safety director and facility engineer to determine if the shelters will provide adequate personnel protection.

(3) Danger areas for debris from target drones with normal controlled flights should be contained within the impact area for the Chaparral missile. Impact areas for target drones which have abnormal flights or which go out of control are not covered herein.

b. Surface danger zone.

(1) Chaparral SDZ requirements are given in figure 12–4 and consists of an impact area and Areas A, B and F. This SDZ is based on the maximum ballistic range of the missile since there is no provision for command destruct by the trajectory safety officer.

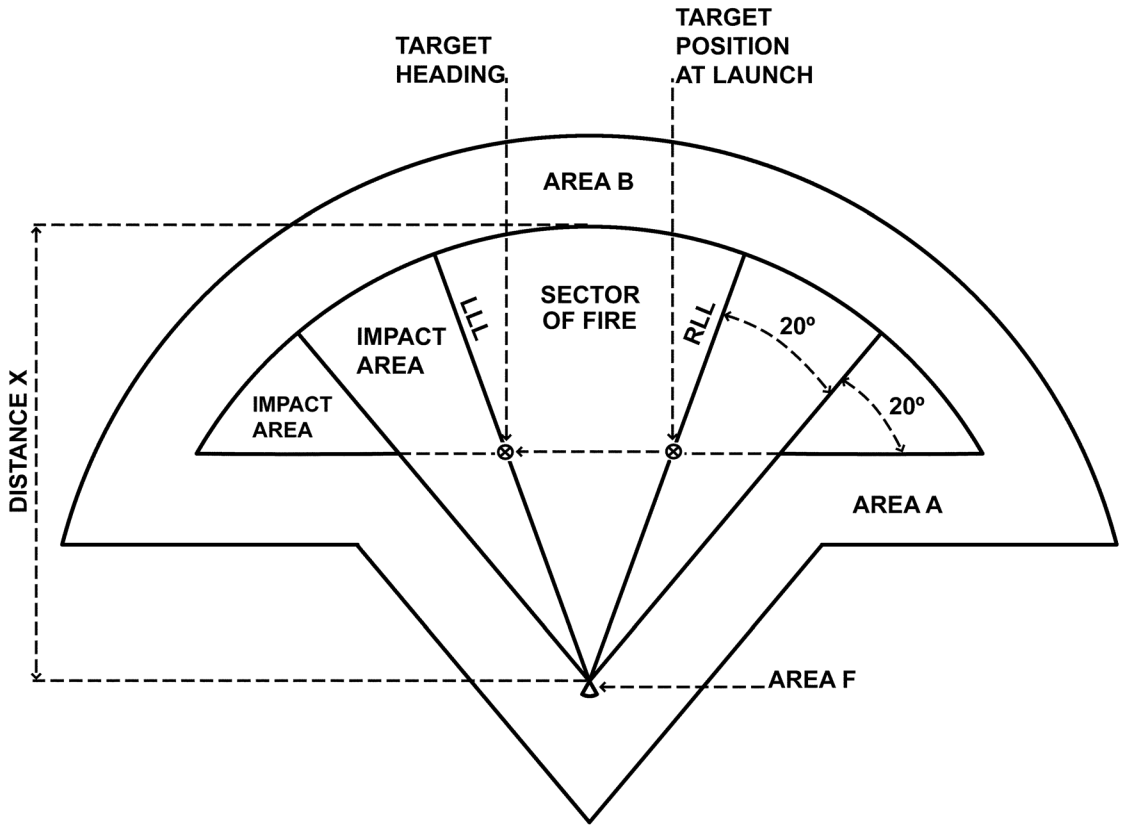

Figure 12–4. Surface danger zone for Chaparral guide missiles at a point in space

(2) Impact areas, which include the sector of fire and 20 degrees on each side, are used for firings at directly outgoing targets. When firings are made at off-tail or crossing targets, the minimum impact area is increased by 20 degrees beyond the heading of the target. The boundaries of the sector of fire must be designated by positioning azimuth limit markers forward of the launcher position. All firings must be accomplished within these limit markers.

(3) Area A is the lateral secondary danger zone. This area is normally adequate to contain the effects of warheads functioning at the edge of the impact area. The 600m width for this area and for Area B is the distance required for the MK 48 series warheads.

(4) Area B is the downrange secondary danger zone. It is normally adequate to contain the effects of a warhead functioning at the forward edge of the impact area.

(5) Area F is the back-blast area that lies totally within Area A. Area F is defined as an area bounded by lines 30 degrees on each side of the missile axis and extending 100m to the rear which should adequately contain primary and secondary motor exhaust and debris.

12–6. MIM–104 PATRIOT guided missile

The PATRIOT service practice and other firings with the PATRIOT guided missile weapon system conducted at or under the control of White Sands Missile Range, NM or McGregor Range, Fort Bliss, TX will be in accordance with the safety requirements of AR 385–63/MCO 3570.1C, this pamphlet, and the training or test range SOPs.

a. Firing conditions.

(1) The PATRIOT guided missile SDZ will be cleared of all personnel prior to firing a missile except as authorized below.

(2) A missile flight corridor drawn on a map or a scale drawing of the firing range is provided for use by the trajectory safety officer. The trajectory safety officer is provided with a means of accurately tracking and plotting the course of the missile and a means of causing the destruction of the missile if the missile intersects the flight corridor boundary. The flight corridor has lateral boundaries that are parallel to and 2 km

closer to the centerline than the lateral boundaries of the impact area. The lateral boundaries of the flight corridor extend to meet the boundary of the impact area beyond the intercept point. Flight corridor boundaries from the launch point intersect the lateral boundaries of the flight corridor at Distance L from the launch point.

(3) Only those personnel actively engaged in fire and control of the missile as specified by the appropriate TMs and FMs will be permitted in the SDZ at the time the missile is fired. The number of personnel authorized access should be the absolute minimum that is compatible with efficient operation. Personnel should, when possible, occupy shelters that are located a minimum of 90m from the launcher and approved by the garrison safety manager.

(4) Danger areas for debris from target drones that have normal flight paths should be contained within the impact area for PATRIOT guided missiles. Impact areas for target drones that have abnormal flight paths or which go out of control are not covered herein.

b. Surface danger zone.

(1) The SDZ includes an impact area, Areas A and B (see fig 12–5), which represents the areas on the ground that will contain the debris from the PATRIOT missile that is destroyed in flight. Labels for SDZ areas are unique to the PATRIOT guided missile.

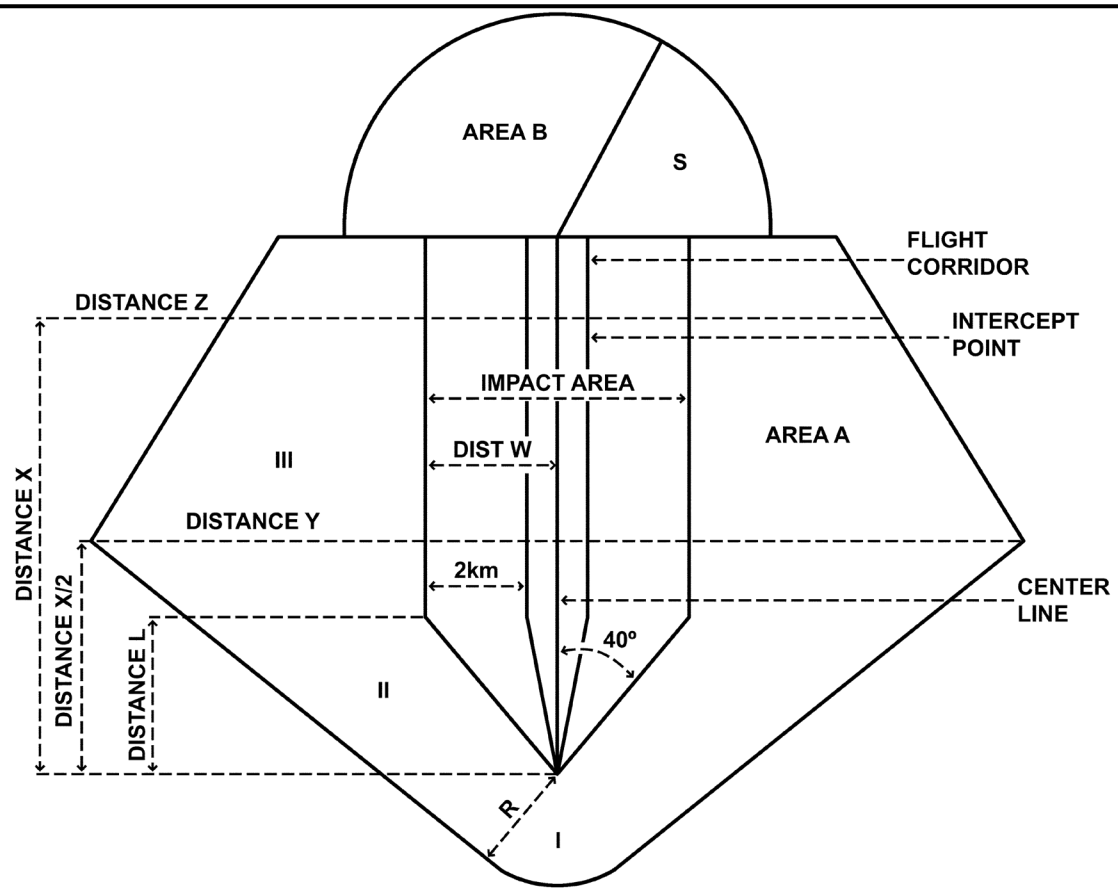

Figure 12–5. Surface danger zone for PATRIOT missiles

(2) The impact area is the area on the ground that contains the ground projections of all of the locations where the missile can be destroyed in flight. The boundary of the impact area is defined by the launch dispersion angle (A), the cross-range dispersion (W), and a line normally (90 degrees) to the centerline located 2 km greater than the intercept range. The azimuth dispersion angle (A) is 40 degrees on either side of the centerline. The lines that are drawn at angle A from the launch point intersect cross-range lines drawn parallel to the center line at a downrange distance of L meters from the launch point.

(3) Area A (lateral secondary buffer zone) is the area on the ground that contains debris from a missile that is destroyed on the lateral boundary of the impact area. Action is taken by the trajectory safety officer to initiate the destruction of the missile when the missile intersects the flight corridor boundary. The debris from the missile follows trajectories that are determined by the kinetic, gravitational, wind and aerodynamic forces

that act on the debris.

(4) Area B is the area beyond the intercept point that contains the debris from a missile that passes the intercept point without being destroyed by the fuze functioning. The missile is automatically destroyed within 2.2 seconds after passing the target if the missile is not destroyed by the warhead when the fuze functions. The debris from the missile that is destroyed after passing the intercept point impacts the ground within Area B. The automatic termination interval varies and is classified as confidential for MIM–104, MIM–104A, MIM–104B, and MIM–104C, standoff jammer counter.

(5) Distances Y and Z are based upon missile altitude at detonation and speed of cross winds.

12–7. MIM–104 PATRIOT guided missile variants (PAC-3 & PAC-3 MSE)

The PAC-3 missile and the upgraded PAC-3 Missile Segment Enhancement (MSE) are agile, high velocity, "hit-to-kill" surface-to-air guided missiles designed to locate, intercept, and destroy tactical ballistic, tactical maneuvering, and air-breathing targets. The PAC-3 missile uses a single stage solid rocket motor, while the PAC-3 MSE uses a dual pulse solid rocket motor. Both systems include aerodynamic vane controls, attitude control motors, and inertial guidance to navigate to an intercept point specified by its ground-based fire solution computer prior to launch. Commands and trajectory data can be updated, if required, during missile fly-out by means of a radio frequency uplink. A PAC-3/PAC-3 MSE firing mission requires a specialized target, extensive land area, a complex range safety system for the target and the PAC-3 and PAC-3 MSE missiles. The specialized range safety office use analysis and simulation to determine all necessary parameters of the surface danger zone for the particular mission scenario. Debris impact areas are also highly dependent upon the wind profile at the time of the mission. Contact the PAC-3 Product Office for assistance in PAC-3 and PAC-3 MSE training mission analysis and development.

a. Firing conditions.

(1) The PAC-3 and PAC-3 MSE guided missile SDZ will be cleared of all personnel prior to firing a missile except as authorized below.

(2) PAC-3 and PAC-3 MSE are fired from a fixed PATRIOT launcher; the danger areas immediately surrounding the launcher and the distance out to safe separation are shown in Figure 12-6. These areas do not vary significantly with the mission scenario, but the areas shown assume that the target is forward of the launcher in the general direction that the launcher is oriented.

(3) Only those personnel actively engaged in fire and control of the missile as specified by the appropriate TMs and FMs/TCs will be permitted in the SDZ at the time the missile is fired. The number of personnel authorized access should be the absolute minimum that is compatible with efficient operation. Personnel should, when possible, occupy shelters that are located a minimum of 90m from the launcher and approved by the garrison safety manager.

(4) Danger areas for debris from target drones that have normal flight paths should be contained within the impact area for PAC-3 and PAC-3 MSE guided missiles. Impact areas for target drones that have abnormal flight paths or which go out of control are not covered herein.

b. Surface danger zone

(1) Launch area SDZ. Figure 12-6 contains the distances for Area E, Area F, and a safe separation distance contour for nominal missile profiles.

(a) Area E (primary forward danger area) is endangered by normal launch debris, overpressure, blast, and hazardous noise levels. It is a composite of a circle with a radius of 152 meters to the left and right of the launcher and an ellipse (122 meters minor axis - left and right of the launcher) that extends 183 meters in front of the launcher.

(b) Area F (rear danger area) is endangered by the solid rocket motor (SRM) plume effects (back-blast debris, blast, overpressure, and hot gases) and hazardous noise levels. It is a composite of a circle with a radius of 152 meters to the left and right of the launcher, an ellipse (122 meters minor axis – left and right of the launcher) that extends 183 meters to the back of the launcher, and a triangle (152 meters aft and 91 meters wide).

(c) Personnel will not occupy Areas E or F for five minutes following launch without a self-contained air supply due to the presence of toxic gases produced by the launch.

(d) The safe separation distance is established by determining the minimum distance required for missile destruct and prevention of missile debris from striking the launcher. This is a radius of 442 meters within an arc of 42 degrees either side of the launcher flight centerline. The vertex of the sector is at the launcher. All missile flight profiles remain inside this sector.

(2) Intercept area and missile self-destruct area SDZs are not covered herein. Contact the PAC-3 Product Office for assistance.

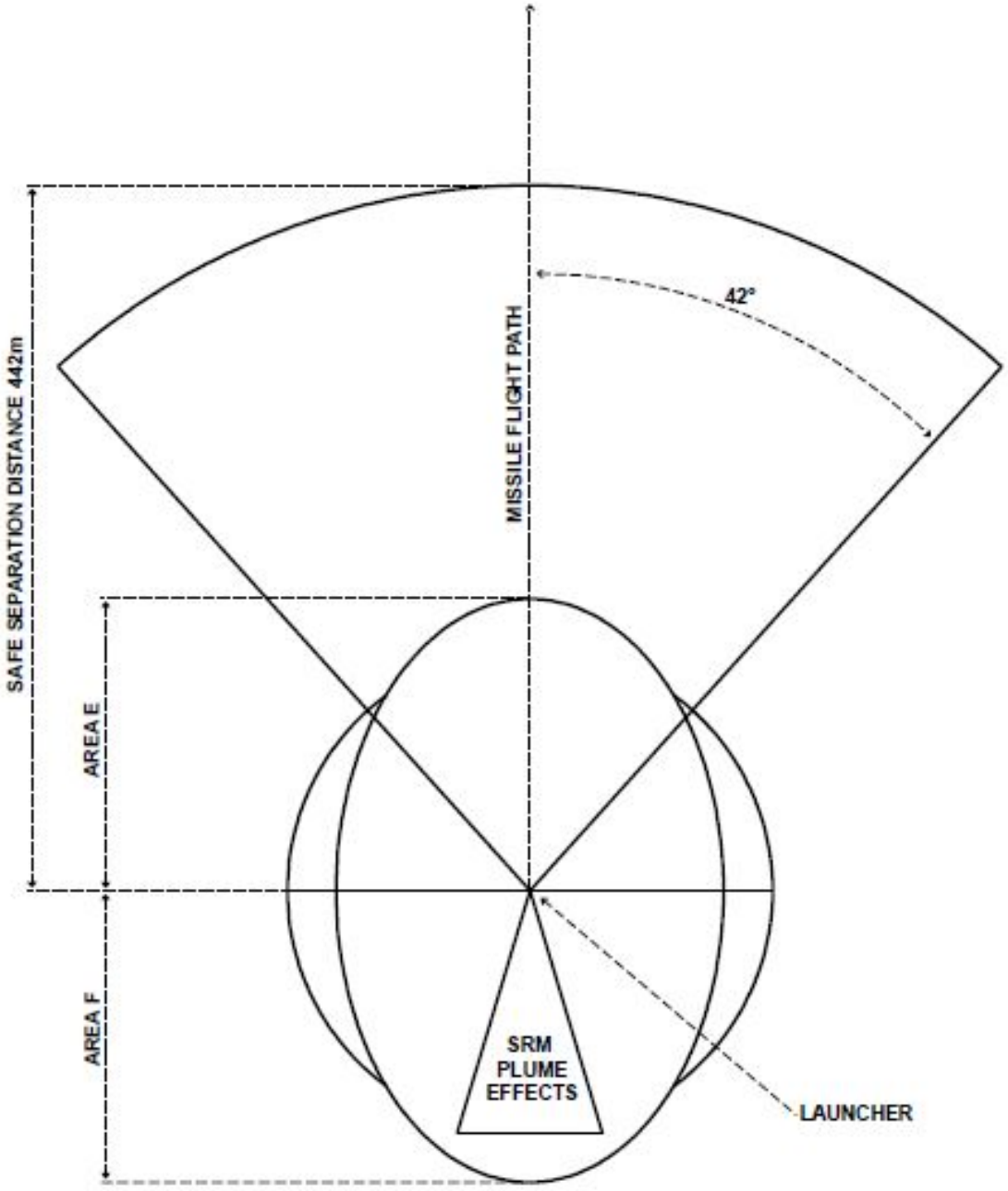

Figure 12–6. Surface danger zone, launch area, for MIM PATRIOT guided missile variants and PATRIOT Advanced Capability (PAC) 3 and PAC 3 Missile Segment Enhancement (MSE)

12–3. CRAM input here

Table 12-1
Surface danger zone for C-RAM 20mm, M940 Multi-purpose Tracer- Self Destruct (MPT-SD)

Altitude (ft)	Dist X (m)	Variable Downrange Dist (m)	Variable Cross range Dist (m)	Variable Downrange Angle (deg)	Variable Dispersion Angle (deg)	Area A (m)	Area B (m)	Vertical Hazard (m)
0	7600	4105	850	4.45	36.20	250	250	5490
1000	7815	4225	865	4.40	35.48	250	250	5615
2000	8035	4355	880	4.35	34.82	250	250	5750
3000	8265	4495	895	4.30	34.08	250	250	5895
4000	8505	4650	910	4.25	33.39	250	250	6045
5000	8750	4815	925	4.19	32.75	250	250	6150
6000	9005	4990	940	4.14	32.05	250	250	6260
7000	9270	5110	960	4.08	31.54	250	250	6370

Notes:
[1]. SDZ represents a single line of fire and must be rotated to account for weapon platform azimuth limits, as shown in fig 12-7
[2]. SDZ holds for firings from the 20mm C-RAM LPWS with quadrant elevations from 5 to 82 degrees.
[3]. SDZ considered dispersion, ricochet, and adverse meteorological conditions.
[4]. Fragmentation effects considered from 100 meters to maximum self-destruct time and at ground impact
[5]. SDZ only holds for interceptor munition. Incoming threat hazards are not included

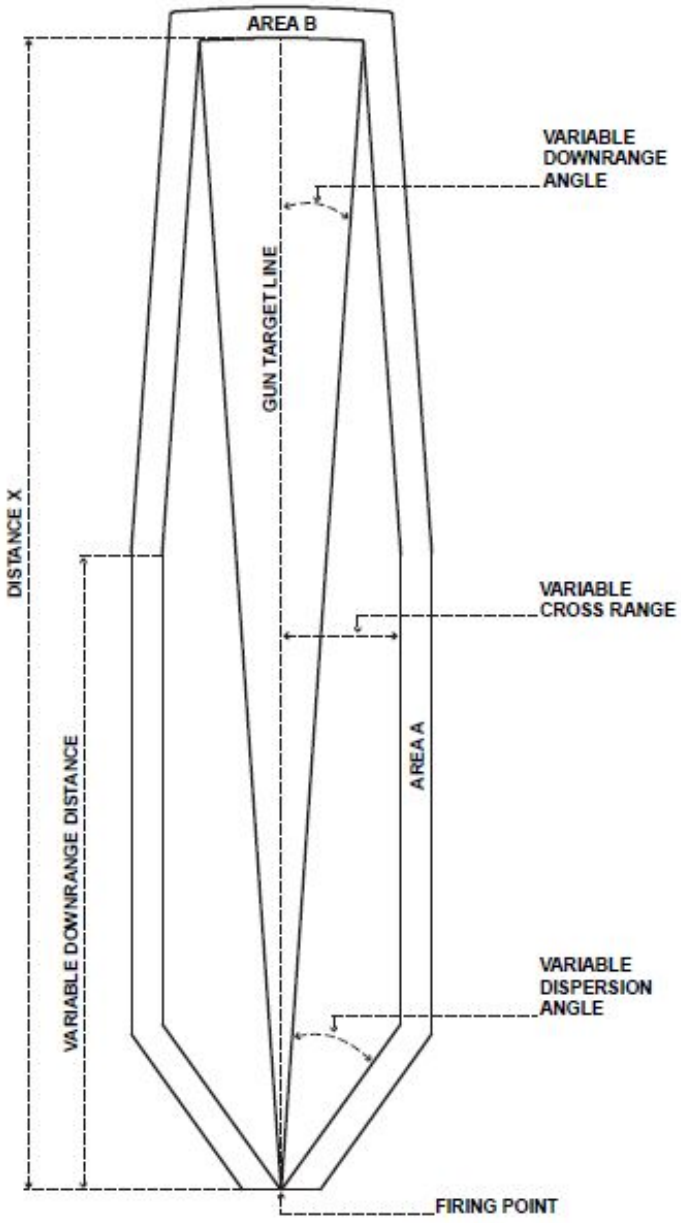

Figure 12–7. Surface danger zone for single target CRAM M940

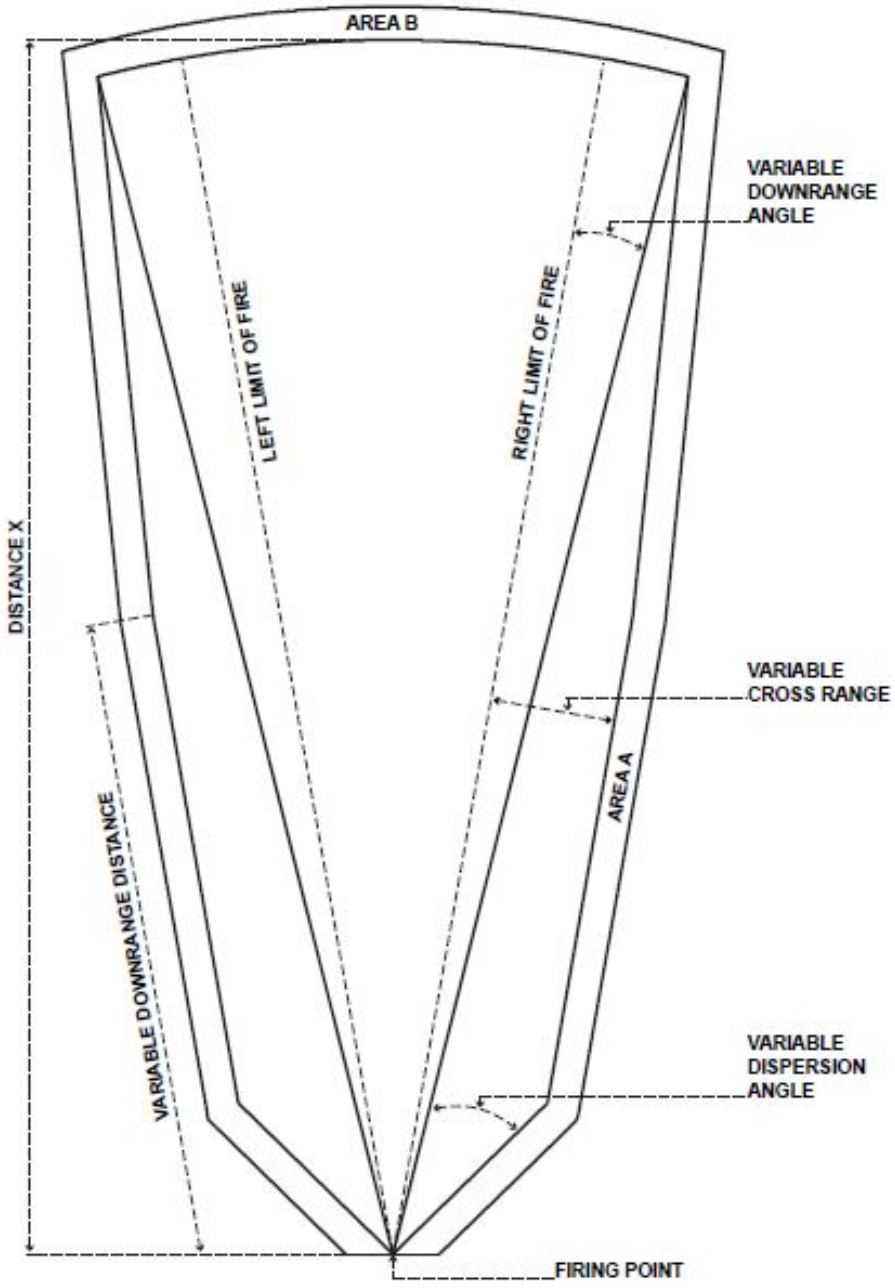

Figure 12–8. Surface danger zone for moving target CRAM M940

Table 12-2
Surface danger zone data for M55A2-TP and M220 TP-T, 20mm weapons

Altitude (ft)	Dist X (m)	Variable Downrange Dist (m)	Variable Cross range Dist (m)	Variable Downrange Angle (deg)	Variable Dispersion Angle (deg)	Area A (m)	Area B (m)	Vertical Hazard (m)
0	5695	3355	950	6.60	51.12	NR	NR	4125
1000	5860	3470	965	6.52	50.35	NR	NR	4240

2000	6030	3550	985	6.47	49.50	NR	NR	4360
3000	6205	3680	1000	6.38	48.82	NR	NR	4480
4000	6390	3775	1020	6.29	48.12	NR	NR	4600
5000	6580	3885	1040	6.24	47.42	NR	NR	4720
6000	6775	4040	1055	6.14	46.51	NR	NR	4845
7000	6980	4160	1075	6.09	45.91	NR	NR	4970

Notes:
1. SDZ represents a single line of fire and must be rotated to account for weapon platform azimuth limits, as shown in fig 4
2. SDZ holds for firings from the 20mm C-RAM LPWS with quadrant elevations from 5 to 82 degrees.
3. SDZ considered dispersion, ricochet, and adverse meteorological conditions.
4. SDZ only holds for interceptor munition. Incoming threat hazards are not included.
5. M55A2 and M220 cartridges consist of non-explosive filled projectiles.

Chapter 13
Chemical Agents and Smoke

13–1. Chemical agents

The use of lethal or incapacitating chemical agents in training is not authorized. Chemical agent use must be addressed case-by-case in special safety analyses. The exception is the Chemical Decontamination Training Facility, Fort Leonard Wood, MO, where training regularly involves live chemical agents.

13–2. Riot control agents

a. Except when prohibited by regulations or higher authority, commanders may use riot control agents (RCAs) in training, subject to the following:

(1) Use of RCAs in training is limited to CS. All other RCAs are prohibited for training use.

(2) Use of RCAs in training requires supervision by personnel specially trained in field behavior, individual protection, and first aid for RCAs. Army personnel that meet these criteria are chemical officers (branch code 74), chemical NCOs (MOS 54B), school-trained chemical, biological, radiological, and nuclear (CBRN) officers (SSI 3R) and NCOs (SQI C). Marine Corps personnel that meet these requirements are MOS 5702 CBRN systems defense officer, and MOS 5711, CBRN defense specialist.

(3) RCAs will not be used under conditions that are dangerous to life or property. Minimum safe distances to heavily traveled installation roads, railroad right of ways, airfields (including all aircraft landing areas), or inhabited areas are:

(a) CS chambers will be at least 100m away from heavily traveled roads, 500m from aircraft operations and inhabited areas, and 1,000m from the nearest installation boundary unless the CS chambers are designed to contain and filter all CS gas.

(b) Field training exercises involving RCAs will be 500m or more away from public traffic routes, the nearest inhabited buildings, and 1,000m from installation boundaries.

(4) Prior to a scheduled RCA exercise, training supervisors must conduct a readiness evaluation of personnel. Before being exposed to RCAs, all personnel with respiratory ailments, recent eye surgery, or eye infections, open wounds, severe facial acne, or any active dermatitis, and pregnant personnel must be referred to a medical officer for evaluation. The medical officer will evaluate the health records of these individuals and, when necessary, examine the personnel to determine their readiness to undergo training without undue medical risk. The examination results (stating can/cannot participate in training with RCAs only) will be documented in the personnel medical records.

(5) OICs and RSOs must ensure protective masks are available for all personnel participating in training.

(6) When CBRN protective equipment is worn, the OIC/RSO will consider the additional heat stress placed on personnel. When using the wet-bulb globe temperature to determine the heat category, add 10 degrees Fahrenheit if personnel are in body armor and mission-oriented protective posture (MOPP) level two through four. High ambient temperatures, high humidity, and heavy workload are factors that increase the potential for heat injuries. To reduce the heat stress risk, commanders will —

(a) Provide an ample water supply and encourage all personnel to drink plenty of water. OICs and RSOs will monitor personnel undergoing training to ensure personnel frequently drink water to replace lost fluids.

(b) Reduce the MOPP level under high heat stress conditions when possible.

(c) Schedule additional rest breaks during training to allow personnel to cool off. These periods also can be used for critiques. Where possible, use vehicles to move personnel who are wearing protective equipment.

(d) Ensure subordinate commanders and leaders check their personnel for early signs of heat stress. Authorize frequent breaks while operating in protective equipment.

(7) Wearing of contact lenses while masked is not authorized. Personnel who wear contact lenses must remove them and use standard prescription eyeglasses during chemical defense training that includes wearing the protective mask. Unnecessary eye irritation will occur if RCA particles are trapped under contact lenses. All individuals requiring corrective lenses must have masks with correctly fitted optical inserts.

(8) Unprotected personnel will not be exposed to RCAs longer than 15 seconds.

b. Personnel specified in paragraph 13-12*a*(2) will supervise the mask confidence course.

c. Employment conditions.

(1) CS will be used in training only under the supervision of an officer/staff noncommissioned officer/NCO who has received formal training in the characteristics, capabilities, and training applications of these agents.

(2) Only CS in capsule form may be used in the CS chamber.

(3) For the Marine Corps, when CS is used in outdoor confidence courses, the RSO must have been trained in the CS chamber within the past year. The use of a 5702 CBRN defense officer and 5711 CBRN defense specialist is not required.

(4) RCAs will not be released when personnel without proper respiratory protective equipment located downwind will be affected, unless exposure to a controlled concentration is desired. CS agents will not be released within 50m of spectators.

(5) Marine Corps personnel handling or dispensing CS capsules will wear MOPP level four.

(6) Army personnel handling or dispensing CS capsules will wear rubber boots, protective mask with hood, and field clothing secured at neck, wrists, and ankles.

(7) Individuals affected by RCAs will move to fresh air and face into the wind for 5 to 10 minutes, avoid rubbing the eyes, and remain well-spaced from other affected personnel. If accidentally exposed to an RCA, clothing will be removed from the affected skin as soon as possible. Flush the exposed area(s) with large volumes of cool water for not less than 15 minutes, and then seek prompt medical attention. If available, mild soap should be used to cleanse the contaminated skin.

(8) Hot water should not be used when showering as it will raise the vapor point of the CS, resulting in further spreading of contamination.

(9) When eyes are contaminated with a CS agent, treat them with a 1 percent solution of sodium bicarbonate (baking soda). If not available, hold the eyes open with fingers, flush with water for not fewer than 15 minutes, then seek medical attention.

(10) Contaminated clothing will be removed from the area to prevent accidental contamination of unprotected personnel.

d. When RCAs are transported in Army or Marine Corps aircraft, compliance with AR 95–1, AR 95–27, MCO 4030.25B, and MCO 4030.40B is required.

e. For the Marine Corps, the following are requirements for all CS exercises, whether garrison or field training:

(1) Corpsman or medic with unit 5 medic bag.

(2) Designated safety vehicle with a driver who will not be in the chamber, but will have a protective mask on hand.

(3) Instructors will be easily/readily identifiable while in the CS chamber.

13–3. Smoke

The use of smoke in training poses special health and safety issues. The following precautions apply to all smoke training with fog oil, hexachloroethane (HC), red phosphorus, WP, plasticized WP, terephthalic acid (TA), and colored and diesel smokes.

a. Personnel will carry a protective mask when participating in exercises that include the use of smoke. Personnel will mask —

(1) Before exposure to any concentration of smoke produced by M8 white smoke grenades, M83 smoke grenades (TA), smoke pots (HC and TA smoke), or metallic powder obscurants.

(2) When passing through or operating in dense (visibility less than 50m) smoke such as smoke blankets and smoke curtains.

(3) When operating in or passing through a smoke haze (visibility greater than 50m) and the duration of exposure will exceed 4 hours.

(4) Any time exposure to smoke produces breathing difficulty, eye irritation or discomfort. Such effects in one individual will serve as a signal for all similarly exposed personnel to mask.

(5) When using smoke during military operations in urban terrain training or when operating in enclosed spaces. The protective mask is not effective in oxygen-deficient atmospheres. Care must be taken not to enter areas where oxygen may have been displaced.

b. Clothing is to be laundered and personnel will shower after exercises involving exposure to smoke. Personnel exposed to smoke should reduce skin exposure by rolling down their sleeves.

c. Special care must be taken when using HC and TA smoke to ensure that appropriate protection is provided to all personnel who may be exposed. When planning for the use of HC smoke in training, consideration must be given to weather conditions and the potential downwind effects of the smoke. Positive controls, (observation, control points, communications) must be established to prevent exposure of unprotected personnel. Detailed hazard information is available on the appropriate safety data sheet(s).

d. FS (sulfur trioxide-chlorosulfonic acid solution) and FM (titanium tetrachloride) smoke will not be used in training.

e. Smoke will not be used in public demonstrations, displays, or ceremonies unless positive dissipation of the smoke can be assured and no exposure to the public or nonparticipating personnel is expected. A risk management plan will be developed by the agency conducting the public demonstration, in conjunction with the installation RMA (Army), RCO (Marine Corps) and safety director, for all uses of smoke in demonstrations, displays, or ceremonies.

13–4. Smoke pots

a. Personnel manually firing HC and TA smoke pots will mask and keep their head well to one side to the top of the pot and out of the way of sparks and flames to prevent burn injuries. Once HC and TA smoke pots have ignited, personnel will quickly move away a minimum distance of 30m.

b. Precautions will be taken to prevent ground fires. HC and TA smoke pots will not be fired inside buildings, tents, or other enclosed areas because of fire and health hazards from associated fumes. Exceptions are building or structures specially designed for smoke training, and only after conducting a thorough risk assessment, developing and implementing controls, and acceptance of the residual risk by the appropriate commander.

c. HC and TA smoke pots must be kept dry. Any addition of water to HC and TA smoke mixtures may cause it to burn erratically, explode, or result in spontaneous combustion. HC smoke pots will not be ignited during visible precipitation (snow or rain).

d. The M4A2 smoke pot must be vented for at least 5 minutes within 24 hours before use in accordance with TB 3–1365–490–10.

e. When electrically firing the M5 HC smoke pot, at least 30m of WD–1/TT wire will be used.

13–5. Oil smoke candles

Oil smoke candles (M6, SGF2) are used to produce nontoxic smoke in confined areas primarily to simulate fires in buildings or ships for fire drills and to train firefighters. The correct procedure for use is to place the candle on its base atop a stable platform away from combustible materials, pull the safety pin, and release the safety lever.

Chapter 14
Non-Lethal Weapons

14–1. Definition

Department of Defense Directive (DODD) 3000.03E defines non-lethal weapons (NLWs) as "weapons that are explicitly designed and primarily employed so as to incapacitate personnel or materiel while minimizing fatalities, permanent injury to personnel, and undesired damage to property and the environment." Furthermore, "unlike conventional lethal weapons that destroy their targets principally through blast, penetration, and fragmentation, NLW employ means other than gross physical destruction to prevent the target from functioning. NLW are intended to have relatively reversible effects on personnel and materiel."

14–2. General

a. The term "non-lethal" does not mean zero mortality or nonpermanent damage. Fatal injuries can occur if munitions are employed at a distance that is less than the determined minimum safe engagement range.

b. The Inter-Service Non-Lethal Individual Weapons Instructors Course is the only course in DOD that is certified to produce instructors who will train individuals in the proper employment of NLWs.

c. For the Marine Corps, the use of NLW in force-on-force scenarios with the exception of SESAMS is authorized only under approved deviation per AR 385–63/MCO 3570.1C, chapter 1 of this pamphlet, and risk management procedures have been completed in accordance with MCRP 5–12D and MCO 3500.27B.

d. For the Marine Corps, if force-on-force training with NLW is conducted under an approved deviation, Marines may be in the NLW danger zone but must remain outside the minimum target engagement distance at all times.

e. For the Army, Soldiers participating in force-on-force training with NLW may be in the NLW SDZ, but must remain outside the minimum engagement distance at all times.

f. Head shots with NLW are not authorized.

14–3. Surface danger zones

a. Many non-lethal munitions have both a maximum effective range and minimum target engagement distance. Individuals short of the minimum target engagement distance may suffer severe injuries or death. The effects of most non-lethal munitions are greatly decreased at longer ranges.

b. Hazardous effects from certain NLW munitions can be experienced at or behind the firing line. For example, the rubber rounds described in paragraph 14–4 may bounce back when fired against a hard surface.

c. Area R is the portion of the SDZ behind the firer where personnel, equipment, and facilities may be endangered by ricochets to the rear of the firing line.

14–4. 12-gauge shotgun, M1012 (AA51), M1013 (AA52), and bean bag (AA29) projectiles

a. The M1012 (AA51) projectile is a fin-stabilized projectile made of rubber designed for point targets. The M1013 (AA52) is a ball projectile and consists of 18 polyvinyl chloride rubber compound balls designed for crowds/groups.

b. For the M1012 (AA51) and M1013 (AA52), minimum engagement is 10m with a maximum effective range of 20m.

c. The tabular data for the M1012 (AA51) and M1013 (AA52) is contained in table 14–1.

d. The SDZ for M1012 (AA51) and M1013 (AA52) is contained in figure 14–1.

e. When firing the 12-gauge shotgun with the rubber ball grenade launch cup attached, carbon can build up in the barrel. This carbon build up may create a malfunction if the launcher cup is removed and the 12-gauge bean bag (AA29) rounds are fired. Bean bag rounds may get stuck in the barrel.

f. Gas operated shotguns may malfunction when shooting nonlethal ammunition. This may result in increased stoppages/malfunctions or require the weapon to be cycled manually.

g. PPE Level 0 is required.

Table 14–1
Surface danger zone for 12 gauge M1012 and M1013 hard and soft targets

Ammunition	Dist X (m)	Dist Y (m)	Dist W (m)	Area R depth (m)	Area R width (m)	Angle P (deg)	Angle Q (deg)	Dispersion angle (deg)
M1012	500	400	150	50	300	80	35	10
M1013	180	160	75	20	150	75	60	15

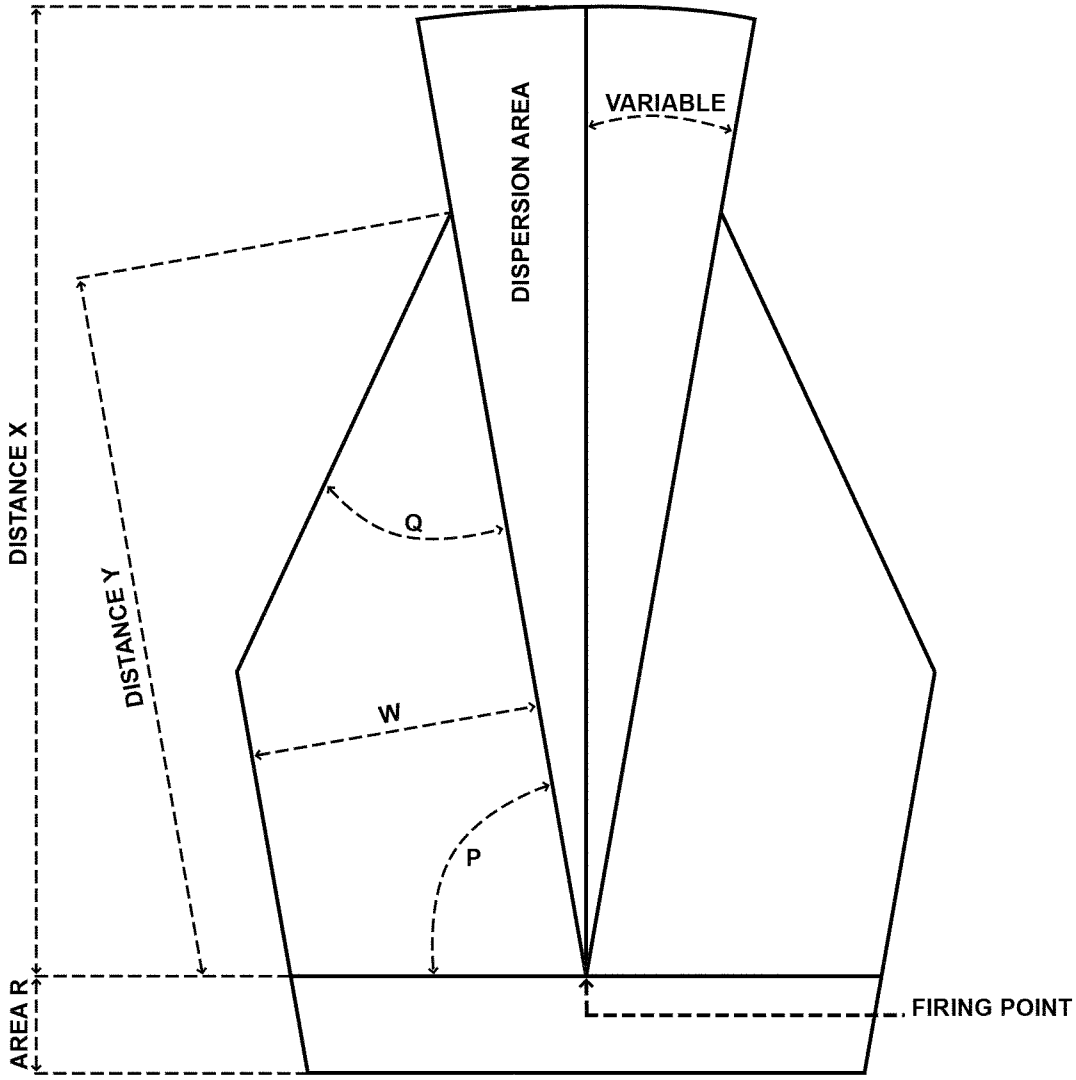

Figure 14–1. Surface danger zone for 12 Gauge M1012 and M1013 hard and soft targets

14–5. 40mm M1006 (BA06) sponge grenade

a. The M1006 (BA06) is a sponge grenade cartridge comprised of a 40mm bullet-shaped foam rubber round.

b. Minimum engagement for this NLW is 10m, with a maximum effective range of 20m.

c. The SDZ for M1006 is contained in figure 14–2.

d. The round is most effective against point targets. At distances of 10m to 50m, aiming point should be center mass of target.

e. Do not skip fire this round.

f. PPE Level 0 is required.

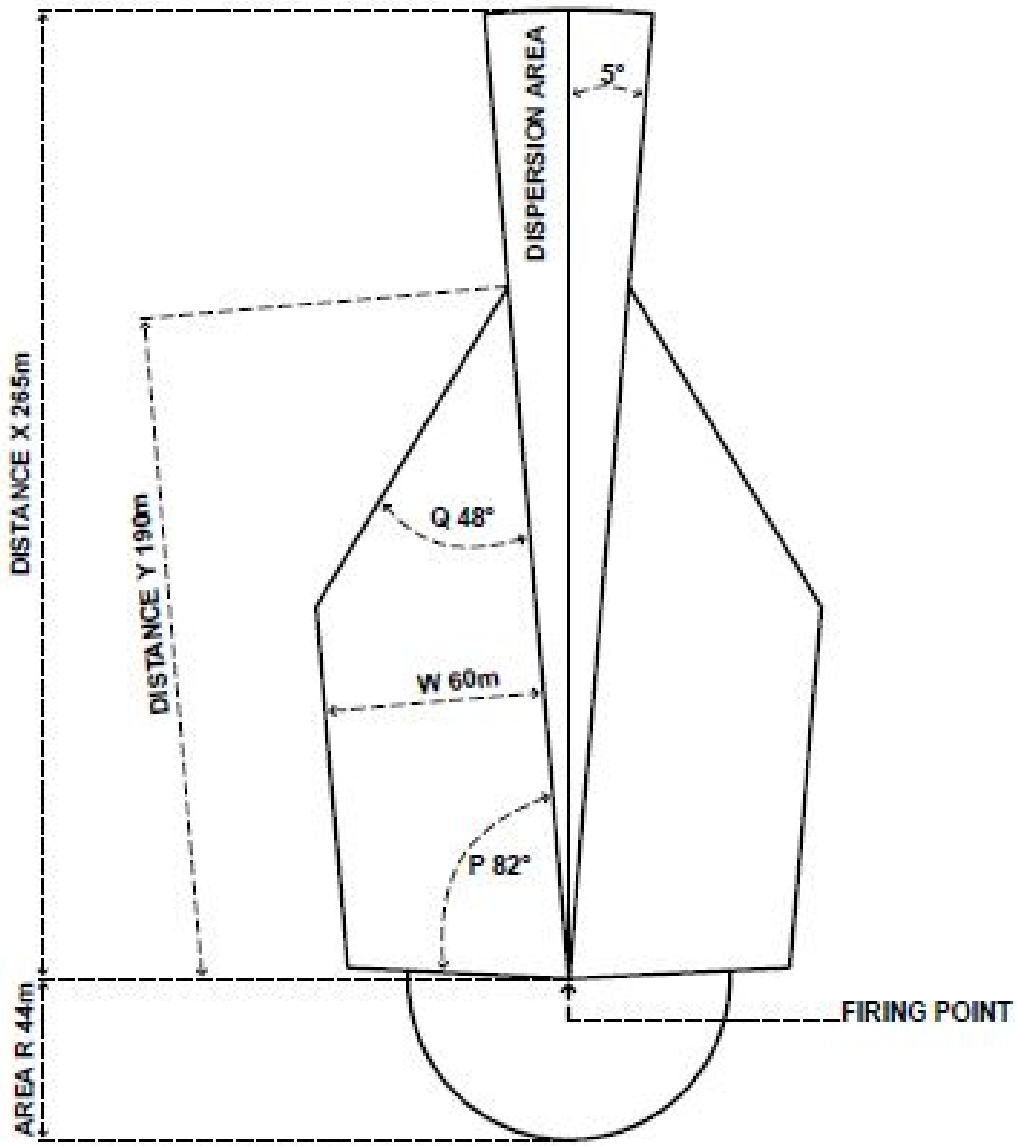

Figure 14–2. Surface danger zone for M1006 40mm sponge grenade

14–6. 40mm grenade foam rubber baton (BA07), rubber ball grenade (BA08), and M1029 (BA13)

a. The BA07 is a foam rubber baton; the BA08 is a rubber ball grenade that will be superseded by the BA13. The M1029 (BA13) is a crowd-dispersal grenade consisting of 48 rubber balls.

b. Minimum engagement range for this NLW is 10m and the maximum effective range is 30m.

c. The SDZ is contained in figure 14–3.

d. At distances of 10m to 30m, the aiming point should be center mass of the group of individual targets.

e. PPE Level 0 is required.

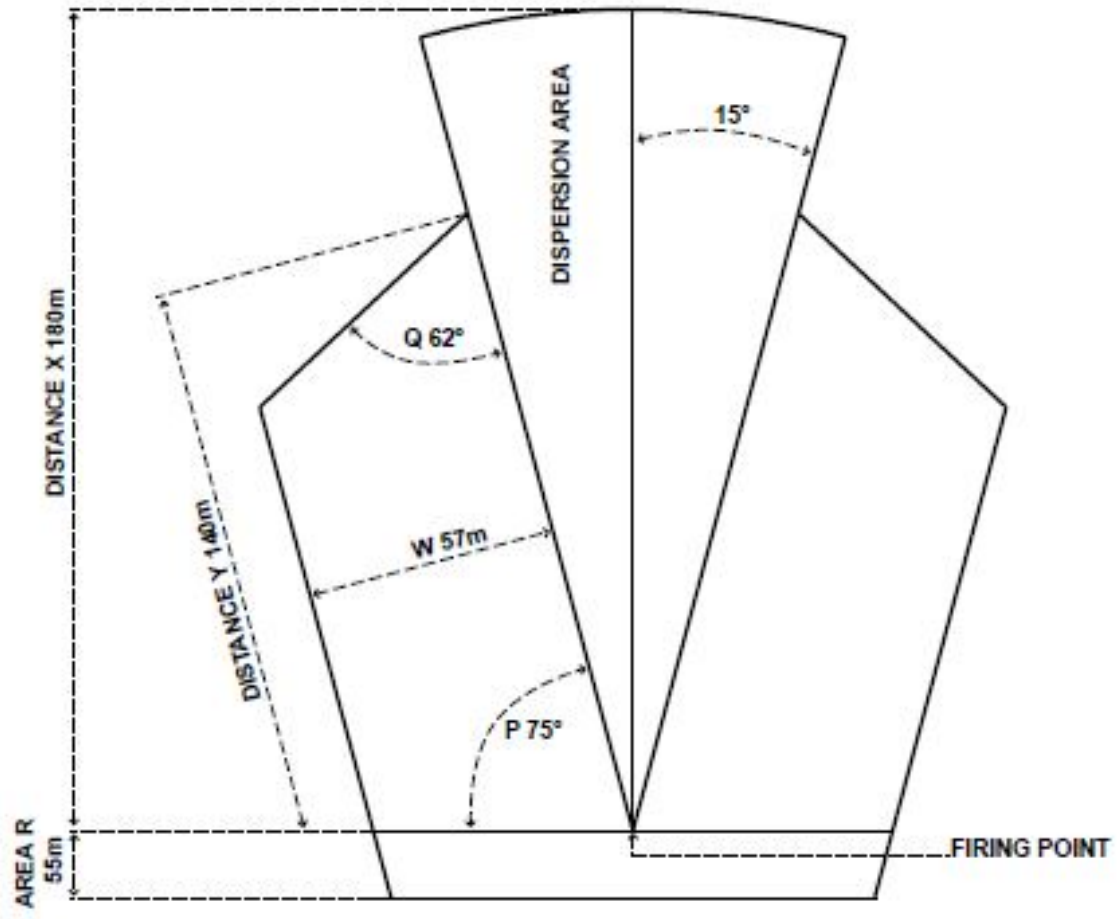

Figure 14–3. Surface danger zone for 40mm grenade foam rubber baton, rubber ball grenade and M1029

14–7. Rubber ball grenade (GG04)

a. The rubber ball grenade (GG04) has a rubber molded body and consists of 100 rubber balls. The rubber ball grenade (GG04) is both a handheld and 12-gauge shotgun launched non-lethal device and is the only non-lethal munition that can be delivered in defilade. The rubber ball grenade (GG04) is an area target munition.

b. The employment distance for the hand thrown rubber ball grenade (GG04) is 16m (50 ft).

c. The employment distance for the shotgun launched rubber ball grenade (GG04) is 61m (200 ft).

d. The minimum safe distance for the rubber ball grenade (GG04) hand thrown grenade is 3m and has an effective range of 20m. Debris may also travel out to a distance of 35m.

e. SDZ data for the hand thrown rubber ball grenade (GG04) is contained in figure 14–4.

f. SDZ data for the shotgun launched rubber ball grenade (GG04) is contained in figure 14–5.

g. When employing these grenades local fire conditions must be considered due to possible fire hazards.

h. PPE Level 0 is required.

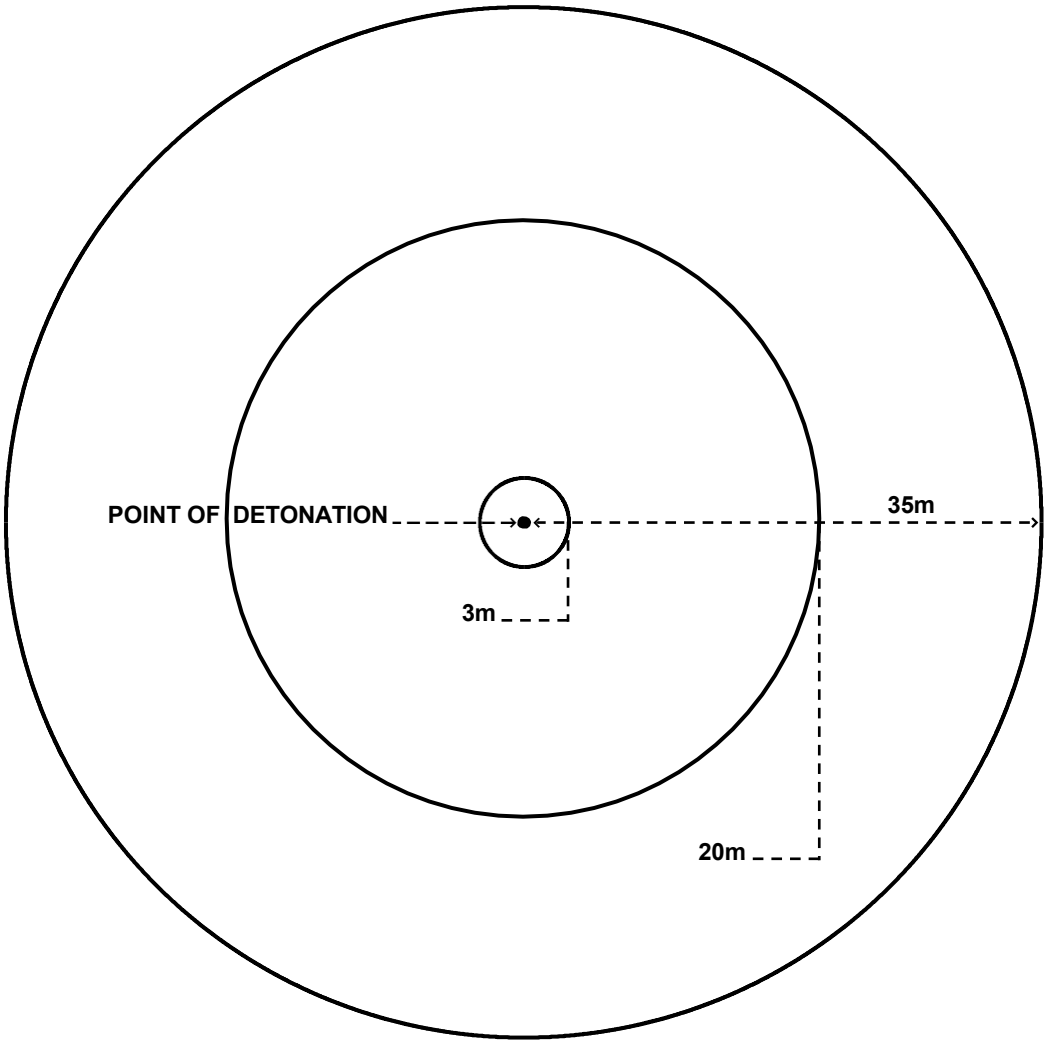

Figure 14–4. Surface danger zone for rubber ball grenade hand thrown

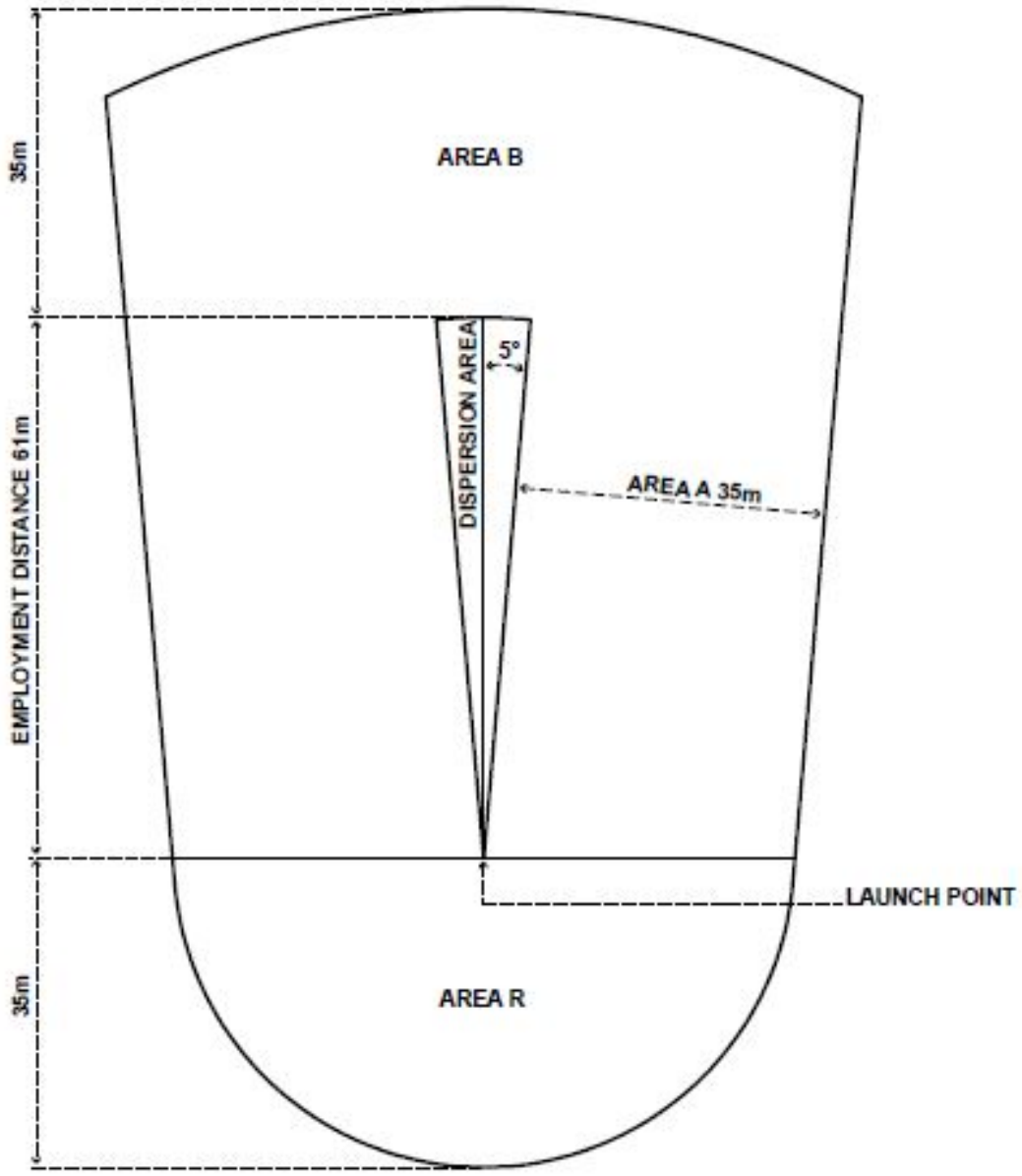

Figure 14–5. Surface danger zone for rubber ball grenade shotgun launched grenade

14–8. M5 modular crowd control munition (WA97)

a. The modular crowd control munition (MCCM) (WA97) is a munition which resembles the M18A1 Claymore Mine. The rubber balls are launched in a fan-shaped distribution pattern.

b. This weapon has a minimum engagement range of 5m and a maximum effective range of 15m.

c. Detonation of the MCCM (WA97) presents a rearward danger zone, Area R.

d. The SDZ is contained in figure 14–6.

e. When firing the MCCM (WA97) from vehicles, use mounting systems in accordance with applicable technical manuals. Mount the MCCM (WA97) on armor-hardened vehicles only.

f. PPE Level 0 is required.

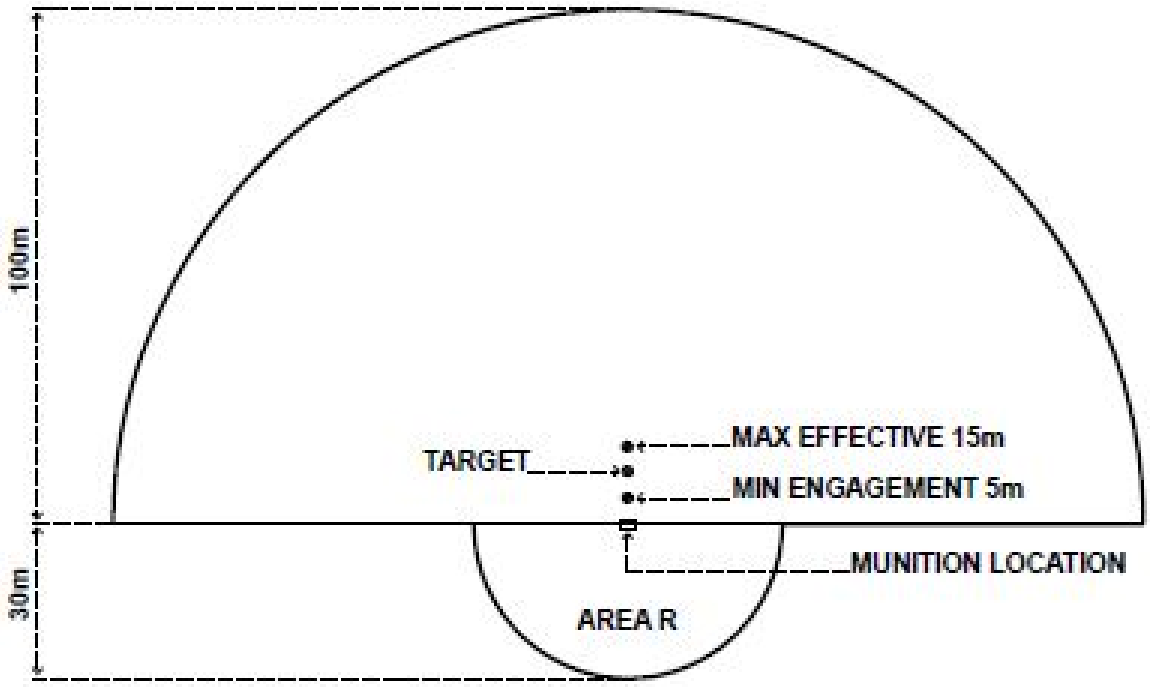

Figure 14–6. Surface danger zone for Modular Crowd Control Munition (MCCM)

14–9. M84 stun grenade (GG09)

a. The M84 stun grenade (GG09) is a non-lethal diversionary device. It is used to apply the minimum force necessary by tactical and non-tactical forces while performing hostage rescue and capture of adversary missions. Stun grenades may cause fires under certain conditions.

b. The daily exposure limit within the noise hazard contour is as follows:

(1) Double hearing protection is required when employing 41 rounds or more per day at 2m.

(2) Single hearing protection is required when employing 2 rounds or more per day at 2m.

(3) Single hearing protection is required when employing 1,000 rounds or more per day at 3m.

(4) The SDZ is contained in figure 14–7.

c. PPE Level 0 is required.

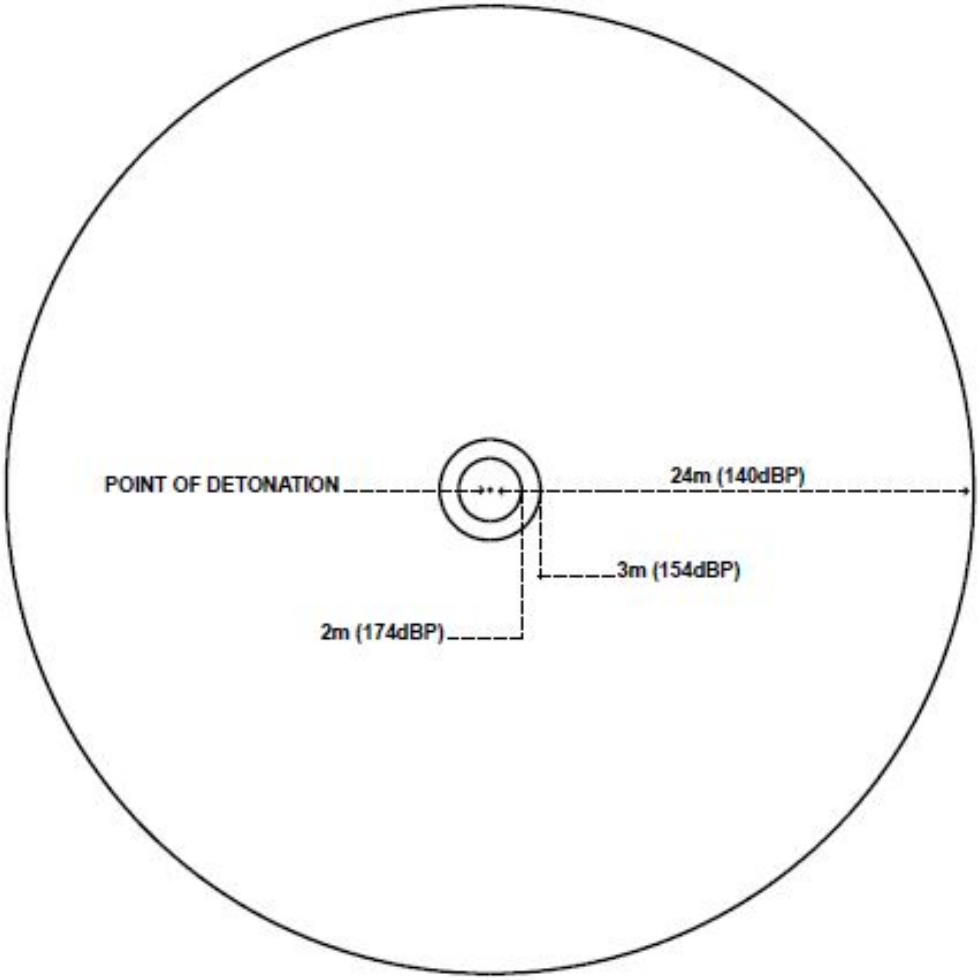

Figure 14–7. Surface danger zone for M84 stun grenade

14-10. MK 20 MOD 0 Improved Flash Bang Grenade (IFBG) (Marine Corps)

a. The IFBG causes temporary incapacitation through flash blindness and hearing loss.

b. PPE level 0 is required.

c. Double hearing protection is required within the 9m noise hazard contour (>165 dBP).

d. Single hearing protection is required within the 9m (>165 dBP) and 155m (>140 dBP).

e. The individual daily exposure limits within the noise hazard contours are as follows:

(1) No more than 50 rounds per day within the 9m noise hazard contour.

(2) No more than 150 rounds per day between the 9m and 155m noise hazard contours.

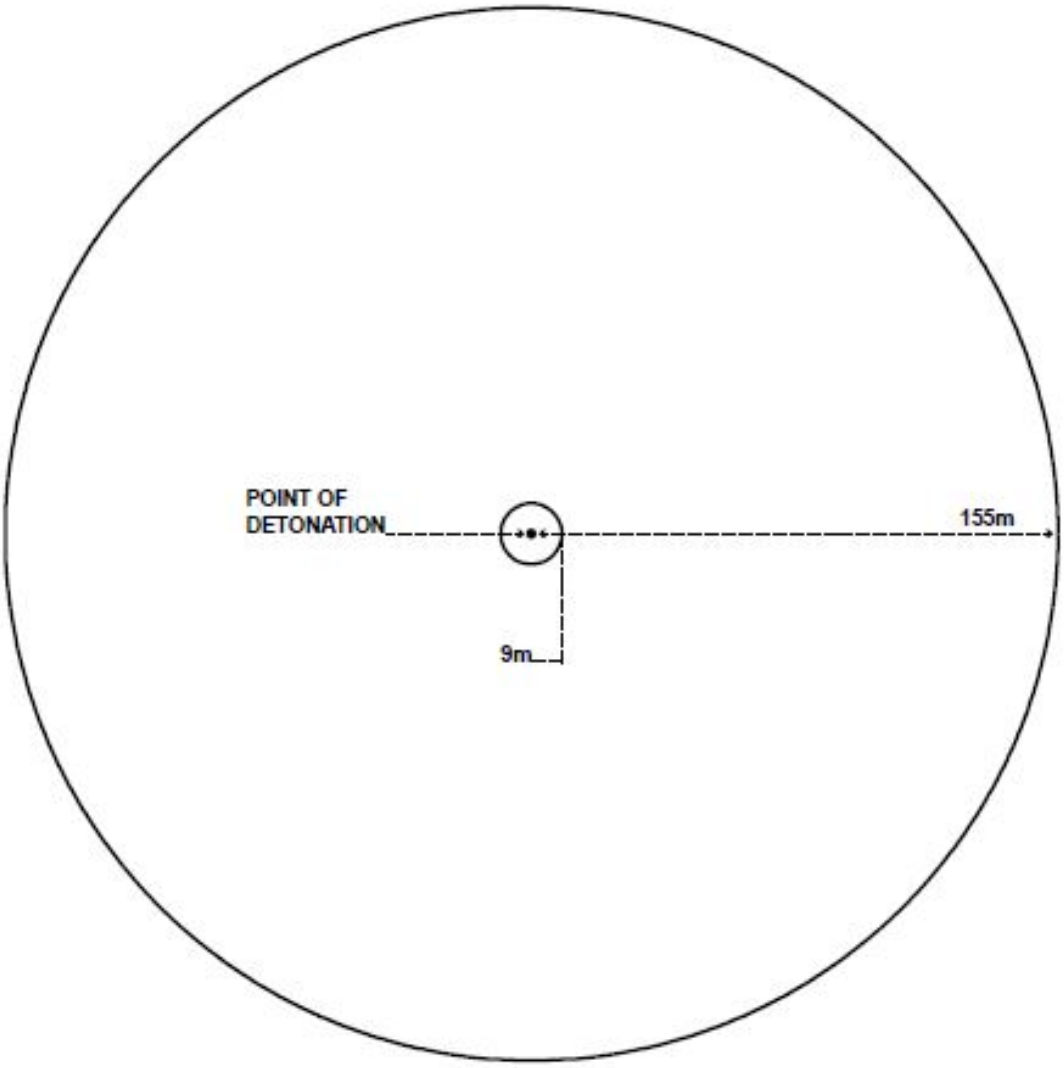

Figure 14–8. Surface danger zone for MK 20 MOD 0 improved flash bang grenade

14–10. M98 (FZ16) and M99 (FZ17) 66mm non-lethal grenade

a. The M98 (FZ16) and M99 (FZ17) 66mm non-lethal grenades are launched from vehicle-mounted tubes. The grenades are packaged three-to-a-tube.

b. The non-lethal grenade M98 (FZ16) is a distraction grenade with a flash and a loud report shortly after impact.

c. The non-lethal grenade M99 (FZ17) is a blunt-trauma grenade that functions with a similar flash/bang followed by the discharge of approximately 420 plastic balls (140 per canister).

d. The SDZ is contained in figure 14–8. The tabular data for these grenades are contained in table 14–4.

e. PPE Level 0 is required.

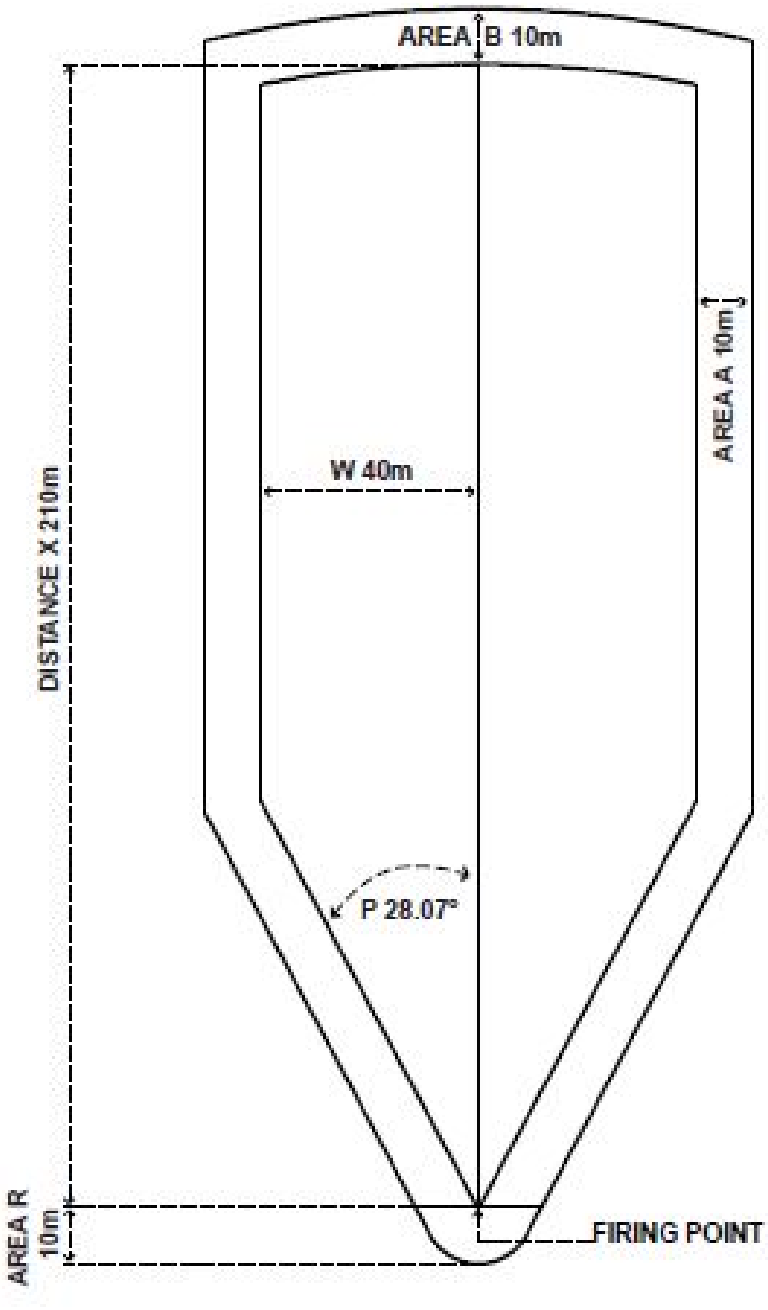

Figure 14–9. Surface danger zone for M98 and M99 grenades

14–11. Launched electrode stun device

a. The device is used to propel wire probes which conduct energy to affect the sensory and motor functions of the nervous system. The launched electrode stun device provides the capability for non-lethal incapacitation of an individual at close range.

b. The two probes are propelled by compressed gas and are connected to the weapon by 25 or 35ft long high voltage insulated wires.

c. The SDZ is contained in figure 14–9.

d. PPE Level 0 is required.

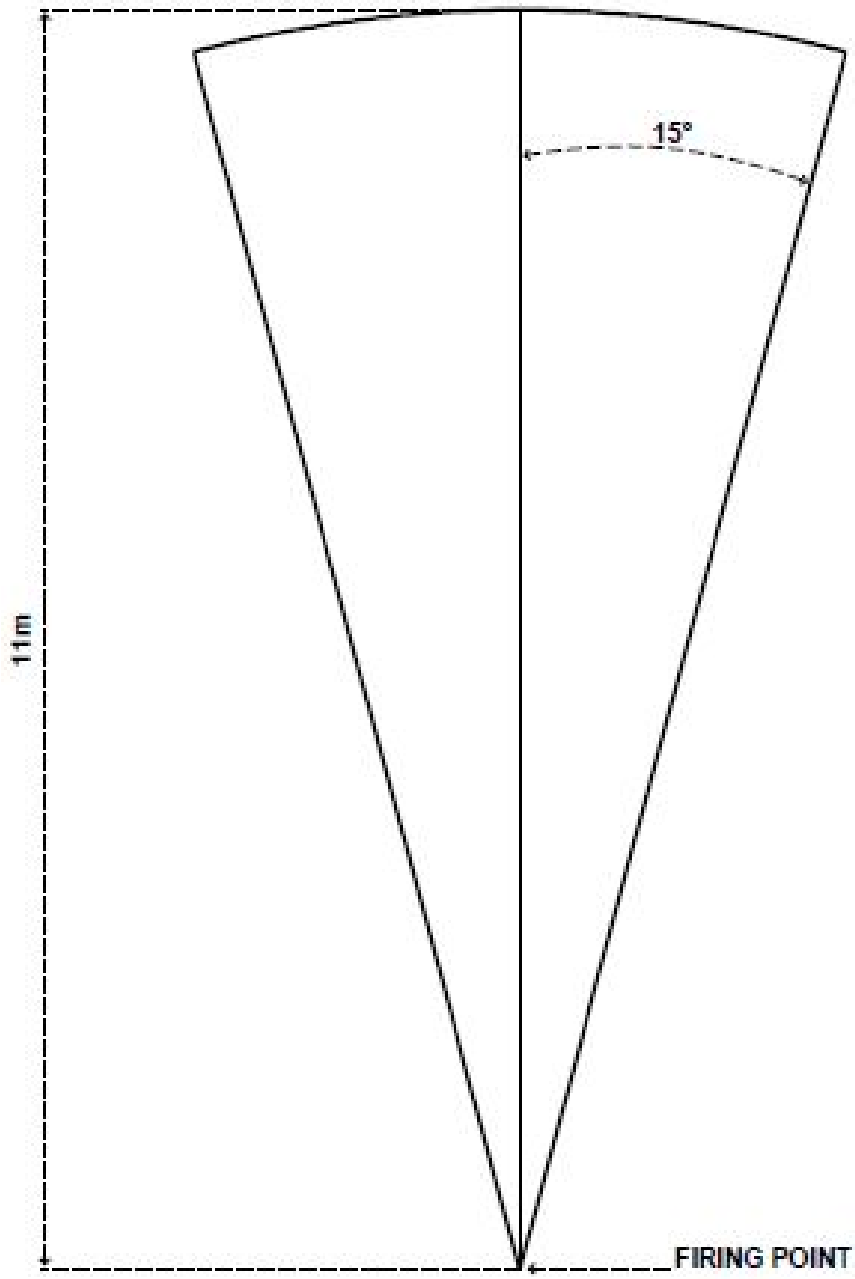

Figure 14–10. Surface danger zone for Launched Electrode Stun Device (LESD)

14–12. M104 non-lethal bursting hand grenade

a. The M104 non-lethal bursting hand grenade has a rubber molded body and has an output that combines a bright flash and loud explosion which consists of 100 pliable rubber projectiles to disorient and confuse targeted personnel.

b. PPE Level 0 is required.

c. Single hearing protection is required by all personnel within 195m.

d. The SDZ is contained in figure 14–10.

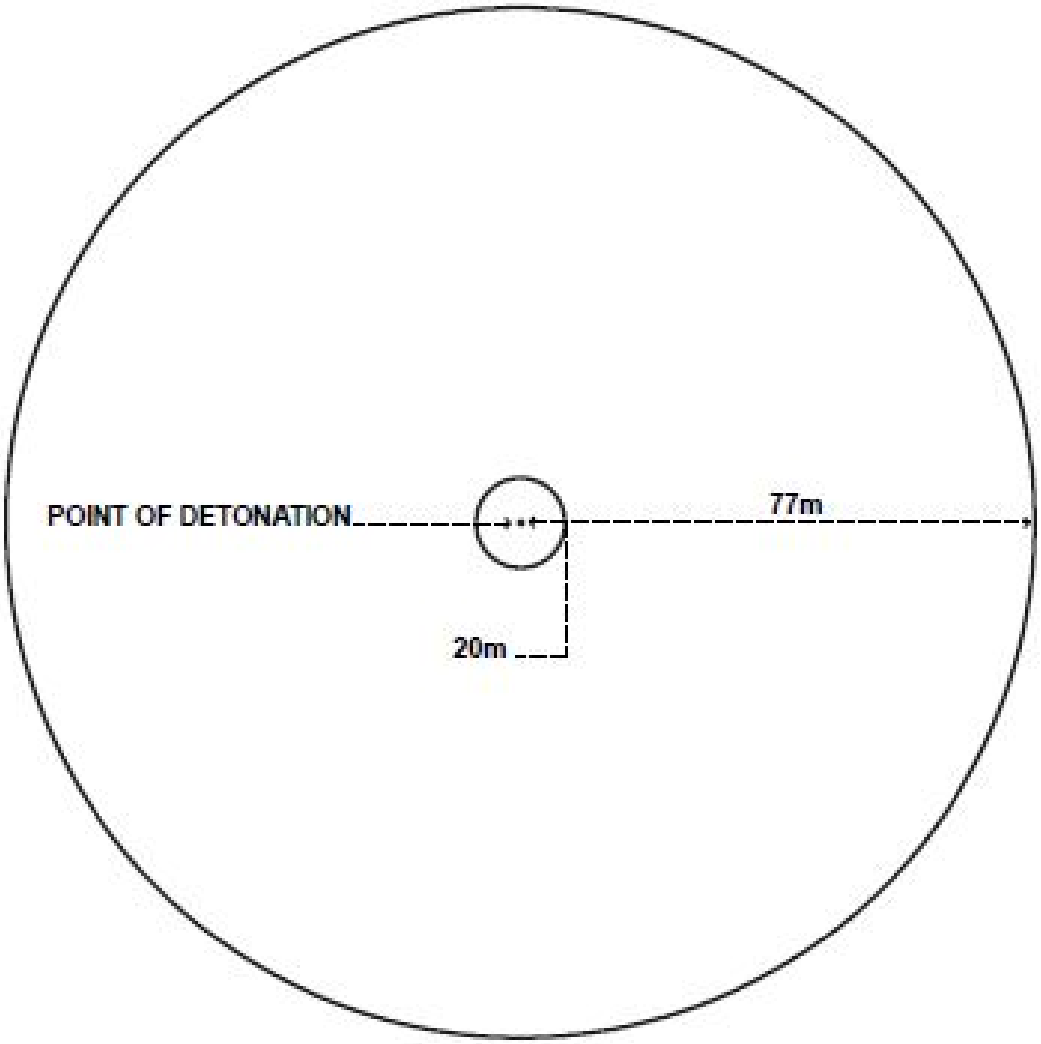

Figure 14–11. Surface danger zone for bursting hand grenade M104

14–13. Non-lethal/tube launched munition system

a. The non-lethal/tube launched munition system (NL/TLMS) is a vehicle or ground-mounted, multi-shot, electrically actuated, non-lethal munitions grenade launcher. The system is a non-lethal addition to the force protection toolset. It provides the user with a non-lethal means of determining potential hostile intent at sufficient stand-off distance. It is composed of a 40mm multi-flash bang cartridge, launcher, and a family of bracket kits. The NL/TLMS will be fired into dedicated impact areas only.

b. The NL/TLMS may be mounted on the Gunner's Protective Kit, Objective-Gunner's Protective Kit or the Marine Corps Transparent Armor Gun Shield. The NL/TLMS may also be ground-mounted on an M3 machine gun tripod. When vehicle-mounted, the NL/TLMS is co-axially mounted with either the M2 .50 caliber machine gun, MK19 40mm machine gun, or the M240G machine gun. The use of the Marine Corps Transparent Armor Gun Shield with the NL/ TLMS installed in an extended position is prohibited until an upgraded universal pintle and base frame bracket assembly is incorporated.

(1) In the extended configuration (pushed forward of the gunner position), a vibration hazard exists which creates the possibility of damage to the base frame.

(2) When used in the retracted configuration (pulled towards the gunner), the use of the M2 .50 caliber machine gun and MK19 40mm grenade launcher is prohibited due to lack of space to mount the ammunition canisters.

c. Table 14–5 below provides the frequency bands, maximum allowable environment (MAE) expressed in

volts per meter (V/m), and S4 phases of NL/TLMS operation. It indicates the electromagnetic radiation to which the NL/TLMS may safely be exposed without a potential premature ignition of the munition.

Table 14–2
Non-lethal Tube Launched Munition System (NL-TLMS) Maximum Allowable Environment (MAE)

Frequency (MHz)	MAE (V/m)	S4 Phases
2-32	15	Handling and loading
400-700	14.10	Handling and loading
700-790	36.30	Handling and loading
790-1000	46.90	Handling and loading
790-1000	387	Handling and loading staged, or platform loaded

Legend for table 14-2:
MAE=Maximum Allowable Environment
MHz=Megahertz
V/m=Volts per Meter

d. Minimum safe target engagement for the NL/TLMS is 31m due to possibility of fragments or debris. Additionally, the stand-off distance will be 31m for known transmitters such as the AN/VRC–104, Counter Radio-Controlled Improvised Explosive Device Electronic Warfare (CREW), CREW-training, and electronically fuzed counter-improvised explosive device systems during handling and loading phases of the NL/TLMS.

e. All personnel will wear eye protection, single-hearing protection, and throat protector provided for the modular tactical vest. While the NL/TLMS is being fired from the vehicle platform, firing personnel will be fully seated in the turret using the turret harness.

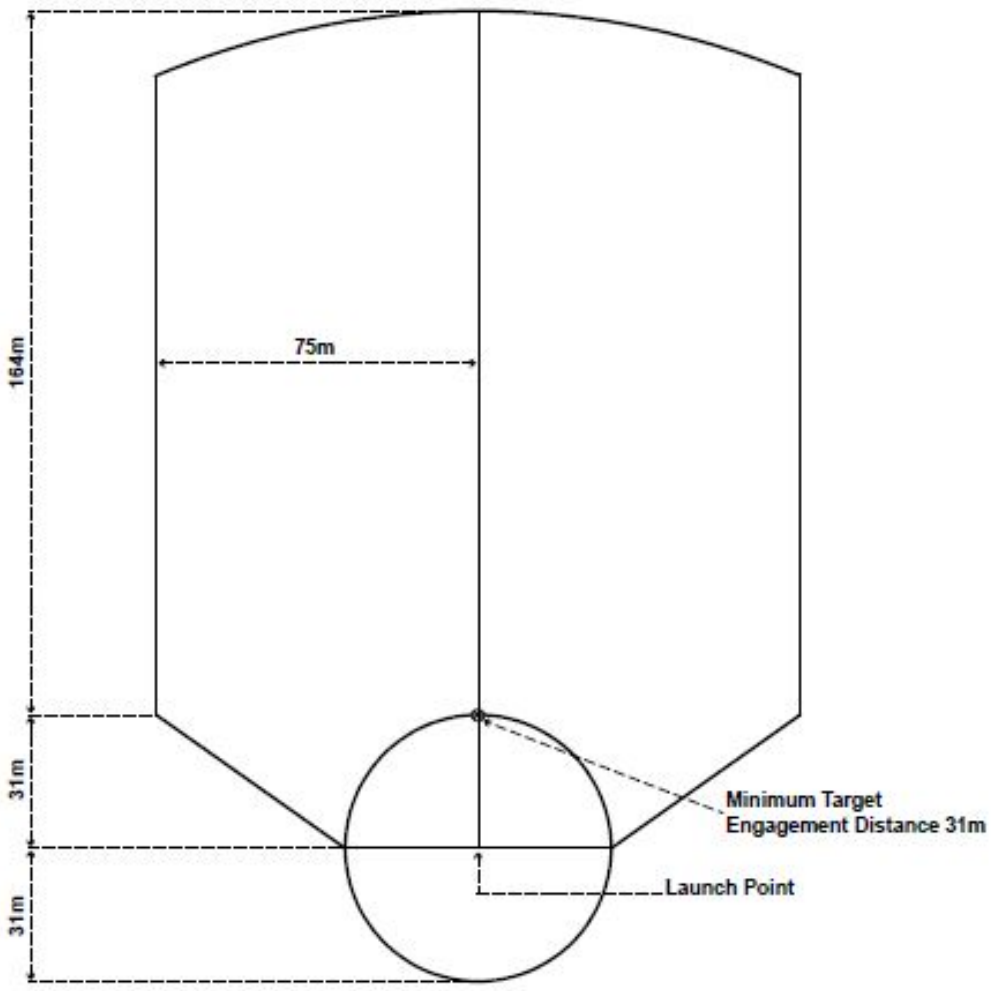

Figure 14–12. Surface danger zone for Non-Lethal Tube Launched Munition System (NL-TLMS)

14–14. Special Effects Small Arms Marking System (Marine Corps)

a. The Special Effects Small Arms Marking System (SESAMS) is a Marine Corps training system that fires a marking cartridge (colored dye) to enhance realism for force-on-force training. Improper use of the SESAMS training system may cause serious personal injury and/or damage to equipment.

b. The mixing of live ammunition and SESAMS rounds is prohibited.

c. Installation commanders should establish a RSO program that specifically addresses SESAMS training system requirements. SESAMS training systems will also be addressed in the installation's range SOP.

d. Upon completion of the SESAMS RSO requirements, installation commanders will certify Marine staff sergeants (and above), or other Service equivalent, as SESAMS RSO.

e. Before SESAMS firing:

(1) Ensure that only Marine Corps procured adapter kits and marking cartridges are used.

(2) Force-on-force training with SESAMS 9mm DODICs (AA12) and (AA21) is prohibited when temperatures are below 38 degrees Fahrenheit. Training with SESAMS 5.56mm DODICs (AB05) and (AB06) is prohibited when temperatures are below 18 degrees or above 104 degrees Fahrenheit.

(3) Account for and remove all live ammunition from the designated training area prior to commencement of SESAMS training exercises.

(4) Instruct all participants that head shots are not authorized.

(5) Ensure that all personnel within the 150m safety distance (zone) wear PPE Level 0 protective equipment and clothing. The use of groin protection and gloves is highly encouraged.

(a) The FX 9000 and 9003 Protective Face Masks are authorized for use. The FX 9003 Protective Face Mask is specifically authorized for use with DODICs (AB05) and (AB06).

(b) The MCU–2A/P Chemical Biological Mask may be used for face and eye protection only if the hard outer eye shields and the C2 canister are attached prior to use with the SESAMS training system.

(c) A balaclava, towel, or neck scarf will be worn so as not to expose any portion of the neck and throat. A commercially produced neck protector is also available from Simunition, the FX 8000 Protective Throat Collar.

(6) Ensure that the 150m safety distance (zone) remains clear of unprotected personnel.

f. During SESAMS firing:

(1) Ensure that qualified medical personnel and appropriate medical equipment are available during all SESAMS training exercises (same as live-fire).

(2) Ensure all personnel wear approved hearing protection during all SESAMS training exercises.

(3) Ensure that a minimum safe engagement distance of 2m (6.5 ft) for the 9mm SESAMS training system and 4m (13 ft) for the 5.56mm system is established and maintained from the muzzle.

g. After SESAMS firing:

(1) Ensure all weapons are returned to their operational state and a function check is performed.

(2) Account for and return all unused ammunition to the appropriate location in accordance with current applicable directives.

14–15. Close combat mission capability kit (Army)

a. All personnel engaged in CCMCK force-on-force training will wear PPE in accordance with the procedures, restrictions, and other guidance contained in technical/operator manuals, references, and/or pamphlets (TM 9–6920–3700–10). No personnel will be allowed within 75m of the outermost boundary of the training area when force-on-force training is being conducted without meeting the minimum PPE safety requirements.

b. All participants will be instructed that no head shots will be taken.

c. The minimum engagement distance is 1.5m (5 ft).

d. All participants will be inspected by the RSO, NCOIC, or OIC prior to the initiation of training to ensure that PPE is worn and that employed individual weapons (M16/M4/M249/M9/M11) have been properly converted to fire low-velocity marking ammunition.

e. Single hearing protection is required to be worn within 5m of 9mm and 5.56mm weapons using CCMCK marking ammunition during firing. See paragraph 2–11c for eye protection requirements.

f. Ensure that the 60m (9mm) or 75m (5.56mm) safety distance (zone) remains clear of unprotected personnel.

g. Vertical Ricochet hazard is 15m (9mm) and 16m (5.56mm).

Chapter 15
Mines, Firing Devices, Trip Flares, Simulators, and Explosive Charges

15–1. General

a. Basic procedures for handling and detonating explosives, mines, firing devices, trip flares, and simulators used by personnel in training are addressed in this chapter. These procedures do not include projectiles, rockets, bombs, fuzes, or firing devices covered in other paragraphs of this pamphlet unless otherwise stated.

b. The following safe practices pertain to standard military and commercial explosives used by the Army, and the Marine Corps, except where noted. They also pertain to items containing explosives such as demolition blocks and mines. Marine Corps units will use the requirements contained in NAVSEA OP5, Volume 1, NAVSEA SWO60–AA–MMA–010, EODB/TM/ TO 60A series, and the Guidebook for Assault Entry Techniques.

(1) For the Army, general safe practices for handling and transporting explosives are prescribed in TM 9–1375–213–12, FM 3–34.214, and DA Pam 385–64. For Marine Corps units, information regarding transportation and handling of explosives are in NAVSEA OP5, Volume 1, NAVSEA SWO20–AF–ABK–010, NAVSEA SWO20–AC–SAF–010, NAVSEA SWO20–AC–SAF–020, NAVSEA SWO–AC–SAF–030, and MCO 8020.10.

(2) EOD demolition activities will be conducted in accordance with the provisions of AR 75–15 and EODB 60 series publications for U. S. Army EOD personnel, and NAVSEA OP5 and EODB 60 series publications for Marine Corps EOD personnel.

(3) Commercial dynamite will not be stored for prolonged periods at temperatures above 90 degrees because exudation of the nitroglycerin is likely to occur. Storage below 32 degrees tends to make it sensitive to shock. Dynamite will not be moved or transported if there is evidence of exudation or if it has been frozen. In such cases, the dynamite will be considered unserviceable and will be disposed of by EOD personnel. When possible, avoid the use of commercial dynamite in a combat environment due to its storage requirements, sensitivity to moving, and possible detonation from direct fire rounds or artillery fragments. Commercial explosives cannot be burned without risk of explosion. EOD personnel will dispose of commercial explosives.

(4) Unserviceable AE and any AE not to be used as designated for training or operations will be returned to the issuing ASP for disposition.

(5) Some foreign military explosives are not as stable as U.S. explosives. EOD personnel will dispose of foreign explosives under U.S. military control, as appropriate.

(6) Gases released by detonation of explosives are toxic. Avoid exposure to fumes. Position personnel upwind from detonation points and wait until smoke and fumes disperse before proceeding downrange.

(7) Buried charges will be primed with detonating cord leading to above ground electric or non-electric blasting caps. Blasting caps will not be buried underground as they are sensitive to shock and may detonate if hit by a metal tool or other hard object.

(8) Detonating cord should be used to prime charges on above ground charges to minimize the need to use blasting caps. Once the explosives charges are primed with detonating cord, the detonating cord will be initiated with an above-ground electric, non-electric blasting cap, or a modernized demolition initiator (MDI).

(9) Lightning and other sources of extraneous electricity (for example, static electricity, high power lines, radio transmitters, and cellular phones) can initiate electro-explosive devices. Electro-explosive devices are subject to hazards of electromagnetic radiation to ordnance. Non-electric blasting techniques are invulnerable to most extraneous electric signals but not to lightning. All demolition training operations must be discontinued at the approach of an electric or severe dust storm.

(10) Detonation circuits will not be connected or armed on any munition unless the intent is to detonate the munition. When munitions are to be detonated, the area will be cleared of all non-mission-essential personnel with a minimum crew remaining to connect the detonation circuit. Live blasting caps or other live detonators will not be located at training sites if munitions are not to be detonated.

(11) All personnel within the SDZ will wear approved protective helmets and hearing protection for all detonations, including while in the confines of missile-proof shelters. IBA, helmet, and hearing and eye protection (Army)/PPE Level 1 (Marine Corps) will be worn by personnel within the SDZ but outside the missile-proof shelter.

(12) Only mission-essential personnel (Army)/ participating personnel (Marine Corps) will be allowed in SDZs during firing.

c. When temporary open storage of explosives is used, stacks will not exceed 227 kilogram (kg) (500 pound (lbs)) of explosives. Distance between stacks should not be less than 45m (150 ft). The RMTK On Range Ammunition Handling (ORAH) Tool should be used to produce explosive danger zones for single or multiple

DODICs when the munitions to be stored are in total support of the training mission.

(1) For the Marine Corps, the RMTK ORAH Tool should be used to produce explosives danger zones for single or multiple DODICs when the munitions to be stored are in total support of the training mission.

(2) For the Army, the RMTK ORAH Tool may be used to produce explosives danger zones for single or multiple DODICs when the munitions to be stored are in total support of the training mission.

d. Live and inert munitions/demolitions will not be mixed.

e. Demolitions effects simulators which contain live explosives, as well as other simulators, are considered live munitions.

f. Basic demolition training will follow the procedures in FM 3-34.214/MCRP 4-17.7L. Field expedient methods outlined in applicable field manuals are authorized for use. Unit commanders will receive prior approval from the installation RMA (Army), RCO (Marine Corps) with concurrence of the installation safety manager (Army) prior to conducting activities employing field expedient procedures or explosives. During basic or familiarization demolition training, instructors will supervise not more than five students while they are priming individual charges. Not more than five students will prime charges at a time. The remainder of students and observers will withdraw to a safe position before priming occurs. Single charges placed against steel, concrete, wood, or other solid material during training or demonstrations will be emplaced on the side nearest observers so that major fragments are propelled away from the observers. Dual initiation systems are preferred over single initiation systems to increase reliability. Consult FM 3–34.214/MCRP 3-27.7L and use the best combination of initiation systems to decrease the possibility of misfires.

(1) While engaging in demolition training, the minimum distances given in paragraph *g* may be reduced to 50m (165 ft) if bare charges of not more than 2.27 kg (5 lbs) are used on the surface of specially prepared sites that conform as follows:

(a) Bare charges will be detonated on a sand cushion that has been screened and is pebble or stone free (material passes through a #10 sieve). The sand cushion will not be less than that specified in table 15–1. Subsequent charges will not be placed where cratering from previous detonations has reduced the depth of sand.

Table 15–1
Dimensions of sand cushion

Explosive (kg/lbs)	Sand depth (m)	Radius of sand surface (m)
.10/0.25	0.60	0.20
.23/0.50	1.00	0.30
.45/1.00	1.30	0.50
.91/2.00	1.60	0.60
1.9/4.00	2.00	1.00
2.27/5.00	2.30	1.10

(b) Bare charges will be detonated on soil free from gravel, rock, metal or other possible debris to a depth of at least 0.15m (6 in). Ground preparation will include loosening and raking the soil. A barricade constructed of sandbags or other suitable protective material at least 1m above the surrounding level of ground will be provided between the location of the charge and personnel. Charges will be placed not less than 1m or more than 2m from the barricade. The detonation site will be maintained to prevent formation of clods or exposure of gravel or rock on or near the surface. It is helpful to place a layer of porous, water permeable matting (geo-textile fabric consisting of woven nylon, and polyester) between a rocky layer of soil and the upper layer of soil that must be free of gravel, rock, metal, or other potential debris. This will help prevent contamination of the upper soil layer from the migration of gravel and rock and help reduce long-term maintenance costs.

(2) Charges placed on steel.

(a) The preferred method of employing steel cutting charges is in a bunker designed for that purpose. Steel cutting charges (amount of explosives and placement) will be calculated based on appropriate formulas and tables in FM 3–34. 214.

(b) If a steel-cutting bunker is not available, charges will be fired in an excavated pit that is at least 1m deep. Steel-cutting charges fired outside of a steel-cutting bunker will not exceed 0.9 kg (2 lbs).

(c) Personnel must be a minimum of 100m from the charge at detonation in a missile-proof shelter, 300m in defilade, or 1,000m if in the open.

(3) Charges placed on concrete.

(a) Charges placed on concrete will not exceed 18 kg (40 lbs) and should be placed on the side nearest observers.

(b) Observers must be at least 100m away in a missile-proof shelter, 300m away in defilade, or 900m away

in the open.

(c) An unoccupied distance of 900m will be provided on the opposite side of the charge where most missile hazards will be thrown.

(4) PPE Level 2.

g. Explosives can propel lethal fragments and debris hazards great distances.

(1) The distance explosion-propelled fragments or debris will travel in air depends mainly on the relationship between weight, shape, density, initial angle of projection, and initial velocity. Fragment and debris hazards from steel-cutting charges extend a greater distance under normal conditions than that from cratering, quarrying, or surface charges of bare explosives.

(2) Fragment and debris hazard distances at which personnel in the open are relatively safe from missiles created by bare charges placed in or on the ground, regardless of type or condition of the soil, are as follows:

(a) Charges more than 227 kg (500 lbs): Minimum 800m fragment and debris hazard distance.

(b) Charges from:12 kg (27 lbs) to 227 kg (500 lbs) charges, computed from the formula: Safe distance in meters=100 times the cube root of the pounds of explosive ($D=100 \times W^{1/3}$).

(c) Less than 12 kg (27 lbs): Minimum 300m fragment and debris hazard distance.

(d) See table 15–2 for computed safe distances for personnel near bare charges.

Table 15–2
Safe distances for personnel (near bare charges)

Charges	Missile hazard distance (m)
more than 227 kg/more than 500 lbs	Minimum 800
12.27 kg/27 lbs to 227 kg/500 lbs	Computed[1]
less than 12.27 kg/less than 27 lbs	Minimum 300[2]

Notes:
[1]Computed missile hazard distance in meters=100 times the cube root of the pounds of explosive: (D=100 X W1/3).
[2]When charges less than five pounds are placed on specially prepared or selected sites (para 15–1*f*(2)(*a*)) to eliminate a missile hazard, distance may be reduced to not less than 50m.

(3) For 0.25-pound charges used to simulate enemy artillery fire and mortar fire that are detonated in specially constructed demolition pits constructed as described in paragraph 15–10*e*(8), the minimum distance may be reduced to not less than 3m.

h. Blast effects generate hazards.

(1) Generally, the greatest danger to personnel is missiles thrown by an explosion. However, blast effect (such as an increase in air pressure) also generates hazards to personnel located within the SDZ. Special protective features used at detonation or demolition sites to eliminate or confine missiles may not reduce or mitigate overpressure and noise hazards.

(2) Hearing protection is required for any exposure to noise greater than 140 dBP. Follow the hearing protection recommendations listing in the technical manuals for the explosive devices used. If the hearing protection recommendations are not listed in the manuals, compute the 140 dBP contour from the formula: Distance to 140 dBP contour in meters=300 times the cube root of the weight of explosive in kg ($D=300 \times W^{1/3}$). Table 15–3 contains the distances for various weights of explosives.

Table 15–3
Hearing protection distances

Weight of explosives (kg)	Weight of explosives (lbs)	Distance to 140 Dbp contour (m)
0.10	0.25	145
0.23	0.50	183
0.45	1.00	230
0.91	2.00	290
2.27	5.00	394
4.45	10.00	497
9.10	20.00	626
22.70	50.00	849
45.00	100.00	1,070
91.00	200.00	1,348

i. Explosive entry techniques are used when assault personnel require immediate access to the target. To

train for this type of mission, individuals may be required to be closer to the detonation than authorized by this pamphlet in paragraph 15–12. Such operations will require a deviation in accordance with AR385-63/ MCO 3570.1D and chapter 1 of this pamphlet.

15–2. Firing devices

a. Electrical firing will be used with caution and will be replaced by non-electric firing systems when the possibility exists of unintentional detonation from extraneous electrical energy sources (for example power transmission lines, cellular telephones, generators, radios, or any weather conditions which produce static electricity or lightning). Electric blasting circuits must be checked for stray electromagnetic energy by using a test set. Test sets will not detect non-transmitting portable equipment that may be in the vicinity. Therefore, total reliance must not be placed on these detection methods to ensure the safety of personnel. Areas selected for demolition training sites will be surveyed for electromagnetic energy. This survey is an installation responsibility. Areas will be controlled to prevent entry of portable transmitting equipment from the surrounding area. The data in tables 15–4, 15–5, and 15–6 showing transmitter and radiative power in watts and minimum separation distances to electric blasting operation apply to operation of a radio, radar, and television transmitting equipment.

Table 15–4
Minimum safe distances between radio frequency transmitters and electric blasting operations

Transmitter power (watts)	Commercial AM broadcast transmitters (m)	HF transmitter other than AM broadcaster (m)
100	229	229
500	229	519
1,000	229	732
4,000	229	1,464
5,000	259	1,678
10,000	397	2,318
25,000	610	3,360
50,000[1]	854	5,185
100,000	1,190	7,320
500,000[2]	2,684	16,755

Notes:
[1]Present maximum power of U.S. broadcast transmitters in commercial AM broadcast frequency range (535 to 1,605 kHz).
[2]Present maximum for international broadcast.

Table 15–5
Minimum safe distances between television and FM broadcast transmitters and electric blasting operations

Effective radiative power (watts)	Channels 2 to 6 and FM (m)	Channels 7 to 13 (m)	UHF (m)
Up to 1,000	315	229	183
10,000	549	397	183
100,000[1]	976	702	336
316,000[2]	1,312	915	442
1,000,000	1,769	1,220	610
5,000,000[3]	2,745	1,891	915
10,000,000	3,111	2,257	1,068
100,000,000			1,803

Notes:
[1]Present maximum power, channels 2 to 6 and FM.
[2]Present maximum power, channels 7 to 13.
[3]Present maximum power, channels 14 to 83.

Table 15–6
Minimum safe distances between mobile Radio Frequency (RF) transmitters and electric blasting operations

Transmitter Power (watts)	Medium frequency, 1.6 to 3.4Mhz, Industrial (m)	HF, 28 to 29. 7MHz amateur (m)	Very high frequency, 35 to 36MHz Public use; 42 to 44MHz public use; 50 to 54MHz, amateur (m)	Very high frequency, 144 to 148MHzamateur; 150.8 to 161.6MHz public use; 222 to 225 MHz amateur (m)	Ultra high frequency, 420 to 450MHz, amateur; 450 to 460MHz, public use (m)
5[1]		2			
10	12	31	12	5	3
50	28	67	28	11	6
100	38	95	40	15	9
180[2]				20	

250	61	150	63	23	14
500[3]			89		
600[4]	92	232	96	35	21
1,000[5]	122	290	125	46	28
10,000[6]	382		397		

Notes:
[1]Citizens band radio (walkie-talkie) (26.96 to 27.41MHz) minimum safe distance is 1.52 m.
[2]Maximum power for 2-way mobile units in VHF (150.8 to 161.6MHz) range and for 2-way mobile and fixed-station units in UHF (450 to 460MHz) range.
[3]Maximum power for major VHF 2-way mobile and fixed-station units in 35 to 44MHz range.
[4]Maximum power for 2- way fixed-station units in VHF (150.8 to 161.1MHz) range.
[5]Maximum power for amateur radio mobile units.
[6]Maximum power for some base stations in 42 to 44 MHz band and 1.8MHz band

b. Electric firing will not be used for demolition training when surveys show that the transmitted field strength exceeds energy levels shown in tables 15–4, 15–5, and 15–6.

c. Static electricity will be eliminated or non-electric firing systems will be used.

d. Approved firing devices (for example, M1, M1A1, M3, M5, M122, XM122, M142, and M152) employed in accordance with Army / Marine Corps FMs/TCs and TMs are authorized for use with practice mines. Since these firing devices can be configured with practice and HE activators, care must be taken to ensure the proper activator is assembled to the proper mine. HE activators will not be used with training mines.

e. A dual electric disconnect system will be used when installing electrical firing systems on demolitions. The main source of power will be turned off and a lockout device will be used.

15–3. Shaped charges

a. Shaped charges will be oriented so that gas jets will be directed toward the target. When practicable, charges should be placed on the side of the target nearest to observers, so that the blast is directed away from them. Observers will be at least 100m away in a missile-proof shelter, 275m in defilade, or 1,000m for unprotected personnel, from shaped charges when fired.

b. PPE Level 1 is required

c. The MK47 Mod 1 demolition shaped charge requires a safe separation distance of 300m for protected personnel. For unprotected personnel, the stand-off distance is 1,610m.

15–4. Bangalore torpedoes

a. Bangalore torpedoes will only be fired while on the ground in a horizontal position. Personnel will be in a missile-proof shelter 100m from the charge, or 200m away in defilade. For unprotected personnel in the open, the minimum safe distance (MSD) is 1,000m at right angles to axis of the Bangalore torpedo, 200m for personnel in the line of axis. If an improvised Bangalore torpedo, in which the explosive weight exceeds the standard, is used against a steel target, fragments (missiles) could be produced which may fly further than the MSD. In that case, the SDZ for steel cutting charges should be used, otherwise, the SDZ for a standard Bangalore torpedo may be used for an improvised Bangalore torpedo.

b. PPE Level 1 is required

15–5. Mine-clearing line charge

a. Firing conditions.

(1) Because of high exhaust temperatures, the mine-clearing line charge (MICLIC) will not be towed behind an M1 Abrams tank.

(2) Non-participating personnel will not be allowed within the MICLIC SDZ or noise hazard contour during firing.

(3) Only participating personnel are allowed within Area F. Such personnel will be in an armored vehicle in a button-up mode with approved single hearing protection.

(4) The M68 inert charge should not be fired more than three times as additional firings may result in breakage of charge blocks and erratic flight of the rocket. Units will record number of firings in accordance with unit SOP.

(5) When firing the M154 Kit, all amphibious assault vehicle hatches will be closed (Marine Corps).

b. Surface danger zone.

(1) SDZ requirements for firing the MICLIC with M58 HE charge are provided in figure 15–1.

(2) The SDZ requirements for firing the MICLIC with M68 inert charge are provided in figure 15–2.

(3) Distance X takes into account the most probable event of charge or cable separation or an unrestrained

rocket motor impacting downrange.

(4) If the detonation command link severs during a charge or cable separation, detonation of the HE charge will not occur.

(5) The fragmentation zone required for the HE charge is for containment of fragments and debris of a normal mine-clearing line charge impact.

(6) MICLIC will not be destroyed by burning. They contain booster charges that detonate when exposed to heat or pressure. Misfired or dud line charges will be destroyed by EOD personnel only after all misfire procedures have been performed by the firing unit.

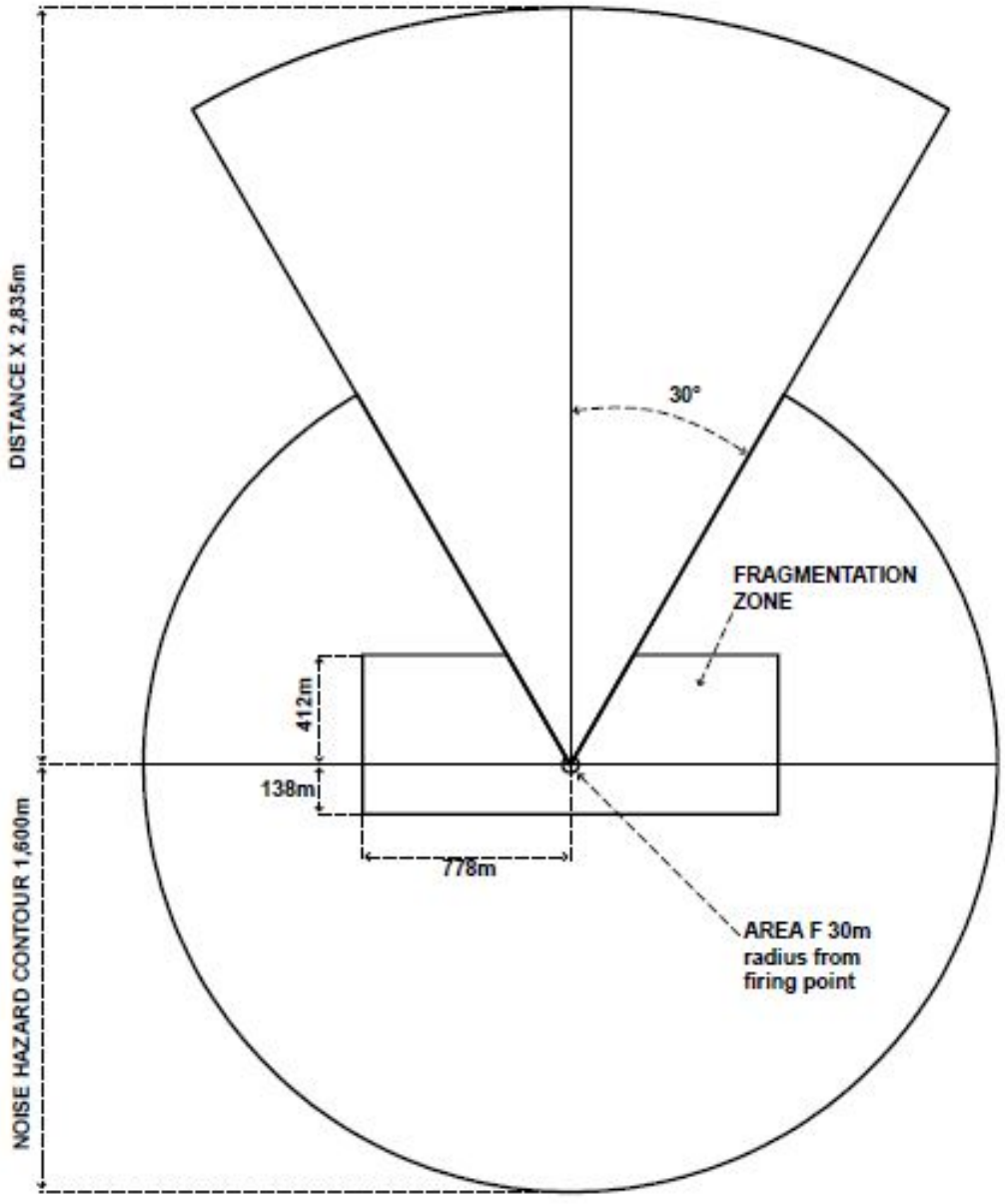

Figure 15–1. Surface danger zone for Mine Clearing Line Charge (MCLIC) with M58 HE charge

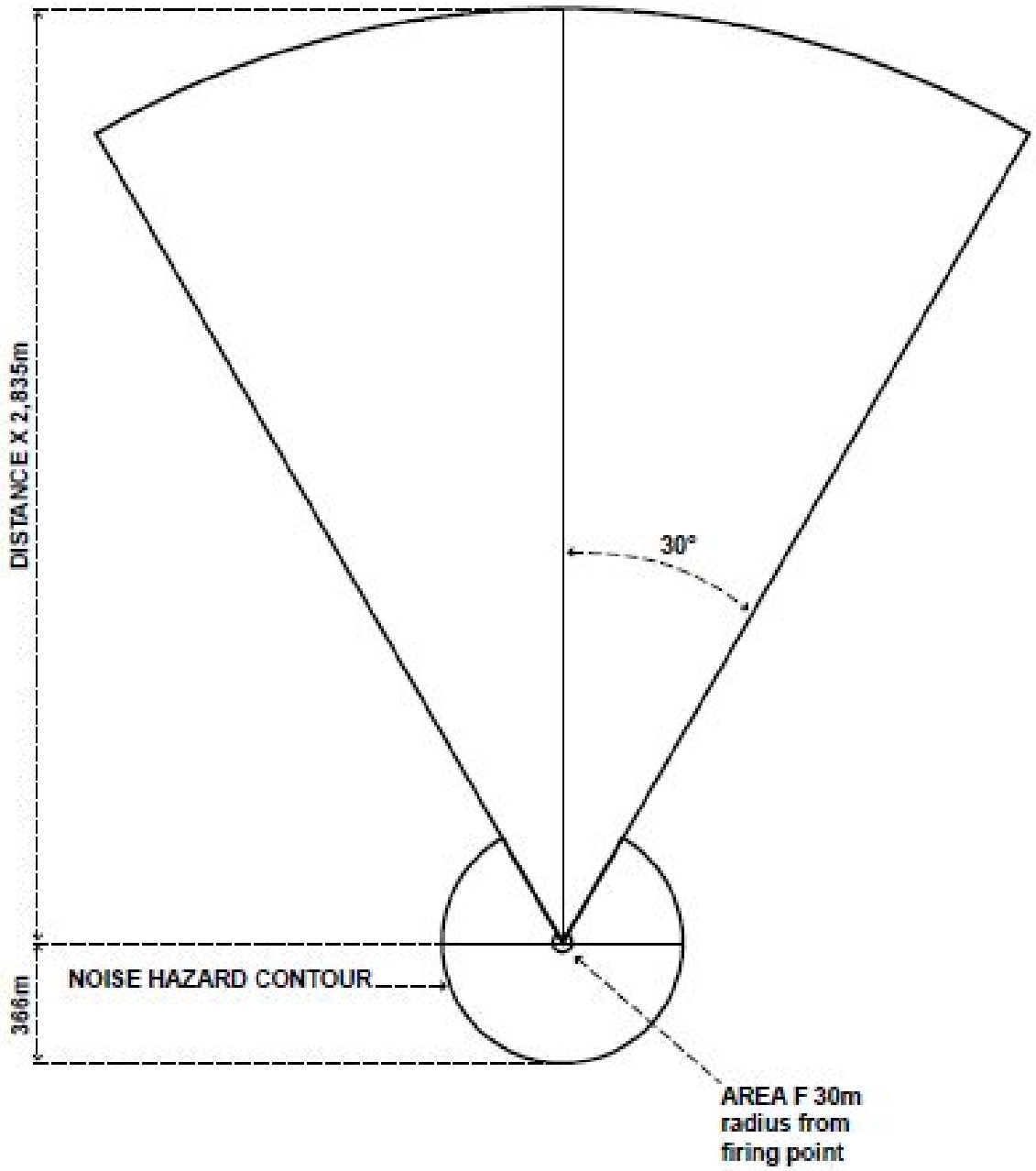

Figure 15–2. Surface danger zone for Mine Clearing Line Charge (MCLIC) with M68 inert charge

c. Anti-Personnel Obstacle Breaching System.

(1) Anti-Personnel Obstacle Breaching System (APOBS) firing personnel will be at least 50m from the launch point and 75m from the deployed grenades and in a prone position. In the event of a catastrophic detonation at the launch point, the rear exclusion area will protect personnel provided that they are in the prone position and use hearing protection.

(2) Personnel without hearing protection shall not be permitted within 1,187m of the launch point.

(3) SDZ requirements for firing the APOBS are provided in figure 15–3.

(4) Vertical hazard for the APOBS is 1266 meters.

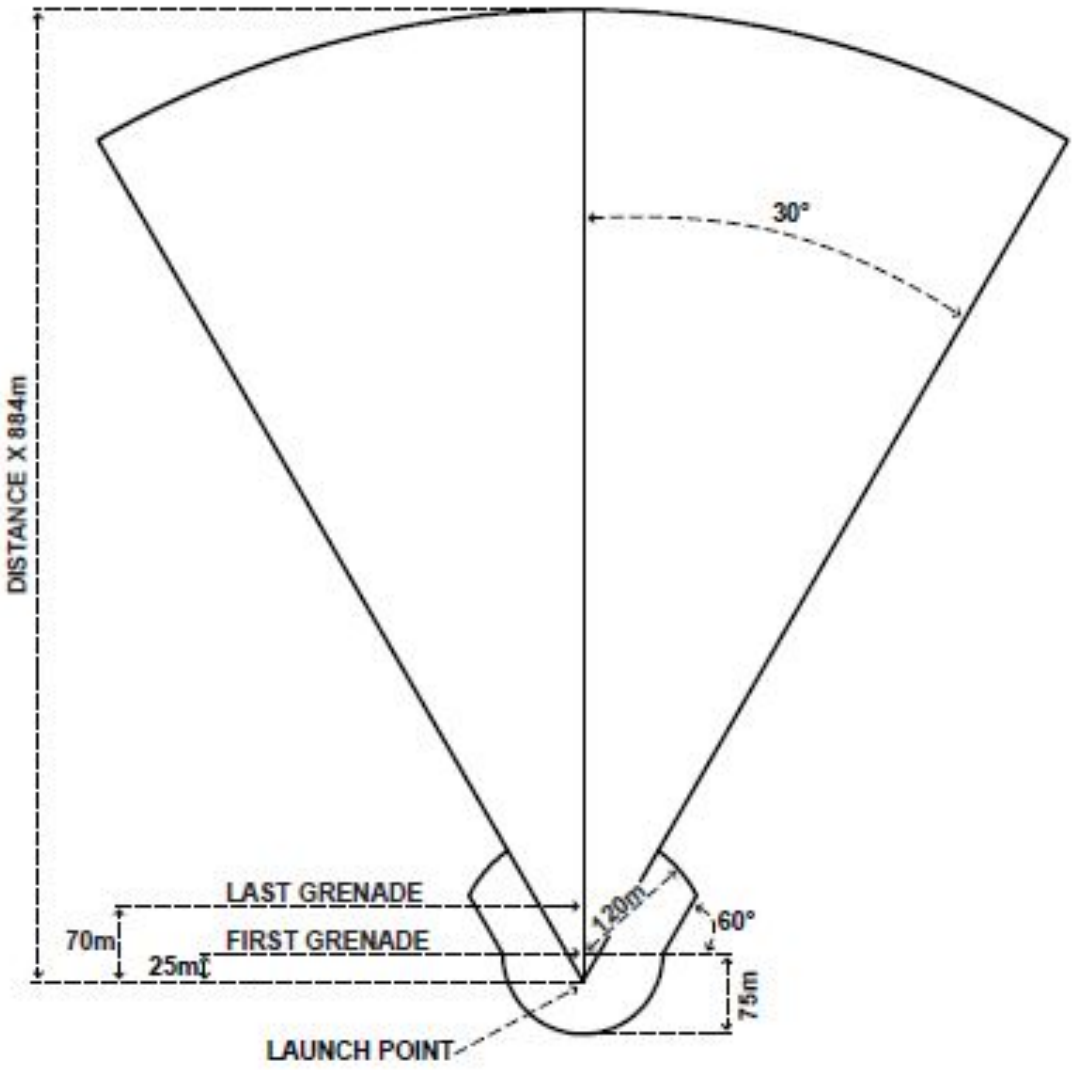

Figure 15–3. Surface danger zone for Anti-Personnel Obstacle Breaching System (APOBS)

15–6. Cratering charges

a. The maximum charge to be fired in training will not exceed 145 kg (320 lbs).

b. MSD for personnel not in missile-proof shelters will depend on the net explosive weight of explosive used. MSD for up to 2 kg (5 lbs) is 100m; for up to 30 kg (66 lbs) is 300m; over 30 kg (66 lbs) is 500m.

c. PPE Level 1 is required.

d. Missile-proof shelters, if strong enough to withstand any material propelled onto it by the detonation, located not less than 100m from the detonation site may be occupied by personnel.

e. All cratering charges will be dual primed with detonating cord. Blasting caps will not be placed underground. Electric or non-electric caps or MDI will be attached to the detonating cord above ground.

15–7. Mines

a. Practice and inert mines will be color coded in accordance with MIL–STD–709D and TM 9–1300–200, paragraph 8–6, and will have the appropriate identification marking stenciled on them. Service, practice, and inert mines and fuzes will not be mixed.

(1) Inert mines and mine fuzes do not present a safety hazard. They will be color-coded and marked in accordance with MIL STD–709D to prevent mixing with practice and HE mines.

(2) Practice mines and their fuzes contain a small, low explosive charge or a smoke producing increment. They will be color coded in accordance with MIL STD–709D.

b. Training with non-self destruct mines is prohibited.

c. Claymore antipersonnel mines will be operated under the following conditions:

(1) *Firing conditions.*

(a) Range OIC will ensure mines are installed correctly and facing into the impact area.

(b) All mines will be secured until the range OIC directs their issue.

(c) Emplaced mines will not be disarmed except by order of the range OIC.

(d) Firing devices will only be connected at the command of the range OIC.

(e) When more than one mine is to be fired, the range OIC will ensure that previous firings have not dislodged the other mines in the impact area.

(f) After firing, the impact area will be inspected to ensure that all mines have detonated.

(g) Misfires will be handled in accordance with TC 3–22.23.

(h) Personnel will not be allowed within 16m to the rear of the mine. Firing personnel may occupy an area between 16 and 100m to the rear of the mine if they are located in a covered position, lying prone in a depression, or behind a physical barrier. All personnel will wear approved protective helmets, body armor, eye protection, and single hearing protection. When the mine is tied to a tree or fired in an area that attenuates the secondary missile hazard, friendly troops within a 16m to 50m radius behind the mine must be in a covered position.

(2) *Surface danger zone.*

(a) SDZ requirements for firing the M18 and M18A1 Claymore mine are provided in figure 15–4.

(b) Vertical hazard for the claymore is 400m.

(c) Care must be exercised when installing mines to prevent the creation of secondary fragment and debris hazards.

(d) All personnel will wear PPE Level 1.

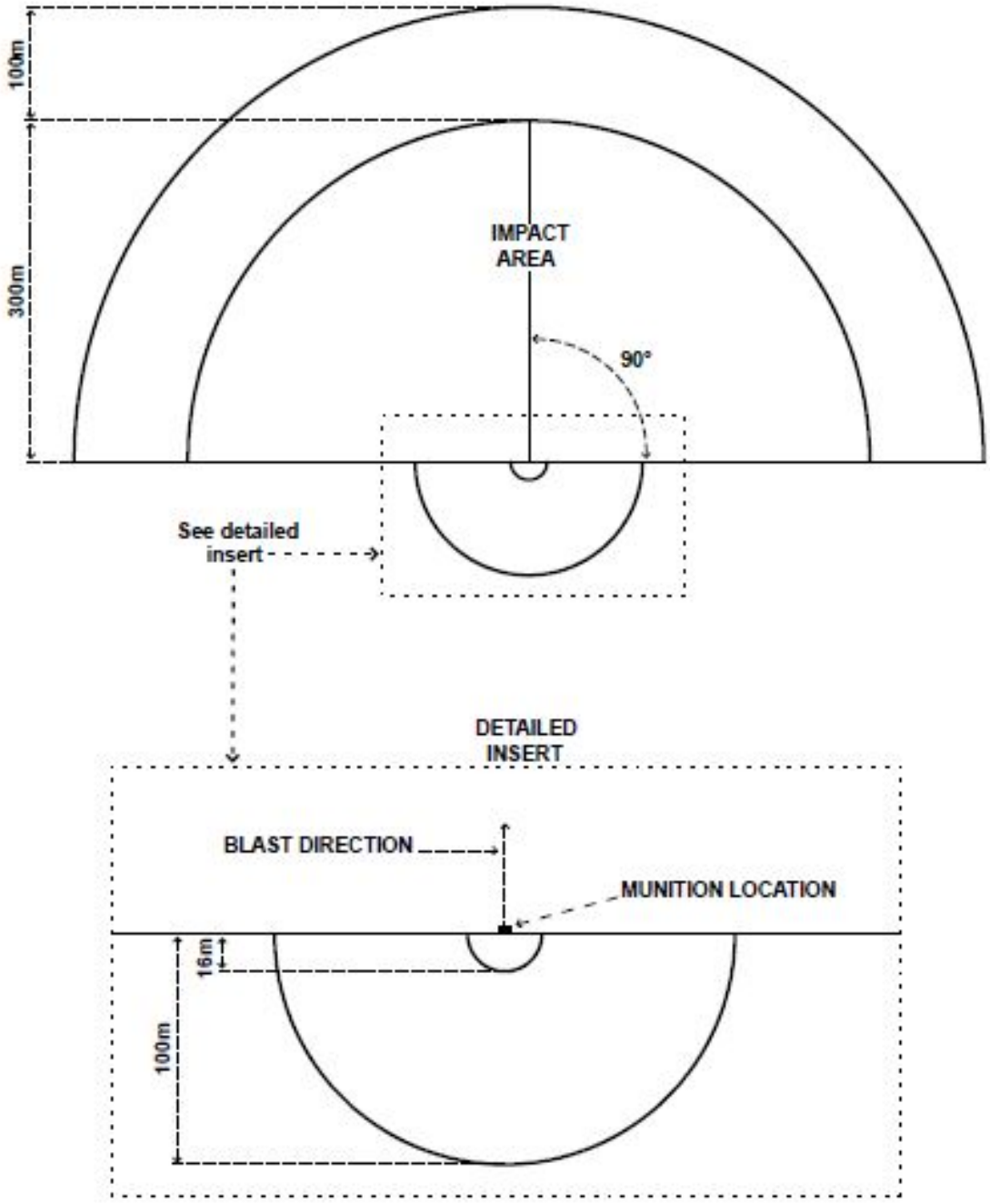

Figure 15–4. Surface danger zone for Claymore mines

d. The Volcano multiple delivery mine system is a rapid mine-dispensing system for launching antitank mines from various vehicles. The air system uses UH–60 Blackhawk helicopters. SDZ requirements for the air system are shown in figures 15–5 and 15–6. The SDZ for the air system is dependent upon aircraft speed, altitude, and the dispenser control setting. The ground system uses cargo or dump truck. SDZ requirements for the ground system are shown in figures 15–7 and 15–8.

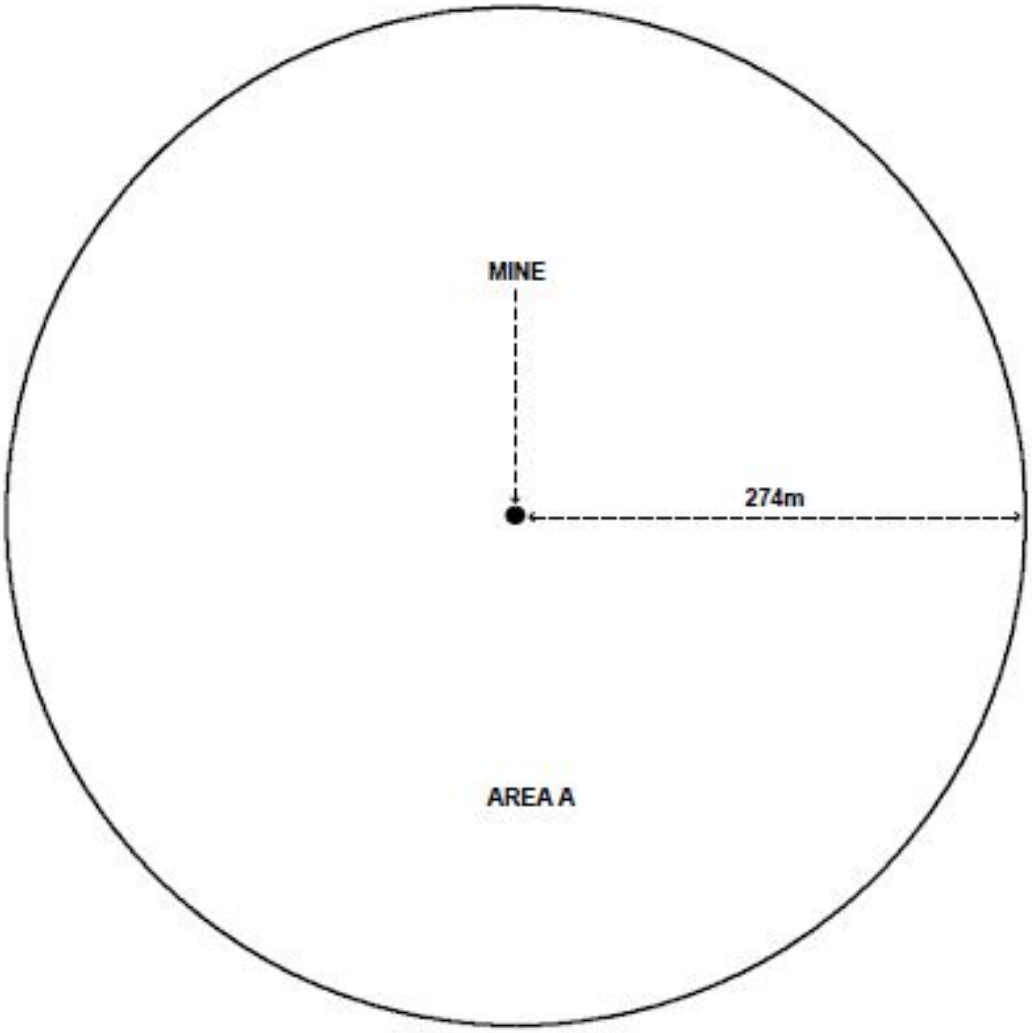

Figure 15–5. Surface danger zone for Air Volcano anti-personnel multiple delivery mine system

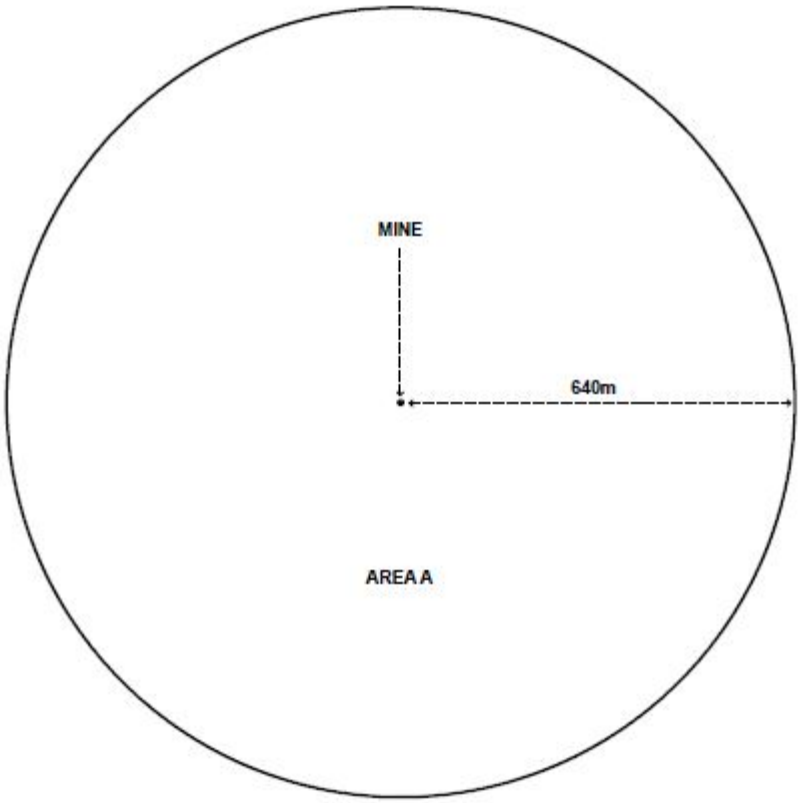

Figure 15–6. Surface danger zone for Air Volcano anti-tank multiple delivery mine system

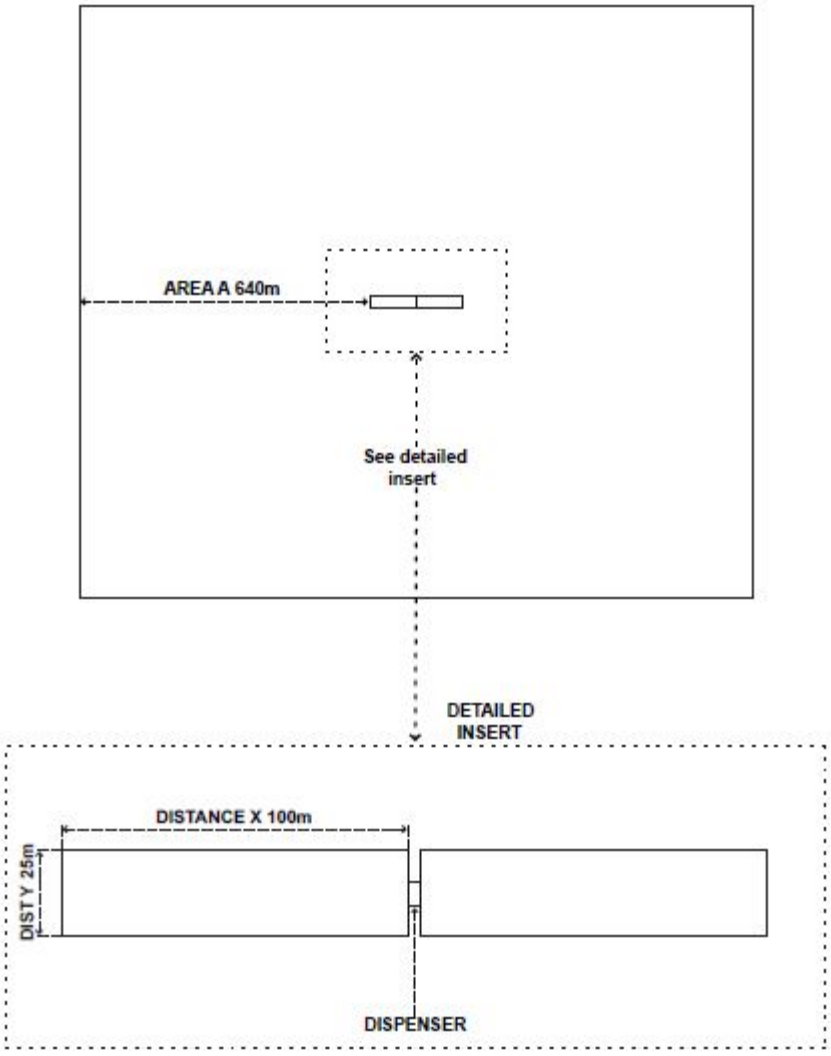

Figure 15–7. Surface danger zone for M87 and M87A1 ground volcano multiple delivery mine system

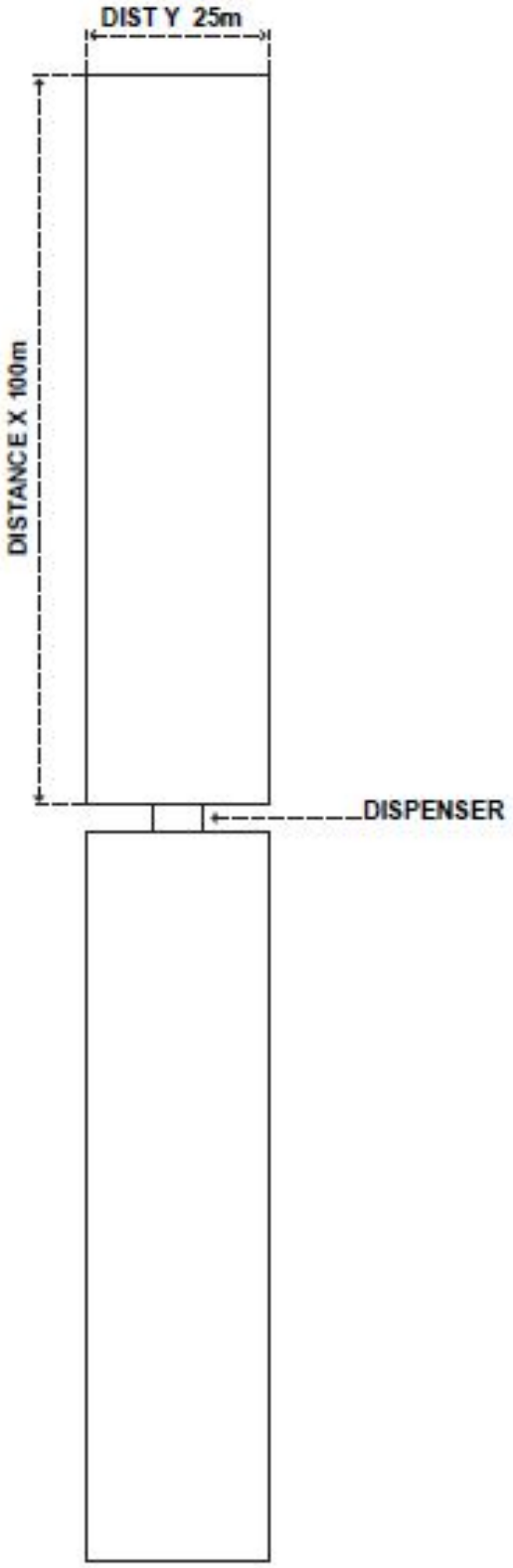

Figure 15–8. Surface danger zone for M88 ground volcano multiple delivery mine system

e. Spider XM7 Network Command Munition is a remote controlled anti-personnel munition system. It is composed of three main components:

(1) The Remote Control Unit is a handheld computer used to monitor and control the functioning of the Spider munition field.

(2) The Repeater is a relay device that is used, if necessary, to extend the downrange control of the Remote Control Unit.

(3) The Munition Control Unit can employ up to six Miniature Grenade Launchers (MGLs). Each MGL has a minimum safe distance of 138m.

(4) Instead of MGLs, the Munition Control Unit can employ up to six Munition Adapter Modules (MAMs). A MAM provides the interface to fire attached lethal and/or non-lethal munitions, (such as the M18 Claymore, the M5 MCCM, and MDI-initiated explosives to include the shock-tube initiation devices such as the M11, M12, M13, M21, and M23. The SDZ for the Spider XM7 using the MAM will depend on what types of peripheral device(s) (either lethal or non-lethal) are connected.

15–8. Firing devices

a. Instructions in TM 9–1375–213–12 will be followed when installing, arming, and disarming firing devices.

b. Firing devices and fuzes, either with or without the standard bases, will not be pointed at personnel.

c. Standard bases containing unfired percussion caps, firing devices, and fuzes will not be carried in the pocket.

d. Standard bases containing unfired percussion caps will be kept separated from firing devices and fuzes until the firing device or fuze is ready to be installed in the mine or booby trap.

e. Safety pins on firing devices and fuzes should be checked for ease of movement before attaching the standard base. The safety pins for locking and positive safeties should easily move.

f. Before removing the tripwire, the positive safety will be installed on armed firing devices or fuzes having a tripwire attached.

g. The assembly, arming, and disarming of antipersonnel mine fuze M605 will be in accordance with TM 9–1345–203–12.

15–9. M48 and M49 trip flares

a. Use inert flares to instruct students in the use, emplacement, and fuzing of service flares.

b. Safeguard trip flare to ensure training personnel do not in advertenly detonate devise closer than 2m of the emplaced flare.

c. Clear trip flare firing positions of flammable material to prevent accidental fires. Do not use the M48 trip flare in areas where fire could cause serious damage.

15–10. Simulators

a. M80 explosive simulators detonate 3 to 5 seconds after ignition of the fuse cord and are capable of causing serious injury. Fuse cord tips should not be split since this reduces burning time and increases the potential for injury to personnel. Do not use M1 and M2 type fuse igniters to ignite the M80 fuse cord or hold the M80 simulator when ignited.

b. Procedures for the safe use of other simulators are contained in TM 9–1370–206–10, TM 9–1370–207–10, and TM 9–1370–208–10. No attempt will be made to disarm or disassemble simulators.

c. See TM 9–1370–207–10 for the M142 atomic explosion simulator firing precautions.

d. Commercially manufactured fireworks (designated for civilian use) will not be handled, stored, or used in any way by military personnel on an installation.

e. When explosive charges (TNT blocks or composition C4) are used to simulate detonation of mines and incoming artillery projectiles, mortars, and bombs during exercises or on the infiltration course, the following procedures will be used:

(1) Charges will be fired in specially prepared detonation pits with the charge positioned in the center of the pit. See paragraph (8) for demolition pit requirements.

(2) Only charges of standard issue TNT blocks or composition C4 of one-quarter pound will be used. Composition C4 may be cut into 0.25-pound blocks in accordance with FM 3–34.214. TNT blocks will be cut in accordance with the instructions in the corresponding TM.

(3) Charges will be detonated electrically from a position that allows a clear view of the pit and the immediate vicinity. Follow safety precautions in paragraph 15–2, and tables 15–1 through 15–3 when using electric blasting caps and circuits.

(4) Blasting circuit wires leading to charges in the detonation pits will be buried, preferably in conduit, or otherwise secured to prevent personnel from becoming entangled in or tripping over the wires.

(5) Only one charge will be emplaced in a pit at a time.

(6) Pits will be inspected and cleared of objects prior to emplacing charges to remove potential hazardous missiles.

(7) Charges may only be detonated when crawling personnel are 3m or more from the center of the pit and erect personnel are 25m or more from the pit.

(8) Detonation pits will be constructed in the following manner:

(a) Pits will be excavated in the shape of a cone at least 1.5m in diameter by 0.6m deep. Excavated pits will be backfilled 0.3m with clean, clay-free sand that has passed through a #10 screen. Any object larger than sand grain size is considered a pebble. Pits will be free draining so that the sand filled area will quickly drain clear of water. Soil conditions may require that drains be constructed.

(b) A ring of sandbags or other suitable barrier material (for example, treated timbers) 0.6m high with an inside diameter of 2m will be constructed around each pit. Construct a barrier at least 1m outside of the sandbag rings that does not project above the top of the sandbags. These detonation pit barriers will be physically different from any other barrier which personnel are expected to negotiate and will be sufficient to keep personnel 1m away from the detonation pits.

(c) Dimensions given above for detonation pits and sandbag rings with barriers are minimum requirements and will not survive extensive use without frequent maintenance. Larger diameters and depths, as well as double-walled sandbag rings, are recommended for detonation pits used more than once a week.

(d) A dual electrical disconnect system will be used when charges are being placed in the pits. The main source of power will be turned off by the individual placing the charge in the pit. Once the power is turned off, a lockout device will be used.

f. Demolitions effects simulators (DES) charges are explosives which use detonating cord, blasting caps, a modern demolition initiator, cardboard, and sand or chalk to simulate other explosives. Extreme care must be exercised when using DES. DES is an explosive and all safety guidance contained in this pamphlet and FM 3–34.214 must be followed. All procedures and MSDs for the charge that is simulated must be followed. For example, a DES Bangalore torpedo would require the same MSDs and procedures for an actual Bangalore torpedo. All demolitions effects simulators must be marked as DES.

g. Improvised explosive device (IED) simulators provide visual and audible effects with minimal risk to participants. These devices can be remote-detonated or hard-wired for direct firing.

(1) The use of non-pyrotechnic IED simulators with pyrotechnics and/or explosives is not authorized.

(2) The use of flour or starch-based products in place of the recommended smoke simulation powders is not authorized. Flour and starch-based products can be flammable and the resulting plume of flour or starch-based product could ignite should an ignition source be present.

(3) Non-pyrotechnic IED simulators can produce extreme recoil reaction when initiated. Simulators must be secured using ground stakes and/or sandbags.

(4) Never attempt to alter non-pyrotechnic IED simulators or operate them with any altered, broken, or missing parts. The misuse of this equipment may cause serious injury or death.

(5) Remote initiators must be in the possession of the individual making the electrical or pneumatic connections. Initiators will not be connected to the non-pyrotechnic IED simulator until all safety requirements have been met.

(6) Hazard areas for IED simulators are contained in equipment instruction manuals and must be enforced at all times. Personnel within the hazard area of a non-pyrotechnic IED simulator will wear the following PPE: eye protection, single-hearing protection, and helmet.

(7) Do not place a non-pyrotechnic IED simulator in such a manner that it will be pointed at personnel when initiated.

(8) Should a non-pyrotechnic IED simulator fail to function, a wait time of 10 minutes is to be observed prior to approaching the simulator. Simulators are to be disarmed (disconnect the device from the initiator) and approached from the base end. Ensure discharge end is pointed downrange and that the device is secured to prevent movement.

(9) All setup, training, and disassembly involving live (armed) non-pyrotechnic IED simulators will be conducted outdoors.

(10)Non-pyrotechnic IED simulators will not be stored, carried, or transported live. They are not to be assembled until they are on site and being readied for immediate use.

(11)OICs, RSOs, and personnel using non-pyrotechnic IED simulators will receive training prior to receiving equipment and the use of it in training exercises. Only those personnel who complete the required training will be authorized to draw the equipment from issue sites.

(12)Strict accountability must be maintained of non-pyrotechnic IED simulators as they are functional and realistic in appearance.

(13)The compressed CO2 gas used to activate the cuing devices can cause serious injury or death if improperly handled. Follow safety instructions in equipment instruction manuals regarding the use of the CO2 gas and its containers.

h. Man-portable Aircraft Survivability Trainer Weapon Effect Signature Simulator (MAST WESS), XM176. The following must be observed for adequate protection of the various parts of the XM176:

(1) The SDZ for the XM176 is a circle with a radius of 10m from the WESS launcher. This distance will also provide the minimum 2m safe distance for UV exposure and the minimum 6m safe distance for IR exposure to the skin and eyes.

(2) Require everyone within 33 meters of the WESS launcher to wear single hearing protection.

15–11. Safety requirements for firing aerial pyrotechnics (Marine Corps only)

a. Personnel participating in exercises that include the firing of aerial pyrotechnics such as Smokey Sams or Smokey Guns will wear PPE Level 1 and other protective equipment required by SOPs.

b. Inspect Smokey Sam rockets prior to use and report all rockets that appear to have moisture damage. Damaged rockets will not be fired.

c. When firing these pyrotechnics, anyone may stop the firing sequence if it is not safe to fire, or if the dispensing aircraft is within 610m (2,000 ft) as prescribed in NAVAIR TM 11–75–63.

15–12. Training conducted in explosive entry techniques

a. Explosive entry techniques are used in operations where assault personnel require immediate access to the target. To train for this mission, individuals must be closer to the detonation than is authorized elsewhere in this chapter. Because of the unique character and requirements of this training, the following special safety guidelines are established to support this training.

(1) Minimum safe distance for personnel will be determined using the formula $D_{(ft)} = K \times W^{1/3}$ where D=minimum distance in feet, K=a constant (the K factor for explosive entry techniques is set at 18) and the $W^{1/3}$ =cube root of weight of the explosives in pounds. This is the limit at which the possibility of eardrum damage is less than 1 percent with single hearing protection. This minimum safe distance is related to blast overpressure and does not reflect fragmentation or debris damage. When a barrier or shielding (such as a blast blanket) is used during training, the minimum safe distance from overpressure will be calculated using a K factor of 12.

(2) Fragmentation standoff will equal the blast standoff when a protective barrier is provided between the explosive and the personnel. This barrier may be in the form of wood, cement, metal, or a ballistic blanket barrier. The barrier must be able to absorb all fragmentation.

(3) All personnel within the fragmentation distance of a detonation will wear PPE Level 2. Personnel conducting the detonation will also wear fire-resistant hoods, coveralls, and gloves. Clothing with short sleeves is not authorized when conducting this training.

b. For the Marine Corps, SDZs for ranges dedicated to the conduct of explosives entry techniques will be set and approved by CG, MCCDC (C465).

15–13. M2 and M4A1 Selectable Lightweight Attack Munition and the M3 Demolition Attack Munition

a. The M2 and M4A1 Selectable Lightweight Attack Munition (SLAM) and the M3 Demolition Attack Munition (DAM) is a multipurpose munition with anti-disturbance and anti-tamper features, designed to be readily portable and hand-emplaced against lightly armored targets. The primary lethal mechanism is an explosively formed penetrator (EFP). The hazardous fragment distance of the EFP is highly dependent on the orientation of the munition and line of fire.

b. The M2 self-neutralizes and the M4A1 self-destructs. Do not attempt to change the setting after the activation lever is pulled. Once the activation lever is pulled, the time/mode on the selector switch is entered into memory and cannot be changed. Physically moving the selector switch after the activation lever is pulled appears to change the setting, but the original setting will remain in the memory.

c. The M3 DAM has one mode of operation, which is by command detonation. The DAM contains explosive but has no battery, electronics, or associated parts including sheer pin activation lever, or passive sensor. Manual warhead initiation is provided using M6 or M7 blasting caps with M1A4 priming adapter.

d. All personnel within 240m (792 ft) of a detonating SLAM/DAM are required to wear single hearing protection.

e. SDZ for the M2 and M4A1 SLAM and M3 DAM is in figure 15–9. Vertical hazard distance for the EFP is 2,969m. Distance X is 236m, except in the direction of the EFP, in which case it is 3,911m 20 degrees on either

side of the anticipated line of travel of the EFP. Personnel outside that 40 degrees cone protected by 3 in of armor may be as close as 100m to the detonation point.

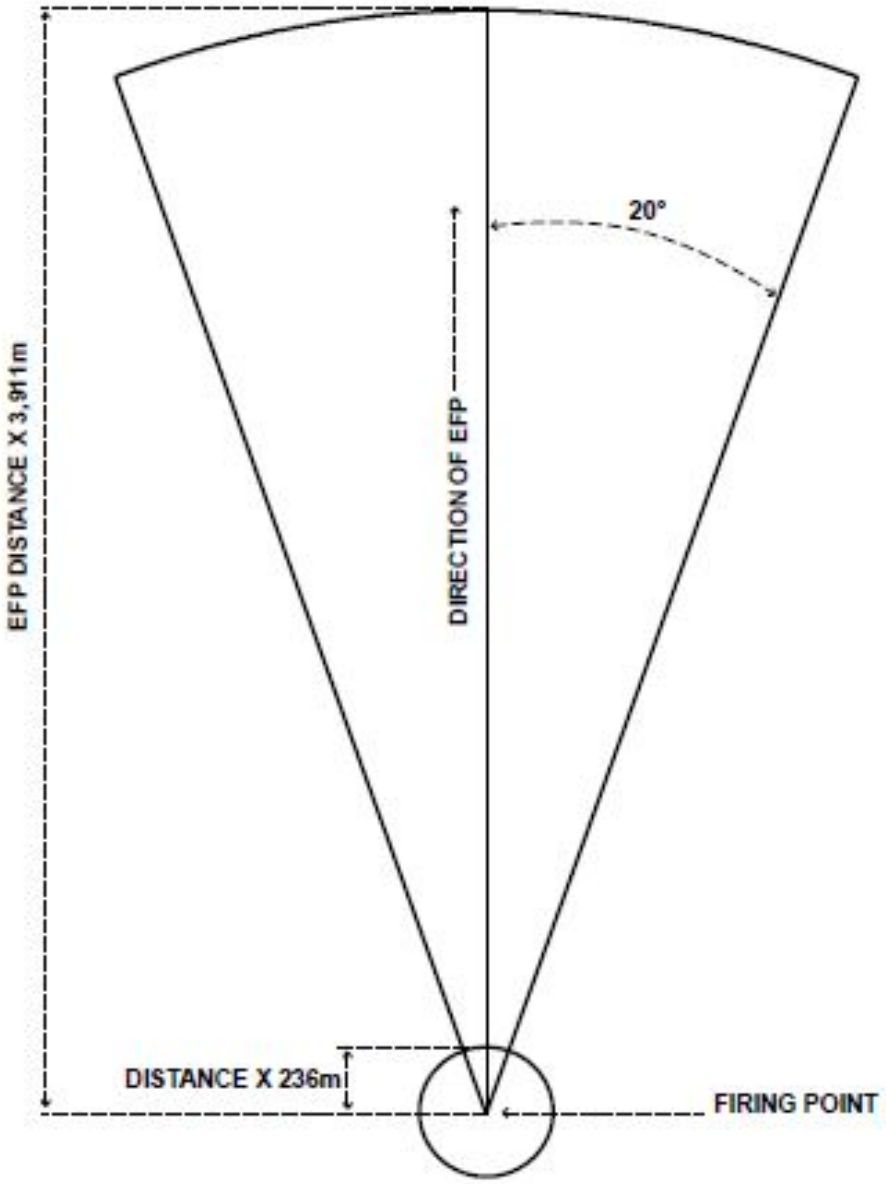

Figure 15–9. Surface danger zone for M2M4A1 Selectable Lightweight Attack Munition (SLAM) and M3 Demolition Attack Munition (DAM)

15–14. Rifle Launched Entry Munition and Grenade, Rifle Entry Munition

a. The Rifle Launched Entry Munition (RLEM)/Grenade Rifle Entry Munition (GREM) M100 is a lightweight, muzzle-launched, rifle grenade designed to break down a door and allow the entry into a building or enclosed area with minimum hazard to the operator. The RLEM/GREM is fired from the muzzle of a personal weapon (M16-series rifles and M4-series weapons). It has a bullet trap which allows the use of 5.56mm M855 ball and M856 tracer rounds. The RLEM/GREM is launched by firing a round to a distance of at least 15m. It has a standoff rod that provides optimal distance for initiation of the explosive charge. A disk on the end of the standoff rod prevents penetration of the rod into the target. The warhead has a plastic cover which eliminates the explosive splashing toward the gunner. The pyrotechnic adapter keeps the explosive away from the tail section, preventing flyback of the tail toward the gunner.

b. The GREM–Target Practice (GREM–TP) M101, is a reusable training device used to train personnel

for the GREM. The GREM–TP is externally similar in shape and form to the GREM, but it is nonexplosive. M195 grenade cartridges are used for firing because there is no bullet trap. Each GREM–TP comes with five standoff rods.

c. Tabular data is contained in table 15–7. The SDZ requirements for firing the M100 and M101 are provided in figure 15–10.

d. For personnel within 535m of device functioning PPE level 1 is required.

Table 15–7
Surface danger zone data for Rifle Launched Entry Munition (RLEM) and Grenade Rifle Entry Munition (GREM) (hard and soft targets)

Munition	Dist X (m)	Dist W (m)	Area A (m)	Area B (m)	Angle P (deg)
M100	135	25	90.4	90.4	33
M101	135	25	NR	NR	33

Table 15 legend:
NR=Not Required

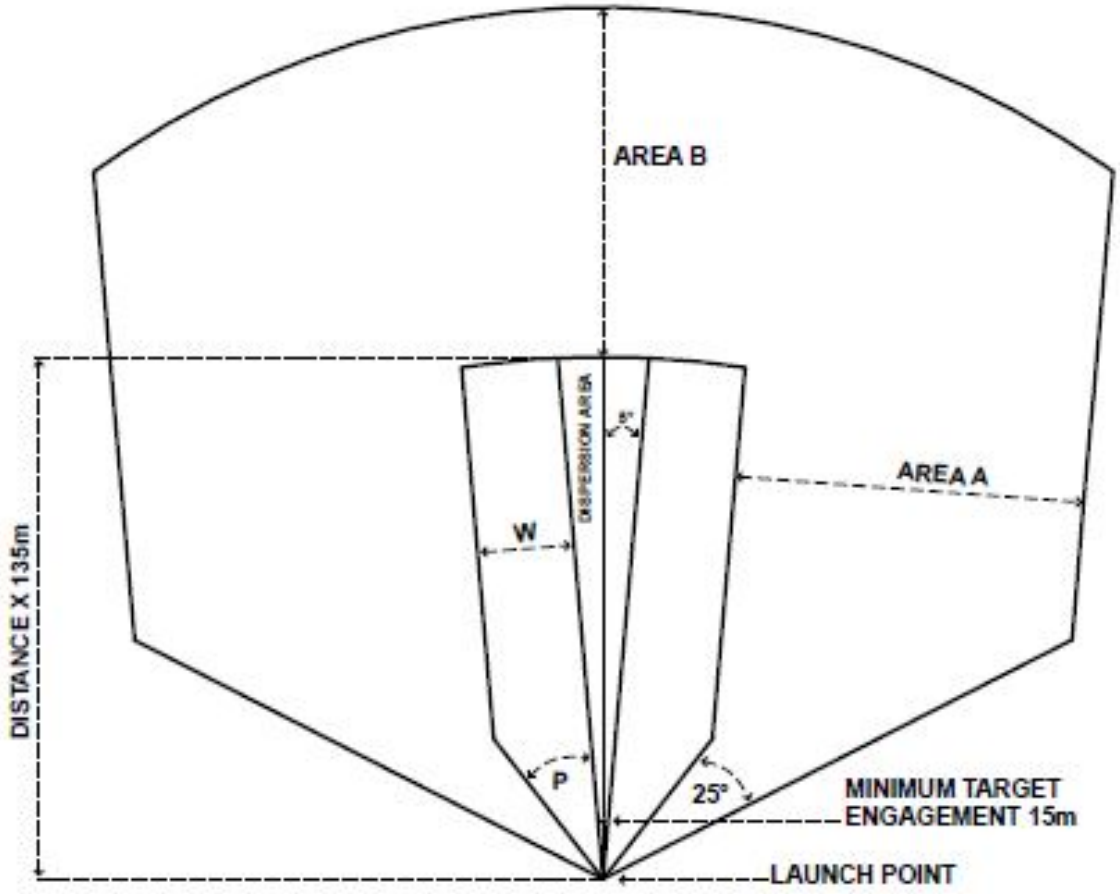

Figure 15–10. Surface danger zone for Rifle Launched Entry Munition (RLEM) and Grenade Rifle Entry Munition (GREM)

Chapter 16
Laser Range Safety

16–1. General

The fundamental concept of laser range safety is to prevent direct and collateral injury or damage resulting from laser use. Personnel using or supervising the use of lasers will be thoroughly familiar with all aspects of laser operations, systems employed, and associated dangers during training.

a. Safe use of military lasers and laser systems. This chapter provides guidance for the safe use of military lasers and laser systems on military ranges as listed in MIL–HDBK–828C and JP 3–09.

b. Safe treatment of lasers. Lasers will be treated as direct-fire weapons.

c. Laser systems. Laser systems will be directed only at approved targets and from approved operating positions/ areas or on designated headings and altitudes.

d. Laser usage. Unfiltered Class 3B or 4 lasers will be used only on certified laser ranges approved for laser usage in accordance with paragraph 16–3. These lasers will be operated only in restricted airspace.

e. Nominal ocular hazard distance. The nominal ocular hazard distance (NOHD) is the distance from an operating laser to the point where the laser is no longer an eye hazard [for example, the irradiance or radiant exposure during operation is not expected to exceed the appropriate maximum permissible exposure (MPE) level].

f. Unprotected personnel. Unprotected personnel must not be exposed to laser radiation within the NOHD of the laser system.

g. Protected personnel. Personnel within the LSDZ will wear laser eye protection during laser operations. Eyewear must be appropriate for the wavelength and corresponding optical density required of the laser system in use. Skin protection should be worn when appropriate.

h. Aided viewing. Aided viewing involves the use of optical devices including binoculars, scopes, rangefinders, and so forth. The magnification of laser energy can significantly increase the NOHD of the laser. The use of magnifying optical devices to observe the target during laser operation is permitted if specular surfaces have been removed from the LSDZ, appropriate laser filters are used, or it is being viewed beyond the NOHD-magnified. Optical devices not marked with the level of protection at the laser wavelength should be assumed to offer no protection unless verified. Personnel should not deliberately view direct laser radiation with magnifying optical instruments within NOHD-magnified unless the optical devices have the appropriate filtration to limit the exposure to below the MPE level.

i. Optical interrupt laser systems. Optical interrupt (OI) laser systems use intense light to cause visual field obscuration in targeted individuals. OIs are intended to be primarily a warning device, with an inherent and secondary capability to achieve ocular suppression effects as the situation dictates. The OI device should meet stringent safety criteria and be able to deliver a warning effect to targeted personnel by obscuring their vision. The devices currently in use may be Class 3R or greater laser systems that can be safely employed for training. However, due to the intensity of the laser beam, it can pose an eye hazard within the NOHD if incorrectly employed. If exposure distances are known and briefed prior to use which are equal to or less than the NOHD of the system, the OI laser system must be terminated.

j. Backstops. Backstops, natural or manmade, are features downrange from the target which terminate the beam, thus limiting the hazard distance. The optimal use of backstops is key to minimizing laser hazards.

k. Buffer zones. The buffer zone is a conical volume starting at the laser exit port and extending to the backstop or NOHD, expanding over this distance as defined by the divergence of the laser plus buffer angle. The buffer angle depends on the aiming accuracy and stability of the laser device and is usually greater than the divergence. The laser horizontal buffer zone could be partially or completely included in the danger zones of other weapons used on ranges.

l. Laser surface danger zone designation. The LSDZ is the designated region or ground area where laser radiation levels may exceed MPE levels, thereby requiring control during laser operation. When used in conjunction with live-fire weapons, the LSDZ might be more elongated than the SDZ/WDZ if not terminated by an adequate backstop. LSDZs can be generated, either manually or by using the RMTK Laser Range Management Tool (LRMT), to support training plans, map data, information requests, and so forth. This effort includes inputting the laser system and range data (for example, firing points and targets) and performing analysis to mitigate risk to ensure the laser training can be safely conducted on a given operational training range. For the Marine Corps, when using a laser in conjunction with a live fire weapon, if the LSDZ fits within the parameters of the SDZ of the weapon/munition being fired then a separate LSDZ is not required. However, the range being used must be assessed for specular reflectors.

m. Hazardous laser output. Unless otherwise specifically authorized, when lasers are not in use, hazardous laser output should be prevented by removing batteries, installing such devices as output covers, or rotating the

laser into the stowed position.

n. Laser exit port. The laser exit port must be covered or stowed and the device turned off when not engaged in training. Non-laser operations such as viewing through common optics can be conducted in a non-laser controlled area with the laser exit port cover removed if the laser is turned off.

o. Laser systems modes. When laser systems have both training and combat operating modes, the combat mode will be employed only if safely contained in the laser training range's controlled area. SOPs will enforce this measure.

p. Force-on-force operations. Force-on-force laser operations involve combat simulation, target acquisition, illumination and/or pointing, target designation, weapons guidance, or range-finding against friendly and/or opposing forces. Force-on-force laser tactical exercises are approved on a case-by-case basis, dependent on the scheme of maneuver and risk analysis submitted by the using unit. Tactical exercises involving force-on-force units using laser systems other than the Multiple Integrated Laser Engagement System may require approval by the senior commander (Army)/ installation commander (Marine Corps). Only Service-approved laser devices are used in force-on-force tactical exercises. Risk management procedures are completed in accordance with ATP 5–19, MCRP 5–12D, and MCO 3500.27B.

16–2. Procedural guidance

The policies and responsibilities for laser usage on ranges and training areas are defined in AR 385–63/MCO 3570.1C. Provided is procedural guidance on how to fulfill those policies and responsibilities.

a. Specific institutional guidance for laser range safety. The institutional laser range authority provides guidance to installations via Service-specific regulations. The institutional laser range authority maintains publications relating to laser use on ranges and establishes or recommends the requirements for training programs. They ensure certification of ranges for laser use in accordance with paragraph 16–3 of this pamphlet.

(1) *Army.* The CG, U.S. Army Public Health Center Nonionizing Radiation Program (MCHB–IP–ONR) provides laser range specific technical expertise to TCM Ranges on laser hazards to personnel operating lasers. The U.S. Army Public Health Center expertise includes evaluation of laser systems and recommendations on policies and procedures to limit exposure to lasers on ranges. A non-ionizing radiation protection study by the U.S. Army Public Health Center and a safety confirmation by the Developmental Test Command of the U.S. Army Test and Evaluation Command should be performed on the laser system prior to use on laser ranges. Non-fielded lasers systems or laser systems not in their original configuration (such as, a laser was fielded for use in a helicopter and now is planned to be mounted on a vehicle), the organization using the laser must obtain a safety release from Developmental Test Command prior to use on the laser ranges.

(2) *Marine Corps.* The CG, MCCDC (C465) is responsible for Marine Corps range safety, of which laser safety is one component. CG, MCCDC (C465) serves as the proponent for all matters pertaining to the oversight and coordination of laser ranges with Marine Corps ranges and training areas. Additionally, CG MCCDC (C465) has overall authority for all Marine Corps laser range management issues in coordination with installations and other Services for laser range requirements.

b. Specific installation guidance for laser range safety. For the Army, the senior/installation commander has the authority to implement policies and procedures for safe laser operations in accordance with technical information provided in MIL–HDBK–828C series and other regulatory guidance. For the Army and Marine Corps, the senior/ installation commander normally assigns responsibilities for the following laser range safety procedures to the RMA (Army), RCO (Marine Corps):

(1) Develop SOPs pertaining to laser range safety that include proper controls of hazardous laser radiation. SOPs should include details on laser radiation and other laser related hazards such as releasing guided ordnance that may unintentionally acquire radiation sources within the field of detection other than the target, or lasing an unapproved target. Update SOPs as necessary to account for new laser systems, training areas, and targets.

(2) Review the laser range certification process and range SOP annually or when changes are made.

(3) Use the Range Facility Management Support System to record date, start and stop time for lasing periods, and type of laser or other appropriate information for each laser operation (such as, laser firing log).

(4) Review unit laser training/use plans as part of the range approval process to identify potential deficiencies in the training plan and monitor compliance with safety policies and procedures. Guidelines for unit laser training/use plans are included in this chapter. The installation should ensure the following guidelines have been incorporated into the unit training/use plan.

(a) Laser systems are approved and appropriate for the designated range.

(b) Limits of the LSDZ are properly identified and are contained within the certified laser range area.

(c) Ground personnel locations requiring PPE are identified.

(d) Access to hazardous areas for unprotected personnel is limited.

(e) Targets, laser firing area/line/points, orbit points, and laser-to-target orientation are verified to ensure they can be supported by the laser system and the range.

(f) PPE requirements are verified to ensure they are appropriate for the wavelength and optical density requirements of the laser and weapon systems being used.

(g) Training mode/filter requirements are evaluated and implemented if necessary.

(h) Signs warning of potential laser hazards are at the access points to the laser range.

(i) Emergency response procedures are identified and up to date.

(5) Provide laser briefings and indoctrination on laser operations and testing, to the affected public. The information in the briefing will be at the user level (that is, complex scientific data or terminology will be avoided).

(6) Laser range incident investigations will include:

(a) Review incident in accordance with local SOP and training plan.

(b) Request technical advice on laser capabilities and laser hazard effects.

(c) Gather information about the incident.

(d) Prepare and submit data for the investigation report.

(e) Request unit perform a proper investigation which includes notification of the particular unit's change of command and, for the Marine Corps, the institutional laser range authority.

c. Specific unit level guidance on laser range safety.

(1) Implement the policies and procedures set forth by the installation to ensure safe use of lasers.

(2) Prepare and submit laser training plans for approval to perform laser activities on a specific laser range or training area. A unit laser training plan should include the following factors:

(a) Determine laser operations in support of training requirements.

(b) Review training to be accomplished against local SOPs.

(c) Coordinate to select a range whose laser range certification supports the laser system(s) to be used and training exercise to be accomplished.

(d) Review laser modes/tactics to be employed to ensure they support the laser system and range.

(e) Identify targets, laser firing area/line/points, laser-to-target orientation, and orbit points that can be supported by the LSDZ. The laser must be terminated or the NOHD fully contained within the controlled area of the range.

(f) Identify ground personnel locations.

(g) Identify range hazard concerns (such as, conflicts, impact areas, and clearing requirements).

(h) Employ risk management in order to identify administrative controls to be implemented by the units.

(i) Identify PPE requirements.

(j) Identify communications requirements.

(k) Review the installation SOP to be aware of local emergency response procedures and laser injury response protocol.

(3) Intentional lasing above the horizon where the NOHD of the laser exceeds restricted airspace or the installation boundary requires coordination with the Laser Clearinghouse at Kirtland AFB and the FAA. It also requires, as part of the event planning, measures to ensure aircraft are not lased.

(4) Range laser safety inspection prior to use. The unit shall conduct laser safety inspections of the range and its operations prior to use and will confirm the following areas, at a minimum, are covered:

(a) Laser warning signs are posted.

(b) Range configuration is acceptable (targets/backstop, range boundaries, laser firing area/line/points).

(c) LSDZ is clear of specular reflectors (this can be conducted via range sweep in accordance with local SOPs).

(d) Laser range or training area is clear of non-participating personnel and equipment (this can be conducted via range sweep in accordance with local SOPs).

(e) Participating personnel in the area are aware of lasing activities and using appropriate PPE.

(f) Laser systems are authorized per the training plan.

(g) Training filters/modes are used, as applicable.

(h) Communication and terminology are agreed upon with range operations (Army), range control (Marine Corps).

(i) Correct any discrepancies prior to training.

(5) Safety brief/pre-mission brief. The range OIC or laser RSO provides safety briefs/pre-mission briefs to laser range users and observers prior to laser operations. At a minimum, the brief should include as appropriate —

(a) Laser systems to be used and their purpose (for example, range finding, target acquisition/pointing, designating, or sensor disruption).

(b) Control measures specific to the lasers employed and the range upon which they are used.

(c) Authorized tactics, laser firing positions (ground and air), laser-to-target orientation, weapons release points, and weapon performance.

(d) Drawings, photographs, descriptions or grid points of authorized targets.

(e) Communication procedures that include specific frequencies (or channels), controlling authorities, and standardized terminology.

(f) Acquisition, identification, and tracking procedures for targets.

(g) Missile/ordnance mode of operation.

(h) Requirements for beam termination and means to accomplish it.

(i) Control measures to minimize the risk of unauthorized personnel, vehicles, or aircraft entering the range area.

(j) Run-in headings and flight profiles to be used for airborne laser operations or permissible LSDZ for ground- based laser operations.

(k) Review of mission profiles to prevent misdirection of laser guided weapons.

(l) Type of eye protection to be worn and description of proper use.

(m) Potential hazards posed by the laser system (for example, backscatter, ignition of flammables, sensor disruption, or misdirection of laser guided weapons) and any other associated non-laser hazards.

(n) Risk considerations for location of personnel within the SDZ/WDZ for observing/lasing the target area to weapons impact.

(o) A review of applicable range SOP information.

(6) Guidance prior to laser operations. The OIC and laser RSO also perform the following functions in advance of laser operations:

(a) Review and approve laser systems and targets.

(b) Use only approved lasers on the range.

(c) Laser systems are used only at the approved operating position or firing points and always pointed toward the target; verify laser firing area/line/points and laser-to-target orientation.

(d) Laser systems engage only authorized targets.

(e) Target is positively identified in accordance with appropriate safety procedures before operation of a laser system.

(f) Ensure all non-participating personnel in the immediate area of the laser firing position are outside the LSDZ.

(g) Target area is clear of all non-participating personnel.

(h) Supervise pre-fire checks. Pre-fire checks that require operation of the laser system may be made in a controlled area with the laser beam terminated by an approved backstop. Pre-fire checks that do not require operation of the laser, but require use of the optics, may be safely made in any area. To use the optics without firing the laser, follow SOP to ensure power to the laser is turned off.

(7) General guidance during laser operations includes the following:

(a) Communications are maintained between the laser system operators, the range operations firing desk (Army), range control (Marine Corps), and all affected range personnel.

(b) Personnel follow safety procedures in accordance with local SOP.

(c) Training filters/modes are used, as required.

(d) PPE is used, as required.

(e) Approved training plan is followed.

(f) Coordinate emergency response, as necessary.

(8) Cease fire operations. If unsafe conditions are observed laser operations must be stopped. All/any personnel have the responsibility to call a “CEASE FIRE” when appropriate. The following are reasons to cease laser operations:

(a) Any specular reflection is detected in the target area.

(b) Poor target tracking is observed.

(c) Non-participating personnel and/or traffic enter the laser range or training area.

(d) Loss of communication with the range operations firing desk (Army), range control (Marine Corps).

(9) Guidance after laser operation includes the following:

(a) Laser will be powered down by removing batteries, installing output covers, or rotating the laser into its stowed position.

(b) PPE will be stowed IAW local SOP.

(10)Procedures for laser incident investigations include the following actions:

(a) Ensure laser system involved in the incident is quarantined.

(b) Report the incident to the installation laser range authority in accordance with the local SOP and in accordance with paragraph 16–6.

(c) Provide information on training activity/exercise, as necessary.

(d) Provide information on what happened, where, when, and how.

(e) Provide information on personnel who may have been exposed to a laser hazard.

(f) Provide the essential parts of the pre-operational briefing.

16–3. Laser range certification

The certification process is the approval of a range or training area for laser usage.

a. Army. The Army does not certify, per se, ranges for laser use. For the purpose of this chapter, the term certification means the approval of a training event where lasers will be employed. This certification/approval is delegated to the installation as a normal part of approving training events on the range complex. The training request, along with the pertinent unit training plan and risk mitigation plan, will be evaluated in accordance with the principles contained in this chapter and MIL–HDBK–828C. The RMTK LRMT may be used in this process. Questions regarding laser safety in the range complex should be directed to TCM Ranges.

b. Marine Corps.

(1) Certification of Marine Corps laser ranges will be accomplished by a range laser safety specialist or an approved Marine Corps laser range certifier in coordination with CG, MCCDC (C465). Laser ranges will be certified using guidelines contained in MIL–HDBK–828C, MCO 3550.9, and in conjunction with the RMTK LRMT. The certification data will be held on file at the installation range control office and CG, MCCDC (C465) for future reference. Questions regarding laser safety or certification should be directed to the institutional laser range authority.

(2) The installation RCO will assist the institutional laser range authority in performing range certification for the safe use of lasers.

16–4. Laser range design

During the design phase of ranges upon which lasers will be used, the following procedures will be performed in order to ensure safe laser use. For the Army, this is done during site selection by the installation as a preliminary part of the laser range certification process. For the Marine Corps, the institutional laser range authority may be asked to provide input to the design of the range with regard to technical requirements.

a. Conduct site analysis to determine range design requirements.

b. Determine whether an existing range can be modified or a new range must be established to meet the training requirements.

c. Perform risk analysis.

d. Provide technical guidance on range design to support safety, mission, and environmental requirements.

e. Request technical guidance on construction requirements from the appropriate installation agency.

f. Consult the institutional range authority.

16–5. Other safety considerations

a. Laser-guided munitions and other laser detectors may unintentionally acquire radiation sources within the field of detection other than the target. Fields of detection vary and are specific to individual weapons and detectors or sensors. Training will be planned to ensure that the angle between the laser designator line of sight and laser detectors (such as laser-guided munitions or laser-spot trackers) will not allow the munitions to impact on the laser source or scattered radiation from the laser platform.

b. Extreme caution will be taken when using a target designating laser in conjunction with ordnance delivery aircraft. The potential exists for the laser seeker of the munition to lock onto the designator or its radiated energy (beam or reflected beam) instead of the target. The following procedures will be followed to reduce this risk.

(1) The pilot of the attacking aircraft will confirm the location of the designator and the target before

releasing munitions.

(2) Approach paths will be designated and briefed to both the designating and forward air controller personnel and the aircrews prior to conducting the mission. Aircraft approach paths will be planned to preclude crossing laser designator beams with the laser seeker. The laser seeker should intersect the designator beam well forward of the laser firing point, angling toward the target.

(3) Only participating personnel will be within the danger zone of the weapon employed. Additionally, only participating personnel will be located at the designator or close to a direct or reflected beam of the laser designator during operations.

(4) Munitions will not be launched or released toward the laser designator. See applicable TMs, FMs,/TCs current MIL–HDBK–828C, and doctrinal publications for recommended employment procedures.

c. NVDs can detect laser energy but they will not be used for laser eye protection. These devices are not "cover-all" goggles; laser energy may enter the eye from offset angles where protection is not afforded. The damage threshold for NVDs may be as low or lower than the damage threshold for the human eye. These devices can be bloomed (white out), damaged, or destroyed from exposure to laser radiation thus creating ancillary safety hazards.

16–6. Laser accident/incident reporting

Report all suspected laser accidents/incidents, regardless of injury, in accordance with AR 385–10, DA Pam 385–24, DA Pam 385–40, TB MED 524, MCO 5104.1C, BUMEDINST 6470.23, and AFI 48–139. The expeditious examination and treatment of laser eye injuries are critical in minimizing loss of visual acuity. Expeditious medical guidance is available through the Tri-Service Laser Injury Hotline at 1–800–473–3549 or 937–938–3764, DSN (312) 798–3764, or esoh.service.center@us.af.mil.

Chapter 17
Live-Fire Exercises

17–1. Safety during live-fire exercises

a. Live-fire phases of training exercises are conducted with maximum realism and safety. If safety or terrain limitations do require some unrealistic actions to be taken, personnel should be briefed, in detail, on why artificial actions are required and what the unit would do if confronted with a similar situation in combat.

b. CALFEX (Army)/CAX (Marine Corps) involve the participation of two or more combat arms and/or DOD services. Air and ground weapons shall be used in accordance with current doctrine unless specifically prohibited from use by this pamphlet. Because of the dangers and complexities associated with CALFEXs/CAXs, commanders will thoroughly review training scenarios (scheme of maneuver and fire support) and ensure close coordination among participants. Commanders will apply risk management to all aspects of the CALFEX/CAX.

17–2. Information for commanders

a. Training to permit highly realistic maneuvers and live-fire exercises involves specific personnel safety requirements. Senior commanders (Army)/installation commanders (Marine Corps) will publish specific range guidance (for example, range regulations, SOPs, and so forth) that applies specifically to their installations. This guidance will define safety requirements to support live-fire training exercises. Directives developed for a particular location are not authorized for use at a different location.

b. Commanders whose units participate in live-fire exercises will —

(1) Make certain that all individual gunners who will take part in live-fire exercises, including fighting vehicle, tank, and aviation gunners, have fired and passed a qualification course for the weapon or system they will fire in the exercise.

(2) Conduct day and/or night rehearsal (dry run) exercises prior to the live-fire and maneuver exercise. The commander will assess the proficiency and experience level of their unit and the degree of risk involved to determine the scope and duration of the rehearsal and if it should be executed on the same range on which the live-fire and maneuver training will be conducted. The rehearsal should be scheduled as close to the actual event as is feasible to retain individual situational awareness and skills. Additionally, whenever feasible, rehearsals should replicate as closely as possible the conditions involved in the actual event. Rehearsals will be conducted based on the Scheme of Maneuver (SOM) that has been submitted and approved by Range Control. In the event that the SOM changes during the conduct of the live fire and maneuver/movement, Range Control will be notified and additional rehearsals will be conducted based on those changes. All personnel that will be participating in the exercise, to include range safety personnel (i.e. ARSOs), will be part of the rehearsal. In addition, rehearsals will include a review of range safety requirements for the live-fire and maneuver range. The review should include, but is not limited to, lateral limits, danger zones for weapons and AE used, air limitations and restrictions, both for live-fire and medical evacuation, and emergency and/or casualty evacuation procedures. For the Army, the CG, U.S. Army Special Operations Command, may approve deviation from this requirement for Army Special Operations Forces.

(3) Orient participants on the capabilities of the weapons used by other components in the CALFEX/CAX.

(4) Designate individuals (such as observer-controllers) who are not part of the tactical or administrative scheme to monitor safety. These individuals will maintain visual contact with maneuvering elements and should have some means of signaling a cease-fire. Communications with the tactical operations center is mandatory.

c. For battalion/squadron or larger exercises, a field grade commissioned officer will be appointed as the exercise OIC.

d. For the Marine Corps, the commander will assess the proficiency and experience level of their unit in determining the quantity of observers-controllers (that is, ARSOs) required for the event. Other factors influencing this decision should include, but are not limited to, the scheme of maneuver, geometry of the attack, composition of forces, dispersion of forces, visibility, weather conditions, and fatigue. Marine Corps observers-controllers report to the exercise RSO and will have training in local range safety procedures and SDZ employment.

17–3. Exercise planning

a. Units will conduct live-fire exercises in support of properly identified and trained-to-standards mission essential task list (METL) tasks. Tactics, techniques, and procedures employed during the live-fire exercises must be consistent with the standards published in the applicable Army Training and Leader Development Strategy mission training plan and/or battle drills. Command approval from the next higher command is required for any live-fire exercise not consistent with the unit's established METL.

b. Detailed written plans will be developed between the RMA (Army), RCO (Marine Corps) and the exercise OIC. It will require submission of formal risk management documentation prior to execution. For the Army, if residual risk is extremely high, approval is required by the ACOM/ASCC/DRU commander or designated official in accordance with risk decision authority (DA Pam 385–30). The garrison safety manager will review the completed plan and risk management documentation that will include:

(1) A detailed plan of maneuver and fire support.

(2) A list of weapons, AE (for example, ammunition, pyrotechnics, or smokes), and chemicals to be used.

(3) When planning live fire and maneuver/movement training, marking targets and personnel with 'like' devices (i.e. chemlights) is not authorized. This includes splattering a target with the liquid from a broken chemlight.

(4) Targets and personnel can be marked but not with same type devices and need to be preplanned. Marking either targets **or** safety personnel is authorized and must be identified in the Scheme of Maneuver and Risk Management matrix and briefed to all personnel participating in that exercise during the range safety brief.

(5) Unit control measures, including means of communication.

(6) Terrain feature and facilities required.

(7) Emergency action plans. Include, as appropriate, the need for emergency equipment such as litters or fire extinguishers, prepositioning of emergency responders, and coordination with medical treatment facilities.

c. Impact distance and limits of advance are as follows:

(1) The distances to which unprotected troops can safely move near the impact are (that is, Areas A, B and C) indicated in the chapter on each weapon or weapons system.

(2) To determine how close unprotected troops may maneuver to the target area, an impact area and a danger zone must be established for each target area used. Danger zones must be computed and issued to leaders and safety personnel before starting the exercise. When several types of weapons are being fired into one target area, the combined total danger zone (composite danger zone) will govern. These restrictions normally should not preclude unit commanders from selecting tactically sound supporting weapon positions for their scheme of maneuver, provided the positions and directions of fire do not exceed the total range area available for the exercise. When feasible, leaders and safety personnel will be shown the physical limits of the danger zone by ground survey.

(3) The short limit of the impact area may be moved in the direction of the target area by definite pre-arrangement to permit forward movement of troops.

(4) Demolitions may be used during live-fire exercises according to chapter 15.

(5) Selection of weapon positions will be the responsibility of unit leaders taking part in the exercise.

(6) Terrain will be used to enhance safety features when it is being selected for live-fire exercises involving overhead and/or flanking fire.

d. During live-fire exercises planning, the risk management process must address possible hazards from friendly fire and control measures to reduce or eliminate them, while executing the METL task to published standards.

e. A review of lessons learned may provide beneficial information to identify and mitigate risks (for example, U.S. Army Combat Readiness/Safety Center Web site, Army Lessons Learned Web site).

17–4. Firing precautions

a. Overhead fire of personnel may be authorized, provided they have positive protection from the munitions being fired. Protected positions for personnel and vehicles are discussed in ATP 3–37.34/Marine Corps Warfighting Publication (MCWP) 3-17.6.

b. The senior commander (Army)/installation commander (Marine Corps) (or designated representative) can authorize overhead fire above unprotected personnel except for specifically prohibited weapon systems, following the provisions of this section.

c. Weapons specifically authorized for overhead fire of unprotected personnel are:

(1) All artillery cannon firing indirect fire. See chapter 10 for safety precautions.

(2) Machine-guns (5.56mm, 7.62mm, and .50 caliber) on ground tripods or vehicle mounts (ring mounts excluded) firing from a stationary position.

d. Only ammunition certified for overhead fire will be used.

e. All firing of direct-fire weapons will be from positions that provide an unobstructed field of fire.

f. Overhead fire with machine guns in live-fire exercises will be as follows:

(1) Bullets will not be permitted to impact between the firing position and the rear of the line of unprotected

personnel. All impacts should be a minimum of 50m beyond the forward line of unprotected personnel.

(2) Positive stops must be used to prevent crossfire and depression of the muzzle during firing.

(3) A minimum clearance or safety limit must be established using the guidelines for overhead fire in FM 3–22.65 and FM 3–22.68. Marine Corps personnel use MCWP 3–15.1.

(4) The rate of fire will not exceed 70 rounds per minute for 5.56mm and 7.62mm machine guns and 40 rounds per minute for .50 caliber machine guns.

(5) Weapons will be test fired before delivery of overhead fire to verify effectiveness of the positive traverse and depression stops.

(6) Tracer ammunition may be used as a check to track the projectile flight path.

g. In addition to the requirements of paragraph *f*, the following precautions will apply to overhead fire with machine guns for a confidence infiltration course:

(1) Firing will be from approved platforms as described in TC 3–21.75.

(2) Qualified field maintenance/ordnance personnel will inspect the mounts and weapons before being declared safe to deliver overhead fire.

(3) A minimum clearance of 2.5m over the heads of personnel or the highest obstruction within the field of fire will be maintained. Minimum clearance is the distance between the lowest shot in the dispersion pattern (as determined by the test firing) and the bodies of individuals in erect positions on the highest point of ground, log, or other obstacle over which personnel must travel, or heights of barbed wire strands or posts on the course, whichever is higher.

h. All firing of indirect fire weapons will be from positions in which the site to mask allows engagement of the targets nearest to the forward line of troops. Selection of firing positions, direction of fire, and fall of shot must prevent the projectiles from striking trees or other obstacles in the area from the weapon position to a point forward of unprotected personnel. The forward point is defined as the bursting radius of the round, plus 12 range probable errors.

i. When field artillery is fired during CALFEX/CAX with maneuvering personnel, the impact area will be adjusted according to the maneuver location of troops to maintain safe separation distance. The troop side of the impact area will be determined in relation to the movement of the personnel. Unprotected troops must not be permitted to enter danger zones after firing has commenced.

j. Weapons will be grouped by muzzle velocity as cited in FM 6–40 or pertinent Marine Corps TMs. Weapons will be bore-sighted as prescribed in FM 6–50. Tubes will be clean and dry before start of exercise and will be cleaned during the exercise in accordance with appropriate weapon TMs.

k. All ammunition to be fired should be uniformly conditioned to ambient temperature consistent with the tactical situation.

l. Registration.

(1) At least two rounds should be fired for registration. Targets should be selected in the central portion of the target area. After registration, corrections must be applied to deflection and quadrant elevation limits. If no registration is fired, meteorological and velocity error (MET + VE) corrections will be applied immediately before the exercise starts.

(2) To compensate for drift in high-angle fire, the right deflection limit will be moved to the left by the amount of the maximum drift listed within the range limits for the charges being fired. The left limit will be moved to the right by the amount of the minimum drift listed within the range limits for the charges being fired. To determine the appropriate drift, the tabular firing table and graphical firing scale must be examined and the safer value used. If a drift value is not listed in the tabular firing table or on the graphical firing scale for the ranges to the near and far edge of the target area, the nearest safer value will be used.

m. Overhead fire above unprotected personnel from a moving vehicle or aircraft is prohibited.

n. Cannon and mortar flanking fire must not impact any closer to unprotected personnel than the fragmentation radius (Area A) prescribed for each weapon.

o. Small arms (5.56mm, 7.62mm, and .50 caliber), ground-mounted or vehicle-mounted machine guns may be fired at low angles of elevation (near the flank of an individual or unit). For the SDZ, there must be an angle of 15 degrees or distance of 100m (whichever provides greater separation) between the limit of fire and the near flank of the closest individual or unit and all impacts are beyond the individual or unit. For the batwing SDZ, all non-participating personnel must be outside of the SDZ. Tripod, traversing and depression stops will be used on machine guns to maintain the required angle and distance between the line of fire and the near flank of an individual or unit.

p. Range SOPs will address firing and maneuver unit locations to ensure no unprotected personnel are exposed to training fires.

17–5. Fire control

The unit commander makes the final decisions on fire control measures. The following conditions must be met:

a. The ammunition in (1) through (7) below may be authorized for use in live-fire exercises only when it is fired into designated (dedicated high hazard) impact areas through which personnel are not permitted to maneuver.

(1) 40mm HE.

(2) 66mm light antitank weapon (HE).

(3) Hand grenades (HE), except as noted in paragraph 17–5*d*.

(4) MAAWS (HE and HEAT).

(5) 25mm (HE).

(6) M74 66mm TPA.

(7) HE ICM munitions (Marine Corps).

b. Final coordination lines must be identified to all participating units.

c. Weapons used in live-fire exercises will be controlled so that danger zones do not overlap areas in which unprotected personnel are maneuvering.

d. A RSO will directly supervise and control the throwing of fragmentation grenades. The following procedures apply:

(1) Hand fragmentation grenades may be thrown during live-fire exercises. Hand grenades will be carried in accordance with FM 3–23.30. The fragmentation characteristics of the grenades must be considered and appropriate safety precautions taken to include the following:

(a) Impact areas will be free of obstacles (such as trees, thick vegetation, tank hulls, deep snow, or standing water).

(b) A minimum side-to-side distance of 5m between each individual during the throwing exercise is required.

(c) Throwing positions will protect the throwers from fragments.

(d) EOD personnel will destroy dud grenades in place or safe and remove before troops enter the grenade impact area. If EOD personnel are unable to locate or destroy any dud grenades, troop maneuver through the impact area is not authorized.

(2) Individuals being transported by vehicle or aircraft will not carry fragmentation, offensive, or WP grenades attached to web equipment.

17–6. Maneuver in temporary impact areas

a. The senior commanders (Army)/installation commanders (Marine Corps) may approve maneuver through temporary impact areas containing unexploded munitions, except those identified in paragraph 17–5*a*.

b. The senior commanders (Army)/installation commanders (Marine Corps) may approve maneuver through temporary impact areas after reviewing a risk assessment and accepting residual risks. The following munitions, although not identified in paragraph 17–5*a*, may present high or extremely high risk if present.

(1) .50 caliber SLAP M903.

(2) 20mm HE.

(3) 30mm HE.

(4) All HEAT ammunition because of type of fuze action and sensitivity.

(5) All ordnance fuzed with mechanical time fuzes.

17–7. Air support

a. During live-fire exercises, the following control measures are required prior to firing aircraft-mounted weapons or dropping air-delivered ordnance:

(1) Positive identification of personnel locations.

(2) Positive identification of the target(s).

(3) Positive clearance to drop/fire ordnance as given by the controlling ground or airborne forward air controller (Marine Corps).

(4) Approved abort procedures and locations to drop unexpended bombs when necessary.

(5) Attack flight paths, location of bomb safety lines, and access corridors will be known and visually verified by ground personnel and participating aircrews.

(6) Direct communications will be established and maintained between the OIC, the forward air controller, and the fire support coordination center that coordinates the direct support artillery fire in the vicinity of an air strike.

(7) Minimize danger to attacking aircraft from ricochet of ground-fired HE projectiles, and ceasing fire of flat trajectory weapons in the vicinity of air targets under attack within the SDZ (see chap 4 for vertical hazard

distances).

(8) Firing across, within, or through access corridors will not be permitted without coordination with the forward air controller.

(9) Close air support conducted by Marine Corps FW and RW aircraft will be conducted in accordance with appropriate TMs, MAWTS–1 publications, training and readiness manuals, and squadron SOPs.

b. Fire support by Air Force FW aircraft will be conducted in accordance with Air Force Instruction (AFI) 13–212 Volume 1.

Appendix A
References

Section I
Required Publications

Unless otherwise stated, all publications are available at http://www.apd.army.mil/.

AFI 13-212 Volume 1
Range Planning and Operations (Cited in para 17-7*b*) (Available at www.e-Publishing.af.mil)

AR 75–1
Malfunctions Involving Ammunition and Explosives (RCS CSGLD–1961(MI)) (Cited in paras 2–10*b*, 2–10*c*(3), 10–3*c*(1).)

AR 75–15
Policy for Explosive Ordnance Disposal (Cited in para 15–1*b*(2).)

AR 95–1
Flight Regulations (Cited in para 13–2*d*.)

AR 95–2
Airspace, Airfields/Heliports, Flight Activities, Air Traffic Control, and Navigational Aids (Cited in paras 2–4*c*, 2–5*g*(3).)

AR 95–27
Operational Procedures for Aircraft Carrying Hazardous Materials (Cited in para 13–2*d*.)

AR 385–10
The Army Safety Program (Cited in paras 2–12*e*(6)(a), 16–6.)

AR 385–63
Range Safety (Cited in paras 1–1, 1–4*a*, 2–3*a*(1), 3–3*b*, 7–2*b*(6), 11–8*a*(4), 12–6, 14–2*c*, 16–2.)

AR 405–80
Management of Title and Granting Use of Real Property (Cited in para 2–3*a*(4).)

DA Pam 385–11
Army Guidelines for Safety Color Codes, Signs, Tags, and Markings (Cited in para 2–2*a* and *g*.)

DA Pam 385–24
The Army Radiation Safety Program (Cited in para 16–6.)

DA Pam 385–30
Mishap Risk Management (Cited in paras 2–12*b*(4)(c) and (d), 2–12*d*(1), 4–1*c*, 17–3*b*.)

DA Pam 385–40
Army Accidents Investigations and Reporting (Cited in paras 2–10*b*, 16–6.)

DA Pam 385–64
Ammunition and Explosives Safety Standards (Cited in paras 2–10, 2–10*a*, 2–10*a*(2)(a)(3), 15–1*b*(1).)

ATP 3–09.60
Techniques for Multiple Launch Rocket System (MLRS) and High Mobility Artillery Rocket System (HIMARS) Operations (Cited in paras 10–12*b*(1), 10–13*c*(7).)

ATP 3–37.34
Survivability Operations (Cited in para 17–4*a*.)

ATTP 3–06.11
Combined Arms Operation in Urban Terrain (Cited in para 6–1*b*(7).)

ATP 5–19
Risk Management (Cited in paras 11–8*a*(4), 11–8*c*(2), 16–1*p*.)

BUMEDINST 6470.23
Medical Management of Non-Ionizing Radiation Casualties (Cited in para 16–6.) (Available at https://rtam.telecom.usmc.mil/) (Registration and a common access card (CAC)-enabled computer are required.)

DODI 1100.22
Policy and Procedures for Determining Workforce Mix (Cited in para 1–5*a*.) (Available at http://www.dtic.mil/whs/directives.)

DODI 3200.16
Operational Range Clearance (Cited in para 2–10*c*(4).) (Available at http://www.dtic.mil/whs/directives.)

FM 3–04.111
Aviation Brigades (Cited in para 2–10*a*(2)(b).)

FM 3–04.140
Helicopter Gunnery (Cited in paras 11–2*c*(2), 11–3*e*, 11–4*e*(1), 11–5*b*(1)(b), 11–11*b*(2)(a).)

FM 3–22.68
Crew Served Weapons (Cited in para 17–4*f*(3).)

FM 3–34.214
Explosive and Demolitions (Cited in paras 15–1*b*(1), 15–1*f*(1), 15–1*f*(5), 15–1*i*(1)(a), 15–10*e*(2), 15–10*f*.)

FM 4–25.11
First Aid (Cited in para 5–1*c*(7).)

FM 6–40
Tactics, Techniques, and Procedures for Field Artillery Manual Cannon Gunnery (Cited in paras 10–9*a*(4), 17–4*j*.)

FM 6–50
Tactics, Techniques, and Procedures for the Field Artillery Cannon Battery (Cited in para 17–4*j*.)

FM 10–67–1
Concept and Equipment of Petroleum Operations (Cited in para 2–10*a*(2)(b).)

MAWTS–1
Aerial Gunnery Manual (Available from Commanding Officer, Marine Aviation Weapons and Tactics Squadron One, Marine Corps Air Station, Yuma, AZ 85369.) (Cited in paras 11–4*e*(1), 11–4*g*(2)(a), 17–7*a*(9).)

MCBul 8011
Class V(W) Materiel Allowance For Training and Security (Cited in para 10–11*a*(2).) (Available at http://www.mccdc.marines.mil/.)

MCO 3500.27B
Operational Risk Management (ORM) (Cited in paras 11–8*a*(4), 11–8*c*(2), 14–2*c*, 16–1*p*.) (Available at www.marines.mil.)

MCO 3550.9
Range Certification and Recertification (Cited in para para 16-3b(1)) (Available at www.marines.mil.)

MCO 3570.1C

Range Safety (Cited in paras 1–1, 1–4*a*, 2–3*a*(1), 3–3*b*, 7–2*b*(6), 11–8*a*(4), 12–6, 14–2*c*, 16–2.) (Available at http://www.marines.mil.)

MCO 5104.1C
Navy Laser Hazards Control Program (Cited in paras 16–3*b*(1), 16–6.) (Available at http://www.marines.mil.)

MCO P5102.1B
Navy and Marine Corps Mishap and Safety Investigation Reporting and Record Keeping Manual (Cited in para 2–10*b*.) (Available at http://www.marines.mil.)

MCO P8011.4H
Table of Allowances for Class V(W) Material Peacetime (Cited in para 10–11*a*(2).) (Available at http://www.marines.mil.)

MCO 8025.1E
Class V (W) Malfunction and Defect Reporting (Cited in paras 2–10*a*(2)(d), 2–10*b*, 2–10*c*(3), 10–3*c*(1).) (Available at http://www.marines.mil.)

MCRP 3–1.6.24
Tactics, Techniques, and Procedures for Multiple Launch Rocket System (MLRS) Operations (Cited in paras 10–12*b*(1), 10–13*c*(7).) (Available at http://www.marines.mil.)

MCWP 3–15.1
Machines Guns and Machine Gun Gunnery (Cited in para 17-4*f*(3) (Available at http://www.marines.mil.)

MCWP 3–17.6
Survivability Operations (Cited in para 17–4*a*.) (Available at http://www.marines.mil.)

MCRP 5–12D
Organization of the Marine Corps Forces (Cited in paras 14–2*c*, 16–1*p*.) (Available at http://www.marines.mil.)

MIL–HDBK–828BC
Range Laser Safety (Cited in paras 11–10*f*, 16–1*a*, 16–3*b*(1), 16–3*a*, 16–5*b*(4).) (Available at http://www.assistdocs.com/search/search_basic.cfm.)

MIL–STD 709D
Ammunition Color Coding (Cited in para 17–7*a*(1).) (Available at http://dodssp.daps.mil.)

NAVAIR TM 11–75–63
Launchers, Single Bay LMU-23/E and Power Bay LMU-24E for Smokey Sam (Cited in para 15–11c.) (Available at https://nossa.nmci.navy.mil/.) (Registration and a CAC-enabled computer are required.)

NAVSEA OP5 (Including Volume 1)
Ammunition and Explosives Safety Ashore (Cited in paras 1–5*g*(2), 2–10, 2–10*a*, 2–10*a*(2)(a)3, 15–1*b*(2).) (Available at https://nossa.nmci.navy.mil/.) (Registration and a CAC-enabled computer are required.)

NAVSEA SWO60–AA–MMA–010
Demolition Materials (Cited in paras 1–5*g*(2), 15–1*b*.) (Available at https://nossa.nmci.navy.mil/.) (Registration and a CAC-enabled computer are required.)

NAVSUP P–801
Ammunition Unserviceable, Suspended and Limited Use (Cited in paras 2–10*a*(2)(c), 2–10*b*, 2–10*b*(1), 2–10*b*(2).) (Available at https://nossa.nmci.navy.mil/.) (Registration and a CAC-enabled computer are required.)

NEHC TM 6290.99–10
Indoor Firing Ranges Industrial Hygiene Technical Guide (Cited in para 2–8*a*.) (Available at http://www-nehc.med. navy.mil/downloads/IH/indoor_firing_range.pdf.)

OPNAVINST 3770.2K
Airspace Procedures and Planning Manual (Cited in para 2–4*c*.) (Available at http://doni.daps.dla.mil/.)

TB MED 524
Control of Hazards to Health from Laser Radiation (Cited in para 16–6.)

TB 9–1300–385
Munitions Restricted or Suspended (Cited in paras 2–10*b*, 2–10*b*(1), 2–10*b*(2).) (Available at https://mhp.redstone.army.mil.)

TB 9–1310–251–10
Operator's Manual Range Clearing Procedures for Cartridge 40MM: TP, M918 (Cited in para 5–2*b*(9).) (Available from https://www.logsa.army.mil/etms/find_etm.cfm.)

TB 3–1365–490–10
Smoke Pot, HC, 10-lb., M1 and 30-lb., ABC–M5; Smoke Pot, Floating, HC, M4A2; SGF2, AN–M7A1; and Smoke Pot, Floating, MK7MOD0 and Smoke Pot, Floating, Screening, TA, Practice, M8 (Cited in para 13–4*d*.) (Available from https://www.logsa.army.mil/etms/find_etm.cfm.)

TC 1–600
Unmanned Aircraft System Commander's Guide and Aircrew Training Manual (Cited in para 11–5*b*(1)(b).)

TC 3–04.11
Commander's Aircrew Training Program for Individual, Crew, and Collective Training (Cited in paras 11–2*c*(2), 11–3*e*.)

TC 3–04.35
Aircrew Training Manual, Utility Helicopter, Mi-17 Series (Cited in para 11–3*e*.)

TC 3–21.75
The Warrior Ethos and Soldier Combat Skills (Cited in para 17–4*g*(1).)

TC 3–22.23
M18A1 Claymore Munition (Cited in para 15–7*c*(1)(g).)

TC 3–23.30
Grenades and Pyrotechnic Signals (Cited in paras 5–1*a*, 5–1*c*(7), 17–5*d*(1).)

TC 25–8
Training Ranges (Cited in paras 2–2*g*, 5–1*a*, 5–1*e*(2), 11–3*e*.) (Available at http://www.marines.mil.)

TM 08655A–10A
Light armored vehicle-mortar variants (Cited in para 9–11.) (Available at http://www.marines.mil.)

TM 3–23.25
Shoulder-Launched Munitions (Cited in para 6–1*a*(1).)

TM 9–1300–200
Ammunition, General (Cited in para 15–7*a*.) (Available from https://www.logsa.army.mil/etms/find_etm.cfm.)

TM 9–1330–200–12
Operator's and Organizational Unit Maintenance Manual for Grenades (Cited in para 5–1*c*(4).) (Available at http://www.logsa.army.mil.)

TM 9–1345–203–12
Operator's and Unit Maintenance Manual for Land Mines (Cited in para 15–8*g*.) (Available from https://www.logsa.army.mil/.)

TM 9–1370–207–10
Pyrotechnic Simulators (Cited in para 15–10*b* and *c*.) (Available from https://www.logsa.army.mil/.)

TM 43–0001–28
Army Ammunition Data Sheets for Artillery Ammunition: Guns, Howitzers, Mortars, Recoilless Rifles, Grenade Launchers and Artillery Fuzes (Federal Supply Class 1310, 1315, 1320, 1390) (Cited in paras 9–11, 10–3*d*.) (Available at http://www.logsa.army.mil/.)

TM 43–0001–29
Army Ammunition Data Sheets for Grenades (Cited in para 5–1*c*(4).) (Available at http://www.logsa.army.mil/.)

USAF AFI 13–212
Range Planning and Operations (Cited in para 17–7*b*.) (Available at http://afpubs.hq.af.mil/.)

29 CFR 1910.1025
Occupational Safety and Health Regulations for Lead (Cited in para 2–7*a*(1).)

29 CFR 1926.200b
Safety and Health Regulations for Construction: Accident Prevention Signs and Tags-Signs, Signals, and Barricades (Cited in para 2–2*a*.) (Available at http://www.access.gpo.gov/.)

33 CFR 334
Danger Zone and Restricted Area Regulations (Cited in para 2–6*a*, *b*, and *c*.) (Available at http://www.access.gpo.gov/.)

Section II
Related Publications

A related publication is a source of additional information. The user does not have to read it to understand this publication. Unless otherwise stated, all publications are available at http://www.apd.army.mil/.

AR 15–6
Procedures for Investigating Officers and Boards of Officers

AR 25–30
The Army Publishing Program

AR 40–5
Preventive Medicine

AR 40–10
Health Hazard Assessment Program in Support of the Army Acquisition Process

AR 200–1
Environmental Protection and Enhancement

AR 360–1
The Army Public Affairs Program

AR 405–90
Disposal of Real Estate

DA PAM 40–501
Hearing Conservation Program

AFI 48–139
Laser and Optical Radiation Protection Program (Available at http://www.e-publishing.af.mil/.)

ANSI Z136.1
American National Standard for Safe Use of Lasers (Available from http://webstore.ansi.org/.)

CTA 50–900
Clothing and Individual Equipment (Available at https://webtaads.belvoir.army.mil/usafmsa.)

DODD 3000.03E
DOD Executive Agent for Non-Lethal Weapons (NLW), and NLW Policy (Available at http://www.dtic.mil/whs/directives/.)

DODD 5030.19
Military Airspace and Air Traffic Service Functions (Available at http://www.dtic.mil/whs/directives/.)

Department of Health, Education, and Welfare Publication Number 76–130 (Publication PB 266–426)
Lead Exposure and Design Considerations for Indoor Firing Ranges, Technical Information, December 1975, National Institute for Occupational Safety and Health (NIOSH) (Available at National Technical Information Service, (800) 553–6847.)

FM 3–20.12
Tank Gunnery (Abrams)

FM 3–20.21
Heavy Brigade Combat Team (HBCT) Gunnery

FM 3–22.65
Browning Machine Gun, Caliber .50, HB, M2

FM 3–34.210
Explosive Hazards Operations

FM 4–30.51
Unexploded Ordnance (UXO) Procedures

FM 23–65
Browning Machine Gun, Caliber .50 HB, M2

FAA Handbook 7400.2
Procedures for Handling Airspace Matters (Available from www.faa.gov/.)

Federal Acquisition Regulations Subpart 7.5
Inherently Governmental Functions (Available at http://www.acquisition.gov/far/html/Subpart%207_5.html.)

JP 3–09
Joint Fire Support

Marine Corps TM 1185–14/1
Operation, Organizational, and Intermediate Maintenance Instructions with Illustrated Parts Breakdown (Smoky Sam Simulator/Antiaircraft Artillery Visual Cueing System) (Available at http://www.logcom.usmc.mil/sp_logon/, access request required for site access..)

Marine Corps TM 1185–14/2
Loading and Firing Checklist for LMU–23A/E Single Bay Launcher (Available at http://www.logcom.usmc.mil/sp_logon/, access request required for site access.)

Marine Corps TM 1290–12/1
Operators' Manual-Simulator Laser Target (AN/GVT–1) (Available at http://www.logcom.usmc.mil/sp_logon/, access request required for site access.)

MCO 3574.2J

Entry Level and Sustainment Level Marksmanship Training with the M16A2 Service Rifle and M9 Service Pistol (Available at www.marines.mil.)

MCO 8011.4
USMC Training Ammunition Class V (W) Materiel (Peacetime) (Available at www.marines.mil.)

MCO 8027.1D
Interservice Responsibilities for Explosive Ordnance Disposal (Available at www.marines.mil.)

MCO P4030.19K
Preparing Hazardous Materials for Military Air Shipments (Available at http://www.marines.mil.)

MCO P8020.10B
Marine Corps Ammunition Management and Explosives Safety Policy Program (Available at http://www.marines.mil.)

NAVSEA SW020–AF–HBK–010
Motor Vehicle Driver and Shipping Inspector's Manual for Ammunition, Explosives and Related Hazardous Materials (Available at https://nossa.nmci.navy.mil/.) (Registration and a CAC-enabled computer are required.)

SPAWAR INST 5100.12B
Navy Laser Hazards Control Program (Available at https://nossa.nmci.navy.mil/.) (Registration and a CAC-enabled computer are required.)

Technical Paper 18
Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel (Available at https://www.ddesb. pentagon.mil/documents/TechnicalPapers.aspx.)

TM 9-1330-210-10
Grenade, Rifle: Entry Munition (GREM), M100 and Grenade, Rifle, Practice: Target Practice (GREM-TP), M101

TM 9–1375–213–12
Operators and Unit Maintenance Manual (Including Repair Parts and Special Tools List) Demolition Materials (Available from https://www.logsa.army.mil/.)

TM 9–6920–361–13&P
Operator, Organizational, and Direct Support Maintenance Manual (Including Repair Parts and Special Tools List) Field Artillery Trainer Kits (With Field Artillery Trainer M31) (Available from https://www.logsa.army.mil/.)

TM 43–0001–27
Army Ammunition Data Sheets Small Caliber Ammunition (FSC 1305) (Available from https://www.logsa.army.mil/.)

TM 43–0001–30
Army Ammunition Data Sheets for Rocket Systems, Rocket Fuzes, Rocket Motors (FSC 1340) (Available at https://www.logsa.army.mil/etms/find_etm.cfm.)

TM 43–0001–36
Army Ammunition Data Sheets for Land Mines (FSC 1345) (Available from https://www.logsa.army.mil/.)

TM 43–0001–37
Army Ammunition Data Sheets for Military Pyrotechnics (FSC 1370) (Available from https://www.logsa.army.mil/.)

TM 43–0001–38
Army Ammunition Data Sheets for Demolition Materials (Available from https://www.logsa.army.mil/.)

TM 60–series publications
Explosive Ordnance Disposal Technical Manuals (Commander, U.S. Army EOD Technical Detachment, 2008 Stump Neck Road, Indian Head, MD 20640–5096.)

21 CFR 1040
Performance Standards for Light-Emitting Products (Available from http://ecfr.gpoaccess.gov/.)

29 CFR 1910
Occupational Safety and Health Standards (Available from www.access.gpo.gov/.)

33 CFR 334.10
Navigation and Navigable Waters (Available from http://ecfr.gpoaccess.gov/.)

40 CFR 260
Environmental Protection Agency, Military Munitions Rule: Hazardous Waste Identification and Management; Explosives Emergencies; Manifest Exemption for Transport of Hazardous Waste on Right-of-Ways on Contiguous Properties; Final Rule (Available from www.access.gpo.gov/.)

Section III Prescribed Forms
Unless otherwise indicated, DA forms are available on the Army Publishing Directorate Web site at http://www.apd.army.mil/.

DA Form 5687
Initial Inspection Checklist for Indoor Ranges (Prescribed in para 2–7*d*(1).)

DA Form 5688
Detailed Inspection Checklist for Indoor Ranges (Prescribed in para 2–7*d*(2).)

DA Form 7632
Deviation Approval and Risk Acceptance Document (Prescribed in para 2-14*d*(2).)

Section IV Referenced Forms

DA Form 2028
Recommended Changes to Publications and Blank Forms

Glossary

Section I
Abbreviations

ACC
area of critical concern

ACOM
Army commands

AFI
Air Force Instruction

AGL
above ground level

AMC
U.S. Army Materiel Command

AP
armor piercing

APERS
anti-personnel

API
armor-piercing incendiary

AR
Army Regulation

ARSO
assistant range safety officer

ARSMM
Army Range Safety Messages and Memoranda

ASCC
Army Service component command

ASP
ammunition supply point

ATC
air traffic control

ATP
Army Techniques Publication

ATWESS
anti-tank weapons effect signature simulator

AT&A
air traffic and airspace officer

BFA
blank firing adapter

CAC
common access card

CALFEX
combined arms live-fire exercise

CAMDV
control authority maximum divert

CAX
combined arms exercise

CBRN
chemical, biological, radiological, and nuclear

CCMCK
close combat mission capability kit

CFA
controlled firing area

CFR

Code of Federal Regulations

CG
commanding general

cm
centimeter

CR
crossrange

CREW
Counter Radio-controlled improvised explosive device Electronic Warfare

CS
0-chlorobenzyl denemalononitrite

CVC
combat vehicle crewman

DA
Department of the Army

DARAD
Deviation Approval and Risk Acceptance Document (DA Form 7632)

DDESB
Department of Defense Explosives Safety Board

DDI
drill, dummy, and inert

DES
demolitions effects simulators

DOD
Department of Defense

DODD
Department of Defense directive

DODI
Department of Defense instruction

DODIC
Department of Defense identification code

DR
downrange

DRU
direct reporting unit

DTL
designator target line

DU
depleted uranium

DZ
drop zone

EFP
explosively formed penetrator

EOD
explosive ordnance disposal

EPR
enhanced performance round

FAA
Federal Aviation Administration

FIST
fire support team

FL
flechette

FM
field manual

FRPC
full range practice cartridge

ft
feet

FW
fixed wing

GBU
guided bomb unit

GMLRS
Guided Multiple Launch Rocket System

GTL
gun target line

GS
general schedule

HC
hexachloroethane

HE
high explosive

HEAT
high-explosive anti-tank

HEDP
high-explosive dual-purpose

HEP
high-explosive plastic

HIMARS
High Mobility Artillery Rocket System

HMMWV
high-mobility multipurpose wheeled vehicle

IBA
improved body armor

ICM
improved conventional munitions

IDAP
integrated defensive armed penetrator (MH-60)

IED
improvised explosive device

IL
illumination

IR
infrared

JP
Joint Publication

JPADS
Joint Precision Airdrop System

JTAC
joint terminal attack controller

kg
kilogram

KTAS
knots true airspeed

LAW
light anti-tank weapon

lb
pound

LDA
launcher danger area

LOA
letter of agreement

LOAL
lock on after launch

LOAL-D
lock on after launch-direct

LOBL
lock on before launch

LSDZ
laser surface danger zone

m
meter

m^3
cubic meter

MAAWS
multi-role antiarmor anti-personnel weapons system

MAM
Munition Adapter Module

MCCDC
Marine Corps Combat Development Command

MCO
Marine Corps order

MCRP
Marine Corps Reference Publication

MCWP
Marine Corps Warfighting Publication

MDI
modernized demolition initiator

MEA
mission essential area

MELB
mission enhanced Little Bird

MEP
mission essential personnel

METL
mission-essential task list

mg/m
milligrams per meter

MHz
megahertz

MIL–HDBK
Department of Defense Handbook

MLRS
Multiple Launch Rocket System

mm
millimeter

MOPP
mission oriented protective posture

MOS
military occupational specialty

MPE
maximum permissible exposure

m/s
meters per second

MSD
minimum safe distance

MSL
mean sea level

MTL
missile target line

NAVSUP
U.S. Naval Supply Systems Command

NCO
noncommissioned officer

NLW
nonlethal weapon

NR
not required

NVD
night vision device

ODCS
Office of the Deputy Chief of Staff

OIC
officer in charge

PE
probable error

PGK
precision guidance kit

PPE
personal protective equipment

QE
quadrant elevation

RCO
range control officer

RDA
ricochet danger area

RMA
range management authority

RMTK
Range Managers Toolkit

RRPR
reduced range practice rocket

RSO
range safety officer

RTAM
Range and Training Area Management

RW
rotary wing

SARSA
Small Arms Range Safety Area

SDZ
surface danger zone

SESAMS
Special Effects Small Arms Marking System

SLAP
saboted light armor penetrator

SMAW
shoulder-launched multipurpose assault weapon

SOP
standard operating procedure

SOUM
safety of use message

SRM
solid rocket motor

SRSO
senior range safety officer

SRT
steel reactive target

SRTA
short-range training ammunition

SUA
special use airspace

T
time, tracer

TA
terephthalic acid

TACP
tactical air control party

TB
technical bulletin

TC
training circular

TM
technical manual

TNT
trinitrotoluene

TOW
tube-launched, optically tracked, wire-guided

TP
training practice

TRADOC
U.S. Army Training and Doctrine Command

TW
tilt wing

UAS
Unmanned Aircraft System

USACE
U.S. Army Corps of Engineers

USATCES
U.S. Army Technical Center for Explosives Safety

USASOC
U.S. Army Special Operations Command

VMC
visual meteorological conditions

VT
variable time

WDZ
weapon danger zone

WP
white phosphorous

Section II Terms

140 dBP contour
The distance at which the impulse noise produced by the weapon or explosive is 140 decibels peak level. See also hearing hazard zone.

ammunition lot
A quantity of components, each of which is manufactured by one manufacturer under uniform conditions, and which is expected to function in a uniform manner. The lot is designated and identified by assignment of an ammunition lot number and preparation of an ammunition data card.

angle of deflection
The angle of travel of bullet fragments relative to the plane of the target surface towards the shooter.

Angle P
The angle beginning at the firing point, located to the left and right of the dispersion area, which defines the area which contains projectiles after making initial contact with the target medium.

Angle Q
The angle beginning at distance Y, located to the left and right of the dispersion area, which defines the area which contains projectiles after making initial contact with the impact medium.

approved hearing protector (or protection)
Hearing protector types that are approved for use by the Army and are listed in DA Pam 40–501.

Area A
The secondary danger area (buffer zone) that laterally parallels the impact area or ricochet area (depending on the weapon system) and contains fragments, debris, and components from frangible or explosive projectiles and warheads functioning on the right or left edge of the impact area or ricochet area.

Area B
The secondary danger area (buffer zone) on the downrange side of the impact area and Area A which contains fragments, debris, and components from frangible or exploding projectiles and warheads functioning on the far edge of the impact area and Area A.

Area C
The secondary danger area (buffer zone) on the up-range side of the impact area and parallel to Area B which contains fragments, debris, and components from frangible or exploding projectiles and warheads functioning on the near edge of the impact area.

Area D
The safe area between Areas C and E for indirect, overhead fire of unprotected personnel in training.

Area E
The danger area between an indirect fire weapon system and Area D. This area is endangered by muzzle debris, overpressure, blast, and hazardous impulse noise. Personnel in service batteries firing from approved tactical configurations may occupy Area E.

Area F
The danger area to the rear of a weapon system that is endangered by back-blast debris, overpressure, blast, and hazardous impulse noise.

Area G
The danger area between the CAMDV area and Area C which exists during the firing of artillery rounds equipped with a PGK. This area accounts for the possibility of a locked PGK canard resulting in a short round.

Area H
The area to the rear of a weapon system (for example, TOW missile) that contains warhead particles (collapsed shape charge and warhead fragments) during an "eject only" firing event.

Area I
The area immediately in front of certain missile weapon systems designated as the initial zone of impact for "eject only" firing events. Area I may not be occupied under deviation.

Area of Critical Concern
Any item deemed necessary to protect during range operations

Area R
The portion of the SDZ behind the firer where personnel, equipment and facilities may be endangered by ricochets to the rear of the firing line.

Army Special Operations Forces
Those active and reserve component Army forces designated by the Secretary of Defense that are specifically organized, trained, and equipped to conduct and support special operations.

autonomous designation
Designation of a target for a laser-guided munition conducted by the firing platform.

assistant Range Safety Officer
Officer, WO, or NCO designated and briefed by the OIC and RSO, who assists the RSO in carrying out the safety responsibilities for the range or activity.

backstop, laser
Opaque structures or terrain in the controlled area of a LSDZ such as a hill, dense tree line, or a windowless building that would completely obstruct any view beyond it and completely terminate a laser beam that may miss the target.

barrier
A permanent or temporary impediment to foot and or vehicular traffic which personnel are prohibited to pass without approval from the RMA (Army), range control (Marine Corps). A barrier may be sentinel, wire fencing, gate, sign, or other access-limiting device.

buttoned-up
All hatch covers are in a closed and secure position.

cease-fire
A command given by anyone observing an unsafe firing condition on any training complex to immediately terminate an active (hot, wet) firing status of a weapon system(s).

central register
An official record of range safety deviations held at the respective ACOM/ASCC/DRU.

certified ammunition
Ammunition, to include fuzes, propellants, and projectiles, which have been cleared by the U.S. Army Materiel

Command for overhead fire of unprotected personnel.

cold firing status
A firing condition where authorization to fire a weapon system has not been given or has been revoked by the installation range operations firing desk (Army), range control office (Marine Corps). Also referred to as a dry firing status.

combined arms live-fire exercises (Army)/combined arms exercise (Marine Corps)
A combat exercise in which Army/Marine Corps combined arms teams in combat formation conduct coordinated combat firing and maneuver practice in executing the assault, seizure, and defense of appropriate objectives. Tactical air support may be included.

command responsibility
As it relates to range safety, commanders down the entire chain of command are responsible for the safety of their personnel.

conservation
The protection, improvement, and use of natural resources according to principles that will provide optimum public benefit and support of military operations.

contaminated area
Any area where there are known or suspected unexploded munitions (dud ammunition or explosives) regardless of type.

Control Authority Maximum Divert area
The additional danger area immediately surrounding the Probable Error area which exists during the firing of artillery rounds equipped with a PGK.

control tower
A structure usually situated behind the firing line or position from which range operations of a training event is controlled.

cookoff
A functioning of any or all of explosive components due to high temperatures within a weapon system.

crew-served weapon system
Any weapon system requiring two or more personnel to fire the system.

cross-sectional terrain profile
A profile of the SDZ being considered for deviation at a point laterally downrange where a hill mass is expected to attenuate projectiles and/or hazardous fragments.

decibel peak level
A logarithmic method of expressing the peak pressure caused by an explosion.

dedicated impact area
See impact area.

deviation
A departure from the requirements of this pamphlet and the policy in AR 385–63/ MCO 3570.1C.

direct fire
Fire delivered on a target when the weapon system is laid by sighting directly on the target using the weapon system sighting equipment.

dispersion area
The area within the SDZ located between the GTL and the ricochet area. This area accounts for human error, gun or cannon tube wear, propellant temperature, and so forth.

Distance D
Distance along specific angle, measured from the weapon target line, at the firing position downrange for selected direct fire weapons. Distance D defines maximum projectile distance along this line.

Distance L
The distance downrange from the launch point where the launch dispersion angle intersects the flight corridor boundaries for the PATRIOT missile.

Distance W
The maximum lateral distance a projectile will ricochet after impacting within the dispersion area. Distance W defines the maximum lateral edge of the ricochet area.

Distance X
The maximum distance a projectile (to include guided missiles and rockets) will travel when fired or launched at a given quadrant elevation with a given charge or propulsion system.

Distance Y
The maximum distance downrange at which a lateral ricochet is expected to occur when a projectile is fired at a given quadrant elevation.

double hearing protector (or protection)
Wearing earplugs in combination with noise muffs or noise attenuating helmets. Impulse levels can be so high that single hearing protection does not adequately protect hearing.

downrange
A descriptive term used to address the orientation of personnel, materiel, or property relative to the direction or path of ammunition and or explosives (to include guided missiles and rockets) fired or launched from weapon systems. The direction of orientation is from the firing line or position toward the target.

dud
An explosive item or component of a weapon system that fails to function as intended when fired.

eject only firing event
A firing sequence where the launch motor of a missile functions, ejecting the missile out of the launcher, but the flight motor fails to ignite, causing the missile to tumble. As the missile tumbles and strikes the ground, sufficient G–Force initiates the warhead causing warhead particles to be projected outward.

far edge
The boundary of the impact area that borders the outside edge of Area B and is farthest from the firing point or position.

field expedient explosive device
A standard item of explosive that is combined with other standard explosive items or non-explosive items using techniques and procedures outlined in doctrinal publications (FMs and TMs).

final safety acceptance inspection
ACOMs, ASCCs, and DRUs safety inspection of new construction or modification of a range prior to release from the contractor or other contracting agent, Government or non-Government.

firing lane
The area within which a weapon system is fired. It consists of a start-fire line, cease fire-disarm line, and left and right limits of fire.

firing line
The line which consists of firing points or positions, from which weapon systems are fired downrange.

firing position

The point or location at which a weapon system (excluding demolitions) is placed for firing. For demolitions, the firing position is the point or location at which the firing crew is located during demolition operations.

flak jacket
Fragmentation body armor protective vest (CTA 50–900 update.)

fork
The change in angle of elevation necessary to produce a change to the center of impact equivalent to four probable errors.

guided missile
An unmanned vehicle moving above the surface of the earth whose trajectory or flight is capable of being altered by an external or internal mechanism.

gun target line
An imaginary line drawn between the firing position and target position. Also referred to as the line of fire.

HC smoke
Hexachloroethane-zinc oxide used to generate screening smoke.

hangfire
An undesired delay in the functioning of a firing system. A hangfire for a rocket occurs if the rocket propellant is ignited by the firing impulse but the rocket fails to exit the launcher within the expected time.

hearing hazard, hearing hazard zone
All personnel exposed to levels of 140 dBP and above must wear hearing protection. The area where the impulse noise levels are 140 dBP or higher and hearing protection is required.

hearing protection zone
Area on the range within which all personnel must wear hearing protection during weapons fire. It may be larger than the hearing hazard zone, but never smaller.

high-hazard impact area
See impact area.

hot firing status
A firing condition where authorization to fire a weapon system has been given by the installation range operations firing desk (Army), range control office (Marine Corps). Also referred to as a wet firing status.

impact area
The ground and associated airspace within the training complex used to contain fired, placed, dropped, thrown, or launched AE, and the resulting fragments, debris, and components from various weapon systems. Indirect fire weapon system impact areas include probable error for range and deflection. Direct fire weapon system impact areas encompass the total SDZ from the firing point or position downrange to Distance X. It also includes Area B when required.

a. Temporary impact area. An impact area within the training complex used for a limited period of time to contain fired, placed, dropped, thrown, or launched AE and the resulting fragments, debris, and components. Temporary impact areas are normally used for non-dud producing AE, and should be able to be cleared and returned to other training support following termination of firing.

b. Dedicated impact area. An impact area that is permanently designated within the training complex and used indefinitely to contain fired, placed, dropped, thrown, or launched AE and the resulting fragments, debris, and components. Dedicated impact areas are normally used for non-sensitive AE.

c. High-hazard impact area. An impact area that is permanently designated within the training complex and used to contain sensitive high explosive AE and the resulting fragments, debris, and components. High hazard impact areas are normally established as part of dedicated impact areas where access is limited and strictly controlled due to the extreme hazard of dud ordnance (for example, ICM, HEAT, 40-mm, and other highly sensitive

AE.)

improved conventional munitions
Munitions characterized by the delivery of two or more antipersonnel or antimateriel and/or antiarmor sub-munitions.

indirect fire
Fire delivered on a target when the weapon system is not in line of sight with the target.

installation
An aggregation of contiguous or near contiguous, common mission supporting real property holdings under the jurisdiction of the Department of Defense within and outside the continental United States. Examples include, but are not limited to, posts, camps, bases, and stations.

installation Range Management Authority (Army), Range Control Officer (Marine Corps)
A commissioned officer, WO, NCO, or civilian who serves as the central point of control and coordination for all activities conducted within the installation/community training complex and implements and enforces the installation/ community range safety program. This may include the scheduling and maintenance of the training complex.

intrabeam viewing
Looking directly into the path of a laser beam or reflected beam.

intraline distances
The distance used for separating certain specified areas and locations within explosive establishments.

instructor pilot
A qualified warrant or commissioned officer that is placed on military orders and is assigned the responsibility for the safe operation of assigned aircraft and associated weapon systems.

large rocket
A stabilized, free ballistic trajectory, long range field artillery type rocket with a range capability of greater than 100 km when using a nonnuclear warhead.

laser
A device capable of producing a narrow beam of intense light (LASER-light amplification by stimulated emission of radiation). See TB MED 524, MIL–HDBK–828C, and JP 3–09 for more information on lasers.

laser buffer zone
A safety margin on either side, above, and below the approved target area extending to a distance at which the beam is terminated by a backstop extending across the target zone or the NOHD limit is reached. A vertical buffer zone covers the angular distances below the highest point on a backstop or above the non-lasing area. The laser horizontal buffer zone covers the angular distance to the left of the left most target and to the right of the right most target.

laser range finder
A range finder employing a laser device to emit a pulsed laser beam that is aimed at the target. The range is determined automatically by electronically measuring the time it takes for the light beam to travel from the laser to the target, be reflected from the target, and return to the range finder.

laser safety eyewear
Protective eyewear designed specifically to permit the user to be exposed to either a direct or reflected laser beam from a specific laser device without eye injury.

laser surface danger zone
A V-shaped zone designed to contain a laser beam (while lasing) with buffer zones on either side, above, and below the approved target.

logistics assistance representative
Department of Army civilian personnel in the grade of GS–11 and above who have received training in specific weapon systems and are qualified in accordance with AR 75–1 to assist in performing malfunction investigations.

low-angle fire
Fire delivered at angles of elevation equal to or below the angle corresponding to the maximum range of the gun and ammunition.

malfunction
Failure of an ammunition item to function as expected when fired, launched, or when explosive items function under conditions that should not cause functioning. Malfunctions include hangfires, misfires, duds, abnormal functioning and premature functioning of explosive items under normal handling, maintenance, storage, transportation, and tactical deployment. Malfunctions do not include accidents or incidents that arise solely from negligence, malpractice, or situations such as vehicle accidents or fires.

military operations in urban terrain
A terrain complex where manmade construction impacts on the tactical options available to commanders. Military operations in urban terrain facilities replicate urban sprawl environments.

misfire
A complete failure to fire that is not necessarily hazardous. Because it cannot be readily distinguished from a delay in functioning (hangfire), it must be handled as worst case in accordance with procedures for the weapon system.

mission-essential area
The area within the SDZ located adjacent to the impact area that is allowed to be occupied only by essential personnel needed to accomplish the assigned task or mission.

mission-essential personnel
Those individuals who are directly involved or in support of weapon systems firing without whom the firing mission could not take place.

navigable waterway
Any body of water open to the free movement of marine vessels.

near edge
The boundary of the impact area that borders Area C and is nearest to the firing point or position.

nominal ocular hazard distance
The intrabeam distance within which the laser beam's irradiance or radiant exposure falls below the applicable exposure limit.

nominal ocular hazard distance-magnified
The nominal ocular hazard distance for intrabeam viewing through 7x50 binoculars that transmit 70 percent at 1064 nanometers and 85 percent at 694.3 nanometers.

non-participating personnel
Personnel that are not under the direct OIC/RSO control/responsibility and are not involved in the overall exercise/ training event in any way.

nonstandard explosive item
An explosive device, material, or component that has not been through a DoD Service munitions qualification process, such as being type classified by AMC, or is a standard explosive item that has been altered to change its characteristics and function.

Officer In Charge
The officer, WO, or NCO responsible for personnel conducting firing or operations within the training complex.

operational area
Multiple firing points contained in a designated area from which weapons such as artillery can be fired safely.

operational range
A range that is under the jurisdiction, custody, or control of the Secretary of Defense and- that is used for range activities, or although not currently being used for range activities, that is still considered by the Secretary to be a range and has not been put to a new use that is incompatible with range activities.

overhead fire
Weapon system firing that is delivered over the heads of unprotected personnel in training or personnel located anywhere in the SDZ.

participating personnel
Personnel that are under direct OIC/RSO control/responsibility participating in or part of an overall exercise/training event and directly involved in some or all of the tasks or events associated with the overall exercise/training.

primary danger area
An area within the SDZ where hazards are known to exist and in which no unprotected Soldier/Marine or materiel is permitted since injury or death to such personnel and damage to materiel is probable. Target, dispersion, and ricochet areas are primary danger areas.

probable error
A measure of the impact distribution in the dispersion pattern around the center of impact dimensionally expressed in firing tables as one interval of the dispersion rectangle.

proper eye protection (or eye armor)
Approved eye protection, as a minimum, when required by safety and or installation/community range regulations and or standing operating procedures.

proper hearing protection
Approved single or double hearing protection, as a minimum, when required by safety or installation range regulations or standing operating procedures.

public traffic route distance
The distance in feet used to separate any public highway, navigable stream, passenger railroad, or aircraft taxiway from potential explosion sites. (See DA Pam 385–64 for quantity-distance tables.)

quality assurance specialist (ammunition surveillance)
Department of Army Civilian personnel in the grade of GS–09 or above who have received 2 years of ammunition training and are qualified in accordance with AR 75–1 to assist in performing malfunction investigations.

range error
Difference between the range to the point of impact of a particular projectile and the range to the mean point of impact of a group of artillery projectiles fired with the same data.

range officer
See “installation Range Management Authority” (Army), Range Control Officer (Marine Corps)”.

range personnel
Persons designated to assist the RMA (Army), RCO (Marine Corps) in executing the Installation Range Safety Program.

Range Safety Officer
The officer, WO, or NCO who is the direct representative of the OIC of firing or other operations. The RSO is responsible to the OIC for insuring the adequacy of safety of firing, training operations, and ensuring

compliance with laser range safety requirements and local standing operating procedures.

rear range
The orientation of personnel, materiel, or property to the rear of a weapon system.

remote designation
Designation provided for laser-guided munitions by a source other than the firing platform.

ricochet area
The area located to the left and right of the dispersion area that contains projectiles after making initial contact with the target medium. For SDZs having Angles P and Q, it is also the area located to the left and right of the dispersion area. The ricochet area is defined by Distance W.

ricochet danger area
The area downrange from an artillery target area that contains projectiles and projectile parts (e.g., carrier shells) after making initial contact with the target medium when fired at low angle (less than 800 mils QE).

right and left range
The orientation of personnel, materiel, or property within the SDZ relative to the GTL.

risk management
The process of identifying, assessing, and controlling risks arising from operational factors and making decisions that balance risk cost with mission benefits.

safe area
An area within the SDZ where the probability of injury is minimal to exposed Soldiers/Marines or those provided with protective cover.

safety certification program
A program established and maintained by the battalion/squadron commander to ensure that personnel under their command designated as OICs and RSOs are competent and qualified to carry out the responsibilities and duties of the respective positions.

secondary danger zone
An area outside of the primary danger area which provides containment of fragments, debris, and components from frangible or high explosive projectiles and warheads functioning on the far edge of the primary danger area. Areas A, B, and C are secondary danger areas.

senior Range Safety Officer
The officer designated as the RSO for crew served guided missiles and heavy rockets, excluding direct fire antitank missiles and rockets.

single hearing protector (or protection)
Wearing either earplugs, noise muffs or noise attenuating helmets.

special use airspace
Airspace of defined dimension identified by an area on the surface of the earth wherein activities must be confined because of their nature and or wherein limitations may be imposed upon aircraft operations that are not a part of those activities.

specularly reflective surface
A mirror-like surface capable of reflecting a laser beam.

subcaliber ammunition
Practice ammunition of a caliber smaller than standard for the weapon system. Subcaliber ammunition is economical and may be fired in relatively smaller areas. It is used with special subcaliber equipment and devices to simulate firing conditions with standard ammunition.

surface danger zone
The ground and airspace designated within the training complex (to include associated safety areas) for vertical and lateral containment of projectiles, fragments, debris, and components resulting from the firing, launching, or detonation of weapon systems to include explosives and demolitions.

target area
The point or location within the SDZ where targets (static/moving, point/array) are emplaced for weapon system engagement. For demolitions, it is the point or location where explosive charges are emplaced.

temporary impact area
See impact area.

training complex
Firing ranges and weapons training facilities designated for firing AE, heavy rockets, and guided missiles for training and target practice, and non-live fire sites for maneuver exercises and operations.

training site
A designated location to train, usually within the confines of the training complex. A specific firing range and or weapons training facility designated for firing ammunition and explosives, heavy rockets, and guided missiles for training and target practice, and non-live-fire sites for maneuver exercises and operations.

trajectory safety officer
Assists the SRSO and is responsible for determining when crew served guided missiles and heavy rockets should be destroyed or thrust terminated.

Triple Check
Is a procedure to ensure correct weapon targeting has been verified by at least three independent checks prior to weapon release. Target verification may be a combination of procedures that mitigate human error producing erroneous weapon targeting.

unexploded ordnance
AE which have been primed, fused, armed, or otherwise prepared for action and which have been fired, dropped, launched, projected or placed in such a manner as to constitute a hazard to operations, installations/communities, personnel, or materiel, and remains unexploded either by malfunction or design or any other cause.

unit commander
A commander of an Army or Marine Corps element whose structure is prescribed by competent authority, such as a table of organization and equipment.

uprange
The orientation of personnel, materiel, or property relative to the direction or path of AEs (to include guided missiles and rockets) fired or launched from weapon systems. The orientation is from the target area or impact area toward the firing line or position.

weapon danger zone
WDZ encompasses the ground and airspace for lateral and vertical of impact and post impact effects (ie. Projectiles, fragment, debris and, components) resulting from the firing, launching, and/ or detonation of aviation delivered ordnance. This three-dimensional zone accounts for weapon accuracy, failures, ricochets, and broaches/porpoising of a specific weapon/munition type delivered by a specific aircraft type. Weapon danger zones represent the minimum safety requirements designed for aviation weapons training on DOD ranges.

weapon system qualified
An individual, military or civilian, who has completed a standard program of instruction for a particular weapon system.

weapon system knowledgeable
An individual, military or civilian, who has completed a standard program of instruction for a particular weapon

system or has completed familiarization training established by the senior commander. Familiarization training may involve live-fire training. Familiarization training should be approved by proponent school.

Section III
Special Abbreviations and Terms

APFSDS–T
armor piercing, fin-stabilized discarding sabot-tracer

BB
bunker buster

CPR
common practice round

DAM
Demolition Attack Munition

DAR
Department of the Army representative

dBP
decibels peak

DMOIC
Digital Missile Ordnance Inhibit Circuit

EFSS
Expeditionary Fire Support System

ENA
exposure not allowed

FAH
final attack heading

FS
sulfur trioxide-chlorosulfonic acid solution

GREM
Grenade Rifle Entry Munition

HEAA
high explosive anti-armor assault

IMOIC
Improved Missile Ordnance Inhibit Circuit

IP
intersecting point

JPADS
Joint Precision Airdrop System

JTAC
joint terminal attack controller

LOAL

Lock-On-After-Launch

LOBL
Lock-On-Before-Launch

MAE
maximum allowable environment

Max Ord
maximum ordinate

MCCM
modular crowd control munitions

MEP
mission essential personnel

MGL
Miniature Grenade Launcher

MOIC
Missile Ordnance Inhibit Circuit

MOICE
MOIC Enhancement

NAVAIR
Naval Air

NE
novel explosive

NHA
noise hazard area

NL/TLMS
non-lethal/tube launched munition system

NOHD
nominal ocular hazard distance

NOLSC
Naval Operational Logistics Support Center

OPAREA
operational area

ORAH
On Range Ammunition Handling Tool

RLEM
Rifle Launched Entry Munition

RMA
range management authority

RMTK
Range Managers Toolkit

SA
stay above

SB
stay below

SLAM
Selectable Lightweight Attack Munition

TCM Ranges
TRADOC Capability Manager Ranges

TP–T
target practice-tracer

TPCSDS–T
target practice, cone-stabilized discarding sabot-tracer

UXO
unexploded ordnance

V/m
volts per meter

VI
vertical interval

WDZ
weapon danger zone