Joint Pub 3-09.1

Joint Tactics, Techniques, and Procedures for Laser Designation Operations

28 May 1999

PREFACE

1. Scope

This publication provides joint tactics, techniques, and procedures for employing light amplification by stimulated emission of radiation (laser) target designators, laser acquisition devices, and laser-guided munitions. It describes joint laser planning, coordination procedures, capabilities, and limitations.

2. Purpose

This publication has been prepared under the direction of the Chairman of the Joint Chiefs of Staff. It sets forth doctrine and selected joint tactics, techniques, and procedures (JTTP) to govern the joint activities and performance of the Armed Forces of the United States in joint operations and provides the doctrinal basis for US military involvement in multinational and interagency operations. It provides military guidance for the exercise of authority by combatant commanders and other joint force commanders and prescribes doctrine and selected tactics, techniques, and procedures for joint operations and training. It provides military guidance for use by the Armed Forces in preparing their appropriate plans. It is not the intent of this publication to restrict the authority of the joint force commander (JFC) from organizing the force and executing the mission in a manner the JFC deems most appropriate to ensure unity of effort in the accomplishment of the overall mission.

3. Application

a. Doctrine and selected tactics, techniques, and procedures and guidance established in this publication apply to the commanders of combatant commands, subunified commands, joint task forces, and subordinate components of these commands. These principles and guidance also may apply when significant forces of one Service are attached to forces of another Service or when significant forces of one Service support forces of another Service.

b. The guidance in this publication is authoritative; as such, this doctrine (or JTTP) will be followed except when, in the judgment of the commander, exceptional circumstances dictate otherwise. If conflicts arise between the contents of this publication and the contents of Service publications, this publication will take precedence for the activities of joint forces unless the Chairman of the Joint Chiefs of Staff, normally in coordination with the other members of the Joint Chiefs of Staff, has provided more current and specific guidance. Commanders of forces operating as part of a multinational (alliance or coalition) military command should follow multinational doctrine and procedures ratified by the United States. For doctrine and procedures not ratified by the United States, commanders should evaluate and follow the multinational command's doctrine and procedures where applicable and where consistent with US policies and procedures.

For the Chairman of the Joint Chiefs of Staff:

V. E. CLARK
Vice Admiral, US Navy
Director, Joint Staff

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- **Provides a Discussion of Laser Codes**
- **Covers Laser Safety Considerations**

Overview

Precision weapons will play a key role in the conduct of future battlefield operations.

The light amplification by stimulated emission of radiation (laser) is the enabling technology of more precise weapons. **Laser systems enable** joint forces to engage a wider range of targets with more accuracy and fewer munitions than previously possible.

Laser technology on the battlefield includes laser target ranging and designation systems, laser acquisition systems, and laser-guided weapons (LGWs). **Laser target ranging and designation systems** can provide accurate range, azimuth, and elevation information to locate enemy targets. These can be either aircraft-mounted or ground systems. **Laser acquisition devices** can be aircraft-mounted (laser spot trackers [LSTs]) or mounted on LGWs. **LGWs** home in on reflected laser energy to strike a target.

Laser Target Acquisition

Laser designators can provide precision target marking for employment of air-to-surface and surface-to-surface laser-guided weapons.

Aircrews using laser target acquisition aids have a tremendous advantage over aircrews that have to acquire targets visually. **Ground laser designator operators** (LDOs) have more time than do aircrews. LSTs have a limited field of view but can attack a target even if it can't be visually distinguished from other objects. Optics on aircraft may have a longer line of sight than optics on ground-based systems.

Planning Considerations

Employment of lasers must be carefully planned.

Laser designators **emit a narrow beam of laser pulses** which is susceptible to degradation from atmospheric scatter and a variety of target reflections. The beam may reflect off the target at various angles, depending on the target's shape and composition. **Environmental considerations** such as line of sight and visibility degradation can inhibit successful laser designation operations. LDOs and aircrews must consider these factors when attacking targets. **There are two classifications of targets: area or point targets.**

LDOs must carefully consider operating techniques and locations of laser designators. These techniques include offset designators, delayed designation, and redundant designators.

Procedures

The laser designator operator must consider many factors when selecting a laser designation position.

Safety of ground designators is an essential consideration during designation operations. Aircraft attack headings must be carefully planned to avoid the target-to-laser safety zone. Attack headings inside this zone significantly increase the likelihood that an air-launched weapon will guide, or an LST will track, onto the laser designator instead of the target.

Both ground and aerial observers can designate for laser-guided artillery projectiles. While effective, this procedure requires extensive coordination between the observer and the artillery firing unit.

Ground observers and aircraft can designate for close air support (CAS) operations, whether it is provided from rotary- or fixed-winged aircraft. Using aircraft to deliver LGWs allows the commander to destroy high-threat point targets. Observers and aircraft must know the laser codes to be used prior to actual employment of the LGWs, either through coordination before the CAS mission begins, or as the aircraft approach the target area.

Laser designation support can also be provided to aircraft in a non-CAS role, such as interdiction operations, armed reconnaissance, and other related areas.

Laser Codes

Laser designators and seekers are coded to work in harmony, so that the seeker will track only the target designated.

Laser codes are not entirely compatible across the spectrum of military laser equipment. Some devices and weapons use a three-digit code, while others use a four-digit code. **Multiple coding** allows simultaneous attacks on multiple aim points within an area target without interference from different laser designators.

For joint task force operations, **the joint task force operations officer allocates laser codes** to components. The components further sub-assign the codes to supporting arms, ensuring that the codes are compatible with all component units and laser systems.

Safety

Safety considerations for friendly forces are paramount.

Laser energy is hazardous and must be safely controlled and correctly employed in both training and combat environments. All units involved in laser operations must follow laser safety procedures outlined in this and other laser references, and should establish and enforce laser safety standard operating procedures. Safety considerations are discussed throughout this publication.

The primary danger from current laser designators is to the eye. Units must follow specific procedures to safeguard against eye damage.

CONCLUSION

This publication provides tactics, techniques, and procedures for employing laser target designators, laser acquisition devices, and laser-guided munitions. It prepares for operations involving these precision weapons by describing laser planning, coordination procedures, capabilities, and safety issues.

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CHAPTER I
CONCEPT

"The key principle underlying Coalition strategy was the need to minimize casualties and damage, both to the Coalition and to Iraqi civilians. It was recognized at the beginning that this campaign would cause some unavoidable hardships for the Iraqi people. It was impossible, for example, to shut down the electric power supply for Iraqi C2 facilities or CW factories, yet leave untouched the electricity supply to the general populace. Coalition targeting policy and aircrews made every effort to minimize civilian casualties and collateral damage. Because of these restrictive policies, only PGMs were used to destroy key targets in downtown Baghdad in order to avoid damaging adjacent civilian buildings."

Conduct of the Persian Gulf War, Final Report to Congress, April 1992, Chapter VI, page 131

1. Introduction

a. **The Modern Battlefield. Precision weapons play a significant role in battlefield success by providing commanders with greatly improved weapon accuracy.** This improved accuracy yields higher probability of achieving the desired end state while lowering the probability of collateral damage. The technology enabling increased accuracy of many of these weapons is the laser.

b. **Laser Capabilities.** Laser designators radiate a narrow beam of pulsed energy. Current tactical lasers operate in the near-infrared wavelength spectrum, which is not visible to the human eye. When within range, the laser designator can be aimed so the energy precisely designates a chosen spot on the target. Laser target designators (LTDs) mark targets for laser spot trackers (LSTs) and laser-guided weapons (LGWs). Some laser systems can accurately determine target range and location. When coupled with horizontal and vertical scales, they can measure target azimuth and elevation. LGWs can reduce the number of weapons and/or weapon systems required to achieve an objective, because of increased accuracy. Based on the threat level and environment, LGWs may provide better ways to attack targets.

c. **Laser Procedures on the Battlefield.** The battlefield environment can degrade LGW accuracy. **All elements employing LGWs must conduct thorough planning and follow established procedures to ensure their successful employment.**

2. Laser Use on the Battlefield

Laser technology for the battlefield has developed in many areas, such as laser target ranging and designation systems, laser acquisition systems, and LGWs. Although "infrared (IR) pointers" such as the AN/PAQ-4 and the LPL-30 are technically lasers operating in the .83 micron range, the discussion of their use and associated tactics, techniques, and procedures is not covered in this publication because they are incapable of guiding LGWs.

For further information on these systems, refer to JP 3-09.3, "Joint Tactics, Techniques, and Procedures for Close Air Support (CAS)."

a. **Laser Target Ranging and Designation Systems.** Laser target ranging and designation systems can provide accurate range, azimuth, and elevation information to locate enemy targets. These systems may vary from handheld to aircraft-mounted devices and perform similar functions with varying degrees of accuracy. In combination with global positioning system (GPS), lasers can provide accurate enemy target locations. In addition, lasers in combination with GPS can provide for target area analysis. This analysis can be used to fire weapons accurately at the enemy, to accurately locate future friendly observer locations, and to enable friendly forces to effectively conduct maneuver operations as well as command and control their forces by accurate identification of terrain reference points.

b. **Acquisition Devices.** Of the **two types** of laser acquisition devices, **the first, the LST, is used to aid visual acquisition of the target** to be attacked by another weapon. This type of laser acquisition device is normally mounted on fixed-wing aircraft or helicopters. **The second type of acquisition device is a seeker and guidance kit** mounted on LGWs which guide on coded laser energy.

c. **Striking a Target.** LGWs home in on reflected laser energy to strike a target. Some LGWs require laser target illumination before launch or release and/or during the entire time of flight; some require illumination only during the terminal portion of flight. **Unique laser-guided munitions capabilities can be fully exploited only with careful planning based on a thorough knowledge of each weapon system.**

d. **Basic Requirements.** Six basic requirements are needed to effectively employ laser designators with LSTs or LGWs.

- **Atmospheric conditions must be suitable for laser operations.** Smoke, haze, clouds, and precipitation can significantly attenuate and scatter laser energy and degrade delivery accuracy.

- **A line of sight (LOS) must exist** between the designator and the target and between the target and the LST and/or LGW. For LGWs, this LOS must exist prior to launch or after launch, depending on the weapon's capabilities.

- The **direction of attack must allow** the LST or LGW to sense sufficient laser energy reflecting from the designated target, minimize false target indications,

Unique laser-guided munitions capabilities can be fully exploited only with careful planning based on a thorough knowledge of each weapons system.

and preclude the LGW from guiding on the LTD.

- The **laser designator must designate the target at the correct time** and for the proper duration.

- **The pulse repetition frequency** (PRF) code of the LTD and LST or LGW **must be compatible**

  See Chapter IV, "Laser Codes."

- The **delivery system must release the weapon within the specific weapon's delivery envelope**.

e. **Enemy Use of Laser Countermeasures.** During the past few years, the United States and its allies have become increasingly reliant on laser-guided munitions. Potential US adversaries realize the **importance of laser countermeasures** in a conflict with the United States or its allies. Many of the techniques for countering laser energy and sensitive electro-optical equipment are common knowledge throughout much of the world. Potential US adversaries are well-equipped to detect and counter the increasingly sophisticated laser designator and guidance systems used by the armed forces of Western nations. Prior to the demise of the Warsaw Pact, for example, its literature made continuous reference to the capabilities of natural and manmade obscurants to degrade laser systems, night vision devices, and electro-optical sensors.

f. **Legal Uses of Lasers on the Battlefield.** Protocol IV to the Certain Conventional Weapons Convention (Protocol on Blinding Laser Weapons) **prohibits the use of lasers specifically designed to cause permanent blindness** to unenhanced vision. For all other types of lasers, such as those used for detection, targeting, range-finding, communications, and target destruction, parties to the Protocol have an obligation to "**take all feasible precautions to avoid the incidence of permanent blindness to unenhanced vision**." The United States is not yet a party to the Protocol on Blinding Laser Weapons, but it has been transmitted by the President to the Senate for advice and consent to ratification. The "DOD Policy on Blinding Lasers" was revised on 17 January 1997, and recognizes that accidental or incidental eye injuries may occur on the battlefield through the use of lasers for detection, targeting, range-finding, communications, and target destruction; however, it is Department of Defense (DOD) policy "to strive, through training and doctrine, to minimize these injuries."

Safety considerations designed to minimize these injuries are discussed in Chapter V, "Safety." Appendix E, "Laser Protocol," contains the full texts of Protocol IV and the current DOD Policy on Blinding Lasers.

3. Laser Target Acquisition

a. **Laser Designator Marking.** Laser designators can provide precision target marking for employment of air-to-surface and surface-to-surface LGWs. Precise target marking with laser designators is **directly related** to target size and aspect, laser-beam divergence, designation range, and atmospheric attenuation of the beam.

b. **Target Acquisition. With or without LSTs, as with all acquisition aids, aircrews must always acquire targets visually.** With limited acquisition time, a fighter or attack aircraft aircrew may not see a small target in time to employ weapons. When targets are well camouflaged, acquisition is even more difficult. The aircrew may not be able to distinguish enemy targets from friendly forces or decoys. Even if the target is large, the aircrew often cannot visually distinguish it from natural objects of the same size and color or IR signature.

Ground laser designator operators normally have more powerful optics to acquire targets than do aircrews of fighter or attack aircraft.

c. **Ground and Airborne Laser Designator Operators (LDOs).** Ground LDOs normally have much more time to acquire targets than do the crews of attack aircraft. However, this advantage may be offset by the ground LDO being exposed to fire, or the LDO's inability to accurately laser designate the target due to smoke, haze, terrain, or vegetation. In comparison, attack aircraft LDOs have the following advantages: a generally unrestricted LOS to the target; a less threatened posture; and the possession of better target acquisition and designation systems. Optical viewing allows the operator to pick out camouflaged objects at a distance and distinguish the most important targets when several are in view.

d. **Precision Targeting. Lasers provide the most precise target mark available.** Lasers are not susceptible to wind effects, as are ballistically-delivered target marks such as smoke. Visible target marks may compromise an observer's position and alert enemy forces to impending attack, allowing them to hide or disperse. Visible marks may also obscure the target if not employed properly. *Personnel should be aware of several factors which may affect the precision of a laser mark, and these considerations for planning and employment are discussed in detail in Chapter II, "Planning Considerations." Note: Laser marks may also alert the enemy to the presence of friendlies if the enemy has laser detectors.*

e. **Laser Spot Trackers. LSTs have a limited field of view.** The aircrew must maneuver the aircraft to acquire the laser designator's energy using the LST. A visible mark may also be necessary to help the aircrew align the seeker. When the LST senses the energy and displays the target's position, aircrews are capable of attacking the target even if they cannot distinguish the camouflaged target from other objects on the ground provided they have verified the target by other means.

f. Figure I-1 illustrates IR and laser equipment compatibility. As depicted, **compatibility exists only between LTDs and LSTs**. In other words, all coded laser target designators can work with all coded laser acquisition and/or spot trackers and all coded laser-guided weapons. IR pointers and night vision goggles (NVGs) are only compatible with each other. IR pointers cannot designate for LSTs, and NVGs cannot see the LTD mark. Forward-looking infrared (FLIR) systems are not compatible with LTDs, LSTs, and/or IR pointers.

4. Friendly Forces Safety Considerations

Safety considerations are discussed throughout this publication, specifically in Chapter II, "Planning Considerations," Chapter III, "Procedures," and Chapter V, "Safety." It is key to remember that **laser energy is hazardous and must be safely controlled and employed correctly** in both the training and combat environments.

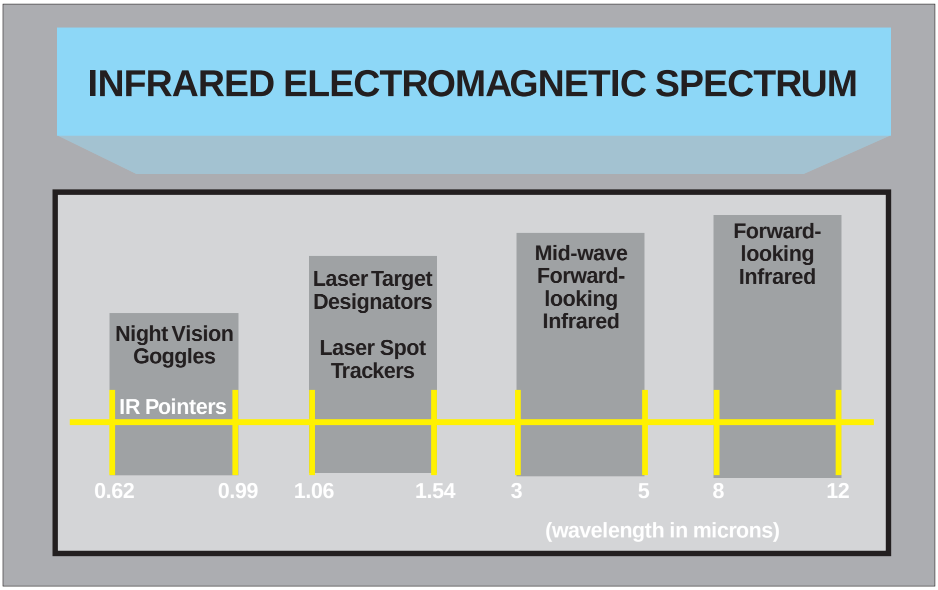

Figure I-1. Infrared Electromagnetic Spectrum

Refer to Military Handbook 828A, "Laser Safety on Ranges and in Other Outdoor Areas," developed by the DOD Laser System Safety Working Group, for the most comprehensive information in a one source document detailing friendly force safety considerations.

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CHAPTER II
PLANNING CONSIDERATIONS

"Victory smiles on those who anticipate the changes in the character of war, not upon those who wait to adapt themselves after the changes occur."

Giulio Douhet

1. Laser Designator Characteristics

a. **Laser Beam.** Laser designators may emit a narrow, collimated beam of laser pulses. The laser designator possesses several unique characteristics, including **beam divergence**, which significantly impact laser operations. Another characteristic is the **single color (wavelength)** of the laser pulses. Laser wavelengths span from the ultraviolet to the visible to the far IR spectrum. **Wavelength determines whether the sensor is visible to the human eye or specific sensor.** Current tactical laser designators fall in the near IR band and are invisible to the human eye. The beam is susceptible to enemy acquisition throughout the laser energy wavelength.

b. **Beam Divergence and Spot Size. The laser spot size is a function of beam divergence and the distance from the laser designator to the target.** If a designator has a beam spread or divergence of 1 milliradian, its spot would have a diameter of approximately 1 meter at a distance of 1,000 meters in front of the designator. For planning purposes, spot size should be determined and ideally equal to no more than half the target surface area.

c. **Optics.** Ground laser designators have **rifle scope-type optics** to help aim the laser energy. The crosshairs allow the laser operator to select a precise aim point.

d. **Atmospheric Scatter.** A seeker may detect scattered radiation that is caused by suspended matter in the atmosphere. It can occur even on clear days. This phenomenon can cause **false seeker lock-on and target indications** within short distances from the laser exit port. This is also referred to as backscatter. Safety impacts of this effect are discussed later in this publication.

Refer also to Military Handbook 828A, "Laser Safety on Ranges and in Other Outdoor Areas," for a further discussion.

e. **Mirrorlike Reflection. Laser energy pointed at a mirror will be reflected, and the beam will remain narrow.** If the mirror is perpendicular to the laser beam (Figure II-1), the beam will be reflected directly toward the laser position. If the mirror is at an angle to the laser beam, the beam will be reflected at an angle equal to the angle of the incident beam (Figure II-2). Any seeker that is looking for this laser energy would have to be in the narrow area of reflection. IR energy is reflected in a narrow beam from bare metal as well as from mirrorlike and glass surfaces.

f. **Scattered Reflection.** If a surface is flat and not shiny, it reflects light and IR energy in a large arc (Figure II-3).

g. **Spillover Reflection.** Spillover occurs when the laser spot is larger than the intended target, or when there is unsteady tracking of the target from the designator. Overspill occurs when some of the laser energy goes beyond the target and impacts an object or terrain behind the intended target. Underspill occurs when some of the laser energy impacts either terrain or an object short of the intended target. When the **target is smaller than the laser spot** or there is unsteady tracking of the target from the designator, there is energy

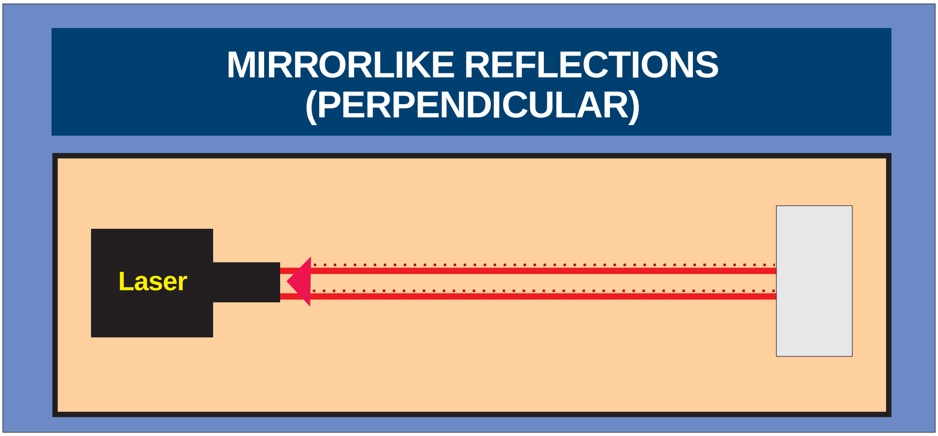

Figure II-1. Mirrorlike Reflections (Perpendicular)

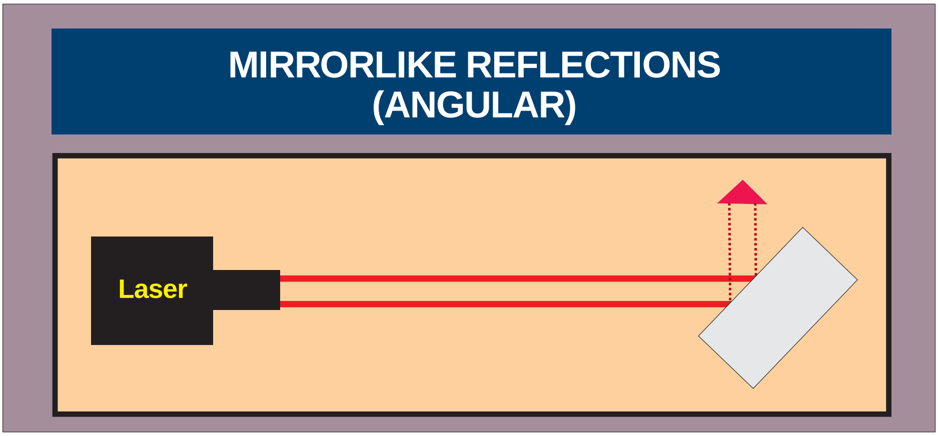

Figure II-2. Mirrorlike Reflections (Angular)

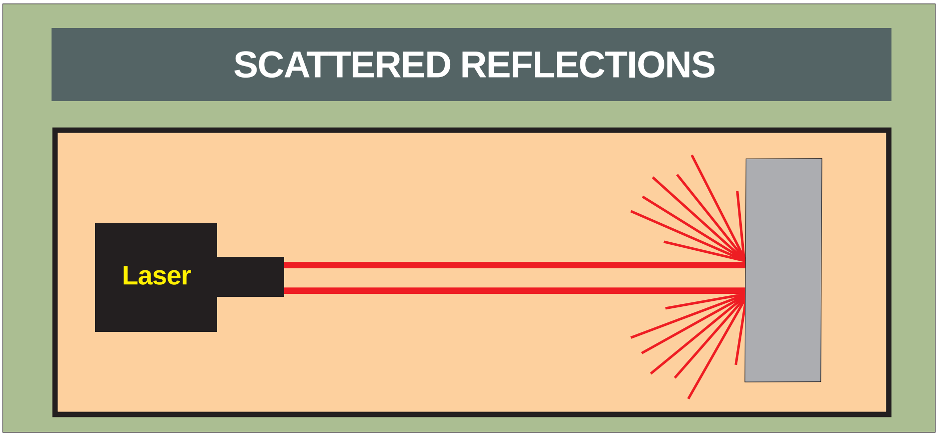

Figure II-3. Scattered Reflections

spillover around the target. This energy spillover is capable of providing scattered reflections off objects near the target (Figure II-4).

h. **Target Reflection.** Most surfaces produce a mixture of mirrorlike and scattered reflections. **Laser energy is reflected in an arc but is strongest at the angle at which it would be reflected if the surface were a mirror.** If the laser designator is perpendicular to a surface, the reflection can be seen from all angles on the designated side, but can be detected best near the laser designator-to-target line (Figure II-5). When the surface is at an angle to the laser designator, the angle of strongest reflection is predictable (Figure II-6).

i. **Vertical Reflection.** The vertical angles of mirrorlike or scattered reflections must also be considered when looking at a target's reflecting surface from the side. **Detectable reflected energy will be strongest at a predicted reflectance angle** (Figure II-7). **Optimum laser spot height depends on specific weapons, the type of delivery, and target characteristics.** Some weapons (PAVEWAY II, for example) lose substantial energy as they descend, and tend to fall short of the target. Since laser seekers are

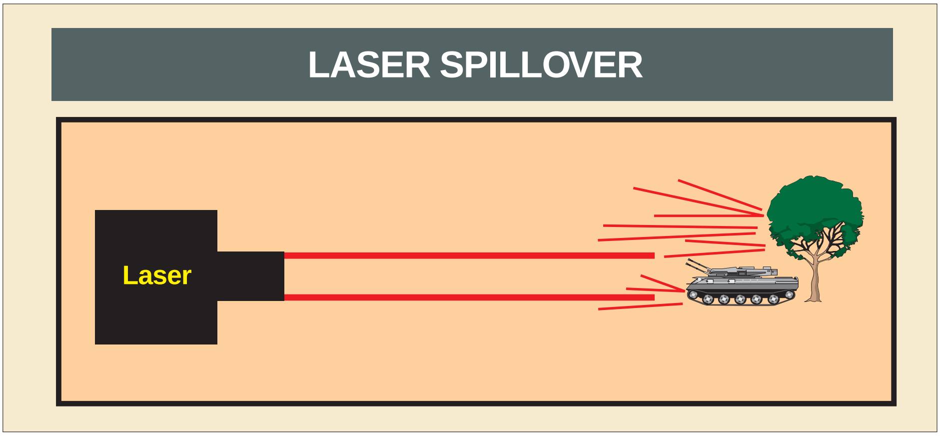

Figure II-4. Laser Spillover

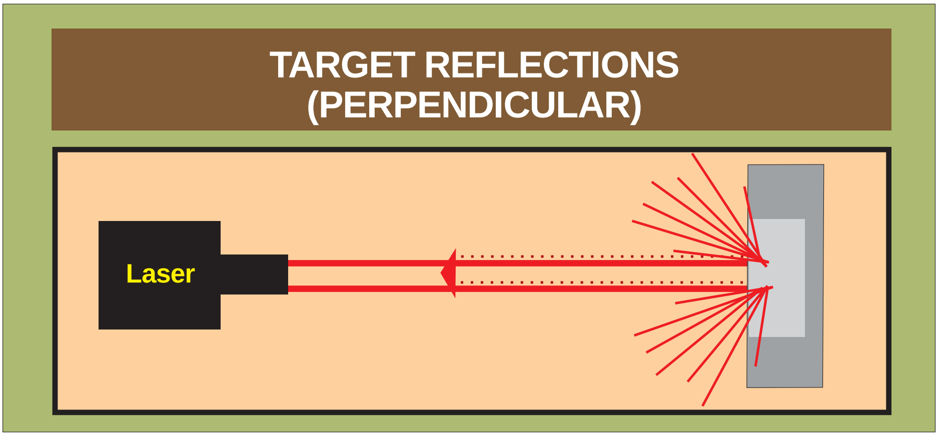

Figure II-5. Target Reflections (Perpendicular)

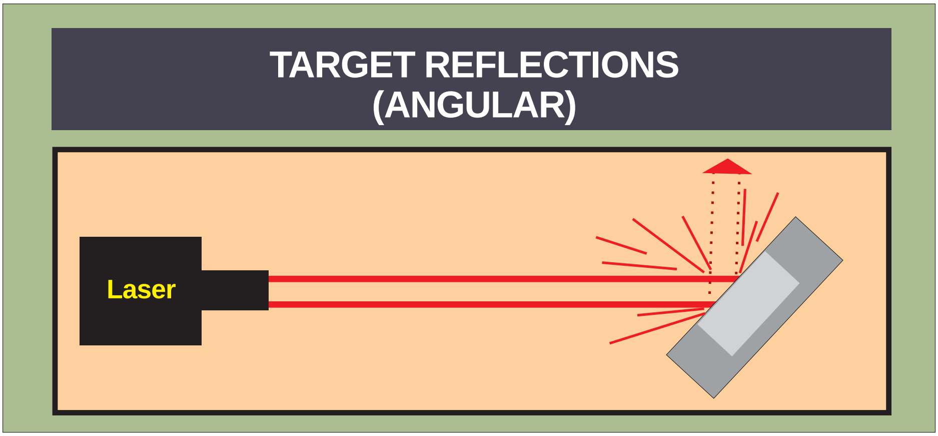

Figure II-6. Target Reflections (Angular)

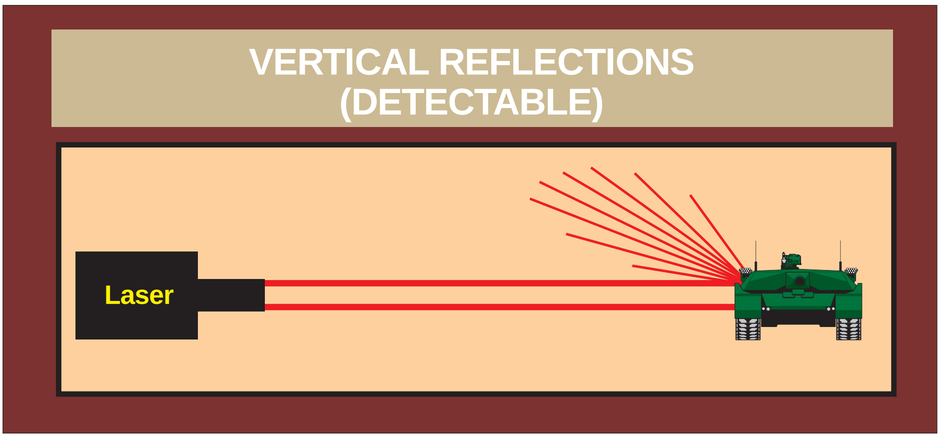

Figure II-7. Vertical Reflections (Detectable)

normally above the horizon, the general rule is to **aim the laser designator at the top third of the target**.

j. **Podium Effect.** A **"podium" effect** can also block a seeker if it cannot see the reflecting surface (Figure II-8). This may occur if an aircraft launches an LGW at a target, and then turns so the laser spot moves to the side of the target and out of view of the LGW seeker.

k. **Reflection in a Chosen Direction.** A laser seeker may be heading to the target from a known direction. For maximum effectiveness, the **designator should be aligned** so that reflection is strongest where the seeker is looking (Figure II-9); however, this does not guarantee target acquisition.

l. **Target Material. Certain materials reflect laser energy better than others** (e.g., the reflection of laser energy off water is 2 percent; olive-drab metal [dirty] 2 to 30 percent; concrete, 10 to 15 percent; asphalt, 10 to 25 percent; unpolished aluminum, 55 percent; vegetation, 30 to 70 percent; brick, 55 to 90 percent). For targets with higher reflectivity, the probability of a laser seeker picking up the laser spot is increased. The precise amount of laser energy reflected from a target is difficult to determine.

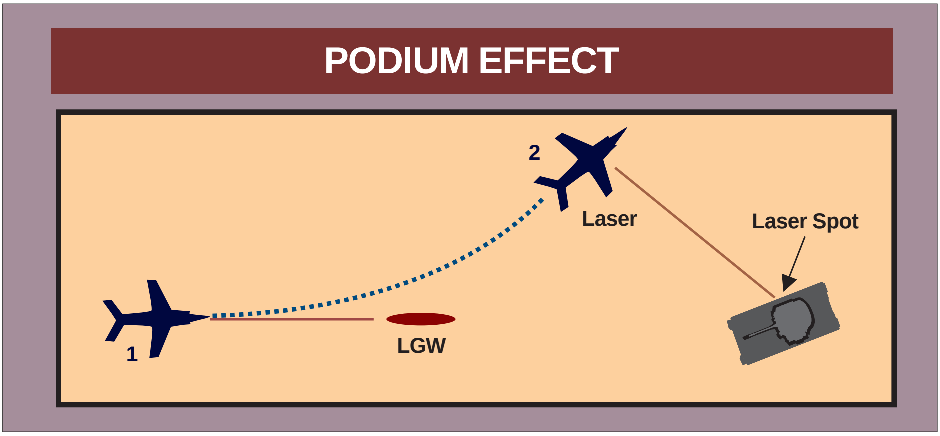

Figure II-8. Podium Effect

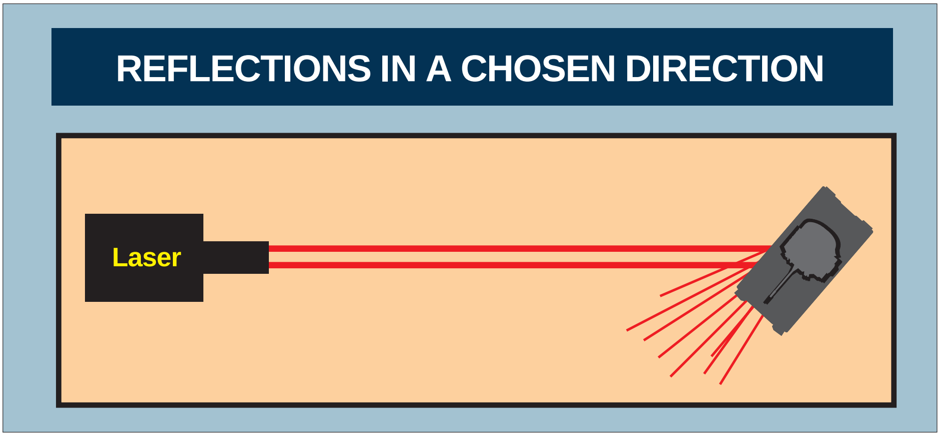

Figure II-9. Reflections in a Chosen Direction

m. **False Seeker Lock-on.** Laser seekers may occasionally lock-on to other reflected energy instead of the target. Even in optimum conditions the seeker may incorrectly lock onto the LTD or the atmospheric scatter present along the laser beam. In this case, a seeker is most likely to detect stray energy only in the immediate vicinity of the designator. To help to minimize seeker lock-on of the designator position due to LOS with the LTD optical port, the **designator should be masked from the seeker field of view**. The designator can be masked by terrain, vegetation, or means of a temporary screen such as blankets or a tarp.

WARNING: This does not guarantee that the laser seeker will not lock onto the laser designator.

Generally LST-equipped aircraft can operate throughout the optimal attack zone without hazard to the ground personnel operating the LTD. However in some situations, LSTs have shifted from the designated target to the laser source (LTD) while the aircraft is operating in the 120 degree attack zone. For this reason, **aircrews must not use LSTs as the sole source for target verification**. Aircrews should verify that they are attacking the target through additional means (such as visual description, non-laser target mark, or other related methods). When the seeker's progress can be monitored by watching the airborne LST-equipped aircraft, it may be possible to detect an improper lock-on in time to prevent a mishap by aborting the aircraft's weapon launch or turning off the designator prior to the weapon's launch and/or release, resulting in an aborted delivery. **Once the weapon has been released, terminating the laser designation will not ensure the safety of friendly forces**. By eliminating the LGW's guidance source (the laser spot), the weapon will simply continue to fly a ballistic profile in the direction of release. This action may, in fact, further endanger friendly forces, especially if they are located between weapon release position and the initial laser spot.

- **Lock-on Errors** for All Types of Ordnance (Free-Fall, Forward Firing (Aerial), and Ground Launched Projectiles).

•• Aircraft LST or LGW locks on to designator. (1) The designator is the only return in the LST or LGW field of view (FOV) or (2) Aircraft LST or LGW sees **multiple points** along the laser beam (to include the LTD). The LTD is the last significant pulse from the aircraft LST or LGW.

•• Aircraft LST or LGW locks on to backscatter. Backscatter and/or spillover energy is of sufficient intensity in a portion of the laser beam to cause the aircraft LST or LGW to lock on. Position of **lock-on is at the last significant pulse** (furthest in distance from the LST or LGW) of the minimum acceptable level of intensity to cause to lock.

•• Aircraft LST or LGW fails to lock-on to anything. Aircraft LST or LGW **fails to lock** due to one or more factors: (1) Failure of designator; (2) The laser designator and LGW are not set to the same code; (3) Low power of designator; (4) Poor aiming of designator; (5) Aircraft LST or LGW is inoperative; and/or (6) Aircraft LST or LGW position is such that the LTD, laser beam, and target are not in the seeker FOV.

- **Prevention** of these errors

•• LDOs should generally **aim** at the center of mass or in such a way as to avoid over spill.

•• Ensure that the LTD and LGW are on the **same laser code**.

•• When external designators are used, ensure that the LGW and/or LST has the proper geometry to keep the illuminated target in its FOV.

•• Aircraft attack headings should be **close to the laser designator-target line**, but outside a 10 degree zone on either side of this line

See Chapter III, "Procedures," paragraph 1c for further discussion.

•• If possible, ground designator operators should **screen the sides of the designator position** (out to several meters in front) using vegetation, tarps, and other related materials.

n. **Laser Boresight. If the laser energy and sighting mechanism of the designator are not matched to the same point (i.e., the target), mission success will be impaired.** Some ground designators do not have a means to check or correct boresight in the field. Others, like the laser marker night vision sight for use on the AN/PEQ-1 and AN/PEQ-1A special operations laser marker (SOFLAM) systems, make it possible to field check the boresight at operational ranges at night. Employment of newer daylight filters allow the field check at short to moderate ranges in the daytime.

o. **Entrapment. Entrapment is the absorption of laser-radiated energy from any direction.** For example, energy directed into the mouth of a tunnel, a dark window, or the tread wheels of a tank may be absorbed rather than reflected, preventing seeker acquisition.

p. **Spot Jitter. Spot jitter is the result of motion of the designator**, or of the beam developed by the designator, **around the intended aimpoint**. This motion may result in a laser-spot bouncing movement on the target that increases with the designator distance from the target.

2. Environmental Considerations

Several environmental factors can inhibit successful laser designation operations. Tactics and techniques must, therefore, take these factors into consideration (See Appendix A, "Laser Equipment Descriptions," for details).

a. **Line of Sight. Unrestricted LOS must exist** between the designator and the target and between the target and the LST or LGW.

b. **Visibility Degradation**

- **Clouds and/or Fog.** Clouds and fog attenuate laser energy and degrade the ability of LSTs and LGWs to see the spot. Since the laser spot is only acquired after the bomb comes out of the cloud, laser-energy acquisition time is short; therefore, ballistic accuracy is essential. Typical minimum ceilings and times of flight can be found in appropriate system operating manuals. In conditions of reduced visibility, current laser systems provide signal transmission ranges only slightly greater than visual range.

- **Darkness.** Laser-energy transmission is unaffected by darkness, but darkness makes locating, identifying, and tracking targets more difficult for the LDO. Night sights for laser designators enhance operator target identification and engagement during night battlefield operations. However, not all hand-held LTDs are adaptable for night sights and, therefore, **night vision capabilities on some LTDs may be limited**.

- **The Obscured Battlefield.** Smoke, dust, and other particulates in the air may attenuate or reflect the laser beam, thereby preventing reflection from the target of sufficient energy for lock-on by LSTs or LGWs. Laser energy reflected from such particles may also present a false target to the tracker or the munitions. Backscatter refers to a portion of the laser energy that is scattered back in the direction of the seeker by an obscurant. Since backscatter energy competes with the reflected energy from the target, a seeker may attempt to lock onto the obscurant rather than the target. LDOs can reduce the effect of enemy obscurants by following some simple rules of thumb. **Positioning is a key to reducing the degradation obscurants imposed on laser performance.** Possible considerations are positioning lasers on flanks or on high ground where smoke is likely to be less heavy along the LOS and repositioning from an obscured to a non-obscured position. Using multiple lasers and transferring the mission from an obscured laser to a non-obscured laser are other possible tactics to counter enemy obscurants.

- **Nonreflecting or Refracting Optical Surface Targets.** Tunnels and other targets that have no capability to reflect laser energy cannot be directly laser designated. Instead, the designator must be aimed at a nearby reflecting surface that will give satisfactory weapon effectiveness against the intended target. For example, aiming the laser slightly above a tunnel opening would allow a weapon to impact at that critical point.

- **Obstructions. Optimum positioning of ground laser designators is essential.** Obstructions such as trees, limbs, leaves, and grass between the designator and target may prevent a clear, unobstructed view for the use of ground laser designators. Jungle operations could thus preclude the use of ground designators and limit the effectiveness of airborne laser designators (ALDs).

- **Temperature Extremes.** Extreme temperatures affect batteries, such as the NiCad batteries used for the ground/vehicle laser locator designator (G/VLLD) and modular universal laser equipment (MULE) system, the NiCads used with the compact laser designator, and those used with the LTD. For example, cold-soaked batteries have a reduced capability to power lasers. SOFLAM is operable using BA-5590 lithium batteries, which are much less susceptible to "cold soaked" limitations on run time.

- **Solar Saturation.** Laser seekers look for a spot of IR energy that stands out from the background. When the seeker dome is cracked, pitted, or glazed, the seeker may detect so much IR energy from the sun that it cannot discriminate the laser spot. This condition is most likely to be a problem when using low-angle LGWs or LST-equipped aircraft, especially against targets above the horizon after sunrise and before sunset.

- **Heat Vapor.** When lasing targets during the hottest portions of the day, heat vapor may have an adverse effect on the beam. The beam may be refracted in causing degraded target designation.

3. Seeker Characteristics

a. **Seeker Code.** Laser seekers look for laser designator energy on a specific PRF code. **Designators and seekers must work together as a team** on a specific code because seekers will not detect designators set on other codes.

See Chapter IV, "Laser Codes".

b. **Field of View.** All **seekers** have a limited FOV, and therefore **must be oriented so that the target falls within that FOV** to see the laser designator spot.

c. **Acquisition Time.** To avoid detection by enemy forces and conserve battery energy, **LDOs may limit the amount of time they designate a target**. Laser seekers and munitions, therefore, could have a very short time to detect the laser spot and guide to the target. LGWs require a minimum amount of time to acquire and track a target. **By limiting the amount of laser designation time, LDOs may significantly degrade LGW accuracy, resulting in failure to achieve objectives and increased potential for fratricide.** Additionally, LST-equipped aircraft may not have enough time to acquire the target under short designation time conditions. Required acquisition time is mission-specific, and should be pre-briefed.

d. **Seeker Sensitivity.** Different laser guidance and acquisition systems require different amounts of reflected laser energy to operate. For example, under ideal conditions, a G/VLLD must be within 5 kilometers (km) of an average stationary target to provide optimum cannon-launched guided projectiles (CLGPs) (COPPERHEAD) guidance

Aircrews should not use LSTs as the sole source for target verification, since the LST may lock-on to the LTD.

whereas, under similar conditions, a PAVE PENNY (US Air Force [USAF] pod-contained) LST can acquire a LTD spot at a distance as great as 30 km.

4. Seeker Types

a. **Airborne LST.** An airborne LST points out laser designated targets to the aircrew, who can then attack the target with any weapons on board. Aircrews may require this target cue because of the difficulty in seeing camouflaged targets at long ranges and high aircraft speeds. LSTs require the laser pulse code to match the designator. LSTs have a limited FOV that requires the aircrew to align the aircraft accurately so the seeker is able to acquire the laser energy. Service tactics and procedures manuals provide detailed guidance on aircraft positioning for laser spot trackers. **Aircrews should not use LSTs as the sole source for target verification,** since the LST may lock-on to atmospheric backscatter or the LTD.

b. **Laser-Guided Missiles (LGMs) and COPPERHEAD CLGPs.** LGMs and CLGPs must be precisely aimed to see the laser energy on the target. Based on the LGM- or CLGP-predicted time of flight, the **laser designation must be timed to optimize LGM or CLGP terminal guidance**. If the laser designator is turned on late, the LGM or CLGP may miss. Turning the laser designator on early will not cause a miss, but it might give the enemy information to locate the laser designator.

c. **Laser-Guided Bombs (LGBs).** LGBs must also be released so that the target is within the seeker's FOV. If the aircraft does not have an LST, a visible target mark may be required as an aiming cue. Because the laser pulse codes are preset on most LGBs and cannot be changed while airborne, the **LDO must use the code set in the bomb**. Whenever possible, the aircrew should communicate directly with the LDO so the laser can be turned on at the best time. Delaying designation until the last 8 seconds of weapon flight may be required in some cases (e.g., PAVEWAY II LGBs). Delayed lasing should not be required for low-level laser-guided bombs (LLLGB). See paragraph 8 for a detailed discussion of delaying laser.

5. Target Types

Targets on the battlefield are classified as either area or point targets.

a. **Area Targets. An area target covers an area rather than a single point.** Area targets include infantry formations, field artillery positions, assembly areas, motor pools, command posts, aircraft parking ramps, logistics sites, and other targets that are large in size or surface area. They are normally neutralized with a large volume of fire delivered throughout the target area. Area targets may be designated for missions using laser designators to designate either specific targets within an area or the general area itself.

b. **Point Targets. A point target requires accurate placement of munitions in order to neutralize or destroy it.** Tanks, guns, bunkers, surface-to-air missile systems, bridges, communications sites, and watercraft are examples of point targets. Laser designators greatly enhance the ability of the observer or controller to engage and destroy or neutralize point targets.

6. Designator Operator Positioning Considerations

Laser weapons demand increased emphasis on basic observer and controller techniques. Laser designators are normally employed by Army fire support teams (FISTs) and combat observation and lasing teams (COLTs), USAF tactical air control parties (TACPs), naval gunfire shore fire control parties, terminal air control parties, Marine Corps forward observers (FOs) on the ground, certain Army, Navy, Air Force, and Marine Corps aircraft equipped with designators, and special operations forces (SOF). To enhance observer and LDO team survivability, terrain, cover and concealment, and standoff distance must be properly used when observing enemy avenues of approach and chokepoints. The **vulnerability of LDOs**, especially ALDs, **must also be considered** when designating point targets like tanks, armored personnel carriers and guns. When using standoff procedures for survivability, the LDO must be aware that the beam divergence of laser designators at long standoff ranges could preclude effective point-target designation. **Wind direction is an important consideration** for LDO positioning for target areas where multiple weapon releases are anticipated. LDOs should position themselves and select order of target attacks so that successive targets will not be obscured by smoke and debris from previous weapons impacts (i.e., the LTD should be set upwind of targets and the targets designated from the farthest downwind first to the most upwind last). **Target orientation in relation to the LTD is critical** in determining the aircraft attack direction based on the direction of the reflected energy (Refer to Figures II-5 through II-8).

7. Offset Laser Designation

When enemy countermeasures or laser alarms are likely to affect laser operations, offset designation may be used. When offset designating, the laser designator is aimed at an object near the target to provide an **approximate target mark or initial aim point**. The LDO should select an object with good reflection, such as a building, to enhance acquisition.

a. **Offset Procedures.** When designating for an LST aircraft delivering unguided weapons, an offset aimpoint may be used. Accurate bearing and distance from the offset to the target and target description should be passed to the aircrew.

b. **Shift Procedures.** When offset designating for an airborne LST, the aircrew may request the laser to be shifted to the actual target for LGW employment. When directed by the aircrew, the designator is smoothly moved from the offset aim point to the target.

8. Delayed Laser Designation for LGBs

Delayed lasing is normally associated with PAVEWAY II. This technique is used to preserve LGB energy during low level releases to keep the LGB from impacting short. **To avoid missing the target, the laser designator must be turned on at a time that will permit the bomb to follow an optimum glide path. Lasing too early will cause the weapon to guide on, and turn down toward the target prematurely, losing valuable energy, and will cause impacts short of the target.** The aircrew will know the proper moment to turn the laser on to meet the minimum lase time for proper guidance. Therefore, if required, **communications channels must be clear** so the aircrew can call for laser activation. **In the absence of positive two-way communications, target designation time and duration must be predicted on the basis of a known time-on-target (weapon impact time) and specific LGB laser requirements.** The specific LGB and the delivery tactics of the fighter or attack aircraft will dictate the minimum designation time required to guide the weapon to the intended target. PAVEWAY II LGBs, for example, when delivered from a low-altitude loft maneuver, will restrict the designation of the target to the final 8 seconds of the weapon's flight. Delivery of a PAVEWAY II from a high-dive delivery (30 to 60 degrees) or medium altitude level delivery allows for either continuous or delayed lasing, but in all cases the laser should be on for the final 8 seconds of bomb time-of-fall.

For more information on delayed lasing's association with PAVEWAY II, see Appendix A, "Laser Equipment Descriptions," Annex T, "Laser-Guided Bombs (PAVEWAY II) (Air Force, Navy, and Marine Corps)," and Appendix D, "LGB And LLLGB Delivery Profiles." See Appendix D, "LGB And LLLGB Delivery Profiles," for a description of LGB and LLLGB delivery profiles.

9. Delayed Laser Designation for HELLFIRE

Designation delay can be used in HELLFIRE engagement when the missile is fired in a lock-on after launch (LOAL) mode. Delayed lasing can be utilized in conjunction with a HELLFIRE engagement where there are low cloud ceilings in the target area. Additionally, delayed lasing will benefit the designation unit because the laser will be energized a less period of time, thereby giving the enemy less time to react if they have laser warning receivers. Like all LGW engagements, positive two-way communications greatly increase the chances of a successful engagement when using this technique.

10. Redundant Laser Designation

Redundant laser designation is a technique employing two or more laser designators in different locations but on the same code to designate a single target for a single LGW. Note: This technique is not recommended. Redundant laser designation may offer some advantages when attacking high-priority targets. **The primary advantage** is that if one designator malfunctions or is compromised, the seeker may still acquire the reflected energy from the other designator and continue guiding to the target. In the case of moving targets, two designators may preclude a guidance failure as a result of temporary blockage. The danger with redundant laser designation is that the presence of two laser designators may cause the LGW to impact where it is not intended. One of the designators may produce backscatter which pulls the LGW away from the target. If one of the designators is outside the 20-degree safety zone, there is an increased chance of the LGW guiding on it instead of the laser spot. This could also happen if one of the designators is significantly forward of the other. For these reasons, the **advantages of redundant laser designators must be weighed against the disadvantages**. The use of this tactic is discouraged, and should not be routinely employed.

See Chapter III, "Procedures" for more information.

11. Laser Systems Descriptions

Appendix A, "Laser Equipment Descriptions," lists current unclassified laser systems and munitions, and discusses their general functions and characteristics.

CHAPTER III
PROCEDURES

> *"A superiority of fire, and therefore a superiority in directing and delivering fire and in making use of fire, will become the main factors upon which the efficiency of a force will depend."*
>
> **Marshal of France Ferdinand Foch**
> **Precepts and Judgements**

1. General Procedures

a. **Laser Designation Position.** In selecting a laser designation position, the LDO must consider LOS, expected munitions trajectory, tactical situation, cover and concealment, weather, and communications requirements. **The LDO should select positions that are near expected locations of high priority targets while minimizing risks to friendly forces**. If redundant designators are going to be employed, mutual support and coordination with maneuver elements should be addressed. The observer or controller team should determine its position as accurately as possible; survey support should be utilized if available. The team can also determine its geographic position by employing GPS, or by using a MULE or G/VLLD to establish range, azimuth, and vertical angle in relation to a known location.

See Chapter V, "Safety."

b. **Employment.** When employing LSTs with ground laser target designators and LGWs, the following procedures will be used.

- **Attack headings** and laser-to-target lines are normally pre-coordinated between the LDO and LGW-employing aircrew (or their representative). During close air support (CAS) operations, terminal controllers can recommend an attack cone and/or final attack heading or give designator target line (DTL) and allow the aircrew to determine the correct geometry. **The attack heading must allow the aircrew to acquire the reflected laser energy.** Due to the possibility of false target indications, attack headings should avoid the target-to-laser designator safety zone, unless the tactical situation dictates otherwise.

- **The safety zone** (to help minimize the backscatter problem) is defined as a cone (generally 20 degrees) whose apex is at the target and extends equidistant either side of the target-to-laser designator line (See Figure III-1). This cone has a vertical limit of 20 degrees. Aircraft may engage targets from above the cone, as long as they remain above the 20 degrees. The minimum safe altitude for aircraft will obviously vary with the aircraft's distance from the target (See Figure III-2). The aircrew may have difficulty determining how high they need to fly to remain above the 20 degrees; aircraft should therefore remain well above these altitudes or remain outside the 20 degree safety zone altogether.

> **WARNING: The safety zone is not an absolute safety measure. In some situations, LSTs have acquired the atmospheric scatter in front of the laser designator even though the LSTs were outside the safety zone.**

- **The optimal attack zone** is inside a 120 degree cone whose apex is at the target and extends to 60 degrees on either side of the target-to-laser designator line and

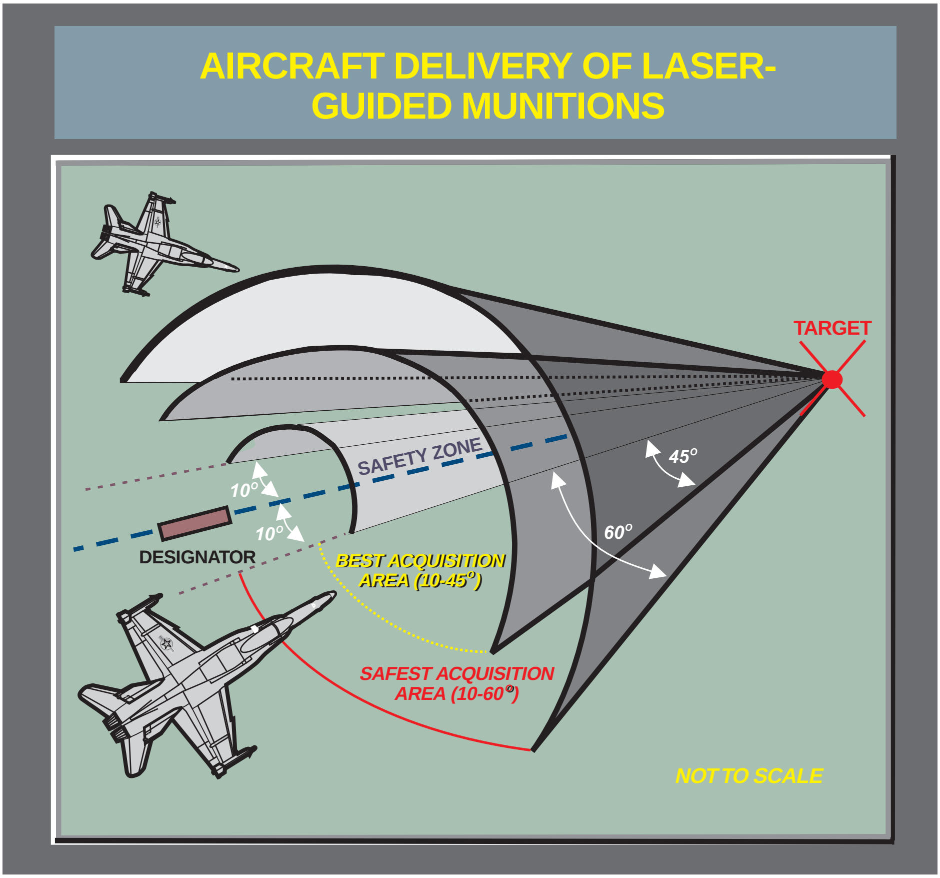

Figure III-1. Aircraft Delivery of Laser-Guided Munitions

is outside the 20 degree safety zone. This leaves an ideal attack zone of 50 degrees on either side of the safety zone. See Figure III-3 for a different perspective on the safety zone and attack zones.

- Generally, LST-equipped aircraft can operate throughout the optimal attack zone without hazard to ground personnel operating LTDs. Risk to the laser designator operator may be reduced by increasing the delivery aircraft altitude and/or offset angle or the designator-to-target distance. While increasing the delivery offset angle improves safety, it may degrade the LST's ability to acquire the laser spot. **The best attack area is therefore from 10 to 45 degrees on either side of the target-to-laser designator line.** In some situations, LSTs have locked onto

MINIMUM SAFE ALTITUDES FOR AIRCRAFT ABOVE THE 20° SAFETY ZONE						
Distance from Target	500m	1km/.6 mile	1.6km/1 mile	5km/3 mile	8km/5 mile	16km/10 mile
Minimum Safe Altitude	600 ft	1200 ft	2000 ft	5800 ft	9700 ft	19,300 ft

Figure III-2. Minimum Safe Altitudes for Aircraft Above the 20° Safety Zone

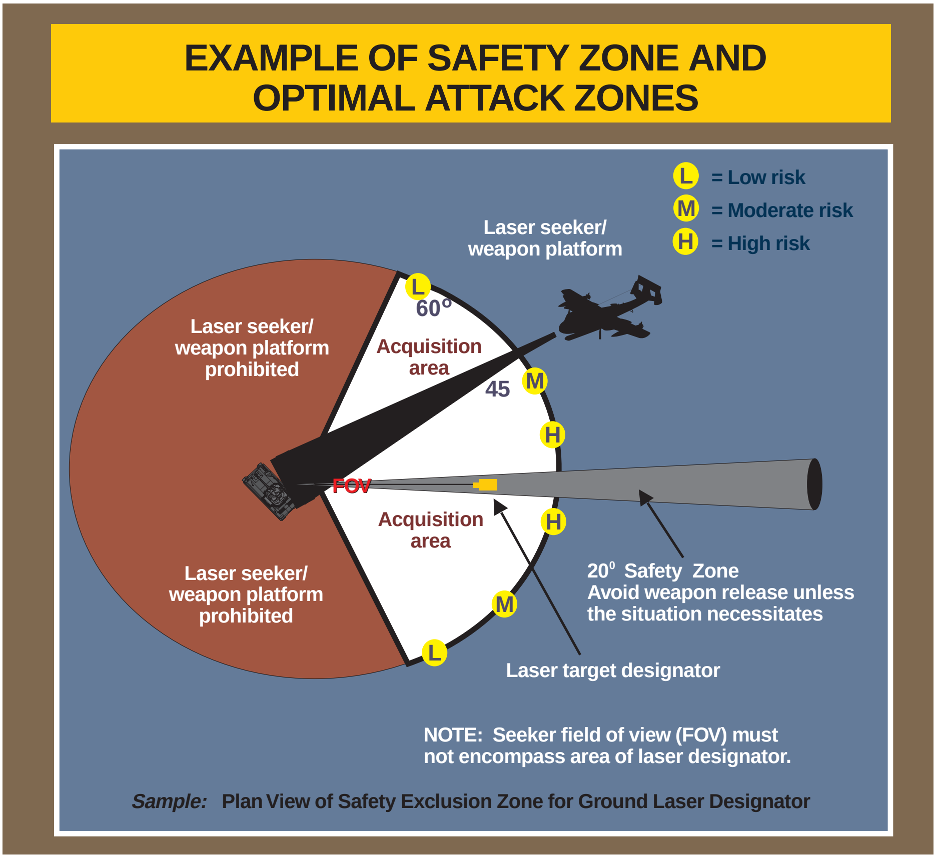

Figure III-3. Example of Safety Zone and Optimal Attack Zones

the laser source while operating in the 120 degree attack zone.

CAUTION: For this reason, aircrews should not use LSTs as the sole source for target verification.

Aircrews should verify that they are attacking the correct target through additional means (such as visual description, terrain features, non-laser target marks). Whenever possible, **planned attacks should avoid placing the designator in the FOV of the LST or LGW**.

c. **Terrain and Target Concealment**

- If the LDO suspects that the **target may be partially masked** from the view of the incoming laser weapon, the LDO should aim the laser at a point on the target believed to be within LOS of the seeker. If the target is well concealed, the laser spot may be aimed at some overhead or nearby object. However, this method is not preferred and should be used only when the situation demands an immediate attack on the target.

- If a designated mobile **target moves out of the view** of the LDO, it may still be possible to salvage the attack. A point near the target may be designated until the target again comes into view or until designation responsibility can be passed to another operator who has the target in sight. It is also possible to move the spot to another target in the immediate vicinity. If the LST or LGW has already locked on, the spot should be moved slowly and without interrupting laser output to the new target location.

CAUTION: Moving the laser spot may seriously degrade mission effectiveness or increase the risk of mission failure.

d. **LDO Survivability.** To enhance survivability, the LDO should **keep designation time to the minimum necessary** for the weapon or seeker being used. This reduces the time available for the enemy to detect, locate, and act to suppress the laser designator.

e. **Laser Designation Timing.** Successful use of LGWs or LSTs depends on the ability of the LDO to designate the target at the proper time. **Laser designation must be closely coordinated with the delivery of an LGW.** Timing requirements should take into account the following.

- Weapons requiring lock-on before launch (LOBL).
- Weapons allowing LOAL.
- Lofted weapons.
- Direct-fire weapons.
- Remaining LTD battery life.
- Laser radiation time constraints due to overheating.
- Susceptibility to laser countermeasures.

f. **Component Interoperability.** Component operations personnel must ensure that laser designators and delivery units have compatible secure communications equipment and common secure codes or the authentication codes necessary for joint communications on non-secure nets.

2. Laser Designation for Artillery

a. **Ground Designator Procedures**

- The FIST, Army COLT, Marine Corps FO team terminal air control parties, USAF TACPs, and SOF use laser designators to designate stationary and moving point or area targets for attack by LGWs and aircraft with LSTs.

- The maneuver commander specifies the priority of target engagements with LGWs in the fire-support plan. The commander's priorities depend on the situation and range to targets. Depending on the situation, the commander may distribute fires by using engagement areas delineated by terrain features or sectors bounded by azimuth and range limits. For example, the commander may specify that all point targets beyond a certain linear terrain feature have priority for attack by LGWs.

•• After the maneuver commander's guidance is given, the fire support coordinator (FSC) will **select planned aiming points** to facilitate rapid attack of targets in the engagement area. The aiming points are transmitted to the next higher FSC, who resolves duplication and forwards the target list to the supporting artillery unit.

•• During offensive operations, the range of some laser designators allows LDOs to remain in an overwatch position at the beginning of the attack and then to **support from successive positions** as the advance continues, alternating their movement to ensure continuous coverage of the forward elements. After the objective is taken and consolidation is under way, the laser designator is rapidly repositioned to designate retreating point targets and respond to possible counterattacks.

•• During defensive operations, the FIST **coordinates the location** of the laser designators with the company commander.

b. **Airborne Laser Designator Procedures.** The greater mobility of ALDs enables the LDO to more easily acquire targets and maintain a constant LOS with them. Aerial observers use the same calls for fire as ground observers. They obtain a gun-target line from the fire direction center (FDC) and position themselves near the gun-target line to increase the probability of target engagement by CLGPs. In a heavy enemy air defense situation, the ALD should stand off as far as possible; in these situations, the **use of suppression of enemy air defenses (SEAD) missions should be planned**. All other procedures remain the same as those used for ground designators.

c. **CLGP and/or "COPPERHEAD" Employment**

- **Optimum use of COPPERHEAD** is against multiple targets in large target arrays outside the range of maneuver direct fire weapon systems (approximately 3,000 meters). COPPERHEAD targets can be engaged as either planned targets or targets of opportunity. **Planned targets are preferred due to the complexity of technical fire direction computations** and ammunition handling procedures in the firing units. Most often, the target of opportunity technique is used only during offensive operations.

- **Targets of Opportunity.** Attacking a stationary target of opportunity requires the observer to determine the target location and transmit a call for fire. Attacking a moving target of opportunity is more complicated because it requires the observer to predict where the target will be (intercept point) by estimating the target speed and direction of movement and comparing it to the firing unit mission processing time. The observer uses this information to determine the proper time (trigger point) to initiate a call for fire so that the round impacts at the target location.

- **Planned Targets.** Planned targets are developed as a result of the fire support planning process. This permits optimal observer positioning and allows the observer to pre-determine intercept, trigger points, and COPPERHEAD engagement areas utilizing footprint templates.

- **Effective employment of COPPERHEAD** is enhanced by techniques used by the fire support officer (FSO) to position the COLT, FIST, or FO before target engagement and by observer techniques at the observation post. Steps involved in optimizing the potential employment of COPPERHEAD are as follows.

•• Position the observer to most effectively accomplish the commander's target attack guidance.

•• Ensure that a target engagement angle T (the angle between the gun-target line and the observer-target line) is no greater than 800 mils, as this would adversely affect COPPERHEAD targeting.

•• Position the observer within the range capabilities of the laser designator. The maximum effective distance for the G/VLLD is 3,000 meters for moving targets and 5,000 meters for stationary targets.

The maximum effective distance for the MULE is 2,000 meters for moving targets and 3,500 meters for stationary targets.

•• Construct a visibility diagram from the selected position when it is occupied.

•• Employ the appropriate COPPERHEAD footprint. Footprints are roughly oval in shape and form around the target location. The optimum limit of engagement is within the boundaries of the footprint. Although COPPERHEAD can maneuver outside the limits of the footprint, the greatest chance of hitting the target is when it is at or near the location sent to the FDC by the observer. The outer boundary of the footprint represents a 50-percent probability of a target-hit; the location sent to the FDC has a target-hit probability substantially higher than 50 percent. The size and shape of the footprint are affected by cloud height, the range from the firing unit to the target, visibility, and the angle of fire (high or low). Footprint templates have been developed to accurately portray the engagement area of each adjusting point. Each footprint template has the oval shaped footprint (to 1:50,000 scale) based on the firing unit range to the target and cloud height, and is marked with a letter identification code.

•• Designate the target continuously during the last 13 seconds of the COPPERHEAD's flight.

NOTE: For a detailed explanation of Observer-FDC COPPERHEAD procedures see Appendix B, "Procedures Guide."

•• If the observer does not acknowledge the "LASER ON" call, the FDC will continue to transmit "LASER ON" until rounds impact.

3. Laser Designation for CAS

This section discusses procedures for using laser designators for CAS missions and includes: (1) Adding laser designation procedures to the CAS briefing and aircrew reporting procedures; (2) Establishing a means of communication between the forward air controller (FAC) and FO to coordinate laser designation of targets when the FAC is not collocated with the laser designator; and (3) Establishing standard terminology for laser-related activities.

For a detailed explanation of CAS employment procedures and tactics, refer to JP 3-09.3, "Joint Tactics, Techniques, and Procedures for Close Air Support (CAS)," and Service-specific CAS publications.

a. **Target Acquisition Considerations**

- Using laser designators for CAS can provide a **fast and accurate means of marking targets** for both LGWs and LST-equipped aircraft. Using target coordinates, smoke, and illuminating flares complements laser designator target-marking and improves the chances for successful first pass target acquisition. Without cueing, aircraft may be pointed too far away from the target to acquire the laser spot. Therefore, when the tactical situation allows, **supplemental marking is recommended** to avoid losing sorties or having to re-attack. Care should be taken to avoid obscuring the target with the secondary mark.

- Aircraft equipped with an LST are able to detect reflected laser energy. These aircraft include: A/OA-1O, non-radar equipped AV-8B, selected F/A-18C/D (when LST is externally mounted as a store), AH-64, MH-60L, and AH-6 aircraft. LST-equipped aircraft can use detected laser energy to acquire and attack both area and point targets. The

extreme accuracy of laser target designation assists fighter and attack aircraft crews in positively identifying the correct target and significantly reduces the possibility of an aircrew misidentifying friendly positions as the target.

- LST-equipped aircraft should notify the terminal controller of their capability. The terminal controller should then pass the laser code to the attacking aircrew. In the case of LGBs, the aircrew will inform the terminal controller of the weapon's laser code because the LGB code must be set prior to takeoff. If a forward air controller (airborne) (FAC[A]) is being utilized, coordination will be made between the ground controller, FAC(A), and the attacking aircrew. Coordination will be critical if the laser designator is not physically located with the terminal controller. A complex example would be a non-laser capable FAC(A) supporting a non-laser capable TACP, who is coordinating with the FO who has a designator. The FAC(A) will subsequently pass the code to the TACP, FIST, and/or FO. The Marine Corps FAC will pass the code to the FO only if the FO is tasked to designate the target.

b. **Standoff LGW Delivery**

- Target acquisition is usually followed by the delivery of LGWs. Some LGWs, such as laser MAVERICK, and LLLGB and/or PAVEWAY III, can be released at standoff ranges that may reduce the delivery aircraft's exposure to enemy air defense systems and increase aircraft survivability.

- Once released, the weapon homes in on reflected laser energy.

- Like any air delivered weapon system, the maneuver commander must fully understand and accept the consequences of a possible failure of the weapon to properly guide to the target. **The final decision to release standoff LGWs from behind friendly lines in a CAS environment rests with the maneuver commander.**

c. **Concept of Employment**

- **Tactical Air Control Party.** The TACP is the Marine Corps or Air Force tactical air control agency located with the supported ground unit. Its **functions** are providing air liaison, advising on the use of air assets, and coordinating and controlling CAS missions to support the ground commander's scheme of maneuver. Three Marine naval aviators or naval flight officers are typically assigned to each Marine Corps TACP: one serves as the battalion air officer who works in the battalion's fire support coordination center (FSCC), and the other two are FACs and usually deploy with the forward rifle companies. The Air Force TACP at battalion level normally consists of one air liaison officer (ALO) and two enlisted tactical air command and control specialists, at least one of whom is an enlisted terminal attack controller (ETAC). TACPs assigned to light battalions may have up to five controllers. The ALO and ETACs provide terminal CAS control.

- **FIST and FO Procedures for CAS.** When possible, the Air Force FAC should be located with the FIST, and the FIST should place a radio close to the LDO (Marine Corps FACs may or may not be collocated with their FOs). Placing a radio close to the LDO will minimize the need to relay laser calls between the pilot and the FIST. At times, the Air Force FAC will not be with the FIST and may not be able to see the target. The FAC will control the aircraft and coordinate laser designation with the FIST. When the FAC and FIST are not together, aircrews may make laser calls directly to the FIST on a frequency assigned by the FAC in the remarks section of the CAS briefing (in accordance with [IAW] Joint Pub 3-09.3, "Joint Tactics, Techniques, and Procedures for Close Air Support [CAS]"). In situations where the Marine Corps FAC is not in an optimum position to designate the target, the FAC may control the aircraft with the FO actually designating the target. The Marine Corps FAC and FO can communicate and coordinate using the TACP local net; however, prior coordination is required.

- **FAC Not Present.** There may be situations where the FAC is not present, or cannot see the battlefield (e.g., security operations in front of friendly positions, night operations). In these situations, a qualified fixed- or rotary-wing FAC(A) may direct the terminal control of CAS in coordination with the TACP. In the absence of a TACP or airborne FAC, the FIST can also **provide emergency control** of CAS. However, under these circumstances, the requesting land commander assumes responsibility for the results of the attack.

- **Special Operations Terminal Attack Controller (SOTAC). SOTACs are** qualified members of Air Force special operations command special tactics teams and are certified to conduct terminal attack control and laser designation operations unilaterally or with other US or coalition units in support of SOF missions. The joint force special operations component commander will track locations, frequencies, and call signs of deployed SOTACs and relay this information to the special operations liaison element in the joint force air component commander's joint air operations center.

- **Other Special Operations Forces.** Other SOF units, primarily Army special forces detachments, Ranger units, and Navy sea-air-land teams (SEALs), are trained and equipped to conduct **terminal control operations** under the SOF core mission of direct action. This could be for CAS or laser designation for an interdiction attack of high-payoff targets deep in enemy territory. SOF forces can emplace remote command-activated designators which can be activated when needed.

- **Marine Expeditionary Unit (Special Operations Capable) (MEU[SOC]).** MEU(SOC)s are the Marine Corps primary forward-deployed Marine air-ground task force (MAGTF). The MEU(SOC)s numerous capabilities include the ability to conduct laser designation for an attack against high-payoff targets. The laser designation capability is resident in both MEU(SOC)'s night targeting system equipped AH-1W Cobra and the direct action (DA) platoon of the force reconnaissance detachment. The DA platoon is capable of surface, subsurface, and parachute insert. As such it can designate targets for MAGTF, joint, coalition, or allied aircraft while operating deep within enemy territory.

d. **FAC Procedures**

- **FAC Responsibilities.** The FAC should expect to use LST-equipped aircraft and aircraft with LGWs. The FAC should plan to use laser target designation to help LST-equipped aircraft identify the target quickly and accurately. **Early planning by the FAC is required** to ensure that the FIST or FO is ready for laser operations when the fighter or attack aircraft first contacts the FAC. **Thus, the FAC must have a thorough working knowledge** of the capabilities of LST-equipped aircraft and of aircraft-delivered LGWs. When conducting CAS with lasers, **always strive for simple communications**. Good preplanning, accurate target location, and reliable communications are essential. Critical targets must be identified to the FAC (The joint CAS briefing format is listed in Appendix C, "CAS Briefing Form [9-Line]").

• **Laser Designation Coordination**

•• The laser designator may be turned on for target acquisition, target identification, or employment of LGWs. The following communication sequence will be employed: (1) TEN SECONDS (time until "LASER ON" call expected); (2) LASER ON; (3) SHIFT (if required); (4) SPOT; and (5) TERMINATE.

NOTE: The "10 SECONDS" call means the aircrew wants the laser on in approximately 10 seconds. The FAC relays the call to the LDO. The "LASER ON" call requires the FAC (or FIST) to ensure that the LDO designates the target immediately. The situation will determine whether the attacking aircrew or elements of the friendly ground forces will make these calls.

•• The FAC (or Army FIST) should acknowledge the **"LASER ON"** call. The FAC may elect to turn the laser on 10 seconds after the "10 SECONDS" call without hearing the "LASER ON" call if problems are expected.

•• Offset designation procedures may be used in a laser countermeasures environment. Following the "LASER ON" call, a "SHIFT" call will be used to shift laser energy from the offset position next to the target onto the target itself. The **"SHIFT"** call, when used, must be pre-briefed to replace the "SPOT" call.

•• The aircrew calls **"SPOT"** when acquiring the laser spot, confirming to the FAC and the wingman that the aircraft or weapon laser seeker has identified a source of laser energy which may be the designated target.

•• For multiple aircraft in the same attack, **"SHIFT"** calls may be used after the lead aircraft calls "SPOT" to direct the LDO to shift the laser to the next aircraft's target. This call is usually used for target acquisition in conjunction with weapons not requiring terminal laser guidance.

•• The last call in the sequence is **"TERMINATE."** The pilot makes this call to turn the laser off.

• **Turning the Laser Off.** Minimizing the time a laser is on is important in a laser countermeasures environment and when employing battery operated laser designators. **Careful planning must be conducted when aircraft are attacking in line or wedge formations** to ensure that the lead aircraft does not terminate the laser before the wingman's lock-on. When in trail, each aircraft may want to make separate laser on and terminate calls, depending on their separation. The laser designator operator will turn the designator off:

•• When the "TERMINATE" call is heard;

•• When the weapon hits the target(s); or

•• After 20 seconds (or longer, if requested) to conserve the laser's battery.

- **Laser Countermeasures Environment.** When operating in a high laser countermeasures environment, the FAC may have to coordinate **laser designation based on timing rather than radio calls**. In such a case, the CAS briefing includes the time to LASER ON. The FAC would say, for example, "LASER ON IN 4 MINUTES READY, READY, HACK." Standardized communications calls include: "LASER ON AT 35" or "LASER ON IN 5+00, HACK" (use of the atomic clock method is preferred). Aircrew should acknowledge the "HACK." As required, FAC will give the LDO a similar briefing. The LDO will designate at the specified time and continue designating as required.

- **If No Spot Is Acquired.** If no spot is acquired, the FAC should refer to back-up or CAS talk-on procedures. Post ordnance delivery procedures follow standard CAS practices. If a subsequent attack is conducted, the FAC should verify that the aircrew knows the location of the target and that the LDO and the LGW and/or LST are set on the same laser code. If the weapons do not guide, the FAC should inform the aircrew. Re-attacks should not be attempted in a high threat environment.

- **Emission Control Procedures.** Some missions may require that laser target designation be accomplished in a radio silence environment. For these missions, there will be an established time-over-target window when the laser designator will be turned on. Aircrews need, at a minimum, the following information prior to the mission:

  •• Target coordinates;

  •• Target elevation;

  •• Time-on-target LASER ON time and LASER OFF time;

  •• Laser code and DTL;

  •• Target description;

  •• Friendly location(s); and

  •• Threat.

e. **LDO Procedures.** The LDO must be extremely responsive to the aircrew's "LASER ON" call. Unless using offset designation procedures, the **LDO must designate only one target** and not move or search while the designator is on and aircraft are in the area. Following the FAC's instructions explicitly will help prevent confusion and miscoordination.

f. **LST-Equipped Aircraft-Aided Delivery of Non-Laser-Guided Weapons.** With an LST-equipped aircraft, the aircrew can use the laser spot as an aid to visually acquire the target. Delivering non-LGWs on well-camouflaged targets may require continuous designation to accurately deliver strafing or ballistic ordnance.

CAUTION: Aircrews should not use LSTs as the sole source for target identification.

g. **LGB and PAVEWAY II (and III).** The laser code is set on the ground prior to launch and cannot be changed by the aircrew in the air. The FAC will pass the LGB code to the LDO.

- **Run-In.** When planning the mission, the FAC must carefully select the run-in heading to ensure first pass delivery and safety for friendly ground positions.

- **LGB Release.** LGBs must be released within the weapon's delivery envelope. For best results, the **aircrew must see the designated target**. In some cases, the attacking aircraft may have sufficiently accurate bombing references from onboard navigation cues to permit releasing the bomb without the aircrew seeing the target. Because of the risk to friendly ground forces, the FAC should avoid loft attacks with weapons release behind friendly positions.

- **Laser Call Coordination.** Timely coordination of "LASER ON" and "TERMINATE" calls are essential to effective LGB delivery, especially in a CAS environment. Designating the target too early may cause LGBs to guide too soon and hit well short of the target.

- **Standoff Delivery of LGBs.** Delivery of LGBs near friendly forces is a risky venture and requires **extremely close coordination** between the delivery aircraft and FAC, attack helicopter, and LDO. Because of the inherent risk to friendly ground troops, the ground commander requesting the support must authorize LGB standoff deliveries. If the LGB guidance system detects reflected laser energy from the target designator too soon after release, it tends to pull the LGW down below its required trajectory and the bomb will hit well short of the target. For this type of attack, **it is critical to delay lasing, i.e., begin designating the target only during the last part of the bomb's flight**. The aircrew must call "LASER ON" based upon its computation of the bomb's time of flight to ensure safe and accurate terminal guidance. The aircrew must know exactly where the target is and make a very accurate delivery and release of the weapon. If the bomb is released in a high angle loft, continuous lasing is possible because the seeker won't see the designator until it apexes and starts down. **Again, only the ground commander can authorize a loft delivery from behind friendly lines.** The aircrew is solely responsible for delivering a weapon within guidance parameters. Weapons delivered for optimum laser profiles are not necessarily optimized for unguided or ballistic trajectories that will permit target destruction without laser guidance.

  See Appendix D, "LGB And LLLGB Delivery Profiles," for examples of LGB delivery profiles.

h. **LLLGB/PAVEWAY III Delivery.** The LLLGB/PAVEWAY III is an advanced LGB with a standoff delivery capability from all altitudes. This bomb has a wider FOV than the PAVEWAY II, is not as delivery-parameter sensitive, and is not negatively affected by early laser designation. In fact, **continuous lasing is best** since it results in the best bomb flight profile and provides the most time for lateral and/or wind corrections. After a proper delivery, the LLLGB will maintain level flight while looking for reflected laser energy. If the LLLGB does not detect reflected laser energy, it will maintain level flight to continue beyond the location of the designated target. Approach angles should be planned so that a long hit will not result in fratricide. Ground commander and aircrew responsibilities remain unchanged.

i. **Laser-Guided Missile Delivery.** FAC procedures for delivering LGMs like MAVERICK (AGM-65E) and HELLFIRE (AGM-114) are similar to those for delivering LGBs. The FAC's role in planning the mission, briefing and getting the aircrew onto the correct run-in heading, and commencing illumination of the target remains the same. However, one major difference exists — **the**

The lock-on and launch ranges of LGMs in good visibility may be beyond the range a FAC is able to see and clear the aircraft.

lock-on and launch ranges of LGMs in good visibility may be beyond the range a FAC is able to see and clear the aircraft. When the aircraft has been acquired by the FAC, the FAC should ensure that the target's position in relation to the approaching aircraft is correct (appears locked onto the target).

j. **Mixed Munitions Procedures.** If the aircraft is carrying both unguided bombs and LGWs, consideration should be given to delivering the LGW on the first pass, before ordnance-generated visibility degradation can occur. Successfully delivering an LGW on the first pass has the added advantage of providing all aircrews in the flight with the precise location of the target; however, the tactical situation, FAC coordination, and aircrew and aircraft capabilities will dictate the tactics used.

k. **Attacks by Multiple Aircraft.** Use of laser designators and LST-equipped aircraft facilitates rapid attacks by two or more aircraft. The aircraft operate as a flight under the control of a single FAC, who is responsible for planning and briefing the mission. Actual tactics will need to be understood by all participants. Separation of aircraft in the flight is based on the tactical situation, the flight profile, release altitude, and fragmentation pattern for the munitions employed. **Multiple aircraft attacks on multiple targets require increased coordination and planning.**

- **Attacks on a Single Target.** Single aircraft employing LGWs may be able to destroy a target. Multiple aircraft attacking a single target provide redundancy and increased likelihood of target destruction at the earliest possible time. The aircraft may be in a trail or other tactical formation. A single designator is required, but a redundant designator may be considered if the situation warrants. The attack is carried out by either (or both) aircraft achieving lock-on and successful munitions release. FAC procedures remain the same, except that the FAC may clear the second aircraft to perform a follow-up attack on the target (using LGWs or nonguided munitions).

NOTE: Multiple aircraft, each dropping LGBs, should space deliveries so as to avoid degrading LGB accuracy of follow-on attacks due to smoke, dust, and debris.

- **Attacks on Multiple Targets**

  •• **Simultaneous tactical formation attacks** on multiple targets may require as many laser designators as there are aircraft. **The laser equipment must be set on different codes to prevent all the aircraft in the formation from locking on the same target.** If the TACP or FIST has only one laser designator or all targets are not visible from their position, coordination with adjacent unit laser-designator operators will be required. Communications must be established and authority obtained to use the adjacent unit laser designators. Communications connectivity is done before the aircrew is briefed. The FAC controlling the attack gives the command to each LDO to begin designating targets.

  •• **Sequential target attacks** (aircraft in trail) can be accomplished by designating with a single laser designator or multiple laser designators. If all LGWs have the **same laser code, timing between LGW releases must be sufficient** to deconflict the attacks on separate aim points (i.e., the second set of LGWs should not be released until the laser designator has moved the laser spot to the new aim point). If the LGWs have **different codes, the time between attacks must be sufficient** for the designator operator to change codes and move the laser spot to the follow-on aim point. It is better to use separate laser designators on different codes for each aim point; however, more coordination is required. **Using multiple designators has the added advantage of reducing the length of time any single laser is on and exposed to enemy counteraction.** As with the tactical formation attack, the mission is planned, briefed, and controlled by a single FAC. The FAC also controls the LDOs.

  See Appendix B, "Procedures Guide," for a discussion of ground and airborne designation procedures for CAS.

l. **Night and/or Low Light Operations**

- **General.** Because of target acquisition problems, CAS at night is more difficult for both the FAC and the attacking aircrew. The ability to use visual cues is determined by the natural light, availability and correct placement of artificial illumination, and whether or not the battle area is marked by muzzle flashes, tracers, explosions, and fires. Sighting-in the laser designator and maintaining the spot on the target is difficult, particularly if the target is moving. Flare effects, ordnance flashes, and the lack of a visible horizon also place aircrew at risk of becoming spatially disoriented. Coordination and proper separation between individual aircraft in the flight are more difficult at night and generally result in a slower pace of operations. Unaided visual sighting of an aircraft without lights at night is virtually impossible. CAS procedures and release approval for night operations will be different from daytime conditions.

- **Laser-Aided Night Attacks.** Using a laser designator and LST-equipped aircraft greatly reduces the aircrew's target acquisition problem if it is allowed to deliver the munitions on the spot appearing on the heads-up display (HUD). Without corroborating sensors such as FLIR and NVGs, this procedure should not be employed where safety of friendly troops is of primary concern, i.e., CAS. When aircrew are employing FLIR and NVGs, however, they are able to "visually" acquire and confirm the selected target after receiving the laser spot from an LST. Once the aircrew has acquired the target, a normal system attack may be prosecuted. Attacks on multiple targets and attacks by multiple aircraft at night may be more susceptible to obscuration than daytime attacks because of decreased visual activity.

- **Night Vision Device Employment**

See JP 3-09.3, "Joint Tactics, Techniques, and Procedures for Close Air Support (CAS)," for a discussion of night vision device employment.

4. Rotary-Wing Close Air Support

a. **General.** Using rotary-wing aircraft to deliver LGWs allows the ground commander to destroy high-threat-point targets. Rotary-wing aircraft may be equipped with any combination of ALDs, LSTs, and LGWs. All laser designators can assist laser-system-equipped rotary-wing aircraft in target acquisition and provide terminal weapons guidance. Rotary-wing aircraft are employed by the Army as maneuver elements under direct control of the ground commander or aviation unit commander. One of the functions of Marine attack helicopters is to provide CAS in support of the MAGTF. Precise engagements will be aided by the use of LGWs. Army special operations attack helicopter crews are also trained to perform CAS with LGWs.

b. **Laser Designation for Rotary-Wing Aircraft**

- **Employment.** Laser designation for target acquisition provides fast and accurate target hand-off. Certain rotary-wing aircraft are equipped with LSTs and aid the pilot's visual target acquisition by providing cockpit indications on the location of the laser spot. Target acquisition can be followed with the delivery of either LGWs or nonguided weapons. The aircraft can designate either for their own weapons or for other rotary-wing or fixed-wing aircraft.

- **Communications.** Communication between the LDO and the aircrew is essential for positive target hand-off to LST-equipped rotary-wing aircraft. Positive target hand-off requires **prior coordination**. The LDO must provide

Communication is essential for positive target hand-off to LST-equipped rotary-wing aircraft.

the appropriate laser code, laser-target line in degrees magnetic, and laser spot offset (if applicable).

c. **Laser Designation for Rotary-Wing Aircraft with HELLFIRE LGMs.** The lock-on and launch ranges of LGMs can be several miles. LGMs provide extended standoff for high-threat targets. The pilot has several options for firing mode, firing method, and missile seeker lock-on.

- **Firing Modes**

  •• **Single Fire or Manual Mode.** In the single-fire mode, **one missile is launched**. This mode can be used with autonomous direct, remote direct, and remote indirect fire methods, as discussed below.

  •• **Rapid Fire.** Rapid fire is a technique of launching **two or more missiles on the same code**. Multiple targets can be engaged by launching missiles at least 8 seconds or more apart, as specified by the LDO. Once the first missile hits the first target, the LDO must smoothly move the laser spot to the next target.

  •• **Ripple Fire.** In the ripple fire mode, **missiles are fired one after the other** on different codes. For best effect, multiple laser designators should be used to achieve ripple fire. Each laser designator operates on a different laser code, and the weapon's seekers are coded to match each designator.

  •• **Rapid or Ripple Fire.** Using multiple codes and laser designators, the **combination** of rapid or ripple fire can be achieved.

NOTE: Missiles can be launched singly in either the rapid or ripple mode.

- **Firing Methods**

  •• **Direct Fire Method.** Direct fire is achieved using **either autonomous or remote laser designators**. When using remote designators, the rotary-wing aircraft is free to resume terrain masking or engage other targets after each LGM launch. This capability is called "fire and forget" and increases aircraft survivability and flexibility.

  •• **Indirect Fire Method.** Indirect fire is achieved by using **remote laser designators**. Vulnerability of rotary-wing aircraft to enemy direct-fire weapons and radar detection is minimized by employing LGMs in the indirect-fire method. The LGM is launched while the aircraft is positioned behind masking terrain features, like trees and hills. The pilot selects a trajectory for the LGM (either high or low) over the masking terrain feature. The seeker will then locate and lock-on to the remote laser-designated target.

- **HELLFIRE Missile Seeker Lock-on Options**

  •• **Lock-on After Launch.** The LOAL option can be used in the direct-fire mode and is always used for the indirect-fire method. The LGM is launched on a trajectory toward the target with seeker lock-on occurring in flight. This option allows missile launching toward the target area during adverse weather, hazy days, long ranges, or temporary target obscuration. Lock-on will occur when the obstruction to the seeker's view dissipates or is bypassed during the approach to the target area.

  •• **Lock-on Before Launch.** The LOBL option requires direct LOS to the target and requires the seeker to be locked-on to the target before launch.

d. **Engagement Procedures**

- **Communications.** Prior coordination is required to ensure that communications exist between the LDO and the aircrew of the laser-equipped rotary-wing aircraft. Coordinating radio frequencies and call signs may be accomplished by a face-to-face briefing, using signal operating instructions or the aviation unit's operations order, or through the FAC.

- **HELLFIRE Mission Brief**

•• **Target Location.** The HELLFIRE Mission brief will be a standard 9-line brief. Rotary-wing aircraft use the same CAS briefing form as fixed-wing aircraft.

See Appendix C, "CAS Briefing Form (9-Line)"

•• **Codes.** The laser designator and the LGW on the helicopter must be on the **same code**. HELLFIRE LGM codes can be set or changed from the cockpit, allowing the aircrew to match the ground laser designator's code. LGM designator coding is important because it prevents the seeker from homing in on other reflected laser energy.

•• **Laser-Target Line.** The laser-target line must be given to the aircrew in **degrees magnetic**. The aircrew needs this information to align the helicopter, ensuring positive seeker lock-on of the LGM for LOBL delivery or positive in-flight seeker lock-on of the LGM for LOAL. The laser-target line will also allow the aircrew to prevent inadvertently engaging the laser designator. The LDO must be outside a 30º by 40º zone from the aircraft, but within a 120º cone from the target (See Figure III-4).

•• **The Firing Mode.** A single LDO can request single-fire and rapid-fire modes. **Single fire is used to engage a specific target. Rapid fire may be used to engage multiple targets.** Two LDOs employed as a team can request ripple fire or rapid and ripple fire. Prior coordination and thorough pre-mission planning are necessary for ripple fire or rapid and ripple fire.

•• **Number of Missiles.** The LDO may elect to engage multiple targets with multiple LGMs. This procedure may be advantageous to a quick attack of targets at extended ranges. Rapid fire may be used to minimize total LASER-ON time for multiple targets. For example, LASER-ON time to guide four single-launched missiles might be 1 minute and 20 seconds, while LASER-ON time for four rapid-fire-launched missiles in the same situation is, at a minimum, 32 seconds. During multiple missile launches, the **LDO must ensure that laser energy is not interrupted** by obscuration caused by previously launched missiles.

•• **Time Interval. During rapid fire, one missile is launched at a minimum of every 8 seconds.** An LDO may request a longer interval between launches. Considerations for longer intervals between LGM launches include operator experience, terrain, target array, and battlefield obscuration.

A discussion of ground and airborne designation for helicopters is in Appendix B, "Procedures Guide."

5. Laser Designation for Non-CAS Air Attacks

There may be instances where aircrews and ground forces will designate for aircraft not conducting CAS missions, such as interdiction operations, armed reconnaissance, and other related areas.

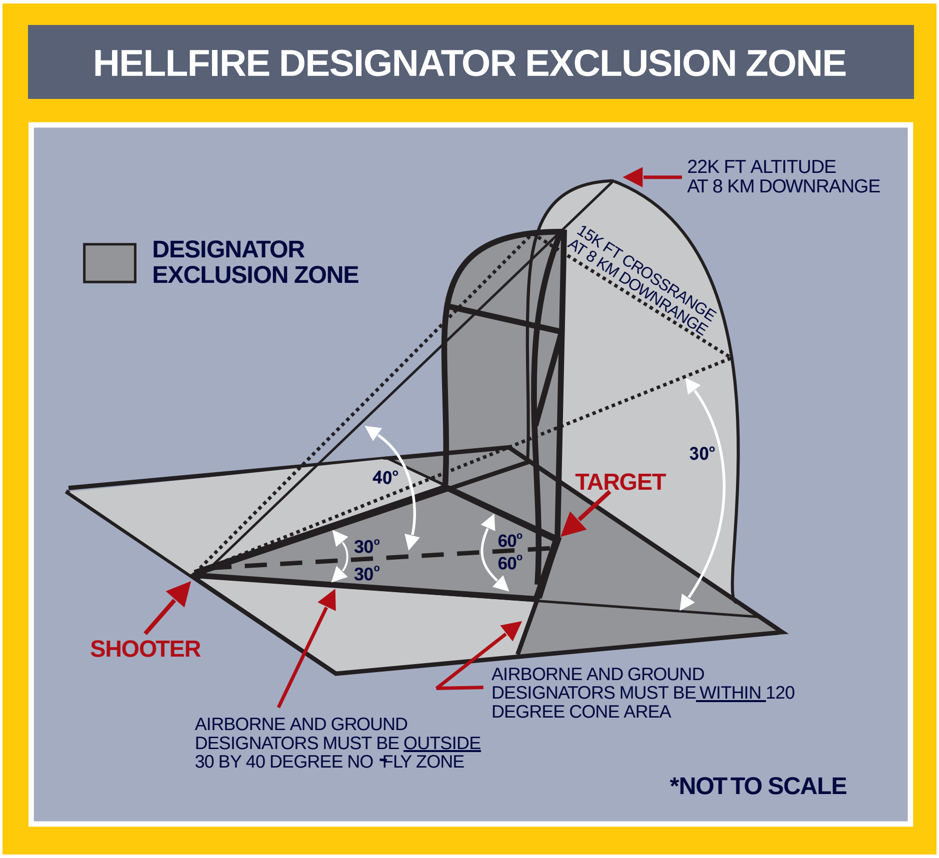

Figure III-4. HELLFIRE Designator Exclusion Zone

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CHAPTER IV
LASER CODES

> *"The instruments of battle are valuable only if one knows how to use them."*
>
> **Ardant du Picq**
> **Battle Studies**

1. Introduction

a. **General.** Laser designators and seekers use a **pulse coding system** to ensure that a specific seeker and designator combination work in harmony. By setting the same code in both the designator and the seeker, the seeker will track only the energy with the correct coding. The seeker will track the first correctly coded, significant laser energy it sees. The seeker will always lock on to the most powerful return in its view. The pulse coding used by all systems discussed in this manual is based on PRF.

b. **Designator and Seeker Pulse Codes.** The designator and seeker pulse codes use a **modified octal system** that uses the numerical digits "1" through "8." The codes are directly correlated to a specific PRF, but the code itself is not the PRF and therefore can be communicated in the clear as required. Depending on the laser equipment, either **a three- or four-digit code can be set**. Three-digit code equipment settings range from 111 to 788. Four-digit code equipment settings range from 1111 to 1788. The three-and four-digit code equipment is compatible, and any mix of equipment can be used in all types of laser operations. However, when using a mix of three- and four-digit code equipment, **all personnel must understand that the first digit of a four-digit code is always set to numerical digit "1"**. The remaining three digits will be set to match the three digits of the three-digit code equipment. As an example, a three-digit code of 657 would be set to 1657 on a four-digit code system or vice versa. **The G/VLLD only allows for three numbers to be set. Upon receipt of a 4-digit code, the operator must delete the first number and set the last three numbers on the G/VLLD.**

> **NOTE: Higher PRF (lower number codes) provide greater laser energy for the seeker and LSTs to receive, and so provide a greater opportunity for success. Lower codes also require more power and so cause shorter battery life.**

c. **Multiple Codes.** Coding allows simultaneous or nearly simultaneous attacks on multiple targets by a single aircraft, or flights of aircraft, employing LGWs set on different codes. This tactic may be employed when several high-priority targets need to be attacked expeditiously and can be designated simultaneously by the supported unit(s).

2. Management of Coded Laser Systems

Laser codes must be controlled and coordinated to maximize weapon effectiveness. The joint force Operations Directorate (J-3) has overall responsibility for laser code management. The J-3 provides blocks of codes to each component. Each component sub-assigns codes to supporting arms (e.g., Army artillery, Marine air wing, etc.). This controlled code assignment prevents interference among joint force unit activities. Each component's supporting arm divides its codes among its subordinate units. Subordinate units assign codes to individual missions and change codes periodically, as the situation requires. **At each step of this process, laser codes must be allocated to**

Aircraft dropping LGBs.

ensure compatibility between laser designation equipment and munitions. Some munitions and equipment are incapable of using all codes. Additionally, certain codes (low code, high PRF, and/or faster pulse rate) are preferred for laser systems requiring precision guidance. Codes must be prebriefed to both the FAC and aircrews for situations where communications cannot be established or authorized.

Chapter III, "Procedures," paragraph 3a, discusses exchange of code information between aircrews and ground elements. This code information is also disseminated in operations documents such as the air tasking order special instructions and the fire support plan.

3. Laser Coding in Conjunction With LGBs

Laser coding can be used effectively and securely with LGBs. LGB codes are set on the bombs before takeoff and **cannot be changed in the air**. The aircrew is told the code, but advance coding information might not be sent to the supported ground unit. When the aircraft is on-station, the aircrew passes the code to the FAC. When the use of an LDO is required, the FAC coordinates with the LDO to ensure that the laser designator is set on the same code as the LGBs.

4. Coding Prioritization

a. **General. PRF codes can affect target engagement success.** The lower the code number, the faster the laser pulse rate. The lower code number and faster pulse rate will give the seeker the most opportunity to acquire the target in the time available, and is appropriate for the most important targets and the most difficult operating conditions. However, **lower code numbers cause faster battery drain**.

b. **Considerations.** When PRF code prioritization is possible, the target priority and difficulty of field operating conditions must be considered. Technical and environmental limitations to be considered when prioritizing codes are designator location and output, beam divergence, weather, seeker sensitivity, and FOV.

CHAPTER V
SAFETY

"For they had learned that true safety was to be found in long previous training, and not in eloquent exhortations uttered when they were going into action."

Thucydides
The History of the Peloponnesian War

1. General

The safety considerations discussed herein are not all-inclusive. **The primary source of danger from laser designators is the laser beam itself.** The invisible beam is highly directional, intense IR radiation that can cause serious harm to the eyes. Due to the relatively low power levels of LTDs, the laser beam does not normally affect other parts of the body. When used properly and with due consideration of the laser hazards outlined in this chapter, laser designators are safe to use in a training environment, as well as for operational use.

Refer to Military Handbook 828A, "Laser Safety on Ranges and in Other Outdoor Areas," for laser safety planning, buffer zone and eye protection information.

2. Laser Eye Safety

a. **Friendly Ground Combat Personnel and Noncombatant Civilians.** The potential danger of eye damage to friendly personnel and noncombatant civilians must always be considered when using laser designators in a battlefield environment where areas occupied by friendly and enemy troops and noncombatant civilians are not well defined. **Proper operating procedures and guidelines must be established and followed** to protect friendly troops and noncombatant civilians. Each Service has determined the necessary safety precautions required for using their respective laser systems. These precautions typically include: (1) establishing laser system nominal ocular hazard distances (NOHDs) or minimum safe direct beam viewing distances (aided and unaided); (2) establishing the appropriate laser eye protection (LEP) requirements (wavelength and optical density); and (3) publishing the technical and safety publications necessary for safe and effective laser system employment. For aircrew using direct-view NVGs (i.e., AN/AVS-6, AN/AVS-9, Type I Design), an inherent degree of protection is afforded to the central field of vision. This protection is provided by the internal structure of the image intensifier tube acting as a mechanical stop against the laser energy. However, aircrew peripheral vision still remains vulnerable to stray reflections and/or off axis viewing. LEP spectacles that fit behind NVGs are currently being developed to protect aircrew peripheral vision. However, compatibility challenges still exist for aircrew integration of these LEP spectacles into their NVG-aided operations. Aircrew using projected image NVGs (i.e., MXU-810/U CATSEYE, Type II), are afforded no central vision protection due to the transparent qualities of the NVG's combiner lens design. Consequently, for these aircrew, LEP can only be provided through the use of LEP spectacles. In addition to aircrew LEP, LASER protection for the NVGs is now available with the introduction of the light interference filter (LIF). The LIF is an out-of-band optical filter designed to protect AN/AVS-6 I2 tubes from LASER damage. The LIF does not provide any additional protection for the human eye, however; it simply laser-hardens the NVGs.

b. **Eye Injury.** The primary danger from currently fielded laser designators is to the eye. The laser beam's highly directional, invisible IR radiation can be refracted by the cornea and eye's lens and transmitted through the vitreous humor onto the retina, causing damage ranging from unnoticeable tiny spots to complete blindness. The principal dangers to the eye result from looking directly back at the laser and from laser reflections off specular (mirrorlike) reflectors. The laser system's inherent concentrated energy output, coupled with a relatively small beam divergence, results in NOHDs for the unaided eye that may range for several kilometers, dependent upon the system's specifications. In addition, if individuals are using direct view magnifying optical systems (i.e., 7X50 binocular, AH-1W 13X telescopic sighting unit, etc.), the NOHDs are extended to even greater ranges to account for the magnification power of the devices. **Operators must use extreme care to avoid hitting friendly personnel and noncombatant civilians with the laser beam during operations.** Specific laser equipment manuals provide minimum safe distances for equipment being used. Individual training ranges have safety regulations that also specify safe distances for laser equipment.

Refer to Chapter I, "Concept," paragraph 2f, and Appendix E, "Laser Protocol," for legal restrictions on the use of lasers.

c. **Reflections.** Reflections from flat objects like mirrors, window glass, reflectors on vehicle tail lights, and certain optical systems do not spread the beam after reflection. These reflections, therefore, can cause eye injury. To calculate the NOHD for a specular reflection, one would use the same intrabeam NOHD and add the sum of the distance from the laser system to the target (specular reflective surface) with the distance back to the viewer. If the sum of these distances is equal to or greater than the NOHD, the viewer would not be at risk for injury. In contrast to a specular reflection, if the incident laser energy strikes a curved or rough surface, the energy will be reflected or spread in all directions. This diffuse reflection poses minimal concern for eye injury due to the decreased intensity and dissociated nature of these reflections. However, some laser designators may possess enough energy, even from a diffuse reflection, to still cause injury to the eye. These systems are said to possess a diffuse reflection viewing hazard. Fortunately, the distances associated with laser system diffuse reflection hazards are typically less than 100 meters, or well within the fragmentation envelope of the LGW in use. Therefore, a diffuse reflection hazard would not likely affect operational employment or tactics. **The minimum safe range increases significantly for anyone viewing a target area through binoculars and other magnifying optics.**

d. **Enemy Personnel. Current US policy on laser use states that US forces will not use lasers specifically designed to cause permanent blindness. It also states that US forces will strive to minimize accidental or incidental eye injuries resulting from laser use, but recognizes that some injuries may occur as a result of these systems. None of the laser systems described in this publication were designed for the purpose of causing eye injury. They should be used properly against enemy targets as the situation dictates**

See Appendix E, "Laser Protocol."

3. Fratricide

Designator profiles behind the launch platform are inherently the safest and will minimize the possibility of fratricide. The possibility of fratricide still exists while operating anywhere within the optimal attack zone. It is highest in the designated safety zone or when a false lock-on is achieved. Attack headings should be planned with consideration for friendly forces and noncombatant civilian locations. **Ultimately the primary mechanisms for limiting fratricide are command emphasis, disciplined operations, close coordination among component commands, rehearsals, and enhanced situational awareness.**

4. Organizational Safety Considerations

Each unit involved with laser weapon systems employment must establish and enforce laser safety standard operating procedures. **Dissemination of current safety, procedural, and regulatory information is essential to safe employment of laser weapon systems.** Equipment performance characteristics and operating range requirements are extensive and dictate what can safely be accomplished. Planners and users must research and follow the most current laser safety information, directives, and regulations.

Delivery parameters and considerations for specific weapons are in FM 101-50-31/TH 61 A1-3-9/FMFM 5-2G-6/NAVAIR 00-130ASR-9, "Joint Munitions Effectiveness Manual/Air to Surface (JMEM/AS), Risk Estimates for Friendly Troops" (C), 19 December 1986.

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APPENDIX A
LASER EQUIPMENT DESCRIPTIONS

ACQUISITION AND DESIGNATION SYSTEMS

PRECISION-GUIDED MUNITIONS

LASER EQUIPMENT DESCRIPTIONS

1. Introduction

System descriptions and nominal characteristics described in this appendix reflect design specifications. The actual capability of laser designators and seekers is degraded by factors discussed in Chapter II, "Planning Considerations." For example, weather, smoke, and other obscurants degrade laser system effectiveness. On the other hand, under favorable conditions, skilled operators can engage targets at ranges well in excess of specifications. A general rule of thumb is **if a target can be seen, it can be designated. If all of the spot is kept on a target, an LGW employed accurately should hit the target.**

2. Laser Equipment and Compatibility

Equipment compatibility has a significant impact on joint laser interoperability. This publication concentrates on six classes of laser and electro-optical equipment: laser-guided weapons, coded laser target designators, coded laser acquisition and/or spot trackers, IR pointers and illuminators, NVGs, and FLIR.

a. **Laser-Guided Weapons.** LGWs are the "business end" of laser systems. They span the entire spectrum of delivery platforms, to include fixed-wing aircraft, attack helicopters, artillery, and naval surface fires. Typical laser guided weapons are shown in Figure A-1.

b. **Coded Laser Target Designators**

- Coded LTDs are ground and airborne systems that have two specific purposes. First, they provide terminal weapons guidance for LGWs. Second, they designate targets for coded laser acquisition/spot trackers. Coded laser target designators emit laser energy with a PRF and require input of specific laser codes for operation. Codes are assigned to LGWs and directly relate to the PRF that harmonizes designator and seeker interface. The airborne platforms having coded laser target designators are shown in Figure A-2. The ground systems having coded laser target designators are shown in Figure A-3.

- Coded laser target designators used for terminal weapons guidance must be set to the same code as the LGW. Certain LGWs, such as LGBs, are coded prior to takeoff and cannot be changed once the aircraft is airborne. However, all coded laser target designators, with the exception of the AC-130H, can change

LASER-GUIDED WEAPONS
Laser-Guided Bombs PAVEWAY II
Low-Level Laser-Guided Bombs PAVEWAY III NOTE: PAVEWAY III is also delivered from medium and high altitudes.
Laser-Guided Missiles AGM-65E Laser MAVERICK AGM-114 HELLFIRE
Laser-Guided Projectiles COPPERHEAD

Figure A-1. Laser-Guided Weapons

AIRBORNE PLATFORMS WITH CODED LASER TARGET DESIGNATORS	
Rotary-Wing	System
AH-1 W (USMC)	NTS
AH-64A Apache	TADS
OH-58D Kiowa Warrior	MMS (LRF/D)
MH-60L (DAP)	AESOP FLIR LRF/D
SH-60B/HH-60H	AAS-44 FLIR LTD/R
Fixed-Wing	System
F-14A/B/D	LANTIRN
F-15E	LANTIRN
F-16C Blk 40	LANTIRN
AC-130H/U	Laser Designator
F-117A	Classified
F/A-18 A/C/D	LTD/R TFLIR/LTDR
AV-8B Day/Night Attack	no LTD, LST in the ARBS and ATF

Figure A-2. Airborne Platforms With Coded Laser Target Designators

GROUND SYSTEMS WITH CODED LASER TARGET DESIGNATORS		
Service	System	Deployment
USMC	MULE LTD	TACPs, FOs Force Recon Detachment
US Army	G/VLLD, LTD SOFLAM, LTD, CLD	COLT and FIST teams SOF
USAF	None	TACPs rely on COLT teams
USN	SOFLAM, LTD, CLD	SEAL, SOF

Figure A-3. Ground Systems With Coded Laser Target Designators

codes while in the tactical environment. The AC-130H LTD is permanently preset with only one code (1688) and cannot be changed. Terminal weapons guidance of LGBs by an AC-130H is possible provided this code is precoordinated. The AC-130U has a codable LTD and can change codes in flight. Coordination for the LTD to match the LGB code is conducted through the air tasking order or FAC nine-line briefing. Sometimes, a designator will serve the dual purpose of target designation for a coded laser acquisition and/or spot tracker and terminal weapons guidance for LGWs. In these cases, the designator, spot tracker, and the weapon must have the same code.

- Weapons employment of LGBs in conjunction with coded laser target designators is either autonomous or assisted. Autonomous LGB employment uses the aircraft's on-board LTD for terminal weapons guidance. Most aircraft capable of delivering LGBs can provide on-board autonomous self-designation. Assisted LGB employment uses an off-board LTD for terminal weapons guidance. This is typically accomplished by a ground team operating a designator (such as a

G/VLLD) or by another aircraft (known as "buddy lasing"). Assisted LGB employment is often required by aircraft without on-board LTDs (such as A/OA-10s or AV-8Bs) that can carry and deliver LGBs but have no on-board terminal weapons guidance capability.

- The OH-58D Kiowa Warrior is equipped with LTDs. The AH-64A Apache also has an LTD, but it cannot acquire or designate (lase) a small segment of laser codes (1711-1788).

- The USMC AH-1W possesses an LTD compatible with all LGWs, including HELLFIRE missiles.

c. **Coded Laser Acquisition and/or Spot Trackers**

- Coded laser acquisition and/or spot trackers are systems which allow visual acquisition of a coded laser designated target. LSTs must be set to the same code as the coded laser target designator in order for the user to see the target being designated. In the case of airborne LSTs, the aircrew acquires the laser designated "spot" (target) and either employs LGBs through use of an LTD or executes visual deliveries of non-laser ordnance. The airborne platforms having coded laser acquisition and/or spot trackers are shown in Figure A-4.

- PAVE PENNY acquires coded laser designations and displays them as target symbols to the pilot via the HUD. Conventional free-fall ordnance, 30mm strafe, and Maverick missiles are then employed with on-board targeting systems. PAVE PENNY aircraft can acquire targets designated by any LTD (ground or airborne). Remember, however, if a PAVE PENNY A/OA-10 is going to drop LGBs, it cannot self-designate since PAVE PENNY is only a laser spot tracker.

- Currently, Marine Corps AV-8Bs and USN/USMC F/A-18s are capable of acquiring targets designated by off-board laser targeting systems. USAF F-16s, F-15Es and US Navy F-14s do not have LSTs and are incapable of visually acquiring coded laser designated targets from off-board systems. Low-altitude navigation and targeting infrared for night (LANTIRN) equipped fighters (F-16C Block 40, F-15E, and F-14A/B/D) use a targeting pod to acquire targets based on inertial navigation system coordinates displayed to the aircrew via HUD or multi-function display symbology. Subsequent terminal weapons guidance is accomplished autonomously or through "buddy" laser designation. Air Force Reserve Component F-16C Block 30 aircraft will also be equipped with an LST and an LTD as well

AIRBORNE PLATFORMS WITH CODED LASER ACQUISITION AND/OR SPOT TRACKERS	
Rotary-Wing	System
AH-64A Apache	TADS
AH-6	LST
Fixed-Wing	System
A/OA-10	PAVE PENNY
AV-8B Day/Night Attack	ARBS/ATF
F/A-18 A/C/D	LST/LDT pod (on selected aircraft)

Figure A-4. Airborne Platforms With Coded Laser Acquisition and/or Spot Trackers

as a FLIR and optical television camera. There will be no degradation in standard configuration loadout.

- The USMC AV-8B Day/Night Attack Harrier incorporates an LST in its angle rate bombing system (ARBS). This LST is similar to the A/OA-10 PAVE PENNY system in that it can acquire any target designated by an LTD. Weapons delivery of conventional non-LGWs is accomplished with the on-board ARBS. It can carry and deliver LGBs, but like the A/OA-10, it requires external terminal weapons guidance by an LTD.

- The F/A-18C/D is unique because it is the only US fighter/attack fixed-wing aircraft equipped with both an LST and LTD. F/A-18s configured with LGBs may also carry laser target designator/ ranger (LTD/R) pods. It is important to note, however, that LSTs are found only on selected F/A-18 aircraft due in part to the fact that carrying an LST reduces air-to-air combat load (AIM-7 or advanced medium-range air-to-air missile) by one pylon hard point. A section (2-ship) of LGB configured F/A-18s may both have LTD/Rs, but LST configuration may vary. The LTD/R and LST are podded systems and configurations will vary from aircraft to aircraft depending on mission loadout and pod availability.

- The OH-58D Kiowa Warrior and AH-1W, SH-60B and HH-60H do not have “true” LSTs. However, if these aircraft are carrying HELLFIRE, the missile can provide some target cueing. The on-board HELLFIRE missile’s seeker head sensor provides target symbology in the cockpit display of what is being designated by the helicopter’s on-board coded laser designator or any other laser source.

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ANNEX A TO APPENDIX A
AIRCRAFT AND HELICOPTER WEAPONS AND CAPABILITIES GUIDE

The capabilities of fixed-wing aircraft are shown in Figure A-A-1. The capabilities of rotary-wing aircraft are shown in Figure A-A-2.

NOTE: Data contained in this appendix is provided only for information. It is not authoritative and should be verified before being used operationally.

FIXED-WING AIRCRAFT CAPABILITIES							
Aircraft M/D/S	Using Service	Ordnance	Laser Capability LST	LTD	Marking Capability	Beacon Capability	Other Systems
AV-8B (Day Attack)	USMC	Laser-guided bombs* AGM-65 Maverick GP bombs Napalm 2.75" rockets 5.00" rockets LUU-2 25mm cannon AGM-122 Sidearm Aerial mines CBUs	YES	NO	Rockets	None	ARBS NVG GPS
AV-8B (Night Attack)	USMC	As above	YES	NO	Rockets	None	TV NVG NAVFLIR GPS
AV-8B (Night/Radar)	USMC	As above	NO	NO	Rockets	None	NVG NAVFLIR GPS Radar
A/OA-10	USAF	Laser-guided bombs* AGM-65 Maverick GP bombs CBUs Aerial mines 2.75" rockets LUU-2/19 LUU-1/-5/-6 flares 30mm cannon	YES	NO	WP rockets 30mm HEI HE rockets	None	NVG
AC-130H	USAF (SOF)	105mm howitzer 40 mm cannon 20mm cannon	NO	YES	GLINT 105mm WP 105mm HE 40mm MISCH LTD (1688 only)	PPN-19 ST-181 SSB PLS	FLIR LLLTV Radar GPS
AC-130U	USAF (SOF)	105mm howitzer 40mm cannon 25 mm cannon	NO	YES	GLINT 105mm WP 105mm HE 40mm MISCH (codable LTD)	SST-181	FLIR ALTV Radar GPS
B-1B	USAF	GP bombs CBUs	NO	NO	None	PPN-19***	Radar
B-2	USAF	Mk 82/84 CBU 87 (CEM)/ 89 (GATOR)/ 97 (SFW) GBU 31 (JDAM) GBU 34	NO	NO	None	None	GPS Radar

Figure A-A-1. Fixed-Wing Aircraft Capabilities

FIXED-WING AIRCRAFT CAPABILITIES (cont'd)							
Aircraft M/D/S	Using Service	Ordnance	Laser Capability LST	LTD	Marking Capability	Beacon Capability	Other Systems
B-52H	USAF	AGM-142 GP bombs Aerial mines Laser-guided bombs CBUs	NO	NO	None	PPN-19*** PPN-20***	FLIR LLLTV GPS NVG Radar
F-14/A/B/D	USN	Laser-guided bombs GP bombs 20mm cannon CBUs Aerial mines LUU-2	NO	YES	Laser	None	NVG LANTIRN FLIR GPS
F-15E	USAF	Laser-guided bombs CBUs GP bombs 20mm cannon AGM-65 Maverick	NO	YES	Laser	PPN-19 PPN-20	FLIR Radars AAM
F-16 (without LANTIRN)	USAF	AGM-65 Maverick Laser-guided bombs* GP bombs CBUs 20mm cannon	NO	NO	WP rockets	PPN-19 PPN-20	Radar GPS**
F-16C/D (with LANTIRN)	USAF	Laser-guided bombs* AGM-65 Maverick GP bombs CBUs 20mm cannon	NO	YES	Laser	PPN-19 PPN-20	FLIR GPS NVG Radar
F-117	USAF	GBU 10/12 GBU 27 Mk 82/84 CBU 52/58/71/87 (CEM)/89 (Gator) Mk 20	YES	YES	Laser	None	GPS INS FLIR DLIR

Figure A-A-1. Fixed-Wing Aircraft Capabilities (cont'd)

FIXED-WING AIRCRAFT CAPABILITIES (cont'd)								
Aircraft M/D/S	Using Service	Ordnance	Laser Capability LST	LTD	Marking Capability	Beacon Capability	Other Systems
F/A-18 A/C/D	USN/ USMC	Laser-guided bombs AGM-65 Maverick AGM-62 Walleye AGM-84 SLAM AGM-88 HARM GP bombs CBUs Aerial mines LUU-2 flares 2.75" rockets 5.00" rockets Napalm/FAE 20mm cannon JDAM/JSOW	YES	YES	Laser WP rockets HE rockets	None	TFLIR NFLIR GPS*** NVG Radar
S-3B	USN	GP bombs CBUs 2.75" rockets 5.00" rockets Aerial mines LUU-2 flares	NO	NO	WP rockets	None	FLIR Radar

LST Laser Spot Tracker
LTD Laser Target Designator
*Though these aircraft can carry and release LGBs, they require off-board designation for terminal guidance.
**GPS on some aircraft (Blocks 40/42; 50/52)
***Lot XVII and up

Figure A-A-1. Fixed-Wing Aircraft Capabilities (cont'd)

ROTARY-WING AIRCRAFT CAPABILITIES						
Aircraft M/D/S	Using Service	Ordnance	Laser Capability LST	LTD	Marking Capability	Other Systems
AH-1 F	USA	BGM-71 TOW missile 20mm cannon 2.75" rockets	NO	NO	Rockets	NVG
AH-1 W	USMC	BGM-71 TOW AGM-114 Hellfire 2.75" rockets 5.0" rockets 20mm cannon LUU-2 AGM-122 Sidearm	NO	YES	Rockets Laser	FLIR NVG GPS
AH-64A	USA	AGM-114 Hellfire 2.75" rockets 30mm cannon	YES	YES **	Laser Rockets	FLIR NVG
AH-64D (including Longbow)	USA	AGM-114L Hellfire 2.75" rockets 30mm cannon	YES	YES **	Laser Rockets	FLIR NVG Radar IDM GPS
OH-58D (Kiowa Warrior)	USA	AGM-114 Hellfire 2.75" rockets .50 cal machine gun Air-to-air Stinger	NO	YES	Laser Rockets	FLIR NVG GPS IDM ATHS MMS VIXL
MH-60L (DAP)	USA	2.75" rockets 30mm AGM-114 Hellfire 7.62 Minigun Stinger	YES	YES	Laser	FLIR NVG GPS
AH-6	USA	2.75" rockets 7.62 Minigun	YES	NO	7.62 Minigun	FLIR NVG GPS
SH-60B	USN	AGM-114 Hellfire AGH-119 Penguin MK-46/MK-50 Torpedoes .50 cal machine gun	NO	YES	Laser	FLIR NVG GPS ESM Radar Datalink
HH-60H	USN	AGM-114 Hellfire .50 cal machine gun	NO	YES	Laser	FLIR NVG GPS

ATHS Airborne Target Handover System
IDM Improved Data Modem
MMS Mast Mounted Sight
VIXL Video Transmission Downlink

**The AH-64 helicopter cannot designate laser codes 1711 to 1788.

Figure A-A-2. Rotary-Wing Aircraft Capabilities

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MAN-PORTABLE LASER SYSTEM COMPARISONS

MAN-PORTABLE LASER SYSTEM COMPARISONS						
		AN/PEQ-1	**AN/PEQ-1A**	**MULE**	**GVLLD**	**CLD**
Magnification		7x	10x	10x	13x	7x
Remote Control	Cable	150 ft	10 ft or 150 ft	N/A	N/A	2 ft
	RF	5 km	5 km	N/A	N/A	N/A
Duty Cycle (@ 20 pps) (min)	c320F	5 on, 1 off x3 30 cool down	5 on, 1 off x3 30 cool down	5 see note 1	9 see note 1	1 on, 2 off
	a320F	5 on, 1 off x3 30 cool down	5 on, 1 off x3 30 cool down	a3 see note 1	4.5 see note 1	1 on, 2 off
Battery Type		BA-5590 Lithium, BB-590 NiCad, lead Acid or Vehicular	BA-5590 Lithium, BB-590 NiCad, lead Acid or Vehicular	BA-6699 special NiCad	BA-6699 special NiCad	Unique Lead-Acid
Battery Life (min) (@ 20 pps)	c320F	90 (Lithium)	90 (Lithium)	5	9	60
	a320F	90 (Lithium)	90 (Lithium)	a3	3 to 6.5	60
Cooling		Circulated liquid, self-contained	Circulated liquid, self-contained	High pressure Nitrous Oxide	High pressure Nitrogen	Non-circulated liquid, self-contained
Night Vision		1.06 I^2 available (Integral Weaver rail) See Note 2	1.06 I^2 available (Integral Weaver & Picatinney rails)	Cryo Thermal (Bottle Type)	Cyro Thermal (Bottle type)	N/A
Warm-up Time (seconds)		5	5	5	3	5
Range Resolution (meters)		35	35	10	35	35
Range Logic		1st/Last	1st/Last	1st (gated)	1st/Last (gated)	1st/Last
Minimum Target Separation (meters)		35	35	c50	c20	35
Effective Range	Designate	5 km (c32 0F)	5 km	3.4 km	5 km	a5 km (3 km typical)
	Range Finding	10 km	10 km	10 km	10 km	10 km

Note 1. This duty cycle is based on the battery life/operating time of the laser system.
Note 2. This night sight is capable of imaging the laser wavelength day or night with the use of daylight filters.

Figure A-B-1. Man-Portable Laser System Comparisons

MAN-PORTABLE LASER SYSTEM COMPARISONS (cont'd)						
		AN/PEQ-1	**AN/PEQ-1A**	**MULE**	**GVLLD**	**CLD**
Weight (lbs)	Laser Unit	9.6	11.2	16.5	28	16
	Batteries	12.6 (5 BA-5590 w/Bag)	12.6 (5 BA-5590 w/Bag)	4.5 1 NiCad	4.5 1 NiCad	2.2 1 Lead-Acid (unique)
	Minimum Usable System (laser,batteries)	22.2	23.8	21	53 (tripod required)	18.2
	w/Tripod	28	29.6	39	53	28.2
	w/Night Sight, w/o tripod	25.75 (tripod not required)	27.3 (tripod not required)	51.8 (tripod required)	61.8 (tripod required)	N/A
	System Total[1] (w/o container w/tripod, NVS, & batteries	31.75	33.3	51.8	61.8	28.2 (NVS not available)
	System Total[2] (w/container)	63	64.5	182	182.7	40
Output Parameters	Energy milliJoule	c80	c80	c80	c100	c50
	Divergence milliradian	.300 @95%	.300 @95%	.250 @90%	.130 @90%	.300 @90%
	Boresight Retention milliradian	.150 (c32 0F)	.150	.100	.035 (vendor data)	.150
Volume (Cu. In.)	Laser Unit	363	370	750	700	420
	Total System (Laser, NVS, batteries, no containers)	800	808	9500	12,750	420
Field of View (°)	Horiz	5	5	4.2	5	7
	Vert	4.75	4.75	4.2	5	a7

Figure A-B-1. Man-Portable Laser System Comparisons (cont'd)

ANNEX C TO APPENDIX A
ANGLE RATE BOMBING SYSTEM (MARINE CORPS)

ANGLE RATE BOMBING SYSTEM (MARINE CORPS)	
Description:	A 3-axis gimballed dual-mode television and LST Enables the pilot to view the laser spot
Function:	Provides day or night, accurate first pass, target attack
Platform:	AV-8B Day/Night attack variants
Employment:	Allows day or night attack of target with LGW or non-guided bombs independent of target movement, wind, dive angle, or release angle variations Provides re-attack navigation and automatic impact spacing
PRF Codes:	Four digits In-flight selectable
System-Unique Capabilities:	Manual or automatic weapon release First-pass accuracy
Limitations:	System affected by smoke or obscurants, as discussed in Chapter II, “Planning Considerations,” for LST
Field of View:	35^o az, $+15^o/-70^o$ el
GIMBAL LIMITS:	As part of the field of view

Figure A-C-1. Angle Rate Bombing System (Marine Corps)

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ANNEX D TO APPENDIX A
LOW-ALTITUDE NAVIGATION AND TARGETING INFRARED FOR NIGHT (AIR FORCE/NAVY)

LOW-ALTITUDE NAVIGATION AND TARGETING INFRARED FOR NIGHT (AIR FORCE/NAVY)	
Description:	Pod-mounted laser designator/ranger, boresighted to FLIR
Function:	Aircraft ranging to target Laser target designation
Platform:	F-14, F-15E, F-16 BLOCK 40
Employment:	Aircraft inertial navigation system update Target designation for LGB deliveries
PRF Codes:	Four digits In-flight selectable
System-Unique Capabilities:	Autonomous laser-designation capability
Limitations:	LANTIRN restrictions can be significant, especially gimbal limits which can restrict the attack flexibility of the system Not an LST Laser cannot be employed above 25,000' MSL
Field of View:	(F-14) $5.87^{o}/1.65^{o}$ az, +32/-150 el (F-15E) $5.85^{o}/1.67^{o}$ az, +30/-150 el (F-16) $6^{o}/1.7^{o}$ az, +35/-150 el

Figure A-D-1. Low-Altitude Navigation and Targeting Infrared for Night (Air Force/Navy)

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ANNEX E TO APPENDIX A
LASER SPOT TRACKER (NAVY AND MARINE CORPS)

LASER SPOT TRACKER (NAVY AND MARINE CORPS)	
Description:	LST see definition
Function:	Locates the laser spot designating a target, then passes necessary ballistic information to allow FLIR or radar acquisition of target and visual HUD or head down display
Platform:	F/A-18
Employment:	Used to locate a target that is designated any correctly coded laser energy to deliver laser-guided munitions Once the target is located, the LST data can be passed to the mission computer for use in the delivery of conventional ordnance
PRF Codes:	Four digits In-flight selectable
System-Unique Capabilities:	After designated target is sighted, aircraft locks on to target and laser can be turned off; conventional ordnance can then be delivered on target
Limitations:	No active rangefinder or designator (if not used in conjunction with onboard LTD/R)
Field of View:	12º/3º az, +30º/-150º el

Figure A-E-1. Laser Spot Tracker (Navy and Marine Corps)

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ANNEX F TO APPENDIX A
PAVE PENNY (AIR FORCE)

PAVE PENNY (AIR FORCE)	
Description:	Pod-contained LST
Function:	To receive laser energy and provide cockpit heads-up steering to source of reflected energy
Platform:	A/OA-10
Employment:	Used to help pilot locate reflected laser energy
PRF Codes:	Four digits In-flight selectable
System-Unique Capabilities:	Very sensitive seeker Expands aircraft capability by providing early target acquisition
Limitations:	Laser spot must be within seeker field of view
Field of View:	4º Level Narrow scan is 20 degrees (+/- from aircraft nose) Level Wide scan is 40 degrees (+/- from aircraft nose)

Figure A-F-1. PAVE PENNY (Air Force)

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ANNEX G TO APPENDIX A
OH-58D MAST-MOUNTED SIGHT (ARMY)

OH-58D MAST-MOUNTED SIGHT (ARMY)	
Description:	MMS is an electro-optical system mounted above the rotor system in a gyro-stabilized turret incorporating a low light-level television, digital thermal imaging system, and LRF/D
Function:	Sight system is used to detect and identify enemy targets while the aircraft is masked LRF/D is used to locate targets utilizing either GRID or LAT/LONG, self-lase its own weapons or designate for all US or NATO standard LGWs
Platform:	OH-58D (I) KIOWA WARRIOR
Employment:	Provides day, night, adverse-weather target detection and identification Employed as a scout or as light division attack helicopters
PRF Codes:	Four Digits In-flight selectable
System-Unique Capabilities:	Tracks stationary or moving targets manually or automatically Automatically points to 8 digit or LAT/LONG grid for target acquisition Incorporates digital communications system (ATHS) interface with artillery and LONGBOW APACHE (IDM)
Limitations:	As discussed in Chapter II, "Planning Considerations," for laser designators
Field of View:	Ranges from 2 to 10 degrees depending on the sight and magnification selected

Figure A-G-1. OH-58D Mast-Mounted Sight (Army)

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ANNEX H TO APPENDIX A
AH-1W NIGHT TARGETING SYSTEM (MARINE CORPS)

AH-1W NIGHT TARGETING SYSTEM (MARINE CORPS)	
Description:	Laser designator and rangefinder with FLIR, direct-view and Coupled Charge Display sensors
Function:	Same as description
Platform:	AH-1W
Employment:	Provides day, night, and limited adverse weather target ranging and laser designation capability Used to engage point targets with TOW or Hellfire missiles
PRF Codes:	Four digits In-flight selectable
System-Unique Capabilities:	Tracks targets manually or automatically Can launch using direct or indirect methods
Limitations:	No Air Data Sensor to automatically optimize FLIR picture
Field of View:	Ranges from 1.0 to 30 degrees depending on the sight and magnification selected

Figure A-H-1. AH-1W Night Targeting System (Marine Corps)

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ANNEX J TO APPENDIX A
AH-64 TARGET ACQUISITION SYSTEM AND DESIGNATION SIGHT (ARMY)

AH-64 TARGET ACQUISITION SYSTEM AND DESIGNATION SIGHT (ARMY)	
Description:	LST and LTD/Rand
Function:	Same as description
Platform:	AH-64
Employment:	Provides day, night, and limited adverse-weather target ranging, LST, and laser-designating capability Used to engage point targets Can laser-designate for its own or "buddy lase" for remotely fired LGWs
PRF Codes:	Four digits In-flight selectable
System-Unique Capabilities:	The TADS LST facilitates handoffs from other laser designators Tracks targets manually or automatically Can launch using direct or indirect methods Seeker lock-on options are LOAL or LOBL
Limitations:	As discussed in Chapter II, "Planning Considerations," for LST and laser designators
Field of View:	Ranges from .36 to 40 degrees depending on the sight and magnification selected

Figure A-J-1. AH-64 Target Acquisition System and Designation Sight (Army)

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AC-130H/U LASER TARGET DESIGNATION CAPABILITIES (AIR FORCE)

AC-130H/U LASER TARGET DESIGNATION CAPABILITIES (AIR FORCE)	
Description:	Integrated into the AC-130's fire control, the LTD/R is mounted on the AC-130H's LLLTV On the AC-130U, the LTD/RF is integrated into the fire control system and the ALLTV
Function:	Primarily used to determine range from the AC-130 to the target Can be used to designate targets for other weapons systems
Employment:	Provides day, night, and limited adverse weather target acquisition and laser designation capability
PRF Codes:	Not applicable LTD/R permanently set to 10 pulses per second (code 1688) on the AC-130H The AC-130U PRF code is programmable
System-Unique Capabilities:	AC-130H: LTD/R integrated with LLLTV AC-130U: LTD/RF integrated with ALLTV
Limitations:	The AC-130H flies a pylon turn around a target and can designate and attack targets on the aircraft's left side The ALLTV on the AC-130U has a 360 degree FOV and can be used to designate targets on either side of the aircraft AC-130H: only has one pulse repetition frequency AC-130U: is being modified to include the capability to reset the PRF

Figure A-K-1. AC-130H/U Laser Target Designation Capabilities (Air Force)

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ANNEX L TO APPENDIX A
GROUND/VEHICLE LASER LOCATOR DESIGNATOR (ARMY)

GROUND/VEHICLE LASER LOCATOR DESIGNATOR (ARMY)	
Description:	Long-range LTD/R Can provide azimuth, range, and vertical angle
Function:	Designates targets or areas that can be detected by CGLP or by aircraft equipped with LST and LGMs set to same code as G/VLLD
Platform:	Mounted in M-981 FIST/M2 IFV/HMMWV vehicle Dismounted on tripod
Employment:	Located in company or troop FISTs and in the combat observation lasing teams
PRF Codes:	Four digits (Note: First digit is fixed)
System-Unique Capabilities:	Uses night sight Two-man portable for short distances
Limitations:	Limited mobility

Figure A-L-1. Ground/Vehicle Laser Locator Designator (Army)

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ANNEX M TO APPENDIX A
LASER TARGET DESIGNATOR (ARMY)

LASER TARGET DESIGNATOR (ARMY)	
Description:	Battery-operated, lightweight, handheld
Function:	Designates targets that can be detected by aircraft equipped with LSTs and LGWs set to same code as LTD
Platform:	Handheld
Employment:	Used by Special Forces units and fire-support personnel in airborne and ranger units
PRF Codes:	Four digits (Note: First digit is fixed)
System-Unique Capabilities:	Easily transportable
Limitations:	Cannot range targets Cannot provide direction and vertical angle Laser-on time limited because of battery life

Figure A-M-1. Laser Target Designator (Army)

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ANNEX N TO APPENDIX A
COMPACT LASER DESIGNATOR (HANDHELD) (NAVY)

COMPACT LASER DESIGNATOR (HANDHELD) (NAVY)	
Description:	Battery-operated, lightweight, handheld
Function:	Designates targets that can be detected by aircraft equipped with LSTs and LGWs set to the same code as the LTD
Platform:	Handheld Can be tripod mounted Tripod has a north-seeking compass and can determine azimuth and elevation
Employment:	Used by special operations forces (SEALs)
PRF Codes:	Four digits (Note: First digit is fixed)
System-Unique Capabilities:	Easily transportable
Limitations:	Cannot provide direction and vertical angle unless mounted on tripod Laser-on time limited because of battery life

Figure A-N-1. Compact Laser Designator (Handheld) (Navy)

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LASER MARKER, AN/PEQ-1(A) (SOF)

LASER MARKER, AN/PEQ-1(A) (SOF)	
Description:	Man-portable laser marker and rangefinding device. Sighting Optics Magnification: 7X (AN/PEQ-1) 10X (AN/PEQ-1A)
Function:	Rangefinding and terminal guidance for laser guided weapons
Platform:	Man-portable, tripod or ground supported
Employment:	To provide SOF operators the capability to mark high priority targets for US air-delivered laser-guided munitions
PRF Codes:	Bands I and II
System-Unique Capabilities:	Basic rangefinding and marking capability Incorporates mounting rails for night vision or thermal sights Capable of 5-1-5-1-5-30 minutes ON/OFF duty cycle Small size and light weight Utilizes standard military batteries (BA-5590, BB-590, BB-490)
Limitations:	As discussed in Chapter II, “Planning Considerations,” for laser designators

Figure A-O-1. Laser Marker, AN/PEQ-1(A) (SOF)

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ANNEX P TO APPENDIX A
AN/PAQ-3 MAN-PORTABLE, UNIVERSAL LASER EQUIPMENT (MARINE CORPS)

AN/PAQ-3 MAN-PORTABLE, UNIVERSAL LASER EQUIPMENT (MARINE CORPS)	
Description:	Man-transportable LTD/R
Function:	Accurately locates targets and provides terminal guidance for LGWs
Platform:	Man-transportable, tripod mounted
Employment:	To provide forward observers, NGF spotters, and FACs the capability to accurately determine location and range to targets To provide laser designation for all surface- and air-delivered LGWs
PRF Codes:	Four digits
System-Unique Capabilities:	Consists of three basic modules: -Laser designator rangefinder module: provides the basic laser designator and ranging equipment -Stabilized tracking tripod module: provides stabilization for the tracking of moving targets and targets at extended ranges -North-finding module: provides a true north reference AN/TAS-4 Thermal Night Sight for night operations
Limitations:	As discussed in Chapter II, “Planning Considerations,” for laser designators

Figure A-P-1. AN/PAQ-3 Man-Portable, Universal Laser Equipment (Marine Corps)

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ANNEX Q TO APPENDIX A
THE LASER TARGET DESIGNATOR/RANGING (NAVY AND MARINE CORPS)

THE LASER TARGET DESIGNATOR/RANGING (NAVY AND MARINE CORPS)	
Description:	Pod-mounted, laser designator and ranger that is boresighted to the FLIR
Function:	Provide aircraft ranging to and laser designation of a target
Platform:	F/A-18A/B/C/D
Employment:	Provide day, night, and limited adverse weather capability for laser ranging and designation Autonomous lasing capability with on-board LTD/R for own aircraft's LGB delivery Assisted lasing capability with on-board LTD/R for another aircraft's LGB delivery ("Buddy lasing")
PRF Codes:	Four digits In-flight selectable
System-Unique Capabilities:	Autonomous laser-designation capability Most power out of all laser designators Aircraft Inertial Navigation System update
Limitations:	Not an LST Environmental factors and smoke dissipate laser Gimbal limits and field of view can restrict attack flexibility Inadequate FLIR magnification under certain circumstances Larger laser spot size on the target may decrease LGB accuracy Laser cannot be employed above 25,000 feet MSL

Figure A-Q-1. The Laser Target Designator/Ranging (Navy and Marine Corps)

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ANNEX R TO APPENDIX A
COPPERHEAD, 155mm CANNON-LAUNCHED GUIDED PROJECTILE (ARMY AND MARINE CORPS)

COPPERHEAD, 155mm CANNON-LAUNCHED GUIDED PROJECTILE (ARMY AND MARINE CORPS)	
Description:	LST in nose of projectile that homes in on laser energy reflected from target during the final portion of trajectory
Function:	Used in conjunction with a ground or airborne laser designator
Platform:	Fired from M109 155mm self-propelled howitzers and M198 155mm towed howitzers
Employment:	Used primarily to attack high priority moving or stationary hard point targets
PRF Codes:	Three digits
System-Unique Capabilities:	Point target accuracy Large footprint within which the round can acquire the target
Limitations:	Requires continuous laser designation during the final 13 seconds of projectile flight

Figure A-R-1. COPPERHEAD, 155mm Cannon-Launched Guided Projectile (Army and Marine Corps)

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ANNEX S TO APPENDIX A
AGM-114 HELLFIRE MISSILE (ARMY, MARINE CORPS, AND NAVY)

AGM-114 HELLFIRE MISSILE (ARMY, MARINE CORPS, AND NAVY)	
Description:	Third-generation air-launched, antiarmor, laser-guided missile
Function:	Used in conjunction with a ground or airborne laser designator
Platform:	AH-1W, AH-64, OH-58D, SH-60B, and HH-60H
Employment:	Employed against armor or other hard point-type targets Autonomous designation or “buddy lasing” for other launch platforms
PRF Codes:	Four digits In-flight selectable
System-Unique Capabilities:	Can launch using direct or indirect methods Can employ single, rapid, or ripple firing techniques Seeker lock-on options are LOAL or LOBL
Limitations:	As discussed in Chapter II, “Planning Considerations,” for all LGWs Only AGM-114 B/K missiles are authorized aboard Navy ships

Figure A-S-1. AGM-114 HELLFIRE Missile (Army, Marine Corps, and Navy)

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ANNEX T TO APPENDIX A
LASER MAVERICK AGM-65E
(NAVY AND MARINE CORPS)

LASER MAVERICK AGM-65E (NAVY AND MARINE CORPS)	
Description:	A short-range, laser-guided, rocket-propelled air-to-surface missile
Function:	Used in conjunction with ground or airborne laser designators
Platform:	AV-8B F/A-18
Employment:	Intended for use against fortified ground installations, armored vehicles, and surface combatants Employs 300-pound MAVERICK warhead with selectable delay fuse
PRF Codes:	Four digits Cockpit selectable
System-Unique Capabilities:	If the missile loses laser spot, it goes ballistic and flies up and over the target; the warhead does not explode (becomes a dud) Cockpit-selectable laser coding and fusing (delay or quick)
Limitations:	As discussed in Chapter II, “Planning Considerations,” for all LGWs

Figure A-T-1. Laser MAVERICK AGM-65E (Navy and Marine Corps)

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ANNEX U TO APPENDIX A
LASER-GUIDED BOMBS (PAVEWAY II)
(AIR FORCE, NAVY, AND MARINE CORPS)

LASER-GUIDED BOMBS (PAVEWAY II) (AIR FORCE, NAVY, AND MARINE CORPS)	
Description:	500-pound LGB (MK-82, GBU-12) 1000-pound LGB (MK-83, GBU-16) 2000-pound LGB (MK-84, GBU-10) PAVEWAY II is compatible with all US ground and airborne designators
Function:	Bomb is released after aircraft is within delivery envelope Bomb begins terminal guidance upon laser energy acquisition
Platform:	Most aircraft capable of employing conventional weapons of same weight class
Employment:	Level, dive, or loft for PAVEWAY II bombs Optimum against point targets
PRF Codes:	Four digits Not cockpit selectable
System-Unique Capabilities:	Accuracy gives high probability of target kill against point targets
Limitations:	Early laser spot acquisition during a low angle, level, or loft, shallow diving delivery tends to cause the bomb to miss short Requires ballistically accurate delivery and continuous laser energy during the last 10 seconds of flight The target must subtend an angle of at least 1 mil/mrad (at designator-to-target range) When delivered from a low-altitude loft manuever (see Appendix D, “LGB and LLLGB Delivery Profiles”), restricts lase on target to last 10 seconds of flight

**Figure A-U-1. Laser-Guided Bombs (PAVEWAY II)
(Air Force, Navy, and Marine Corps)**

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ANNEX W TO APPENDIX A
LOW-LEVEL LASER-GUIDED BOMB (PAVEWAY III) (NAVY AND AIR FORCE)

LOW-LEVEL LASER-GUIDED BOMB (LLLGB) (PAVEWAY III) (NAVY AND AIR FORCE)	
Description:	Termed GBU-24 and GBU-27 (2,000-pound bomb) No 500-pound version GBU-28 (5,000-pound bomb) LLLGB termed PAVEWAY III Third-generation LGB
Function:	Same as LGB
Platform:	Same as LGB
Employment:	Expanded delivery envelopes allowing very low altitude, relatively low ceiling, longer range weapon releases Retains dive-delivery option
PRF Codes:	Four digits Not cockpit selectable
System-Unique Capabilities:	Improved accuracy capability over LGB GBU-10/12/16 Highly resistant to countermeasures (Selectable CCM) Blind-launch capability from extended range If LLLGB does not detect laser energy, it will fly beyond the target and maintain level flight Designed for use in the low altitude environment
Limitations:	Requires continuous laser energy during the last 8 seconds of flight Target must subtend an angle of at least one mil/mrad (at designator-to-target range)

Figure A-W-1. Low-Level Laser-Guided Bomb (PAVEWAY III) (Navy and Air Force)

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ANNEX Y TO APPENDIX A
AN/AAQ-16D AESOP FLIR (ARMY)

AN/AAQ-16D AESOP FLIR (ARMY)	
Description:	FLIR NVS
Function:	FLIR system for LRF/D
Platform:	MH-60L, AH-6
Employment:	Used for night pilotage, target detection, navigation and recognition, nap of the earth flight, search and rescue, and surveillance
PRF Codes:	Four digits In-flight selectable
System-Unique Capabilities:	Telescope has three fields of view Magnification changes in 0.5 seconds
Limitations:	Affected by high humidity
Field of View:	$42^o/6.7^o/2.5^o$ az, $+/-15^o/2.5^o/1^o$ el

Figure A-Y-1. AN/AAQ-16D AESOP FLIR (Army)

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ANNEX Z TO APPENDIX A
SH-60B/HH-60H AN/AAS-44(V) FLIR LTD/R SYSTEM (NAVY)

SH-60B/HH-60H AN/AAS-44(V) FLIR LTD/R SYSTEM (NAVY)	
Description:	Laser designator and rangefinder with FLIR
Function:	Same as description
Platform:	SH-60B/HH-60H
Employment:	Provides day, night, and limited adverse weather target ranging and laser designation capability Used to engage point targets with Hellfire missiles
PRF Codes:	Four digits In-flight selectable
System-Unique Capabilities:	Tracks targets manually or automatically Can launch using direct or indirect methods Can transmit FLIR video to LAMPS datalink equipped ships (SH-60B only)
Limitations:	Passive ranging is inaccurate at low altitudes
Field of View:	1.3, 6.0, and 23.8 degrees along with two digital levels of magnification (47.6X and 95.2X)

Figure A-Z-1. SH-60B/HH-60H AN/AAS-44(V) FLIR LTD/R System (Navy)

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APPENDIX B
PROCEDURES GUIDE

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ANNEX A TO APPENDIX B
GROUND AND AIRBORNE LASER DESIGNATION PROCEDURES FOR THE CLGP "COPPERHEAD"

1. General

COPPERHEAD is a precision weapon with an observer-target range that is greater than maneuver direct fire weapons. Therefore, it is normally employed against target arrays which are outside the range of direct fire systems. The successful use of COPPERHEAD requires careful planning by the FSO and the observer, and detailed coordination between the observer and the firing unit. COPPERHEAD use is limited by the quantities available, battlefield obscuration, cloud height, angle T, and effective range of the laser designator. COPPERHEAD requires uninterrupted LOS from the observer to the target and from the target to the round during the downward trajectory of flight.

2. Communications (See Figure B-A-1)

Communications between the observer and FDC occur using frequency modulation (FM), wire, mobile subscriber equipment, or tactical satellite. US Marine Corps units may use high frequency radio.

3. Fire Mission Procedures

When observers acquire a target which is suitable for engaging with COPPERHEAD, they initiate a call for fire over the appropriate communications net to an artillery battery FDC.

a. **Planned Targets**

- When observers identify a stationary target at the planned target location, they initiate the call for fire. If the target is moving towards the planned target location, observers initiate the call for fire and place control of the unit at their command. Then observers must use the target speed and the known or estimated firing unit response time and projectile time of flight to determine when to issue the command to fire (trigger point). The call for fire is as follows:

ELEMENT	EXAMPLE
Observer identification	"R24, this is A58"
Warning order	"Fire target AF7005, over"
Target description	"4 tanks"
Method of engagement	"4 rounds"
Method of control	"At my command, over"

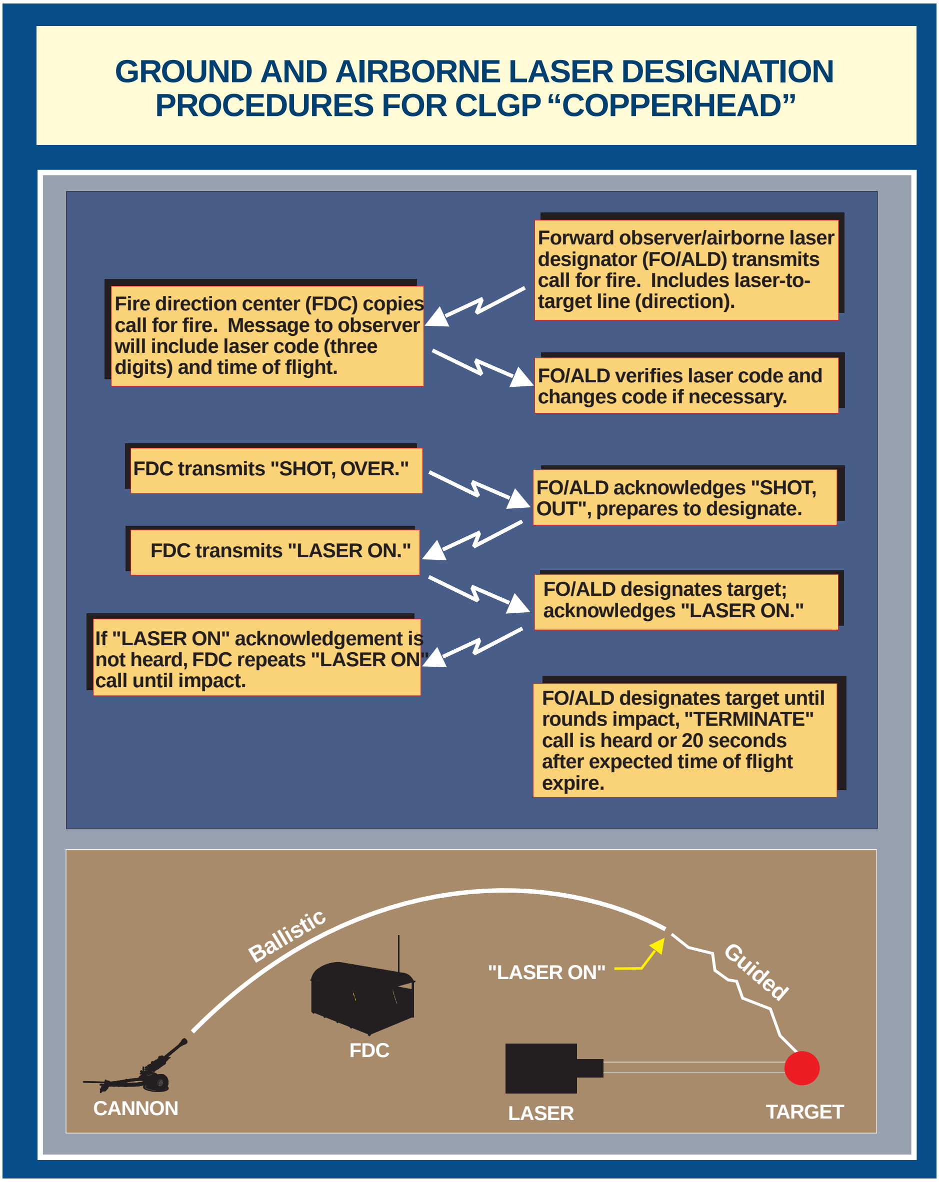

Figure B-A-1. Ground and Airborne Laser Designation Procedures for CLGP "COPPERHEAD"

- The call for fire against a planned target may be streamlined by omitting the target description, method of fire, and method of control. Example:

  "This is A58, fire target AF7005, over"

- The message to observer (MTO) for planned targets is sent from the battery FDC to the observer to confirm the planned target and to provide the observer with the information necessary to establish COPPERHEAD engagement areas or footprints. The elements of the MTO are:

ELEMENT	EXAMPLE
Firing unit identification	"A58, this is R24"
Unit to fire	"R"
Number of rounds	"2 rounds"
Angle T	"Angle T 600"
Footprint letter code	"Set F, Green, over"

- Unless otherwise specified on the COPPERHEAD target list, the FDC will plan to fire two COPPERHEAD rounds on each planned target, though the second round will not be fired unless the observer requests it. If the observer requests "At my command," the battery fires the COPPERHEAD rounds at 30 second intervals after the observer transmits "Fire." If the observer requests "By round at my command," "Fire," must be transmitted for each round.

- **COPPERHEAD Engagement Commands**

•• **Shot.** The FDC transmits "Shot" to the observer as soon as the first round is fired. Unless the observer requested "By round at my command," any additional rounds will be fired at 30 second intervals and "Shot" will not be transmitted.

•• **Designate.** The next and most critical engagement command is "Designate." The FDC transmits this command 20 seconds prior to impact and the observer begins designating the target. "Designate" is used when communicating digitally; in voice communications, the command is "Laser on." The observer must designate the target for the last 13 seconds of the COPPERHEAD round's time of flight.

•• **Designate Now.** When an observer fails to acknowledge the "Designate" command, the FDC transmits "Designate now" until the observer acknowledges or until the time of flight elapses.

•• **Rounds Complete.** The FDC reports "Round complete" after the engagement commands for the last rounds are transmitted.

b. **Targets of Opportunity.** The observer initiates a call for fire against a COPPERHEAD target of opportunity in the same manner as a standard call for fire.

ELEMENT	EXAMPLE
Observer identification	"R24, this is A58"
Warning order	"Fire for effect, over"
Target location	"Grid 436122, direction 1800, over"
Target description	"2 tanks"
Method of engagement	"COPPERHEAD, 2 rounds"
Method of control	"By round at my command, over."

MTO ELEMENT	EXAMPLE
Unit firing	"R"
Target number	"AF7006"
Number of rounds	"2 rounds"
Laser PRF code	"code 241"
Time of flight	"Time of flight, 25, over"

The PRF code transmitted by the FDC in the MTO is a confirmation of the PRF code assigned to the observer by the FSO. If the PRF code in the MTO is different than the observer's pre-assigned code, the observer must change the code on the laser designator before receiving the "Laser on" command.

ANNEX B TO APPENDIX B
GROUND AND AIRBORNE LASER DESIGNATION FOR CAS WITH FAC NOT COLLOCATED WITH LDO OR ALD

1. Communications (See Figure B-B-1)

a. Communications between LDO or ALD and FAC, if not collocated: FM.

b. Communications between FAC and aircraft: FM, ultra high frequency (UHF), or very high frequency (VHF).

c. Communications between LDO or ALD and aircraft: FM, (UHF or VHF when available).

2. Additions to Tactical Air Request

a. **Laser Code.** (FAC gets laser code from the FSO or FSCC and passes to aircraft with LST. FAC obtains or passes laser code to FSO or FSCC for attacking aircraft with LGWs.)

b. Request for LGWs.

c. Laser-to-target line in degrees magnetic.

d. Radio frequency and call sign for final controller to whom pilot will give final attack laser calls.

3. Additions to FAC to Aircrew CAS Briefing (Appendix C, "CAS Briefing Form [9-Line]")

a. Request laser code, four digits (lxxx) set in LGWs on aircraft. In the case of LGM equipped aircraft, the FAC will pass the laser code set in the ground designator, and the LGM seeker codes will be changed to match the ground designator or ALD.

b. Pass laser-to-target line in degrees magnetic.

c. Laser-spot offset information, if applicable.

d. Pass radio frequency and call sign for final controller to whom aircrew will give final attack laser calls.

4. Additions to Aircrew to FAC Reporting Procedures

a. Pass that LGWs are to be delivered and the laser codes set in them.

b. "10 SECONDS" warning call that aircraft will need laser on in 10 seconds.

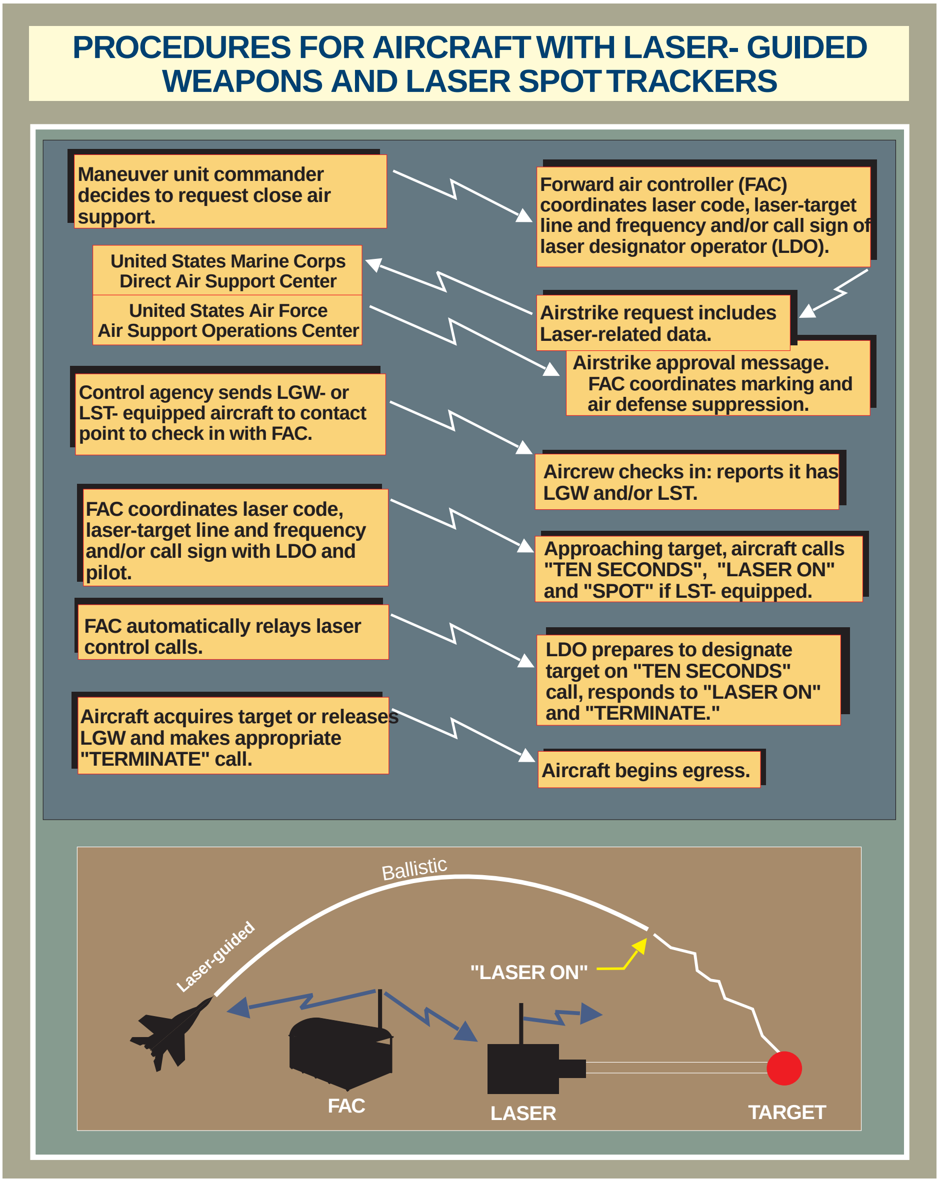

Figure B-B-1. Procedures for Aircraft With Laser-Guided Weapons and Laser Spot Trackers

c. "LASER ON" call.

d. "SPOT" call (for LST-equipped aircraft).

e. "TERMINATE" call when designation is no longer required, based on the aircrew's computation of the time of flight (TOF) of the LGW being delivered.

5. Additions to FAC to LDO or ALD Calls

a. Confirm LST- and LGW-equipped aircraft inbound.

b. Confirm laser code to be used. Ground LDOs and ALDs will change to codes set in LGWs carried by supporting aircraft.

c. FAC automatically relays all laser calls from aircrew to LDO or ALD.

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ANNEX C TO APPENDIX B

GROUND AND AIRBORNE LASER DESIGNATION PROCEDURES FOR HELICOPTERS

1. Communication — Designator (Controller) to Helicopter (See Figure B-C-1)

a. Ground — FM

b. Air — FM, VHF, UHF

2. Target Hand-off to LST-Equipped Helicopter

a. Additions to FO or ALD briefing to helicopter

- Four-digit laser code (lxxx)
- Laser-to-target line in degrees magnetic
- Laser spot offset, if applicable

b. Additions to aircrew to FO or ALD reporting procedures

- “10 SECONDS” warning call that the aircraft will need laser-on in 10 seconds
- “LASER ON” call
- “TERMINATE” call when designation is no longer required

3. Target Engagement for LGM-Equipped Helicopters

a. Additions to FO or ALD briefing to helicopter

- Four-digit laser code (1xxx)
- Laser-to-target line in degrees magnetic
- Number of missiles, if applicable
- Firing mode, if applicable
- Time interval between launches, if applicable
- Radio frequency and call signs for laser calls, if applicable

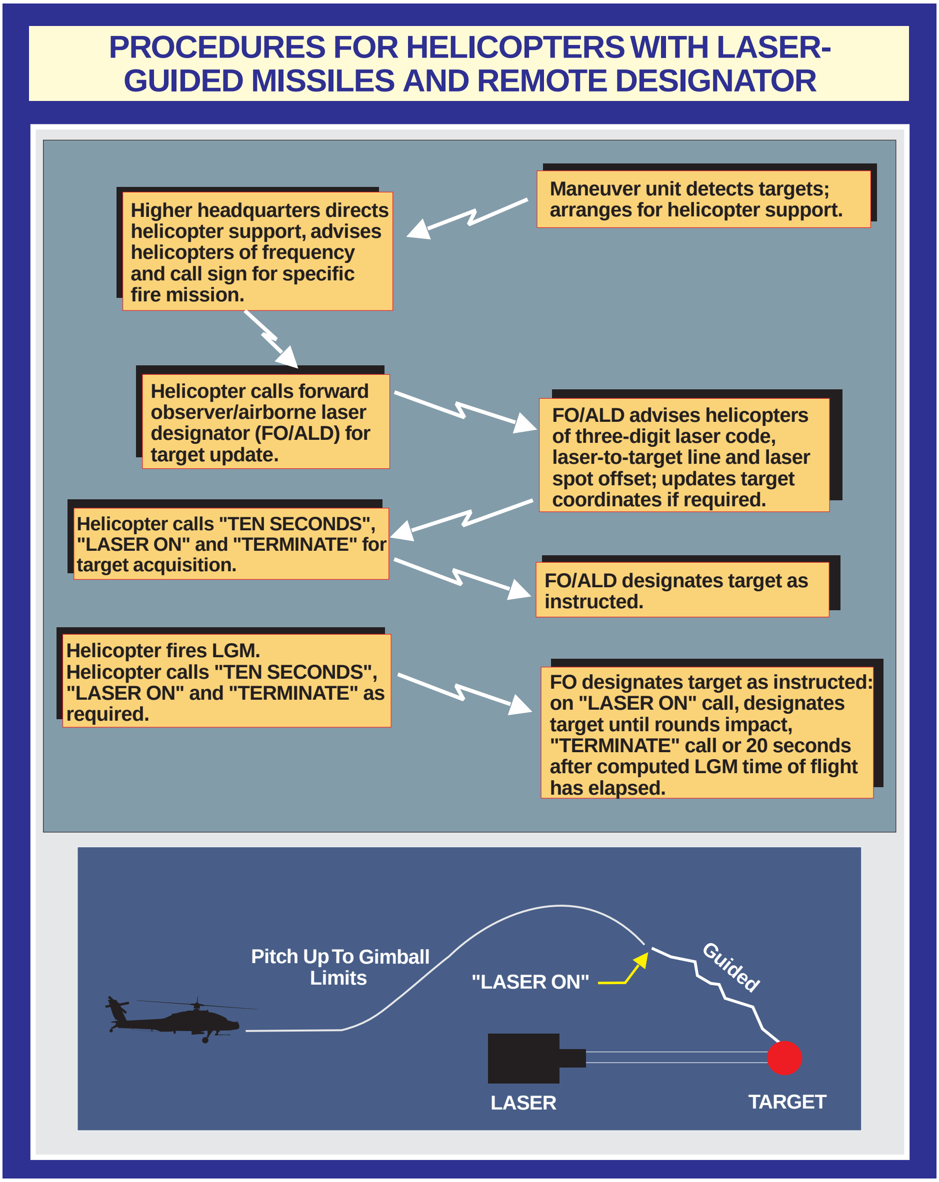

Figure B-C-1. Procedures for Helicopters With Laser-Guided Missiles and Remote Designator

b. Additions to aircrew to FO or ALD reporting procedures

- “10 SECONDS” warning call that the aircraft will need laser-on in 10 seconds
- “LASER ON” call
- “TERMINATE” call when designation is no longer required

NOTE: Army FM 1-112 should be reviewed for more specific AH-64/OH-58D engagement procedures.

4. HELLFIRE Guided Missile Surface Danger Zone

a. A HELLFIRE guided missile is an air-launched antiarmor weapon launched from the AH-64, AH-1, and OH-58D. HELLFIRE homes in on a laser spot projected from either a ground observer, another aircraft, or the launch aircraft itself. The AH-64 can engage targets autonomously or work as a team member. As many as 10 targets can be handed off to the AH-64, providing rapid target engagement. The following operational modes can be selected when firing HELLFIRE.

- **Lock-On After Launch (Direct Launch Mode).** An LOS exists between the HELLFIRE missile and the target; however, HELLFIRE seeker lock-on is inhibited by distance. HELLFIRE is launched in the general direction of the target, locks-on after launch, and then homes to the target.

- **Lock-On Before Launch (Direct Launch Mode).** The HELLFIRE missile seeker tracks the target prior to launch. Once launched, the missile homes to the target.

- **Lock-On After Launch (Indirect Launch Mode).** The HELLFIRE missile is launched from behind a terrain mask or in defilade. The missile seeker then acquires the target and homes in on a preselected trajectory.

b. Surface danger zones for a direct launch and indirect launch provide for all firing modes of the HELLFIRE missile at fixed targets to include the effects of the warhead functioning at the edge of the impact area. No specific warhead area is included because the HELLFIRE missile system has no practice warhead.

c. All laser range control procedures and laser surface danger zone parameters outlined in AR 385-63, Chapter 19, apply to designators being used with the HELLFIRE missile (also see TB MED 524). Because of the large surface danger zones and the limited range of the designators, it may be necessary to place designator operators within the surface danger zones during some training exercises. Three designator zones for designator operators have been established within the surface danger zones. These designator zones and their specific range requirements are provided below.

- **Prohibited Designator Zone.** No designator operators are allowed in this zone because of the unacceptable probabilities associated with the following hazards:

  •• There are remote scenarios where the missile seeker can track the laser backscatter energy at the exit aperture of the designator or along the path of the laser beam; and

  •• The probability of random missile failures is the highest within this zone.

- **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 may track and impact an obstruction (e.g., trees, grass, hills) near the designator operator if it is accidentally illuminated by the laser beam. The possibility of being injured by a random missile failure impacting within 150 meters of a designator operator in this area is less than 4 in 10 million.

  •• Ground-designator operators will wear flak jackets and military issue helmets and be located in protected positions (e.g., sand bags enclosing the designator operator).

  •• The designator will have a clear unobstructed LOS to the target. All obstacles (e.g., trees, rocks, grass) should be at least 500 meters from the laser beam. Special care should be taken to ensure that designator LOS is unobstructed across the entire path of a moving target during the TOF to impact.

  •• Ground-designator operators must ensure that they do not inadvertently lase through dust caused by other personnel, vehicles.

  •• Airborne designators must ensure that they are either over ground conditions that do not create dust or at an altitude where rotor downwash does not create dust.

  •• In peacetime operations, both ground and airborne designators may occupy the protected designator zone when formal justification is provided and a waiver granted IAW the provisions of AR 385-62, Chapter 1 (Formal waivers are usually already in effect for wartime operations). Waivers should be granted when there is no possible way to conduct operations in the unprotected designator zone or outside the surface danger zone(s).

- **Unprotected Designator Zone.** Although designator operators are not vulnerable to a normally functioning missile tracking the backscatter or false targets in this zone, there is still a possibility of a random missile failure. The probability of a random missile failure impacting with 150 meters of the designator is smaller in this zone than in the protected designator zone.

  •• At a minimum, ground designator operators should wear flak jackets and military helmets.

  •• The requirements of subparagraphs 4c above also apply to the unprotected designator zone.

  •• Designator operations (ground and/or airborne) may be conducted in the unprotected designator zone when formal justification is provided and a waiver granted IAW the provisions of AR 385-62, Chapter 1.

d. Two additional areas within the surface danger zones are as follows.

- **Potential Hazard Area.** An area designated to contain a malfunctioning missile at the point of launch. Only mission-essential personnel may occupy this area. Large concentrations of personnel in the potential hazard area is prohibited.

- **Area F.** An area to the rear of the launch point 30 meters wide (15 meters to each side of the launcher) and 50 meters long. Hazards are launch motor blast, high noise levels, overpressure, and debris. Serious casualties or fatalities may occur to any personnel occupying this area. Occupation of Area F by personnel is prohibited.

e. General range requirements are as follows.

- All non-mission-essential personnel will be located outside the HELLFIRE surface danger zone(s).

- The position of the launch platform and designator operators are critical to the safe use of the HELLFIRE missile system. Controls must be established to ensure that proper launcher direction, designator direction, and target coordinates are verified prior to launch of the missile.

- The angle formed between the designator target line and the missile target line will never be greater than 60 degrees. Designator operators (ground and/or airborne) will never be outside this area.

- The launch zone and designator zones to be used during an exercise must be clearly marked to ensure designator operator safety.

- If the LOAL-D is required, the target should be visible to the launch crew to assure proper aircraft alignment.

- Designator rain hoods and port covers should always be used when supplied as a system option.

- Missile launches should be conducted in good visibility conditions to allow the HELLFIRE missile seeker to acquire the target as early as possible during flight.

- Designator codes 470-488 and 782 or greater will not be used for Army Helicopter Improvement Program (OH-58D) designations.

5. HELLFIRE Guided Missile Airborne Designator Danger Zone

a. Many battlefield scenarios require the HELLFIRE to be guided by an airborne designator. The increasing number of aircraft platforms equipped with laser designators has given rise to numerous remote designation (“buddy lase”) techniques. Although aircraft present a viable tactical alternative to a ground based laser, some important items must be considered.

- As with ground-based designators, the backscatter from airborne designators, or the designator itself, may present a lucrative target for the laser detectors in all LGWs, including the HELLFIRE. Unfortunately, depending upon launch platform and employment mode, the launch aircrew may not be able to determine that the missile is receiving laser energy from the designating platform vice the intended target.

  •• **Employment Mode.** If the HELLFIRE is employed in LOBL mode, the weapon LOS is displayed in most launch platforms. With this cueing, trained launch aircrew can determine that the weapon is tracking the designator vice the target. If employed in LOAL, no cueing is provided to the launch aircrew by the weapon. Other aircraft systems may provide this cueing but will generally not be capable of detecting the laser spot in an LOAL scenario. The bottom line is that only an LOBL launch is capable of providing cueing of the weapon's aimpoint; however, even if an LOBL is planned, launch aircrew train to employ in an LOAL mode if a laser spot is not received once clearance to launch has been given. This training consists of ensuring specific safety offset angles are used between the launch platform and the designator to minimize fratricide.

  •• **Launch Platform.** Several US aircraft employ the HELLFIRE, but the amount of aircrew cueing varies greatly. Most platforms, including the AH-1W, the AH-64, and the AH-60, provide aircrew cueing in the form of a pointer at weapon LOS. When receiving properly coded laser energy, the HELLFIRE will lock on and the aircraft weapons control system will display the weapon to target LOS. With this cueing, the aircrew can determine the source of the laser return and validate that the missile is tracking the desired target and not the designator.

- When employed in an LOAL mode, the HELLFIRE will execute a climbing profile and immediately begin searching for properly coded laser energy. The profile will depend upon whether the employment is LOAL low or LOAL high, but can be as high as 20 degrees above the horizon. If an airborne designator is within the missile FOV during an LOAL profile, there is a high probability that the weapon will track and guide on the designator vice the intended target. With a kinematics capability in excess of 10 km, the HELLFIRE may guide to impact on the designating platform with devastating effects. Because of the climbing profile executed by the weapon, especially in an LOAL high, an altitude sanctuary by the designator is not always assured. The geometry for remote designate tactics using an airborne designator must be precise to preclude this possibility.

b. An airborne (or ground) designator to remote designate for HELLFIRE deliveries must remain out of the weapon FOV throughout the TOF. This FOV is defined by the shooter (weapon) to target LOS +/- 30 degrees in the horizontal plane and 40 degrees in the vertical plane. Designator profiles behind the launch platform are inherently the safest available. Field and tactical manuals should be consulted for most current information regarding safety areas and safety zones.

APPENDIX C
CAS BRIEFING FORM (9-LINE)

(Omit data not required, do not transmit line numbers. Units of measure are standard unless otherwise specified. * denotes minimum essential in limited communications environment. Bold denotes readback items when requested.)

Terminal controller: "____________________, this is ____________________________"
(aircraft call sign) (terminal controller)

*1. IP/BP: "____"

*2. Heading: "_______________________________________" (magnetic).
(IP/BP to target)
Offset: "_______________________________________ (left/right)"

*3. Distance: "____"
(IP to target in nautical miles/BP to target in meters)

*4. Target elevation: "___________________________" (in feet MSL)

*5. Target description: "____"

*6. Target location: "____"
(latitude/longitude or grid coordinates or offsets or visual)

*7. Type mark: "________________________" Code: "________________"
(WP, laser, IR, beacon) (actual code)
Laser to target line: "________________" (degrees)

*8. Location of friendlies: "___________________________________"
Position marked by: "______________________________"

*9. Egress: "____"
In the event of a beacon bombing request, insert beacon bombing chart line numbers here.

____

Remarks (As appropriate): "_______________________________________"
(threats, restrictions, danger close, attack clearance, SEAD, abort codes, hazards)

NOTE: For AC-130 employment, lines 5, 6, and 8 are mandatory briefing items. Remarks should also include detailed threat description, marking method of friendly locations (including magnetic bearing and distance in meters from the friendly position to the target, if available), identifiable ground features, danger close acceptance.

Time on target: "______________________________"

OR

Time to target: "Stand by _______ plus _______, Hack."

Refer to JP 3-09.3, "Joint Tactics, Techniques, and Procedures for Close Air Support (CAS)." This format varies slightly from NATO-approved procedures published in ACP 125, Supplement 2(A).

APPENDIX D
LGB AND LLLGB DELIVERY PROFILES

1. Delivery Profiles

a. **General.** LGBs and LLLGBs are not a cure-all for the full spectrum of targets and scenarios facing fighter and attack aircraft, but they do offer advantages in standoff and accuracy over other types of free-fall weapons in the inventory. LGBs and LLLGBs will be employed in a range of missions from CAS to interdiction. The following section describes the basic delivery profiles used in LGB and LLLGB employment.

b. **Medium-Altitude Employment.** LGBs and LLLGBs are excellent performers in dive deliveries initiated from medium-altitude. A steep, fast dive attack increases LGB and LLLGB maneuvering potential and flight ability. Medium-altitude attacks generally reduce target acquisition problems and more readily allow for target designation by either ground or airborne designation platforms. Medium-altitude LGB and LLLGB dive delivery tactics are normally used in areas of low to medium threat. Figure D-1 depicts LGB and LLLGB dive delivery tactics. Medium-altitude level release employment is also a highly effective tactic.

c. **Low-Level Employment.** Low-level LGB and LLLGB employment requires special considerations. There is no "best" delivery profile to fly at the exclusion of all others. The aircrew must consider both survivability and specific target characteristics to determine the best release option available. Low-level employment is one of the most demanding tasks facing fighter and attack aircraft crews today. The aircrew must also consider the significant difference between LGB and LLLGB flight capability. Critical elements for low-level LGB and LLLGB employment are: (1) sufficient airspeed; (2) accurate release parameters; and (3) coordination with the ground or airborne designator. Low-level delivery profiles fall into the following categories: (1) loft delivery; (2) level delivery; (3) pop-up to low-angle dive delivery; and (4) pop-up to long-range toss delivery.

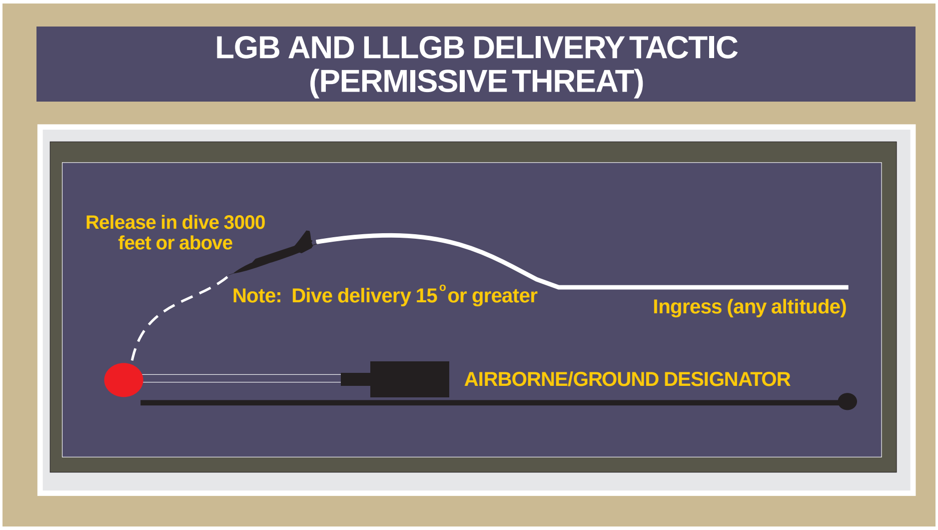

Figure D-1. LGB and LLLGB Delivery Tactic (Permissive Threat)

- **Loft Delivery.** After gaining the supported ground commander's approval, loft deliveries may be initiated prior to target acquisition or designation. This capability increases standoff distance. Advantages of the loft option include minimum non-maneuvering exposure time and maximum standoff capability. Loft angles can vary to fit the tactical environment. Loft deliveries require automated weapons delivery systems to achieve accurate release parameters. When using ground designators, close coordination between aircrews and ground designator personnel is a critical factor. Figure D-2 depicts a PAVEWAY II low-level loft delivery tactic. LLLGBs can be released in a loft mode, but this does not increase range, and increases exposure of the delivery aircraft. Figure D-3 depicts the delivery profile of the PAVEWAY III. Because of the risk to friendly ground forces, the FAC should avoid loft attacks with weapons release behind friendly positions.

- **Level Delivery.** Generally, tactical considerations or weather limitations drive level deliveries from low altitude. The Paveway II level delivery profile will normally cause the delivery aircraft to overfly the target. The main advantage of the LLLGB is in the low-altitude, level-delivery profile; the delivery aircraft can stand well away from the target during its delivery.

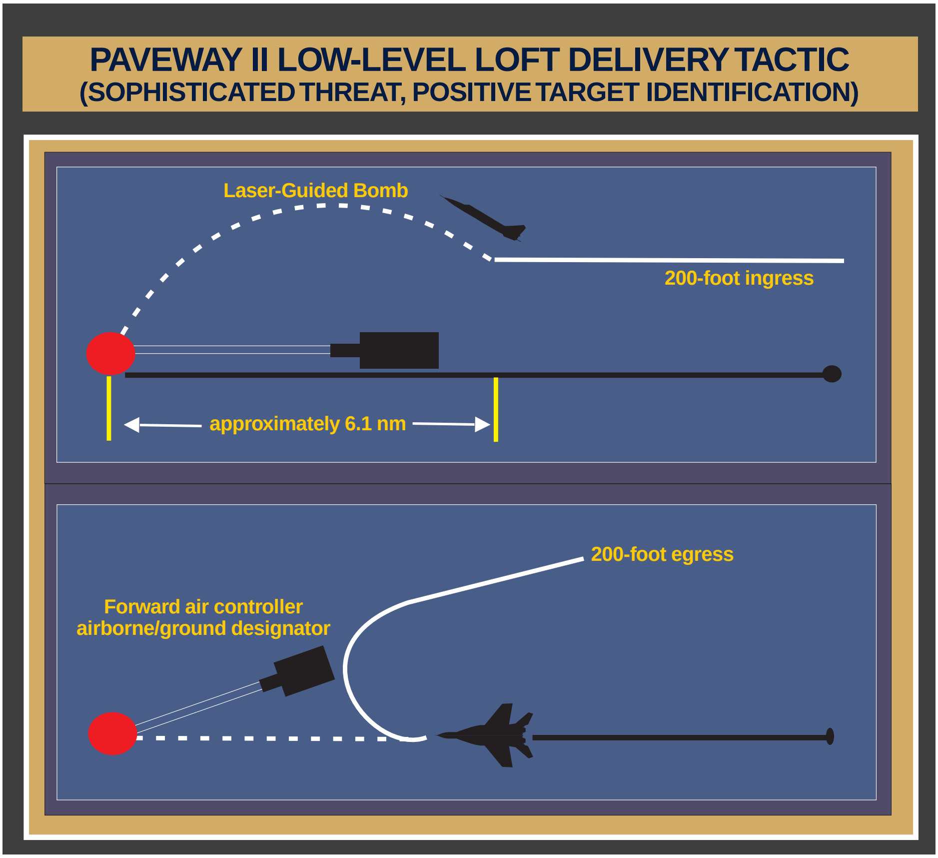

Figure D-2. PAVEWAY II Low-Level Loft Delivery Tactic (Sophisticated Threat, Positive Target Identification)

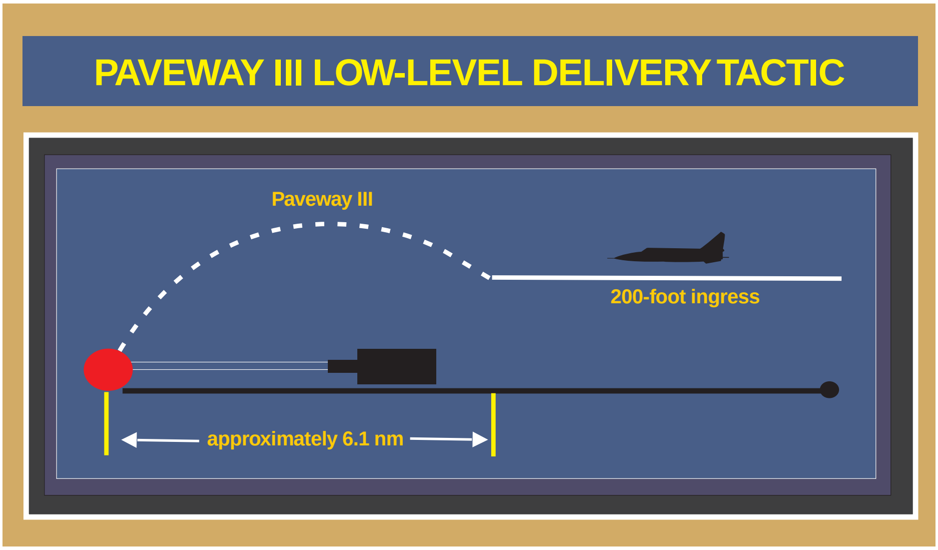

Figure D-3. PAVEWAY III Low-Level Delivery Tactic

- **Pop-up to Low-Angle Dive Delivery.** Pop-up to low-angle dive deliveries offer advantages over level releases. Target acquisition is easier with level delivery because the apex is higher, there is more time available for search, and the bomb has better maneuverability. Exposure is usually longer than for a level approach, so the aircrew should maneuver the aircraft throughout the delivery. Figure D-4 depicts the LGB and LLLGB pop-up delivery tactic.

- **Pop-up to Long-Range Toss Delivery.** Toss deliveries provide increased delivery flexibility over other delivery options; however, they are not normally used in the CAS arena. While ceiling and visibility may dictate release parameters, standoff capability is very good and varies with the type of weapon used and the release altitude which may be restricted by ceiling and visibility. Total exposure time is moderate and non-maneuvering exposure time is minimized. The toss delivery profile is very similar to that illustrated for the loft in Figure D-2.

d. **LLLGB Advantages.** The LLLGB was developed in response to sophisticated enemy air defenses and poor visibility and to counter limitations in low ceilings. The weapon is designed for low-altitude delivery and with a capability for improved standoff ranges to reduce exposure. Unlike the LGB, the LLLGB can correct for relatively large deviations from planned release parameters in the primary delivery mode (low-altitude, level-delivery). It also has a larger delivery envelope for the dive, glide, and loft modes than does the earlier LGB. The wide field of view and midcourse guidance modes programmed in the LLLGB allow for a "point and shoot" delivery capability that allows the aircrew to attack the target by pointing the aircraft at the target and releasing the weapon after obtaining appropriate sight indications. The primary advantage of this capability is that accurate diving or tracking is not required to solve wind-drift problems. An added advantage of the LLLGB in a CAS situation is that if the LLLGB does not detect reflected laser energy, it will maintain level flight to continue beyond the designated target, overflying friendly positions to impact long rather than short of the target.

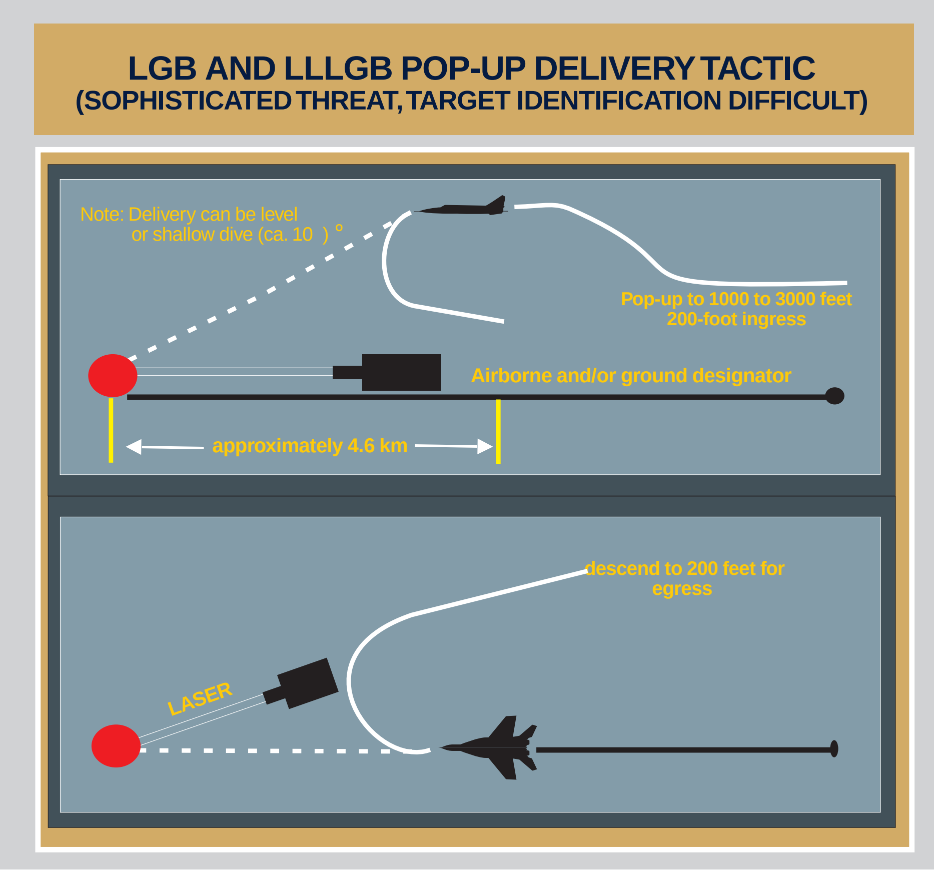

Figure D-4. LGB and LLLGB Pop-Up Delivery Tactic (Sophisticated Threat, Target Identification Difficult)

APPENDIX E
LASER PROTOCOL

1. General

a. The "Laser Protocol to the 1994 Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to be Excessively Injurious or to Have Indiscriminate Effects" was only recently negotiated. It deals with a subject about which there is neither existing conventional (treaty) law nor customary international practice. The United States has not yet ratified the Protocol. The Protocol has no binding effect on the United States or its military personnel.

b. Even if the Laser Protocol did have a binding effect, it does not prohibit the use of the lasers described in this publication because none of them are designed to cause blindness as a combat function. Rather, each is designed for target designation, range finding, and other related areas. Incidental or collateral blindness caused by a legitimate military laser is not prohibited by the Protocol (Article 3).

c. The Secretary of Defense memorandum in Paragraph 3 is an effective constraint on US forces. It also only prohibits lasers designed to cause permanent blindness, and recognizes targeting and range-finding lasers as permissible.

2. Protocol Terms

The terms of the Laser Protocol are as follows.

ADDITIONAL PROTOCOL TO THE CONVENTION ON PROHIBITIONS OR RESTRICTIONS ON THE USE OF CERTAIN CONVENTIONAL WEAPONS WHICH MAY BE DEEMED TO BE EXCESSIVELY INJURIOUS OR TO HAVE INDISCRIMINATE EFFECTS

ARTICLE 1: ADDITIONAL PROTOCOL

The following protocol shall be annexed to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects ("the Convention") as Protocol IV:

"Protocol on Blinding Laser Weapons"
(Protocol IV)

Article 1:

It is prohibited to employ laser weapons specifically designed, as their sole combat function or as one of their combat functions, to cause permanent blindness to unenhanced vision, that is to the naked eye or to the eye with corrective eyesight devices. The High Contracting Parties shall not transfer such weapons to any State or non-State entity.

Article 2:

In the employment of laser systems, the High Contracting Parties shall take all feasible precautions to avoid the incidence of permanent blindness to unenhanced vision. Such precautions shall include training of their armed forces and other practical measures.

Article 3:

Blindness as an incidental or collateral effect of the legitimate military employment of laser systems, including laser systems used against optical equipment, is not covered by the prohibitions of this Protocol.

Article 4:

For the purpose of this Protocol 'permanent blindness' means irreversible and uncorrectable loss of vision which is seriously disabling with no prospect of recovery. Serious disability is equivalent to visual acuity of less than 20/200 Snellen measured using both eyes.

ARTICLE 2: ENTRY INTO FORCE

This Protocol shall enter into force as provided in paragraphs 3 and 4 of Article 5 of the Convention.

CCW Conference: Vienna, Austria 1995
25 September - 13 October 1995

3. DOD Policy on Blinding Lasers

The following is the current DOD policy on the use of blinding lasers.

DOD Policy on Blinding Lasers

The Department of Defense prohibits the use of lasers specifically designed to cause permanent blindness and supports negotiations prohibiting the use of such weapons. However, laser systems are absolutely vital to our modern military. Among other things, they are currently used for detection, targeting, range-finding, communications and target destruction. They provide a critical technological edge to US forces and allow our forces to fight, win and survive on an increasingly lethal battlefield. In addition, lasers provide significant humanitarian benefits. They allow weapon systems to be increasingly discriminate, thereby reducing collateral damage to civilian lives and property. The Department of Defense recognizes that accidental or incidental eye injuries may occur on the battlefield as the result of the use of lasers not specifically designed to cause permanent blindness. Therefore, we continue to strive, through training and doctrine, to minimize these injuries.

Secretary of Defense William J. Perry
January 17, 1997
Current DOD Policy on Blinding Lasers

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APPENDIX F
REFERENCES

The development of Joint Pub 3-09.1 is based upon the following primary references.

1. Joint Publications

a. Joint Pub 1-02, "DOD Dictionary of Military and Associated Terms."

b. Joint Pub 3-0, "Doctrine for Joint Operations."

c. Joint Pub 3-05.5, "Joint Special Operations Targeting and Mission Planning Procedures."

d. Joint Pub 3-09, "Doctrine for Joint Fire Support."

e. Joint Pub 3-09.3, "Joint Tactics, Techniques, and Procedures for Close Air Support (CAS)."

2. Multi-Service Publications

a. FM 90-20/FMFRP 2-72/TACP 50-28/USAFEP 50-9/PACAFP 50-28, "Multi-Service Procedures for the Joint Application of Firepower (J-FIRE)."

b. FM 90-21/FMFRP 5-44/TACP 50-20/USAFEP 50-20/PACAFP 50-20, "Multi-Service Joint Air Attack Team Operations (JAAT)."

c. FM 101-50-31/TH 61 A1-3-9/FMFM 5-2G-6/NAVAIR 00-130ASR-9, "Joint Munitions Effectiveness Manual/Air to Surface (JMEM/AS), Risk Estimates for Friendly Troops (C)."

d. TC 90-7/TACP 50-22/USAFEP 50-38/PACAFP 50-38, "Tactical Air Control Party/ Fire Support Team (TACP/FIST) Close Air Support Operations."

3. Service Publications

a. FM 6-20, "Doctrine for Fire Support."

b. FM 6-20-40, "Tactics, Techniques, and Procedures for Fire Support for Brigade Operations (Heavy)."

c. FM 6-30, "Tactics, Techniques, and Procedures for Observed Fire."

d. FMFM 3-55, "Tactical Directed Energy Warfare."

e. FMFM 6-8, "Supporting Arms Observer, Spotter, and Controller."

f. NWP 3-09.11/FMFM 1-7, "Supporting Arms and Amphibious Operations."

g. Military Handbook 828A, "Laser Safety on Ranges and in Other Outdoor Areas."

APPENDIX G
ADMINISTRATIVE INSTRUCTIONS

1. User Comments

Users in the field are highly encouraged to submit comments on this publication to the United States Atlantic Command Joint Warfighting Center, Attn: Doctrine Division, Fenwick Road, Bldg 96, Fort Monroe, VA 23651-5000. These comments should address content (accuracy, usefulness, consistency, and organization), writing, and appearance.

2. Authorship

The lead agent for this publication is the US Army. The Joint Staff doctrine sponsor for this publication is the Director for Operational Plans and Interoperability (J-7).

3. Supersession

This publication supersedes Joint Pub 3-09.1, 1 June 1991, "Joint Laser Designation Procedures."

4. Change Recommendations

a. Recommendations for urgent changes to this publication should be submitted:

TO: CSA WASHINGTON DC//DAMO-FDQ//
INFO: JOINT STAFF WASHINGTON DC//J7-JDD//

Routine changes should be submitted to the Director for Operational Plans and Interoperability (J-7), JDD, 7000 Joint Staff Pentagon, Washington, DC 20318-7000.

b. When a Joint Staff directorate submits a proposal to the Chairman of the Joint Chiefs of Staff that would change source document information reflected in this publication, that directorate will include a proposed change to this publication as an enclosure to its proposal. The Military Services and other organizations are requested to notify the Director, J-7, Joint Staff, when changes to source documents reflected in this publication are initiated.

c. Record of Changes:

CHANGE NUMBER	COPY NUMBER	DATE OF CHANGE	DATE ENTERED	POSTED BY	REMARKS

5. Distribution

a. Additional copies of this publication can be obtained through Service publication centers.

b. Only approved pubs and test pubs are releasable outside the combatant commands, Services, and Joint Staff. Release of any classified joint publication to foreign governments or foreign nationals must be requested through the local embassy (Defense Attaché Office) to DIA Foreign Liaison Office, PSS, Room 1A674, Pentagon, Washington, DC 20301-7400.

c. Additional copies should be obtained from the Military Service assigned administrative support responsibility by DOD Directive 5100.3, 1 November 1988, "Support of the Headquarters of Unified, Specified, and Subordinate Joint Commands."

By Military Services:

Army:	US Army AG Publication Center SL 1655 Woodson Road Attn: Joint Publications St. Louis, MO 63114-6181
Air Force:	Air Force Publications Distribution Center 2800 Eastern Boulevard Baltimore, MD 21220-2896
Navy:	CO, Naval Inventory Control Point 700 Robbins Avenue Bldg 1, Customer Service Philadelphia, PA 19111-5099
Marine Corps:	Marine Corps Logistics Base Albany, GA 31704-5000
Coast Guard:	Coast Guard Headquarters, COMDT (G-OPD) 2100 2nd Street, SW Washington, DC 20593-0001

d. Local reproduction is authorized and access to unclassified publications is unrestricted. However, access to and reproduction authorization for classified joint publications must be in accordance with DOD Regulation 5200.1-R.

GLOSSARY

PART I — ABBREVIATIONS AND ACRONYMS

AAM	air-to-air missile
ALD	airborne laser designator
ALLTV	all light level television
ALO	air liaison officer
ARBS	angle rate bombing system
ATF	Advanced Targeting FLIR
ATHS	Airborne Target Handover System
BP	battle position
CAS	close air support
CBU	cluster bomb unit
CLD	compact laser designator
CLGP	cannon-launched guided projectile
COLT	combat observation and lasing team
COPPERHEAD	name for cannon-launched guided projectile
DA	direct action
DAP	designated acquisition program
DOD	Department of Defense
DTL	designator target line
ESM	electronic surveillance measures
ETAC	enlisted terminal attack controllers
FAC	forward air controller
FAC(A)	forward air controller (airborne)
FAE	fuel air explosive
FDC	fire direction center
FIST	fire support team
FLIR	forward-looking infrared
FM	frequency modulation
FO	forward observer
FOV	field of view
FSC	fire support coordinator
FSCC	fire support coordination center
FSO	fire support officer
GBU	guided bomb unit
GP	general purpose
GPS	global positioning system
G/VLLD	ground/vehicle laser locator designator

HE	high explosives
HEI	high explosives incendiary
HUD	heads-up display
IAW	in accordance with
IDM	improved data modem
IP	initial point
IR	infrared
J-3	Operations Directorate of a joint staff
km	kilometer
LANTIRN	low-altitude navigation and targeting infrared for night
LDO	laser designator operator
LEP	laser eye protection
LGB	laser-guided bomb
LGM	laser-guided missile
LGW	laser-guided weapon
LIF	light interference filter
LLLGB	low-level laser-guided bomb
LLLTV	low-light level television
LMAV	laser Maverick
LOAL	lock-on after launch
LOAL-D	lock-on after launch-direct
LOBL	lock-on before launch
LOS	line of sight
LRF/D	laser range finder/detector
LST	laser spot tracker
LTD	laser target designator
LTD/R	laser target designator/ranger
MAGTF	Marine air-ground task force
MEU(SOC)	Marine expeditionary unit (special operations capable)
MMS	mast-mounted sight
MSL	mean sea level
MTO	message to observer
MULE	modular universal laser equipment
NFLIR	navigation forward-looking infrared
NGF	naval gun fire
NOHD	nominal ocular hazard distance
NTS	night targeting system
NVG	night vision goggle
NVS	night vision system

PLS	precision locator system
PRF	pulse repetition frequency
SEAD	suppression of enemy air defenses
SEAL	sea-air-land team
SOF	special operations forces
SOFLAM	special operations laser marker
SOTAC	special operations terminal attack controller
SSB	single side band
TACP	tactical air control party
TADS	target acquisition system and designation sight
TFLIR	targeting forward-looking infrared
TOF	time of flight
TOW	tube launched, optically tracked, wire guided
UHF	ultra high frequency
USAF	United States Air Force
USMC	United States Marine Corps
USN	United States Navy
VHF	very high frequency
VIXL	video transmission downlink
WP	white phosphorous

air liaison officer. An officer (aviator/pilot) attached to a ground unit who functions as the primary advisor to the ground commander on air operation matters. Also called ALO. (This term and its definition modify the existing term and its definition and are approved for inclusion in the next edition of Joint Pub 1-02.)

at my command. In artillery and naval gunfire support, the command used when it is desired to control the exact time of delivery of fire. (Joint Pub 1-02)

attack heading. 1. The interceptor heading during the attack phase that will achieve the desired track-crossing angle. 2. The assigned magnetic compass heading to be flown by aircraft during the delivery phase of an air strike. (Joint Pub 1-02)

backscatter. Refers to a portion of the laser energy that is scattered back in the direction of the seeker by an obscurant. (Upon approval of this revision, this term and its definition will be approved for inclusion in the next edition of Joint Pub 1-02.)

buffer zone. A conical volume centered on the laser's line-of-sight with its apex at the aperture of the laser, within which the beam will be contained with a high degree of certainty. It is determined by the buffer angle. (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

call for fire. A request for fire containing data necessary for obtaining the required fire on a target. (Joint Pub 1-02)

close air support. Air action by fixed- and rotary-wing aircraft against hostile targets which are in close proximity to friendly forces and which require detailed integration of each air mission with the fire and movement of those forces. Also called CAS. (Joint Pub 1-02)

enlisted terminal attack controller. Tactical air party member who assists in mission planning and provides final control of close air support aircraft in support of ground forces. Also called ETAC. (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

fire support coordination center. A single location in which are centralized communications facilities and personnel incident to the coordination of all forms of fire support. Also called FSCC. (This term and its definition modify the existing term and its definition and are approved for inclusion in the next edition of Joint Pub 1-02.)

fire support element. That portion of the force tactical operations center at every echelon above company or troop (to corps) that is responsible for targeting coordination and for integrating fires delivered on surface targets by fire-support means under the control, or in support, of the force. Also called FSE. (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

fire support officer. Senior field artillery officer assigned to Army maneuver battalions and brigades. Advises commander on fire-support matters. Also called FSO. (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

fire support team. An Army team provided by the field artillery component to each maneuver company and troop to plan and coordinate all indirect fire means available to the unit, including mortars, field artillery, close air support, and naval gunfire. Also called FIST. (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

forward air controller. An officer (aviator/pilot) member of the tactical air control party who, from a forward ground or airborne position, controls aircraft in close air support of ground troops. Also called FAC. (This term and its definition modify the existing term and its definition and are approved for inclusion in the next edition of Joint Pub 1-02.)

forward observer. An observer operating with front line troops and trained to adjust ground or naval gunfire and pass back battlefield information. In the absence of a forward air controller the observer may control close air support strikes. Also called FO. (This term and its definition modify the existing term and its definition and are approved for inclusion in the next edition of Joint Pub 1-02.)

gated laser intensifier. This is part of the AC-130 low light level television (LLLTV) targeting system and is used as an alternate source of IR illumination. It also has the capability to illuminate and identify IR ("GLINT") tape worn by friendly ground forces. The drawback of the GLINT is it highlights the aircraft to enemy forces using night vision devices. Also called GLINT. (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

grid coordinates. Coordinates of a grid coordinate system to which numbers and letters are assigned for use in designating a point on a gridded map, photograph, or chart. (Joint Pub 1-02)

gun-target line. An imaginary straight line from gun to target. (Joint Pub 1-02)

head-up display. A display of flight, navigation, attack, or other information superimposed upon the pilot's forward field of view. Also called HUD. (This term and its definition modify the existing term and its definition and are approved for inclusion in the next edition of Joint Pub 1-02.)

infrared pointer. A low power laser device operating in the near infrared light spectrum that is visible with light amplifying night vision devices. Also called IR pointer. (Joint Pub 1-02)

initial point. 1. The first point at which a moving target is located on a plotting board. 2. A well-defined point, easily distinguishable visually and/or electronically, used as a starting point for the bomb run to the target. 3. airborne - A point close to the landing area where serials (troop carrier air formations) make final alterations in course to pass over individual drop or landing zones. 4. helicopter - An air control point in the vicinity of the landing zone from which individual flights of helicopters are directed to their prescribed landing sites. 5. Any designated place at which a column or element thereof is formed by the successive arrival of its various subdivisions, and comes under the control of the commander ordering the move. Also called IP. (This term and its definition modify the existing term and its definition and are approved for inclusion in the next edition of Joint Pub 1-02.)

laser. Any device that can produce or amplify optical radiation primarily by the process of controlled stimulated emission. A laser may emit electromagnetic radiation from the ultraviolet portion of the spectrum through the infrared portion. Also, an acronym for "light amplification by stimulated emission of radiation". (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

laser footprint. The projection of the laser beam and buffer zone on the ground or target area. The laser footprint may be part of the laser surface danger zone if that footprint lies within the nominal visual hazard distance of the laser. (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

laser-guided weapon. A weapon which uses a seeker to detect laser energy reflected from a laser marked/designated target and through signal processing provides guidance commands to a control system which guides the weapon to the point from which the laser energy is being reflected. Also called LGW. (This term and its definition modify the existing term and its definition and are approved for inclusion in the next edition of Joint Pub 1-02.)

laser rangefinder. A device which uses laser energy for determining the distance from the device to a place or object. (Joint Pub 1-02)

laser seeker. A device based on a direction sensitive receiver which detects the energy reflected from a laser designated target and defines the direction of the target relative to the receiver. (Joint Pub 1-02)

laser spot. The area on a surface illuminated by a laser. (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

laser spot tracker. A device which locks on to the reflected energy from a laser-marked/designated target and defines the direction of the target relative to itself. Also called LST. (This term and its definition modify the existing term and its definition and are approved for inclusion in the next edition of Joint Pub 1-02.)

laser target designator. A device that emits a beam of laser energy which is used to mark a specific place or object. Also called LTD. (This term and its definition modify the existing term and its definition and are approved for inclusion in the next edition of Joint Pub 1-02.)

laser-target/gun-target angle. The angle between the laser-to-target line and the laser guided weapon/gun-target line at the point where they cross the target. (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

laser-target line. An imaginary straight line from the laser designator to the target with respect to magnetic north. (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

loft bombing. A method of bombing in which the delivery plane approaches the target at a very low altitude, makes a definite pullup at a given point, releases the bomb at a predetermined point during the pullup, and tosses the bomb onto the target. (Joint Pub 1-02)

milliradian. One thousandth of an angle whose apex is at the center of a circle and that subtends an arc of the circle equal in length to the radius: equal to .0572958 degrees. (This term and its definition are applicable only in the context of this publication and cannot be referenced outside this publication.)

offset lasing. The technique of aiming a laser designator at a point other than the target and, after laser acquisition, moving the laser to designate the target for terminal attack guidance. (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

point target. 1. A target of such small dimension that it requires the accurate placement of ordnance in order to neutralize or destroy it. 2. nuclear - A target in which the ratio of radius of damage to target radius is equal to or greater than 5. (Joint Pub 1-02)

precision-guided munitions. A weapon that uses a seeker to detect electromagnetic energy reflected from a target or reference point, and through processing, provides guidance commands to a control system that guides the weapon to the target. Also called PGM. (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

pulse code. A system of using selected pulse-repetition frequencies to allow a specific laser seeker to acquire a target illuminated by a specific laser designator. (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

pulse repetition frequency. In lasers, the number of pulses that occur each second. (PRF should not be confused with transmission frequency, which is determined by the rate at which cycles are repeated within the transmitted pulse). Also called PRF. (This term and its definition modify the existing term and its definition and are approved for inclusion in the next edition of Joint Pub 1-02.)

radar beacon. A receiver-transmitter combination which sends out a coded signal when triggered by the proper type of pulse, enabling determination of range and bearing information by the interrogating station or aircraft. (Joint Pub 1-02)

special operations terminal attack controller. USAF combat control personnel certified to perform the terminal attack control function in support of Special Operations Forces missions. Special operations terminal attack controller operations emphasize the employment of night infrared, laser, and beacon tactics and equipment. Also called SOTAC. (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

special tactics team. USAF Special Operations Forces with combat controllers assigned. The combat controllers are certified air traffic controllers with additional qualifications as Special Operations Terminal Attack Controllers for fire support operations. Also called STT. (This term and its definition modify the existing term and its definition and are approved for inclusion in the next edition of Joint Pub 1-02.)

spillover. The part of the laser spot that is not on the target because of beam divergence or standoff range, improper boresighting of laser designator, or poor operator illuminating procedures. (This term and its definition are approved for inclusion in the next edition of Joint Pub 1-02.)

splash. 1. In artillery and naval gunfire support, word transmitted to an observer or spotter five seconds before the estimated time of the impact of a salvo or round. 2. In air interception, target destruction verified by visual or radar means. (Joint Pub 1-02)

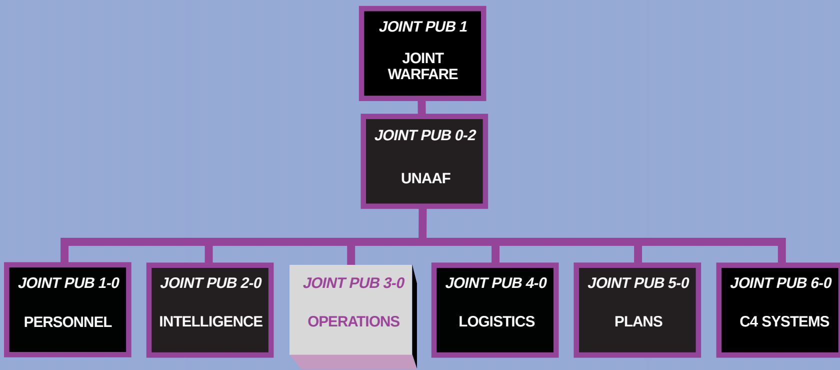
spotter. An observer stationed for the purpose of observing and reporting results of naval gunfire to the firing agency and who also may be employed in designating targets. (Joint Pub 1-02)

tactical air control party. A subordinate operational component of a tactical air control system designed to provide air liaison to land forces and for the control of aircraft. Also called TACP. (This term and its definition modify the existing term and its definition and are approved for inclusion in the next edition of Joint Pub 1-02.)

target acquisition. The detection, identification, and location of a target in sufficient detail to permit the effective employment of weapons. (Joint Pub 1-02)

toss bombing. A method of bombing where an aircraft flies on a line towards the target, pulls up in a vertical plane, releasing the bomb at an angle that will compensate for the effect of gravity drop on the bomb. Similar to loft bombing; unrestricted as to altitude. (Joint Pub 1-02)

JOINT DOCTRINE PUBLICATIONS HIERARCHY



All joint doctrine and tactics, techniques, and procedures are organized into a comprehensive hierarchy as shown in the chart above. **Joint Pub 3-09.1** is in the **Operations** series of joint doctrine publications. The diagram below illustrates an overview of the development process:

STEP #1
Project Proposal

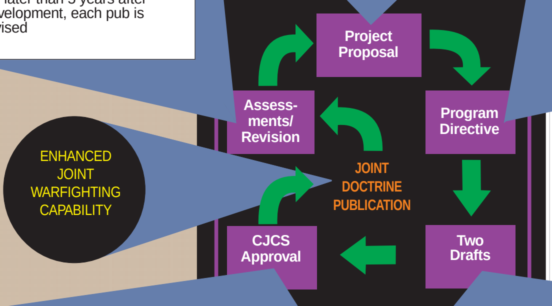
- Submitted by Services, CINCS, or Joint Staff to fill extant operational void
- J-7 validates requirement with Services and CINCs
- J-7 initiates Program Directive

STEP #2
Program Directive

- J-7 formally staffs with Services and CINCS
- Includes scope of project, references, milestones, and who will develop drafts
- J-7 releases Program Directive to Lead Agent. Lead Agent can be Service, CINC, or Joint Staff (JS) Directorate

STEP #5
Assessments/Revision

- The CINCS receive the pub and begin to assess it during use
- 18 to 24 months following publication, the Director J-7, will solicit a written report from the combatant commands and Services on the utility and quality of each pub and the need for any urgent changes or earlier-than-scheduled revisions
- No later than 5 years after development, each pub is revised



STEP #4
CJCS Approval

- Lead Agent forwards proposed pub to Joint Staff
- Joint Staff takes responsibility for pub, makes required changes and prepares pub for coordination with Services and CINCS
- Joint Staff conducts formal staffing for approval as a Joint Publication

STEP #3
Two Drafts

- Lead Agent selects Primary Review Authority (PRA) to develop the pub
- PRA develops two draft pubs
- PRA staffs each draft with CINCS, Services, and Joint Staff

JOINT
CHIEFS OF STAFF