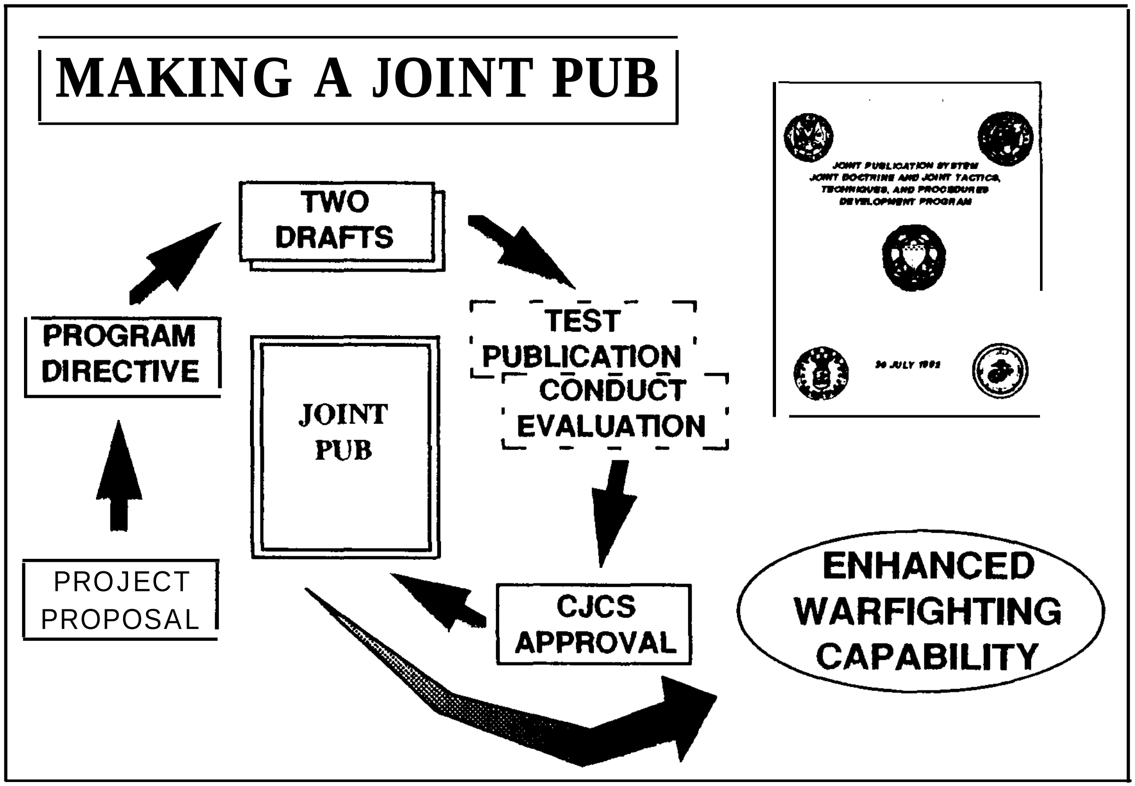
JOINT PUB 3-09.1

JOINT LASER DESIGNATION PROCEDURES (JLASER)

1 JUNE 1991

A large body of joint doctrine (and its supporting tactics, techniques, and procedures) has been and is being developed by the US Armed Forces through the combined efforts of the Joint Staff, Services, and combatant commands. The following chart displays an overview of the development process for these publications.



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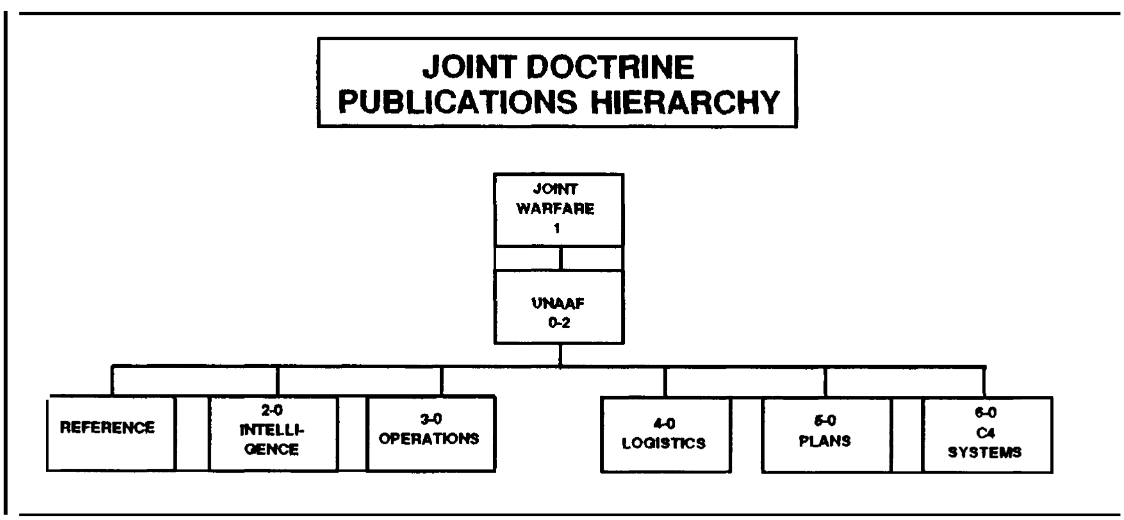

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JOINT LASER DESIGNATION PROCEDURES

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PREFACE

1. Purpose. This publication provides joint procedures for employing laser designators with target acquisition systems and laser-guided weapons to enhance the combat effectiveness of joint US forces.

2. Application

a. Procedures established in this publication apply to the commanders of combatant commands, joint task forces, and the subordinate components of these commands. These procedures may also 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, under criteria set forth in this publication.

b. In applying the procedures set forth in this publication, care must be taken to distinguish between distinct but related responsibilities in the two channels of authority to forces assigned to combatant commands. The Military Departments and Services recruit, organize, train, equip, and provide forces for assignment to combatant commands and administer and support these forces. CINCs exercise Combatant Command (command authority) over these forces. Service component commanders are responsible to both joint force commanders in the operational chain of command and to the Military Departments and Services in the chain of command for matters that the joint force commander has not been assigned authority.

3. Scope. This publication:

a. Encompasses joint tactics, techniques, and procedures for employing laser designators with acquisition devices and laser guided munitions.

b. Describes J-LASER planning and coordination procedures.

c. Describes laser system capabilities and limitations.

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CHAPTER I

CONCEPT

1. Introduction

a. Fighting the Modern Battle. Modern battles will be fought and won by multi-Service forces employed in joint operations. As the complexity of the battlefield increases, developing technologies must meet the challenge. One of the newest technologies is the laser system.

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. They can be aimed so the energy precisely designates a chosen spot on the target. Laser illumination designates targets for laser spot trackers (LSTs) and laser-guided weapons (LGWs). Some laser systems can also accurately determine target range and location. When coupled with horizontal and vertical scales, they can measure target azimuth and elevation. Commanders need fewer munitions when they use LGWs because the improved terminal accuracy of LGWs ensures the desired effects on the target. Additionally, commanders can use LGWs to effectively engage a wider range of targets, including mobile targets.

c. Laser Procedures on the Modern Battlefield. When laser procedures are applied in a high-threat scenario, the battlefield environment can cause a decrease in laser weapon accuracy. For example, LGWs have a limited off-axis capability; therefore, precise attack planning is essential to laser mission accomplishment.

2. Laser Use on the Battlefield. Laser technology for the battlefield has developed in three primary areas: laser target ranging and designation systems, laser acquisition systems, and LGWs.

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.

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 used on LGWs and uses reflected laser energy input to direct the weapon to the designated target.

c. Attacking a Target. LGWs home in on reflected laser energy to attack 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.

d. Basic Requirements. Four basic requirements are needed to effectively use laser designators with LSTs or LGWs:

(1) The pulse repetition frequency (PRF) code of the laser designator and the LST or LGW must be compatible (see Chapter IV, Laser Codes).

(2) A direction of attack must be determined because the LST or LGW must be able to sense sufficient laser energy reflecting from the target being designated.

(3) The laser designator must be designating the target at the correct time.

(4) The delivery system must release the weapon within the specific weapon's delivery envelope.

3. Laser Target Acquisition

a. Laser Designator Marking for Air Support. Laser designators can provide precision target marking for air support. Precise target marking with laser designators is directly related to target size and aspect, laser-beam divergence, and designation range.

b. Target Acquisition. Without LSTs or other acquisition aids, aircrews must 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 distinguish it from natural objects of the same size and color.

c. Ground Laser Designator Operators (LDOs). LDOs normally have much more time and more powerful optics to acquire targets than do aircrews of fighter or attack aircraft. 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 discreetly provide the most precise target mark available. Nonlaser target marks are usually ballistic and can move because of air motion.

Visible target marks may compromise an observer's position and allow enemy forces to expect attack and hide or disperse.

e. Laser Seekers. Laser seekers have a limited field of view. The aircrew must maneuver the aircraft to align the seeker with the laser designator's energy. A visible reference mark may be necessary to help the aircrew align the seeker. When the seeker senses the energy and displays the position, the aircrew can attack the target even if it cannot be distinguished from other objects on the ground.

4. Enemy Use of Laser Countermeasures. Many of the techniques for countering the use of laser energy and sensitive electro-optical equipment are common knowledge throughout much of the world. The Soviet Union and its allies are well equipped to detect and counter the increasingly sophisticated laser designator and guidance systems used by the armed forces of Western nations. The Soviets believe precision-guided munitions (PGM), specifically advanced antitank guided missile systems, are one of the most significant threats to their armored-vehicle inventory. Within the last 10 to 15 years, NATO has become increasingly dependent on PGMs to balance the growing numerical superiority of the conventional forces of the now defunct Warsaw Pact (WP) . A significant number of these advanced weapons employ laser guidance and electro-optic sensors. The Soviets have long recognized that effective laser countermeasures are readily available and relatively inexpensive. WP open literature made continuing reference to the capability of natural and manmade obscurants to significantly degrade laser systems and night vision devices.

5. Summary. The value of laser devices and LGWs has been recognized by the US Armed Forces. Each Service has developed laser systems to meet its particular needs. Common procedures and techniques are required to employ laser systems effectively during joint task force operations. This document describes procedures to be used by all Services in consonance with the Air Force Tactical Air Control System, the Army Air-Ground System, the Navy Tactical Air Control System, and the Marine Corps Air Command and Control System.

CHAPTER II

PLANNING CONSIDERATIONS

1. Laser Designator Characteristics

a. Laser Beam. Laser designators emit a narrow, pencil-like beam of laser pulses that has several characteristics, including minute divergence. Another characteristic is the single color (wavelength) of the laser pulses. Since laser energy wavelengths may fall anywhere from the near infrared (IR) through the near ultraviolet band, the actual wave-length will determine whether the laser is visible. Current tactical lasers fall in the near IR band and are invisible.

b. Beam Divergence and Target 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 (mr), its spot would have a diameter of approximately 1 meter (m) at a distance of 1,000 m in front of the designator (Figure II-I). If this spot were aimed at a 3 m x 3 m box 3,000 m away, the laser spot would be as wide and tall as the box.

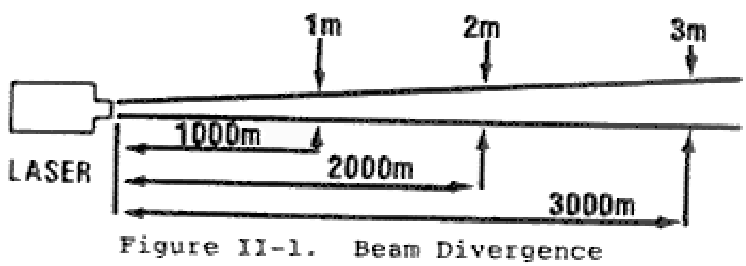

Figure II-1. Beam Divergence

NOTE: Beam divergence is 1 mr

c. Optics. Laser designators have riflescope-type optics to help aim the laser energy. The crosshairs allow the laser operator to select a precise aim point.

d. 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-2), 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-3). Any seeker that is looking for this laser energy would have to be in the narrow area of reflection. Because IR energy is different from visible light, it is reflected in a narrow beam from bare metal as well as from mirrorlike and glass surfaces.

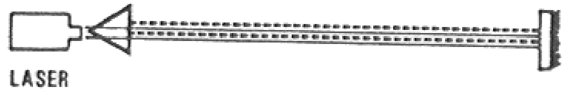

Figure II-2. Mirrorlike Reflections (Perpendicular)

Figure II-2. Mirrorlike Reflections (Perpendicular)

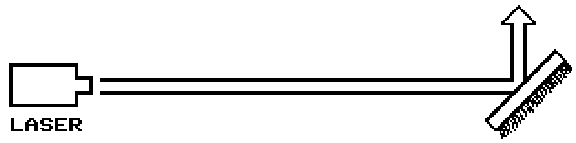

Figure II-3. Mirrorlike Reflections (Angular)

Figure II-3. Mirrorlike Reflections (Angular)

e. Scattered Reflection. If a surface is flat and nonshiny, it reflects light and IR energy in a large arc (Figure II-4).

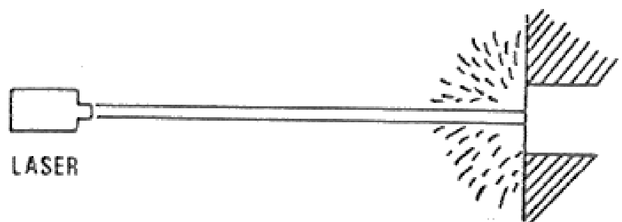

Figure II-4. Scattered Reflections

Figure II-4. Scattered Reflections

f. Spillover Reflection. When the target is smaller than the laser spot or there is unsteady tracking of the target from the designator, there is energy spillover around the target. This energy spillover is capable of providing scattered reflections off objects near the target (Figure II-5).

Figure II-5. Laser Spillover

Figure II-5. Laser Spillover

g. Blocked Reflection. When the seeker is looking for scattered laser energy, it must be able to see the reflecting surface. When a laser designates a surface that the seeker cannot see, the reflections are blocked (Figure II-6). This situation is called "podium effect."

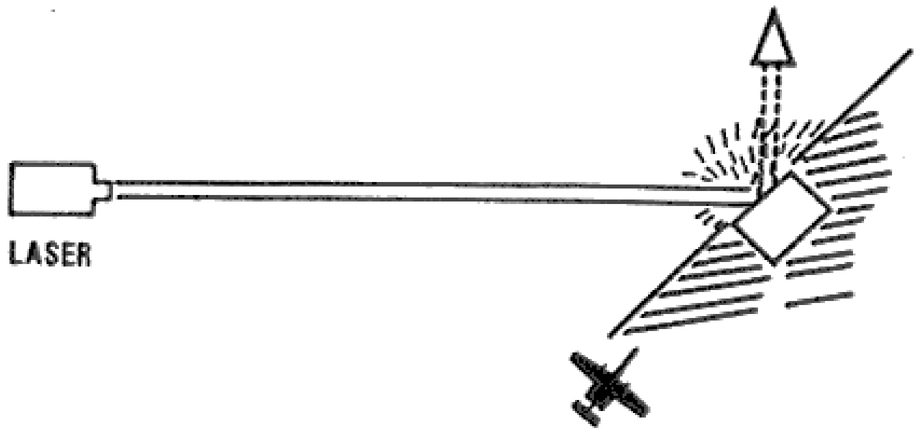

Figure II-6. Podium Effect

Figure II-6. Podium Effect

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-7). When the surface is at an angle to the laser designator, the angle of strongest reflection is predictable (Figure II-8). Glass, water, and highly polished surfaces are mirrorlike and are poor surfaces to designate because they reflect laser energy in only one direction. The seeker must be in that small region and looking toward the reflected energy to acquire the target.

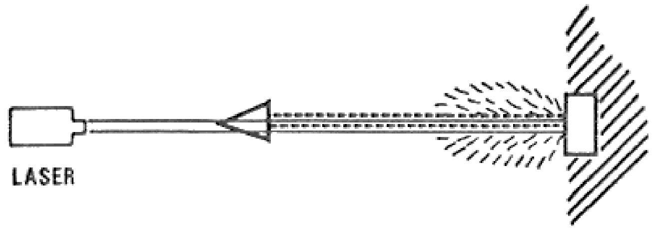

Figure II-7. Target Reflections (Perpendicular)

Figure II-7. Target Reflections (Perpendicular)

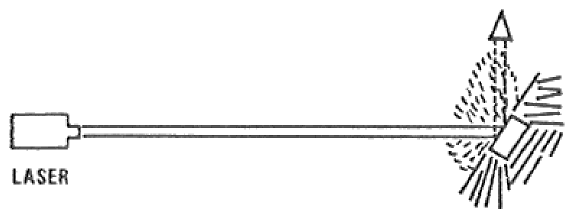

Figure II-8. Target Reflections (Angular)

Figure II-8. Target Reflections (Angular)

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-9). Podium effect can also block a seeker if it cannot see the reflecting surface (Figure II-10). Since laser seekers are normally above the horizon, laser designators are usually aimed at the top third of the target. Optimum laser spot height depends on specific weapons, the type of delivery, and target characteristics.

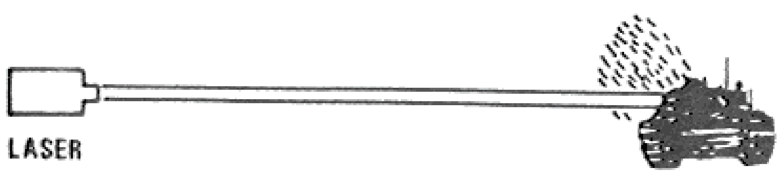

Figure II-9. Vertical Reflections (Detectable)

Figure II-9. Vertical Reflections (Detectable)

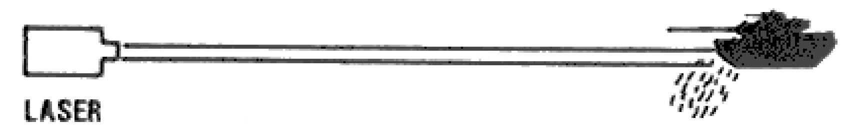

Figure II-10. Vertical Reflections (Blocked)

Figure II-10. Vertical Reflections (Blocked)

j. 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 pointed at a part of the target, so that reflection is strongest where the seeker is looking (Figure II-11); however, the resulting reflected energy may not guarantee target acquisition.

Figure II-11. Reflection in a Chosen Direction

Figure II-11. Reflection in a Chosen Direction

k. Target Material. Certain materials reflect laser energy better than others (e.g., the reflection of laser energy off olive-drab metal (dirty) is 2 to 30 percent; concrete, 10 to 15 percent; unpolished aluminum, 55 percent; water, 2 percent; asphalt, 10 to 25 percent; brick, 55 to 90 percent; vegetation, 30 to 70 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. Best results are obtained when designated targets reflect the laser beam upward and toward the incoming seeker or munition.

l. Seeker Lock-on to Designator. Laser seekers may occasionally lock-on to the designator instead of the target. Intervening grass or leaves, for example, could reflect sufficient laser energy to cause seeker lock-on. In this case, a seeker is most likely to detect stray energy only in the immediate vicinity of the designator. To prevent seeker lock-on to the designator position, 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. When the seeker's progress can be monitored by watching the airborne LST-equipped aircraft or seeing a laser-guided bomb (LGB), it may be possible to detect an improper lock-on in time to prevent a mishap by aborting the aircraft's bombing run or turning off the designator.

m. 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. Ground designators do not have a means to check or correct boresight in the field.

n. Entrapment. Entrapment is the absorption of omnidirectional laser-radiated energy. 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.

o. 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 may result in a laser-spot bouncing movement on the target that increases with the designator distance from the target.

2. Environmental Restrictions. Laser designator and acquisition devices are designed to enhance current capabilities of artillery, naval gunfire, and aircraft in delivering munitions onto ground targets. Several factors can inhibit such enhancement of capabilities: environment, laser system inherent limitations, and target laser employment. Tactics and techniques must, therefore, take these factors into consideration. (See Appendix A for details.)

a. Line-of-Sight (LOS). LOS must exist between the designator and the target and between the target and the laser acquisition device or LGW.

b. Visibility Degradation

(1) Clouds. Clouds 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.

(2) 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 Laser Target Designators (LTDs) are adaptable for night sights and, therefore, night vision capabilities on some LTDs may be limited.

(3) The Obscured Battlefield. Smoke, dust, and chemical particles 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 munition. 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. Generally, a target that can be seen through either day or night optics can be successfully designated. 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 line of sight and repositioning from an obscured to a nonobscured position. Using multiple lasers and transferring the mission from an obscured laser to a nonobscured laser are other simple tactics to counter enemy obscurants.

(4) Concave 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. For weapons like LBGs that tend to miss short, aiming above the opening could guide the bomb into it.

(5) 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 (ALD).

(6) Temperature Extremes. Extreme temperatures affect battery-powered laser operations. For example, a cold-soaked battery has a reduced capability to power a laser.

(7) 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.

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 field of view and, therefore, must be pointed close to the target to see the laser designator spot.

c. Acquisition Time. To avoid detection by enemy forces and conserve battery energy, LDOs limit the amount of time they designate a target. Laser seekers and munitions, therefore, have only a very short time to detect the laser spot and guide to the target.

d. Seeker Sensitivity. Different laser guidance and acquisition systems require different amounts of reflected laser energy to operate. For example, under ideal conditions, a ground-vehicular laser-locator designator (G/VLDD) must be within 5 km of an average stationary target to provide optimum COPPERHEAD guidance whereas, under similar conditions, a PAVE PENNY LST can acquire a laser target designator spot at a distance as great as 30 km. Less sensitive seekers are more susceptible to reflection and to the relative positions of the target, designator, and seeker.

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 require this target cue because of the difficulty in seeing camouflaged targets at long ranges and high aircraft speeds. Normally, LSTs use a laser pulse code established by the LDO. LSTs have a narrow field of view and require the aircrew to align the aircraft accurately so the seeker lines up on the laser energy.

b. Laser-Guided Missiles (LGMs) and COPPERHEAD Cannon-Launched Guided Projectiles (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. LGBs. LGBs must also be aimed so that the target is within the seeker's field of view. 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 10 seconds of weapon flight is ideal. Delayed lasing is not required for low-level laser-guided bombs (LLLGB).

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, assembly areas, motor pools, command posts, aircraft parking ramps, 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 close air support (CAS) 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, 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), Marine Corps air and naval gunfire liaison company (ANGLICO) teams, naval gunfire shore fire control parties, Marine Corps and Air Force forward air controllers (FACs), Marine Corps forward observers (FOs) on the ground, certain Army and Marine aircraft equipped with designators, and special operations forces. 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, BMPs, 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 be obscured by smoke and debris from previous weapons impacts.

7. Offset Laser Designation. When enemy countermeasures or laser alarms are likely to affect laser operations, offset designation 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 can select an object with good reflection, such as a tree, to enhance acquisition.

a. Offset Procedures. When designating for an airborne LST delivering unguided weapons and the offset aim point is far enough from the target to reduce weapon effectiveness, 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 designate the actual target for LGW employment. When directed by the aircrew, the designator is smoothly moved from the offset aim point to the target. With the exact target in sight, the aircrew can deliver weapons precisely and neutralize the target before it reacts. Moving the laser spot during LGW time of flight should be avoided.

8. Delayed Laser Designation for LGBs. Delayed lasing is normally associated with Paveway I/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 prevent the bomb from turning down toward the target prematurely. Normally, the aircrew knows the proper moment to turn the laser on.

Therefore, communications channels must be clear so the aircrew can call for "LASER ON." 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 of 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 I and II LGBs, for example, when delivered from a low-altitude loft maneuver, will restrict the designation of the target to the final 10 seconds of the weapon's flight. Delivery of either a PAVEWAY I or II from a high-dive delivery (30 to 60 degrees) allows the designator the option to designate at any time prior to impact but with sufficient time for the LGB to make flight path corrections to the target. (See Appendix D for a description of LGB and LLLGB delivery profiles.)

9. Redundant Laser Designation. Redundant 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. Redundant designation should not be routinely employed, but it may offer some advantages when attacking high-priority targets. The primary advantage of using two or more designators on the same target is that if one designator malfunctions, 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 podium effect. The Laser-Guided Weapon (LGW) will lock-on and track the designator with the strongest reflected energy.

10. Current and Projected Laser Systems Description. Appendix A lists current and projected unclassified laser systems and their general functions and characteristics.

CHAPTER III

PROCEDURES

1. General Procedures

a. Laser Designation Position. In selecting a laser designation position, the LDO must consider line of sight, expected munitions trajectory, tactical situation, cover and concealment, and communication requirements. The LDO should select positions that are near expected locations of high priority targets while minimizing risks to friendly forces (see Chapter V, Safety Considerations). Additionally, mutual support and coordination within the maneuver elements must be considered if more than one laser designator will be used. The observer or controller team should determine its position as accurately as possible. The team can determine its geographic position by employing the modular universal laser equipment (MULE) or a G/VLLD; i.e., establish range, azimuth, and vertical angle in relation to a known location.

b. Laser-Target and LGW-Target Angle. When a target is designated by laser energy, the greatest reflected energy is normally along the laser-target line. For this reason, the angle between the LGW flight path to target and the laser-to-target line is extremely important. The weapon's flight path must be as close as possible to paralleling the laser-target line. If the angle between the two is too great, the laser seeker may not see the laser spot. The specific angle between the laser-target and LGW-to-target line must be included in mission planning.

c. Techniques for Designating the Target. The laser designator produces a narrow, invisible beam of light when activated by the LDO. A careless LDO may cause laser energy to move off target. The following rules will help keep the ground laser designator on the target:

(1) Assume a comfortable and stable position (e.g., using a prone position and supporting the laser designator with sandbags).

(2) Keep the eye in the same relative position on the eyepiece.

(3) Keep the crosshair positioned near the upper center of the target.

(4) If the target moves, establish a tracking rate by applying smooth horizontal and vertical corrections.

(5) Take slow and shallow breaths.

(6) Squeeze, do not jerk, the trigger.

d. Terrain and Target Concealment

(1) 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.

(2) 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 will degrade mission effectiveness.)

e. 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.

f. 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:

(1) Weapons requiring lock-on before launch (LOBL).

(2) Weapons allowing lock-on after launch (LOAL).

(3) Lofted weapons.

(4) Direct-fire weapons.

g. Communication Between Services. Service 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 inter-Service communications on nonsecure nets.

2. Laser Designation for Artillery

a. Ground Designator Procedures

(1) The Army FIST or Marine Corps FO, in support of maneuver elements, uses laser designators to designate stationary and moving points or area targets for attack by LGWs and aircraft with LSTs.

(2) 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.

(a) After the maneuver commander's guidance is given, the FIST or FO will select planned aiming points to facilitate rapid attack of targets in the engagement area. The aiming points are transmitted to the FSC, who resolves duplication and forwards the target list to the supporting artillery unit.

(b) In the offense, 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.

(c) In the defense, the FIST or FO coordinates the location of the laser designators with the company commander.

b. Airborne Laser Designator (ALD) 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 cannon-launched guided projectiles (CLGP). All other procedures remain the same as those used for ground designators.

c. CLGP/COPPERHEAD Procedures

(1) CLGP fire planning is similar to any other fire support planning. The fire-support communications net is normally FM or wire. The US Marine Corps may use high frequency (HF).

(2) The CLGP procedures followed by the FO and the FDC depend on whether the mission involves a planned target or a target of opportunity. In addition, although stationary targets can be readily engaged using similar target location procedures employed for ballistic munitions, moving targets require additional actions to ensure they can be acquired by the CLGP. (See Appendix B and US Army Field Manual FM 6-30, Appendix C, for examples of CLGP procedures.)

(3) Planned Targets

(a) Planned targets for CLGP or COPPERHEAD are processed by the FIST chief the same as conventional target lists (FM 6-20). The FIST chief may process CGLP or COPPERHEAD target lists separately or as part of a consolidated target list. A message to observer (MTO) from the FDC to the FIST chief confirms the planned target and indicates the units to fire, angle T, guns right or left of observer, and the footprint template to use.

(b) Once the target is identified, the observer estimates the target's speed and direction to determine which planned target location should be used for engagement.

(4) Targets of Opportunity

(a) Attacking a stationary target with CLGP simply requires the observer to determine the target location and then transmit his call for fire. CLGP fire against a moving target is more complex because of the requirement to predict where the target will be when the round arrives. This predicted location, called the intercept point, is determined by estimating the target speed and direction and comparing that information with mission processing times. If, through experience, the observer knows how long it will take the firing unit to process the mission, the observer should use that time. If the observer does not know the unit's processing time, 200 seconds should be used as the time from the initiation of the call for fire to round impact.

(5) Engagement Commands. When using TACFIRE with digital message device (DMD), the light emitting diodes (LED) will display "DESIGNATE." All voice transmissions will use "LASER ON" as follows:

(a) As soon as the first round is fired in a mission, the observer receives "SHOT" from the FDC.

(b) When the round is 20 seconds from impact, the FDC will announce to the observer "LASER ON." If time of flight is 20 seconds or less, "SHOT" and "LASER ON" are transmitted at the same time.

(c) Once "SHOT" has been received, the observer should begin countdown using the time of flight received in the MTO. If the observer has not received a "LASER ON" message, designation should begin not later than 13 seconds before impact.

(d) 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 Naval Gunfire Support (NGFS). Laser designators can be used for NGFS in basically the same manner as for artillery CLGPs. Standard indirect fire procedures require some changes because of special considerations for naval semiactive laser-guided projectiles (SAL GPs). (See Allied Tactical Publication 4 and Naval Warfare Publication 22-2 for detailed instructions.)

a. Target Acquisition and Call for Fire. The observer uses standard procedures to detect targets and communicate the information to the gunfire support ship. The naval gunfire net is normally an HF net. Upon detecting a target, the observer provides the standard elements of an NGFS call for fire (i.e., target grid, altitude, and direction). The type and number of rounds necessary is specified by the spotter. If the target is moving, the spotter will estimate target speed and use an expected position in the call for fire. In this situation, an "AT MY COMMAND" mission is appropriate. An example of an NGFS call for fire is provided in Appendix B.

b. Target Location. Target location must be determined as accurately as possible and provided to the ship by the observer. Grid coordinates, shift from a known point, and polar plot are methods of providing target location. In the latter case, the coordinates of the offset point must be known by the firing ship's combat information center. Estimated target motion or predicted intercept position must be taken into consideration by the spotter.

c. Indirect Fire Mission. The procedure for an indirect fire mission is a clear-cut step-by-step sequence. Appendix B includes sample communications between the NGF ship and spotter during a SAL GP mission. Indirect fire may be conducted against any target, but it must be used against surface targets beyond shipboard sensor or designator range or against targets ashore that are either masked from direct shipboard observation or beyond LOS range.

d. Fire for Effect. The initial salvo may be "Fire For Effect" if the situation warrants. If target motion, security, or other conditions dictate, the spotter or observer might desire precise control of firing time and direct "AT MY COMMAND."

(1) Munitions Mix. If first round accuracy does not preclude the possibility of a fire mission using a mix of ballistic and guided rounds, it may be desirable to initially fire and adjust a ballistic round to correct for errors in ship position or target location. This approach offers a higher assurance that the ballistic aiming point is on or close to the target. "FIRE FOR EFFECT" using a SAL GP should follow the initial adjustment. (CAUTION: Firing ballistic rounds prior to using a GP round may degrade subsequent laser round accuracy because of smoke, dust, debris, etc.)

(2) Target Information. The observer provides a target description to the NGFS ship. Target detection, tracking, and identification information is used to evaluate the level of threat posed to the ship, friendly forces, planned operations, or mission accomplishment.

e. Laser Coordination. The ship will specify the laser pulse code and transmit gun-target line and time of flight. The LDO prepares to designate the target at the call "SHOT" and begins to designate the target at the call "LASER ON" or about 20 seconds before the expected round impact. The laser will normally be on until rounds impact or 20 seconds after "SPLASH" is announced.

4. Laser Designation for CAS

a. General. This section presents procedures for using laser designators for CAS missions. Recommended modifications to existing CAS control procedures include:

(1) Adding laser designation procedures to the CAS briefing and aircrew reporting procedures.

(2) Establishing a means of communication between the FAC and FO to coordinate laser designation of targets when the FAC is not collocated with the laser designator.

(3) Providing for attack coordination between the FAC and the Marine Corps air support radar team (ASRT).

(4) Establishing standard terminology for laser-related activities.

NOTE: For a detailed explanation on CAS employment procedures and tactics, refer to Service-specific CAS publications.

b. Target Acquisition Considerations

(1) Using laser designators for CAS can provide a fast and accurate means of marking targets for LST-equipped aircraft. Using target coordinates, radar beacons, 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 reattack.

(2) Aircraft equipped with an LST are able to detect reflected laser energy. These aircraft include: A-1O, F/A-18, A-6E target recognition attack multisensor (TRAM), A-4M, AV-8B, and USAF A-7 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 aircrew misidentifying friendly positions as the target.

(3) The FIST or FO passes the laser code through the FAC to the aircraft, unless the aircraft will employ LGWs. In the latter case, the aircrew will inform the FAC of the weapon's laser code because the LGB code must be set before takeoff. The FAC will subsequently pass the code to the FIST or FO. The USMC FAC will pass the code to the FO only if the FO is tasked to designate the target.

c. Standoff LGW Delivery

(1) Target acquisition is usually followed by the delivery of LGWs. Some LGWs, such as laser MAVERICK, SKIPPER II, and LLLGB/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.

(2) Once released, the weapon homes in on reflected laser energy and has much better accuracy than a nonguided weapon. Before the attack, aircrews with LGWs must pass the laser code to the FAC.

(3) For standoff LGW deliveries, the ground commander must fully understand and accept the consequences of a possible failure of the weapon to properly guide to the target. Consequently, the final decision to release standoff LGWs from behind friendly lines in a CAS environment rests with the ground commander.

d. Concept of Employment

(1) Tactical Air Control Party (TACP). The TACP is the USMC or USAF tactical air control agency located with the supported battalion. Its functions are providing air liaison with the battalion, advising on the use of air assets, and coordinating and controlling CAS missions to support the ground commander's scheme of maneuver. Three naval aviators or naval flight officers are assigned to each Marine Corps TACP: one serves as air officer in the battalion fire support coordination center (FSCC), the other two are FACs and usually deploy with the forward rifle companies. The Air Force TACP at battalion level consists of one fighter-qualified

officer and two enlisted tactical air C2 specialists. The officer is attached to the battalion as an air liaison officer who advises the ground commander on the capabilities of the use of tactical airpower and is qualified to control CAS sorties. The battalion ALO is also qualified to control CAS and will be used when a FAC is not available.

(2) 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 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, USAF aircrews may make laser calls directly to the FIST on a frequency assigned by the FAC in the CAS briefing. In situations where the USMC 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 USMC FAC and FO can communicate and coordinate using the TACP local net; however, prior coordination is required.

(3) Supporting Arms Liaison Team (SALT). The SALT is the naval air and gunfire coordination agency located with a supported US Army or allied battalion. The SALT is provided by the Marine Corps ANGLICO. It provides liaison with the battalion, advises on using air or naval gunfire assets, and coordinates missions to support the ground commander's scheme of maneuver. Assigned to each SALT is a liaison officer in the FSCC and two firepower control teams (FCTs) that are deployed with the forward rifle companies. The FCT officer is capable of controlling CAS, NGFS, and artillery.

e. FAC Procedures

(1) 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. (The four-Service-approved J-FIRE CAS briefing format is depicted in Appendix C.) When conducting CAS with lasers, always strive for simple communications. Good preplanning, accurate target location, and reliable communications are essential.

(2) Laser Designation Coordination

(a) The laser designator may be turned on for target acquisition, target identification, or employment of LGWs. The aircrew will make the following laser calls:

1. TEN SECONDS (time until "LASER ON" call expected).

2. LASER ON.

3. SPOT.

4. 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.

(b) Normal laser designation time is 20 seconds maximum. The aircrew may request a longer laser on time by saying "LASER ON" and time (e.g., "LASER ON, 30 SECONDS"). The FAC (or Army FIST or Marine Corps FO) 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.

(c) The aircrew calls "SPOT" when acquiring the laser spot, confirming to the FAC and the wingman that the aircrew sees the designated target.

(d) 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, can replace the "SPOT" call.

(e) The last call in the sequence is "TERMINATE." The pilot makes this call to turn the laser off.

(3) 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. The laser designator operator will turn the designator off:

(a) When the "TERMINATE" call is heard.

(b) When the weapon hits the targets.

(c) After 20 seconds (or longer, if requested).

(4) 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. He would say, for example, "LASER ON IN 4 MINUTES READY, READY, HACK." The aircrew hacks his clock and acknowledges. As required, the FAC gives the FIST/FO a similar briefing (e.g., a "HACK" for LASER ON in time to ensure mission success). It is desirable for the LDO to designate (slight offset designation is permitted) for approximately 1 minute to accommodate timing errors by attacking aircrews.

(5) If No Spot Is Acquired. If the aircraft does not get a laser spot for acquisition (LST-equipped aircraft only) on the first pass, the FAC should immediately send the aircraft to a holding point and reconfirm that the LDO and the aircraft have the right laser code set. The FAC should also ensure that pilots know the location of the target area. This procedure is also used when LGWs do not guide.

(6) Radio Silence 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 the following information prior to the mission:

(a) Target coordinates.

(b) Target elevation.

(c) Time-over-target LASER ON time and LASER OFF time.

(d) Laser code and laser-target line.

(e) Target description.

(f) Friendly location(s).

(g) Threat.

(7) Electronic Countermeasures (ECM) and Emissions Control (EMCON) Environment Procedures. Detailed planning by aircrews, FACs, FCTs, or LDOs is required to successfully execute laser target designation in an ECM or EMCON environment. Run-in headings, altitudes, and delivery tactics must be precisely flown to ensure maximum laser energy on target. Laser designation and delivery may be conducted in a limited EMCON environment using the PPN-l9 RABFAC beacon with the forward air controller-target data communicator (FAC-TDC) system.

f. 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.

g. LST-Equipped Aircraft-Aided Delivery of Non-Laser-Guided Weapons. With an LST-equipped aircraft, the fighter or attack aircraft 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 fires or ballistic ordnance.

h. LGB/PAVEWAY I and II. The laser code of the LGB/PAVEWAY I and II seeker 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 FIST or FO to coordinate with the LDO.

(1) Run-In. To take advantage of the capability for munitions delivery on the first pass, the LGB-equipped aircraft must be pointed at the target during its run-in. This requires the FAC to carefully select the run-in heading when planning the mission. In most cases, an initial point (IP), either a prominent terrain feature or a point defined by electronic navigation aids and a run-in heading must be passed to the aircrew as part of the CAS briefing.

(2) LGB Release. LGBs must be accurately delivered and released to guide them to the designated target. 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.

(3) Laser Call Coordination. Timely coordination of "LASER ON" and "TERMINATE" calls is 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.

(4) Standoff Delivery of LGBs. Delivery of LGBs near friendly forces is a risky venture and requires extremely close coordination between the aircraft, FAC, and FIST or FO. Because of the inherent risk to friendly ground troops, only the ground commander can authorize LGB standoff deliveries. See Appendix D for examples of LGB delivery profiles. (WARNING: One way to deliver LGBs from low altitude is a loft attack. In this maneuver, the aircraft pulls up sharply at a predetermined point some miles from the target; and the LGB is lofted upward and toward the target.) However, 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 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. Again, only the ground commander can authorize a loft delivery from behind friendly lines. The aircrew is solely responsible for delivering a ballistically accurate bomb.)

i. LLLGB/PAVEWAY III Delivery. The LLLGB/PAVEWAY III is an advanced LGB with a standoff delivery capability from low altitude. This bomb is not as delivery-parameter sensitive as the Paveway I/II nor is it affected by early laser designation. After a proper low-altitude delivery, the LLLGB will maintain level flight while looking for reflected laser energy. If LLLGB does not detect reflected laser energy, it will maintain level flight to continue beyond the location of the designated target and overfly friendly positions to hit long, rather than short, of the target. Ground commander and aircrew responsibilities remain unchanged.

j. LGM Delivery. FAC procedures for delivering LGMs like MAVERICK and HELLFIRE are similar to those for delivering LGBs. The FAC's role in planning the mission, briefing and getting the air crew onto the correct run-in heading, and commencing illumination of the target remains the same. However, one major difference exists. The lock-on and launch ranges of LGMs in good visibility are several nautical miles--well beyond the range a FAC is able to see and clear an aircraft and beyond the range an aircrew can visually acquire the target. Only the ground commander can authorize employing LGMs near friendly forces.

k. Reattack and Mixed Munitions Procedures. Reattacks are defined as attacks on successive passes by an aircraft against either the same target or nearby targets, under the control of a single FAC, with a minimum-time interval between attacks. If the aircraft is carrying both unguided bombs and LGWs, the LGW should be delivered 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 the precise location of the target.

l. Marine Corps Air Support Radar Team (ASRT) Procedures

(1) ASRT Capabilities. The ASRT is a terminal control agency that provides precision radar tracking and positioning of aircraft. It is normally employed when the pilot cannot visually acquire the target (e.g., at night or during adverse weather conditions. The ASRT can provide precision guidance of CAS aircraft for both actual bombing missions (high-, medium-, and low-level deliveries) or positioning of aircraft for visual CAS (dives, popups, lofts, etc.). The ASRT is equipped with the radar bomb directing set AN/TPB-lD. The ASRT uses the surveyed position of the radar, location of the target, ordnance ballistics, and current wind data, as well as the radar-derived aircraft position, speed, and

altitude to compute information necessary to guide the aircraft to the proper release point.

(2) ASRT Communications. The ASRT receives the target information necessary to conduct a bombing mission from the direct air support center (DASC). The DASC does not normally provide target information and make direct contact with the supported unit; however, it can do so to coordinate the conduct of special missions. To employ LST or LGWs, direct contact is essential to ensure the target is designated at the proper time. When the ASRT cannot establish direct contact with the ground FAC to coordinate the employment of LST or LWG, the DASC, airborne FAC, or aircrew may serve as a relay.

(3) ASRT Employment. The ASRT may be used to position the aircraft to release an LGD or to acquire the laser spot and subsequent terminal control by the FAC. For these operations, the following applies:

(a) Procedures for ASRT control of LGB release are essentially the same as for unguided bomb missions. Unless prebriefed, the aircrew must provide the weapon's code to the FAC, either directly or through a relaying agency (DASC or ASRT), depending on the communication links available. It is also necessary to ensure that the FAC is ready to designate the target. Since LST lock-on is not required to release the bomb within the delivery envelope, the aircraft need not be LST-equipped nor does the designator need to be turned on until the bomb is released. The ASRT will provide precision aircraft guidance to the release point based on a pre-planned attack heading. The aircrew will compute the bomb's time of flight and transmit the "LASER ON" call when required. This call may be transmitted by the ASRT if preplanned between the ASRT and the pilot.

(b) An LST-equipped aircraft is necessary when using ASRT control to direct an aircraft to the laser-acquisition point. During this mission, the ASRT simply assists the FAC with a mission under FAC control by providing precision guidance to the aircraft on a specified attack heading to the laser-acquisition point. The FAC must have communications with the ASRT either directly or by relaying through another agency (DASC) or the aircrew. The aircraft will remain under ASRT control until the aircrew acquires the laser spot, at which time the aircraft is passed to the FAC for terminal control. If the aircrew does not acquire the laser (no lock-on) by a predetermined distance from the target, the ASRT will abort the mission and return control of the aircraft to the FAC. The FAC may elect to repeat the attack or make changes to improve the probability of lock-on.

m. Employing Radar Beacons. Employing radar beacons is discussed in greater detail in appropriate Service manuals. In conjunction with beacon-capable aircraft (F-111/A/E/F, A-7D, F-4E/G, A-6E, F-l6A/B/C), the radar beacon can be used in a laser mission to achieve attack geometry.

n. 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. Air control is somewhat simplified by the practical requirement that all the aircraft ingress on the same nominal heading, either in trail or side-by-side (tactical formation). 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.

(1) Attacks on a Single Target. Multiple aircraft attacking a single target offer 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, and 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 LGW or nonguided munitions). (CAUTION: Multiple aircraft, each dropping LGBs, should space deliveries so as to avoid degrading LGB accuracy from smoke, dust, and debris of follow-on attacks.)

(2) Attacks on Multiple Targets

(a) 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.

(b) 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. A discussion and example of ground and airborne designation for CAS is in Appendix B.

o. Night Operations

(1) 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 it is moving. Aircrews are also faced with the vertigo-inducing effects of flares, ordnance flashes, and the lack of a visible horizon. Coordination and proper separation between individual aircraft in the flight are more

difficult at night and generally result in a slower pace of operations. Finally, sighting an aircraft without lights at night is virtually impossible, and the FAC cannot provide release clearance using daytime safety criteria.

(2) 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). This procedure should not normally be employed where safety of friendly troops is a factor; e.g., CAS. When this procedure is permitted, a night attack with an LST-equipped aircraft is much like completing an instrument approach. All of the necessary information is available to the aircrew on a HUD or elsewhere in the cockpit. The above procedure does not apply to the forward-looking-infrared (FLIR)-equipped aircraft. The aircrew of most FLIR-equipped aircraft can visually acquire the target by using the FLIR after receiving the laser spot. When the aircrew acquires the target, it begins a normal system attack. Attacks on multiple targets and attacks by multiple aircraft at night are even more susceptible to obscuration than daytime attacks because of decreased visual ability and reduced winds.

5. Rotary-Wing Close-In Fire Support

a. General. Using rotary-wing aircraft to deliver LGWs allows the ground commander to destroy high-threat-point targets at extended ranges. 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. Marine Corps rotary-wing attack aircraft can also provide close-in fire support with LGWs and are employed as requested by the ground commander.

b. Laser Designation for Rotary Wing Aircraft

(1) Employment. Laser designators can be used to designate target handoff and LGW terminal guidance for rotary-wing aircraft. Laser designation for target acquisition provides fast and accurate target handoff. 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.

(2) Communications. Communication between the LDO and the aircrew is essential for positive target handoff to LST-equipped rotary-wing aircraft. Positive target handoff requires prior coordination. The LDO must provide 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 target engagement for high-threat targets. The pilot has several options for firing mode, firing method, and missile seeker lock-on.

(1) Firing Modes

(a) Single Fire. 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 in subparagraph (2) below.

(b) 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 approximately 8 seconds or more apart, as specified by the LDO. Once the first missile hits the target, the LDO must smoothly move the laser spot to the next target.

(c) Ripple Fire. In the ripple-fire mode, missiles are fired one after the other as fast as possible. Multiple laser designators can be used (indirect fire requires two remote laser designators). Each laser designator operates on a different laser code, and the weapon's seekers are coded to match each designator.

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

(2) Firing Methods

(a) 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.

(b) 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. It is launched with a preprogrammed autopilot sequence causing the LGM to fly an elevated trajectory (either high or low) over the masking terrain feature. The seeker will then locate and lock-on to the remote laser-designated target.

(3) Missile Seeker Lock-on Options

(a) 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.

(b) 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

(1) Communications. Prior coordination is required to ensure 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 communications electronics operating instructions or the aviation unit's operations order, or through the FAC.

(2) HELLFIRE Mission Brief

(a) Target Location. The LDO must give the location of the target to the helicopter aircrew, using the most accurate means available, so it can align the helicopter to ensure missile lock-on. If the helicopter's position is known, the LDO can provide a magnetic bearing from the helicopter's position to the target.

(b) 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 set the ground laser designator's code. LGM designator coding is important because it counters the use of simple enemy laser countermeasures and prevents the seeker from homing in on other reflected laser energy.

(c) 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.

(d) 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 premission planning are necessary for ripple fire and rapid and ripple fire.

(e) 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 32 seconds. During multiple missile launches, the LDO must ensure that laser energy is not interrupted by obscuration caused by previously launched missiles.

(f) Time Interval. During rapid fire, one missile is launched approximately 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 and example of ground and airborne designation for helicopters are in Appendix B.

CHAPTER IV

LASER CODES

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 target designated by the designator. 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 truncated decimal system that uses the numerical digits 1 through 8, and the codes are directly correlated to a specific PRF. 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 l. 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.

c. Multiple Codes. Coding allows simultaneous or nearly simultaneous attacks on multiple targets by a single aircraft, or flights of aircraft, dropping LGW 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. Controlling and Coordinating Coded Laser Systems. Laser codes must be controlled and coordinated, so each Service is assigned blocks of codes. Each Service subassigns codes to supporting arms (i.e., Army artillery, USMC artillery, NGFS, and inter-Service aviation units). This controlled code assignment prevents interference between supporting arms activities. Each Service'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 ensure compatibility between laser designation equipment and munition. Some munitions and equipment are incapable of using all codes. Additionally, certain codes are preferred for laser systems requiring precision guidance.

3. Management of Designator and Weapon Settings

a. General. The joint force headquarters has overall responsibility for laser code management and provides code management information to appropriate Service agencies (normally a J-3 function). The organization of a joint targeting cell or board has proven to be an efficient mechanism to facilitate this process. (See Joint Pub 5-00.2, "Joint Task Force Planning Guidance and Procedures"). Each Service formulates a plan to allocate settings and issues appropriate coordinating instructions in operations documents like the fire support plan.

b. Army Code Management Example. An Army corps fire-support element (FSE) has overall responsibility for managing ground switch settings in an Army corps' area of operations. Blocks of settings for artillery are assigned to division artillery. The FSE monitors the activities of units operating on or near division boundaries. The FSE changes switch-setting assignments according to the joint plan that prevents duplicate use of settings by adjacent observers and laser designators.

(1) Brigade FSE Responsibility. The Army's lowest level for managing of switch settings is the brigade or regiment FSE controlling fire support for that unit. This FSE provides positive coordination of the switch settings for both the laser designator and the artillery FDC as a part of fire-mission processing.

(2) Battalion Fire Support Officer (FSO) Responsibility. The maneuver battalion FSO coordinates the switch settings for the ground laser designator and LGW systems (except Bs). Usual procedures should require switch settings in the initial request for support and setting confirmation during final coordination for employing the LGWs.

(3) Unit Coordination. Adjacent ground units will normally use fire support liaison personnel to ensure that laser codes do not conflict.

c. Marine Corps Code Management Example. At Marine Air-Ground Task Force (MAGTF) level, different blocks of codes are assigned by the supporting arms special staff (SASS) to artillery, air, and naval gunfire to prevent interference between supporting arms activities. The SASS retains a block of codes for MAGTF special use. Each supporting arm then assigns codes to subordinate units to use on individual missions. Subordinate FSCCs provide positive coordination of the code settings through various fire-support representatives. For individual missions, laser-guided munitions codes are provided to the observer or controller by the munitions delivery system (artillery unit, NGF ship, aircraft). If required in special situations, codes may be assigned to the delivery system and observer or controller by the appropriate FSCC from the block of codes retained by the SASS. Individual aircraft may carry laser-guided munitions with different preset codes to accommodate multiple-aircraft attacks or to allow variation in codes used on consecutive attacks.

4. 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. The FAC coordinates with the LDO to ensure the laser designator is set on the same code as the LGBs. Individual aircraft may carry LGBs with different preset codes. Different preset codes allow for multiple aircraft attacks, multiple weapon releases, and a variation in codes for consecutive attacks.

5. Communications. Codes must be prebriefed to both the FAC and aircrews for situations where communications cannot be established or authorized.

6. 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 best opportunity to acquire the target in the time available. A disadvantage of selecting lower number codes is 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 field of view. Lower code numbers and faster pulse rates are appropriate for the most important targets and the most difficult operating conditions.

CHAPTER V

SAFETY

1. Danger

a. Source. The safety considerations enumerated 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. 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.

b. Eye Damage. Looking at the front of the laser designator when the beam is on or at beam reflections from shiny objects like mirrors, glass, chrome, etc., may result in serious eye damage or blindness. Operators must use extreme care to avoid hitting personnel with the laser beam during operations.

c. Inversion. Caution must be used when the laser-target line is over +30 degrees of the attack heading to ensure the LST or LGB does not detect and guide on the laser designator instead of the target's reflected laser energy.

2. Laser Eye Safety

a. Friendly Ground Combat Personnel. The potential danger of eye damage to friendly personnel must always be considered when using laser designators in a crowded battlefield environment where areas occupied by friendly and enemy troops are not well defined. Proper operating procedures and guidelines must be established and followed to protect friendly troops. Applicable equipment, Service, technical, and safety publications determine the exact parameters and appropriate safety precautions when using laser designators.

b. Optical 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. Because the laser beam spreads so little, the danger zone for direct beam viewing extends over an extremely long distance. 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.

c. Reflections. Specular 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 optical damage. The minimum safe range for such reflections is the same as for direct beam viewing. Since the reflected beam may be from any direction, the danger zone is essentially a circle around the reflector. Specular reflections from curved surfaces like hubcaps and bumpers spread out and reduce the danger and minimum safe range. The minimum safe range increases appreciably for anyone viewing a target area through binoculars and similar optical devices.

3. Organizational Safety Considerations. Each unit involved with laser weapon systems employment must establish and enforce laser safety standard operating procedures. 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 "Joint Munitions Effectiveness Manual/Air to Surface (JMEM/AS), Risk Estimates for Friendly Troops" (C), FM 101-50-31/TH 61 A1-3-9/FMFM 5-2G-6/NAVAIR 00-130ASR-9, 19 December 1986.

APPENDIX A

LASER EQUIPMENT DESCRIPTIONS

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. For example, weather, smoke, and 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 simple rule of thumb is: if a target can be seen, it can be designated. If all of the spot is kept on a target, a laser-guided weapon employed accurately should hit the target.

Acquisition and Designation Systems

Precision-Guided Munitions

SYSTEM	SERVICE	LASER SPOT TRACKER OR ACQUISITION SYSTEM	TARGET DESIGNATION SYSTEM	LASER-GUIDED MUNITION	EMPLOY-MENT PLATFORM	PRF CODE DIGITS	IN-FLIGHT SELECTABLE
TADS	Army	X	X		AH-64A	4	Yes
Pave Penny	Air Force	X			A-7, A-10	4	Yes
TRAM	Navy USMC	X	X		A-6E	4	Yes
MULE	USMC		X		Ground (hand-held or tripod)	3	NA
G/VLLD	Army		X		Ground (tripod or vehicle mount)	3	NA
LTD	Army		X		Ground (hand-held)	3	NA
Pave Spike	Air Force		X		F-4E	4	Yes
Pave Tack	Air Force		X		F-4E, RF-4C, F-111F	4	Yes
LANTIRN	Air Force		X		A-10, F-15E, F-16	4	Yes
MMS	Army	X	X		OH-58D	4	Yes
LTD/R	Air Force		X		AC-130	NA	NA
NOS	USMC		X		OV-10D	4	Yes
Hellfire	Army USMC			X	AH-1/AH-64 OH-58D	4	Yes
Copperhead	Army USMC			X	155-mm howitzer	3	NA
Paveway I, II (LGB), and III (LLGB)	USMC Air Force Navy			X	Any attack or fighter aircraft	4	No
Laser Maverick	USMC			X	A-4, AV-8, A-7, F/A-18	4	Yes

Figure A-1. Laser Systems Quick Reference Summary

SYSTEM	SERVICE	LASER SPOT TRACKER OR ACQUISITION SYSTEM	TARGET DESIGNATION SYSTEM	LASER-GUIDED MUNITION	EMPLOY-MENT PLATFORM	PRF CODE DIGITS	IN-FLIGHT SELECTABLE
5-inch Semiactive Laser-Guided Projectile	Navy			X	DD- and DDG-class ships	4	No
ARBS	USMC	X			A-4M, AV-8B	4	Yes
AGM-123A Skipper II	Navy USMC			X	A-6E, A-7	4	No
Laser Spot Tracker	Navy USMC	X			F/A-18	4	Yes
COMPACT LTD	Navy		X		Ground (hand-held or tripod)	3	NA

Figure A-1 (Cont).

Equipment / System	Human Eye / LLLTV (.4 -.74 μm)	Near IR (.5 - 1.1 μm)	IR (3 - 14 μm)	Radar (1mm - 10cm)
AN/PVS-2b	Rifle Sight			
AN/PVS-4	Rifle Sight			
AN/PVS-5/5a	NVG			
AN/PVS-7b	NVG			
AN/VVS-2	Drivers NVS			
AN/AVS-6	Aviator NVG			
AN/TVS-5	Crew NVS			
AN/TVS-4	Tripod/Vehicle			
AN/TAS-4 (Tow)			Thermal	
AN/TAS-5 (Dragon)			Thermal	
AN/GVS-5		Laser		
AN/PAS-7			Thermal NOD	
AN/VSG-2 TIS		Laser	Thermal	
AH-64 TADS		Laser	Thermal	
AH-64 PNVS			Thermal	
OH-58D MMS	NVG	Laser	Thermal	
AH-1 C-NITE		Laser	Thermal	
AN/PPS-4				GSR
AN/PPS-5				GSR
AN/PPS-15(V)1				GSR

Figure A-2. Laser Systems Planning Considerations
Quick Reference Summary: Equipment/Systems

Aircraft / Equipment	Human Eye / LLLTV (.4 - .74 μm)	Near IR (.5 - 1.1 μm)	IR (3 - 14 μm)	Radar (1mm - 10cm)
A-6E		Laser	FLIR	Radar
A-7		LST	FLIR (limited)	Radar
AV-8B (Night Attack)	NVG	Laser	FLIR	
A/OA-10		LST		
F-15E		Laser	FLIR	Radar
F-16 (LANTIRN)		Laser	FLIR	Radar
F/A-18	NVG		FLIR	Radar
F-111 (Pave Tack)	TVO	Laser	FLIR	Radar
F-117A	CLASSIFIED			
OV-10D (Marine)	NVG	Laser	FLIR	
AH-64	NVG	Laser	FLIR	
AH-1	NVG	Laser	FLIR	
OH-58D	TVO NVG	Laser	FLIR	
OH-6	NVG			
AC-130	TVO	Laser	IR Detector	Radar
HC-130	NVG			Radar
MC-130	NVG		FLIR	Radar
C-130 (AWADS)	NVG (limited)			Radar
MH-53	NVG		FLIR	Radar
B-52	TVO NVG		FLIR	Radar
B-1B				Radar
AGM-65		Laser	IR	
GBU 10/12/15/24		Laser	IR (15)	

Figure A-3. Laser Systems Planning Considerations
Quick Reference Summary: Aircraft/Equipment

Environment \ Wavebands	Human Eye / Low Light TV (.4 - .74 µm)	Near IR (.5 - 1.1 µm)	IR (3 - 14 µm)	Radar (1mm - 10cm)
Drizzle	◑	◑	○	○
Light Rain	◑	◑	○	○
Moderate Rain	◕	◕	◑	◑
Heavy Rain	●	●	●	◑
Light Snow	◑	◑	○	○
Moderate Snow	◕	◕	◑	○
Heavy Snow	●	●	●	◑
Sleet	◑	◑	◑	○
Ice Crystals	◑	◑	◑	○
Hail	◕	◕	◕	◑
Fog	◕	◕	◕	○
High Absolute Humidy	○	○	◑	◑
Dry Haze	◑	◑	○	○
Wet Haze	◕	◕	◑	○
Smoke	◕	◑	◑	○
Blowing Dust	◕	◕	◑	○
Blowing Sand	◕	◕	◑	○

● Total Degradation
◕ Severe Degradation
◑ Some Degradation: degree will vary according to distance between target and sensor.
○ No Degradation

Figure A-4. Laser Systems Planning Considerations
Quick Reference Summary: Environment

ANGLE RATE BOMBING SYSTEM (ARBS) (MARINE CORPS)

Description:	A 3-axis gimballed dual-mode television and LST.
Function:	Provides day or night, accurate first pass, target attack.
Platform:	A-4M, AV-8B.
Employment:	Allows day or night attack of target with LGW or nonguided bombs independent of target movement, wind, dive angle, or release angle variations. Provides reattack 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 obscurances, as discussed in Chapter II, for LSTs.

LOW-ALTITUDE NAVIGATION AND TARGETING INFRARED FOR NIGHT (LANTIRN) (AIR FORCE)

Description:	Pod-mounted laser designator/ranger, boresighted to FLIR.
Function:	Aircraft ranging to target. Laser target designation.
Platform:	F-16, F-15E.
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:	Not an all-weather system.

LST (NAVY AND MARINE CORPS)

Description: LST, also known as laser-detector tracker.

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-l8.

Employment: Used to locate a target that is designated by MULE, OV-10D, or A-6E TRAM to deliver laser-guided munitions.

Once target is located, the LST ballistic data can be passed to the inertial navigation system 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.

PAVE PENNY (AIR FORCE)

Description: Pod-contained laser seeker and tracker.

Function: To receive laser energy and provide cockpit heads-up steering to source of reflected energy.

Can provide A-7 automated release.

Platform: A-10, A-7.

Employment: Used to help pilot locate reflected laser energy.

PRF Codes: Four digits.
In-flight selectable.

System-Unique Capabilities: Very sensitive seeker; capable of engaging targets the pilot cannot see, given adequate designation.

Expands aircraft capability by providing early target acquisition.

Limitations: Laser spot must be within seeker field of view.

PAVE SPIKE (AIR FORCE)

Description:	Pod-contained, electro-optical laser designator and ranging system.
Function:	Optical tracker boresighted to Laser Target Designators (LTD). Provides precision LTD, ranging, and tracking of ground targets for attacks with conventional ordnance or LGWs.
Platform:	F-4D, F-4E
Employment:	Self-lasing for autonomous LGB/LLLGB delivery or "buddy lasing" for other aircraft delivering LGB/LLLGB.
PRF Codes:	Four digits. In-flight selectable.
System-Unique Capabilities:	Uses imaging IR sensors and laser designator or range finder for target acquisition and weapons delivery. Day visual meteorological conditions.
Limitations:	Must see and optically track target. Manual tracking operation throughout gimbal limits. Dependent on operator skill. Not an all-weather system.

PAVE TACK (AIR FORCE)

Description: Pod-contained, FLIR and laser system.

Provides precision laser designation and ranging and tracking of ground targets for attacks by conventional and LGWs during day, night, and limited adverse-weather conditions.

Function: IR detector is boresighted to laser assembly for tracking and designating targets for LGBs and LLLGBs.

Platform: RF-4C, F-4E, F-111F.

Employment: Self-lasing for autonomous use or LLLGB delivery or "buddy lasing" for other aircraft.

PRF Codes: Four digits.
In-flight selectable.

System-Unique Capabilities: Uses imaging IR sensors and laser designator or rangefinder for target acquisition and weapon delivery.

Day and night limited adverse weather system.

Limitations: Not an all-weather system.

Gimbal limits affect designator aircraft flight-path profile during bomb time of flight.

OH-58D MAST-MOUNTED SIGHT (MMS) ARMY

Description:	MMS is an electro-optical system incorporating television visual and thermal imaging systems and laser rangefinder-designator LST.
Function:	Sight system used to laser-designate for other weapon systems.
Platform:	OH-58D.
Employment:	Provides day, night, adverse-weather target acquisition and laser-designation capability.
PRF Codes:	Four digits. In-flight selectable.
System Unique Capabilities:	The MMS's LST facilitates handoffs from other laser designators. Tracks targets manually or automatically.
Limitations:	As discussed in Chapter II for LST and laser designators.

AH-64 TARGET ACOUISITION SYSTEM AND DESIGNATION SIGHT (TADS) (ARMY)

Description: LST acquisition, laser rangefinder and designation system.

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.

Can employ single, rapid, or ripple firing techniques.

Seeker lock-on options are LOAL or LOBL.

Limitations: As discussed in Chapter II for LST and laser designators.

A-6E TARGET RECOGNITION ATTACH MULTISENSORS (TRAM) AIRCRAFT (NAVY AND MARINE CORPS)

Description:	FLIR, combination laser designator-rangefinder, and laser designator-receiver.
Function:	All-weather and night operational aircraft weapon delivery platform.
Platform:	A-6E
Employment:	CAS. Navigate to, locate, track, and attack stationary and moving targets. Laser designator and spot tracker. Autonomous delivery and tracking.
PRF Codes:	Four digits. In-flight selectable.
System-Unique Capabilities:	Laser-designate, track, and display moving targets.
Limitations:	Subsonic. No cannon armament.

OV-10D AN/AAS-37 FORWARD-LOOKING INFRARED/LASER RANGEFINDER-DETECTOR (ID) SYSTEM (AAS-37 FLIR/LRD) (MARINE CORPS)

Description: Improved version of OV-10 BRONCO.

Aircraft has laser target detecting, ranging, and tracking system.

Function: Aerial observer platform for FO or FAC limited CAS.

Airborne laser designator.

Platform: Fixed-wing turboprop aircraft.

Employment: Aerial observer controls fires from supporting aircraft, artillery and mortar batteries, NGFS ships.

Acquires and designates targets through FLIR and on board laser ranger-designator.

PRF Codes: Four digit.
In-flight selectable.

System-Unique Capabilities: Laser ranging capable.

Night observation and designation capable.

Limitations: Subsonic speed.

GROUND VEHICLE LASER LOCATOR DESIGNATOR (ARMY)

Description: Long-range laser rangefinder-designator.

Can provide azimuth 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-98l FIST 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.

LASER TARGET DESIGNATOR (LTD) (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.

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.

LASER TARGET DESIGNATOR/RANGER (LTD/R) (AIR FORCE)

Description: Part of the AC-l30's fire control, the LTD/R is mounted with AC-l30 low light level TV sensors. Laser designation system.

Function: AC-130 crews use the LTD/R to determine range from the aircraft to the target but can designate targets for other weapon systems.

Platform: AC-l30.

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.

System Unique Capabilities: LTD/R integrated with LLLTV and FLIR.

Limitations: AC-130s fly pylon turns around a target and designate and attack targets on the aircraft's left.

Only has one pulse repetition frequency.

MULE (MARINE CORPS)

Description:	Man-transportable LTD and rangefinder.
Function:	Accurately locates targets and provides terminal guidance for LGWs.
Platform:	Man-transportable, tripod mounted.
Employment:	To provide forward observers, NGE 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.
Limitations:	As discussed in Chapter II for laser designators.

COPPERHEAD, 155MM CANNON-LAUNCHED GUIDED PROJECTILE (CLGP) (ARMY AND MARINE CORPS)

Description:	Laser seeker 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 l55mm 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 round can acquire target.
Limitations:	Requires continous laser designation during the final 13 seconds of projectile flight.

HELLFIRE MISSLE (ARMY AND MARINE CORPS)

Description:	Third-generation air-launched, antiarmor, laser-guided missile.
Function:	Used in conjunction with a ground or airborne laser designator.
Platform:	AH-1, AH-64, and OH-58D.
Employment:	Employed against armor or other hard point-type targets.
	Autonomous designation or "buddy lasing" for other launch platforms.
	PRF codes are set into the missile before platform launch, and once airborne, codes cannot be changed.
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 for all LGWs.

LASER MAVERICK (LMAV) AGM-65E (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:	(With modification) A-4M and A-6E, F/A-18, AV-8B, A-7 (USN).
Employment:	Intended for use against fortified ground installations, armored vehicles, and surface combatants.
	Employs 125-pound warhead or 300-pound MAVERICK alternate warhead with selectable delay fuse.
PRF Codes:	Four digits. Cockpit selectable.
System Unique Capabilities:	If missile loses laser spot, missile goes ballistic and flies up and over target; warhead does not explode (becomes a dud).
	Cockpit-selectable laser coding and fusing (delay or quick).
Limitations:	As discussed in Chapter II for all LGWs.

LASER-GUIDED BOMBS (LGM) (PAVEWAY I OR II)
(AIR FORCE, NAVY, AND MARINE CORPS)

Description: 500-pound LGB (MK-82 USN/USMC), 1,000-pound LGB (MK-83 USN/USMC) or (GBU-12 USAF), 2,000-pound LGB (MK-84 USN/USMC) or (GBU-10 USAF) warhead marked with laser guidance.

Two generations, PAVEWAY I and II, are 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: All aircraft capable of employing conventional weapons of same weight class.

Employment: Level or dive for PAVEWAY I bombs; level, dive, or loft for PAVEWAY II bombs.

Optimum against hard and point targets.

PRF Codes: Four digits.

System-Unique Capabilities: Accuracy gives high probability of target kill against point targets.

Limitations: Early laser spot acquisition during a loft or shallow delivery angle tends to cause the bomb to miss short.

Requires ballistically accurate delivery and continuous laser energy during last 10 seconds of flight.

Limitations (cont)

Target must subtend an angle of at least 1 mile (at designator-to-target range)

When delivered from a low-altitude loft maneuver (see Appendix D), restricts lase on target to last 10 seconds of flight.

LLLGB (PAVEWAY III) (AIR FORCE)

Description: Termed GBU-24 (2,000-pound bomb)

No 500-pound version.

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.

System-Unique Capabilities: Improved accuracy capability over LGB GBU-l0/l2.

Highly resistant to countermeasures.

Blind-launch capability from extended ranges.

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 last 8 seconds of flight.

Target must subtend an angle of at least 1 mil (at designator-to-target range).

AGM-123 SKIPPER II (NAVY AND MARINE CORPS)

Description:	MK-83, 1,000-pound LGB with MK-78 SHRIKE, dual-thrust motor for propulsion, gravity bias incorporated for low-level launch capability.
Function:	Inexpensive, standoff, ship attack weapon; close air support; deep strike interdiction.
Platform:	A-6E, F/A-18, A-7
Employment:	A-6, A-7, F/A-18 can launch with FAC control; A-6 can self-designate.
PRF Codes:	Four digits.
System Unique Capabilities:	Increased standoff range with laser-guidance, low-altitude launch capability.
Limitations:	As discussed in Chapter II for all LGWs.

5" SEMIACTIVE LASER-GUIDED PROJECTILE (SAL GP) (NAVY)

Description: A rocket-sustained laser-guided projectile.

Function: Shore bombardment and single-round ship kills.

Platform: DD-963, DDG-5l, DDG-993 class ships.

Employment: Defeat hard and light materiel or personnel targets ashore and afloat.

PRF Codes: Four digits.

System-Unique Capabilities: Same as CLGP.

Limitations: Same as CLGP.

APPENDIX B

PROCEDURES GUIDE

GROUND AND AIRBORNE LASER DESIGNATION PROCEDURES FOR "COOPERHEAD" CLGP

1. Communications

   a. FM or wire (US Marine Corps may use HF).

   b. Observer to fire direction center.

2. General. As with any other fire support planning, COPPERHEAD fire planning must support the concept of operations and be integrated into the maneuver commander's plan. The efficient employment of COPPERHEAD requires that G/VLLD positioning, G/VLLD designation range, the nature of the target, and target movement receive special consideration. While stationary targets can be engaged using procedures similar to those for delivery of high explosive munitions, moving targets require additional actions to ensure that the target can be acquired by the COPPERHEAD projectile. Additionally, the COPPERHEAD procedures followed by the observer and the FDC, and the communications exchanged, depend on whether the mission involves a planned target or a target of opportunity.

3. System Capabilities and Limitations

   a. COPPERHEAD is a precision laser-guided projectile, capable of hitting command selected point targets at all ranges. The COPPERHEAD round can be fired at ranges from 3,000 to 16,100 meters and will hit the spot of reflected laser energy at all ranges. This spot, produced by the G/VLLD, is 12 inches in diameter at 3,000 meters and 19 inches in diameter at 5,000 meters. The spot produced by the laser in the OH-58D helicopter has a tighter focal pattern and can be used at 7,000 meters with a similar sized spot.

   b. The COPPERHEAD round can be maneuvered around the target aim point. The area defined by this maneuvering area is called a footprint and depicts the area in which the round can be maneuvered and still produce a greater than 50 percent reliability of target kill. This probability increases to near 100 percent as the target nears the aim point.

   c. G/VLLD capabilities vary with its use. A ground-mounted G/VLLD can be used to designate moving targets at 3,000 meters and a stationary target at 5,000 meters. A G/VLLD mounted in the FSV can designate moving targets at 4,000 meters and stationary targets at 5,000 meters. The laser in the (MMS) of the OH-58D will lock onto moving targets and can be used to designate stationary or moving targets out to 7,000 meters. Any of these observers can be up to 800 mils left or right of the gun-target line to designate for a COPPERHEAD mission.

d. The COPPERHEAD-G/VLLD system requires uninterrupted LOS from the observer to target and from the target to the round in flight. Because the G/VLLD system is issued with an AN/TAS-4B night sight, a passive infrared sight for use at night and during periods of limited visibility, COPPERHEAD can be fired at night and through some smoke, dust, or rain. If the observer is able to identify the target either with the unaided eye or with the night sight, he can engage it with COPPERHEAD.

e. COPPERHEAD should be used to take advantage of these capabilities and minimize the limitations of the COPPERHEAD-G/VLLD system.

4. Employment of COPPERHEAD

a. Since COPPERHEAD is a precision point target weapon with a range greater than the maneuver direct fire weapons, it should be used as deep as possible to surgically remove selected vehicles. This use should be early in the battle, before the battlefield becomes obscured with heavy smoke and dust.

b. A limited number of COPPERHEAD rounds are available. Their use should be based on the commander's selection criteria. COPPERHEAD, with CAS and conventional artillery, can be used to destroy the enemy reconnaissance vehicles, causing the enemy to deploy early. This can be done without exposing US direct fire weapons at the start of the battle. Then, as they appear, COPPERHEAD can be used to surgically remove enemy vehicles that make a significant difference early in the main battle. Examples of these are: enemy obstacle breaching vehicles, artillery command/reconnaissance vehicles, ADA weapon systems, maneuver command vehicles, and radar systems. As a result, the ground units will have more time to defeat the enemy.

c. An observer planning a COPPERHEAD mission must consider the maneuverability of the round. He must consider the number of selected enemy vehicles that will appear in the footprint during the course of a mission. For example, since rounds are fired at 30-second intervals, a four-round mission will last 1-1/2 minutes. The observer must determine how many vehicles can be expected to be able to engage in the footprint during this time in order to determine how many rounds to be planned on that aim point.

d. COPPERHEAD Footprint Template. To help the operator visualize the COPPERHEAD footprint, the COPPERHEAD footprint template (Figure B-1) was produced. The template consists of a cover card and 13 template cards. The cover card contains an operator cloud height table on one side and minimum cloud height information on the other. The template cards are clear plastic graphic devices, 1:50:000 scale. Each card has the shape of the footprint partially cut into the card. Also, each card is marked with the footprint letter code (A-H, J-N), the type trajectory, the GT range, the interval, the average time of flight, a centerline, a target location pinhole, and an angle T scale. These templates are available through normal Service requisition procedures and are issued with appropriate laser designator systems.

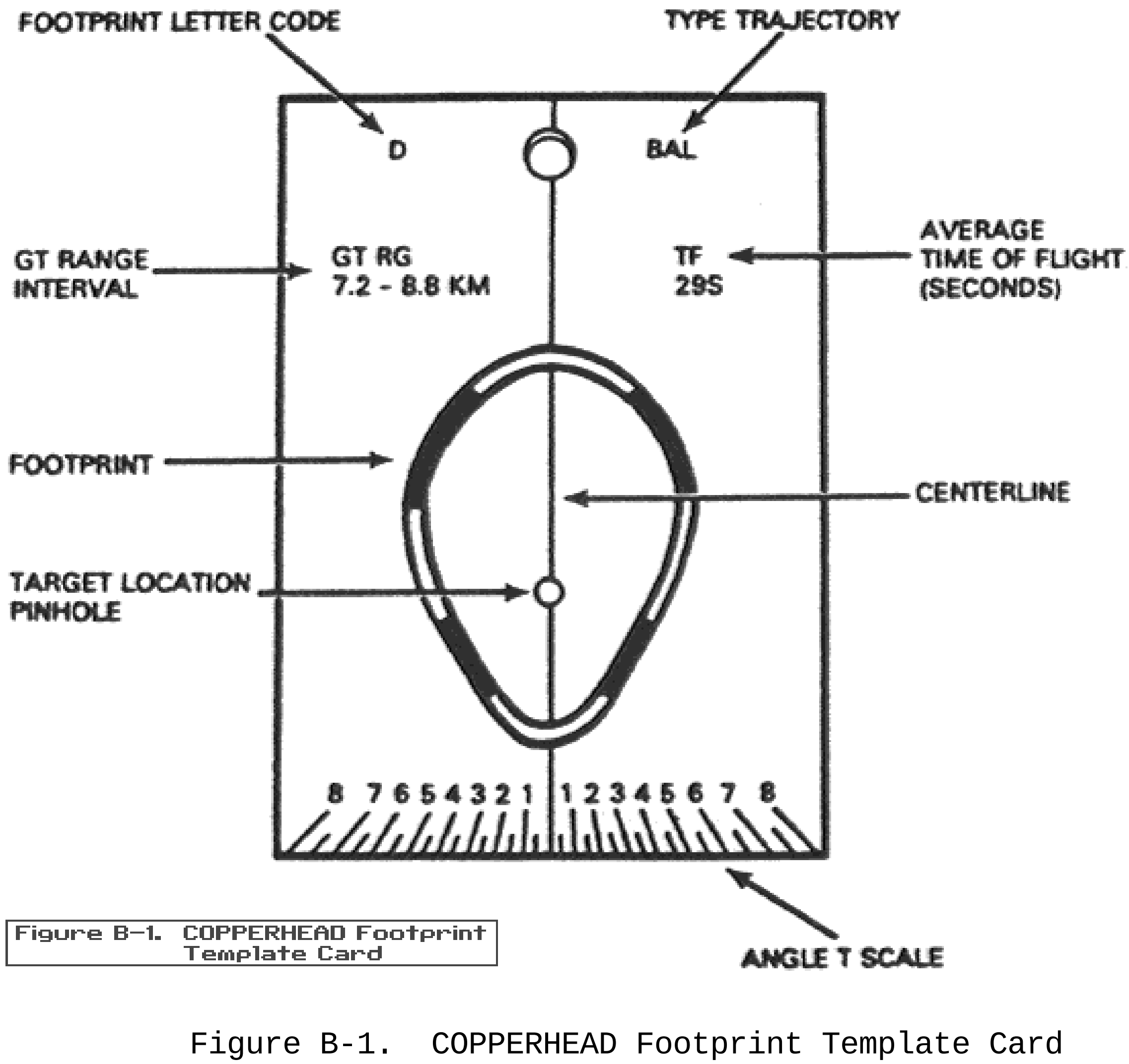

Figure B-1. COPPERHEAD Footprint Template Card

Figure B-1. COPPERHEAD Footprint Template Card

5. Planned Targets

a. The MTO for planned targets is used to confirm planned targets. This MTO is not the MTO for a call for fire, but is used by the FDC to confirm planned targets and provide observer information necessary to establish footprints.

ELEMENT	EXAMPLE
Identification	"A58, THIS IS R24"
Target number	"TARGET AF40l2"
Unit to Fire	"N24"
Number of Rounds	"1 ROUND"
Angle T	"ANGLE T-600"
Guns Right or Left	"RIGHT"
Footprint Letter Code	"SET F, GREEN"

b. After identifying the target, the observer estimates its speed and direction to determine which planned target location should be used for the engagement.

c. The call for fire is as follows:

ELEMENT	EXAMPLE
Observer Identification	"THIS IS A71"
Warning Order	"Fire Target AY5781, OVER"
Target Description	"4 TANKS"
Method of Engagement	"4 ROUNDS"
Method of Control	"AT MY COMMAND, OVER"

d. For immediate responsiveness in engaging priority targets, the observer can streamline the call for fire by omitting the target description, method of engagement, and method of control.

EXAMPLE:

"THIS IS A71."

"FIRE TARGET AY4781, OVER."

e. For both examples above, the planned number of rounds will arrive at intervals of at least 30 seconds. To control the arrival of each round, the observer commands, "BY ROUND, AT MY COMMAND."

6. Targets of Opportunity

a. While COPPERHEAD fire attacking a stationary target simply requires the observer to determine the target location and then transmit the call for fire, COPPERHEAD fire against a moving target is made complex by the requirement to predict where the target will be when the round arrives. This location, called the intercept point, is determined by estimating the target speed and direction while comparing that information with mission processing times. (If, through experience, the operator knows how long it will take the firing unit to process the mission, that time should be used. If not, the operator should use 200 seconds as the time from the initiation of the call for fire to round impact.)

b. The call for fire is as follows:

ELEMENT	EXAMPLE
Observer Identification	"Y5A57, THIS IS Y5A71"
Warning Order	"FIRE FOR EFFECT, POLAR, OVER"
Location of Target	"DIRECTION 1800, DISTANCE,3450, VERTICAL ANGLE +5, OVER"
Target Description	"TANK"
Method of Engagement	"COPPERHEAD, 1 ROUND"
Method of Control	"AT MY COMMAND, OVER"

c. MTO as follows:

ELEMENT	EXAMPLE
Unit Firing	"A2Q27"
Number of Rounds	"2 Rounds"
Laser PRF Code	"CODE 241"
Time of Flight	"TIME OF FLIGHT 25"

d. The PRF code given in the MTO is confirmation of the observer's PRF code designated by his FSO. If in the MTO and the observer receives a PRF code other than that set on the designator, the code on the designator must be changed before "LASER ON" is received.

7. Engagement Commands. When using TACFIRE with a digital message device (DMD), the LED will display "DESIGNATE." All voice transmissions will use "LASER ON," as follows:

a. As soon as the first round is fired in a mission, the observer receives "SHOT" from the Fire Direction Center.

b. When the round is 20 seconds from impact, the FDC will announce to the observer, "LASER ON." If time of flight is 20 seconds or less, "SHOT" and "LASER ON" are transmitted at the same time.

c. After "SHOT" has been received, the observer should begin counting down, using the time of flight received in the MTO. If a "LASER ON" call has not been received, designation should begin not later than 13 seconds before impact.

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

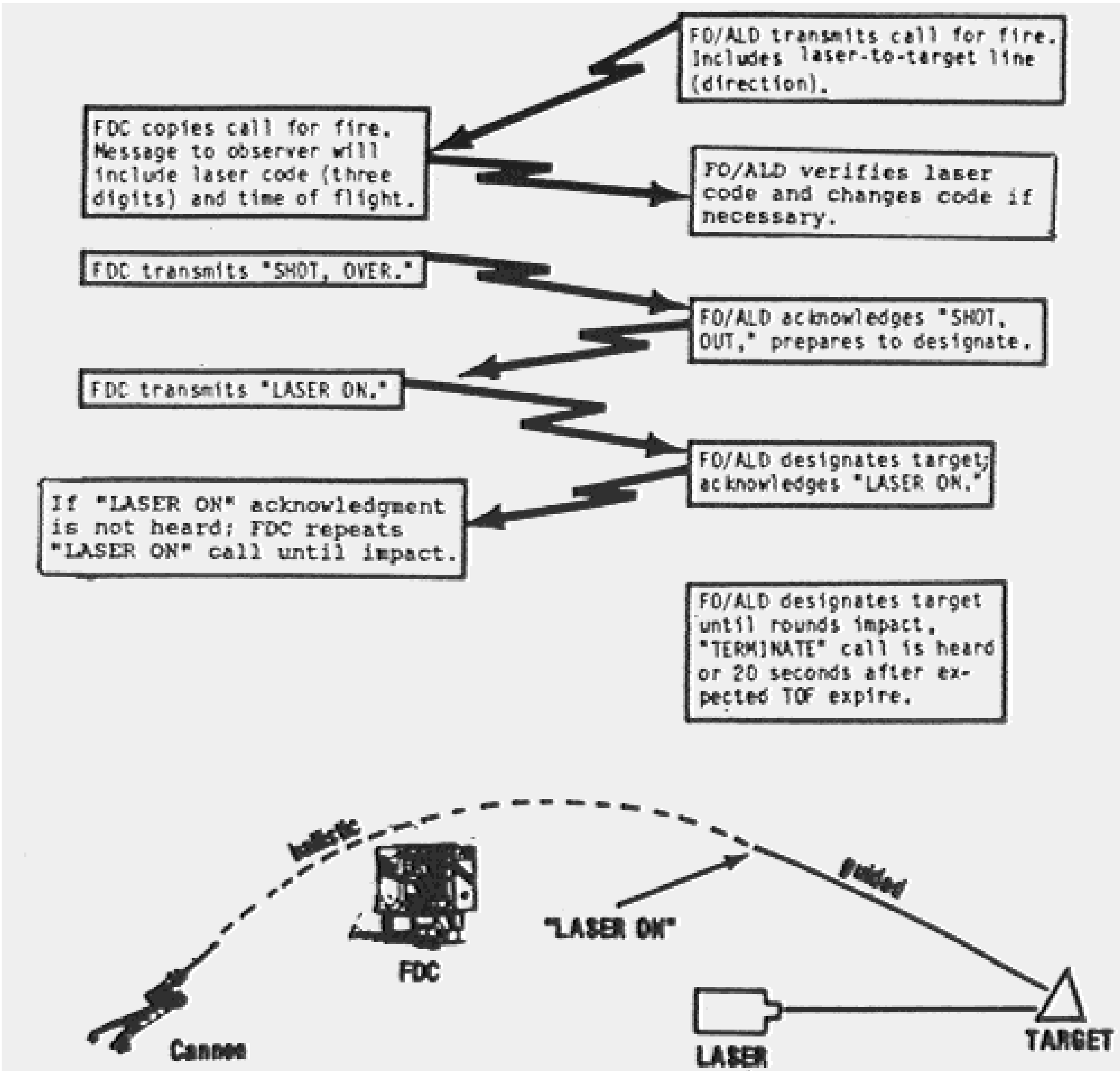

Figure B-2. Ground and Airborne Laser Designation Procedures for Cooperhead CLGPs

GROUND AND AIRBORNE LASER DESIGNATION PROCEDURES FOR NGFS

1. Communications

   a. HF radio (ANGLICO/USMC NGF spot team).

   b. Relay through aerial observer (AO)/FAC if ANGLICO/NGF spot team not present.

2. Call to Ship for Fire

   a. Requester specifies "GUIDED PROJECTILE."

   b. Ship specifies laser code, gun target line, and time of flight (internal if necessary).

   c. Ship calls "SHOT" and "LASER ON." LDO acknowledges.

   d. At "SHOT," LDO prepares to designate target.

   e. At "LASER ON," laser designation commences.

3. LDO will designate the target until one of the following occurs:

   a. "TERMINATE" call.

   b. Rounds impact.

   c. Seventy seconds after expected TOF expires.

4. When necessary, all laser calls are automatically repeated.

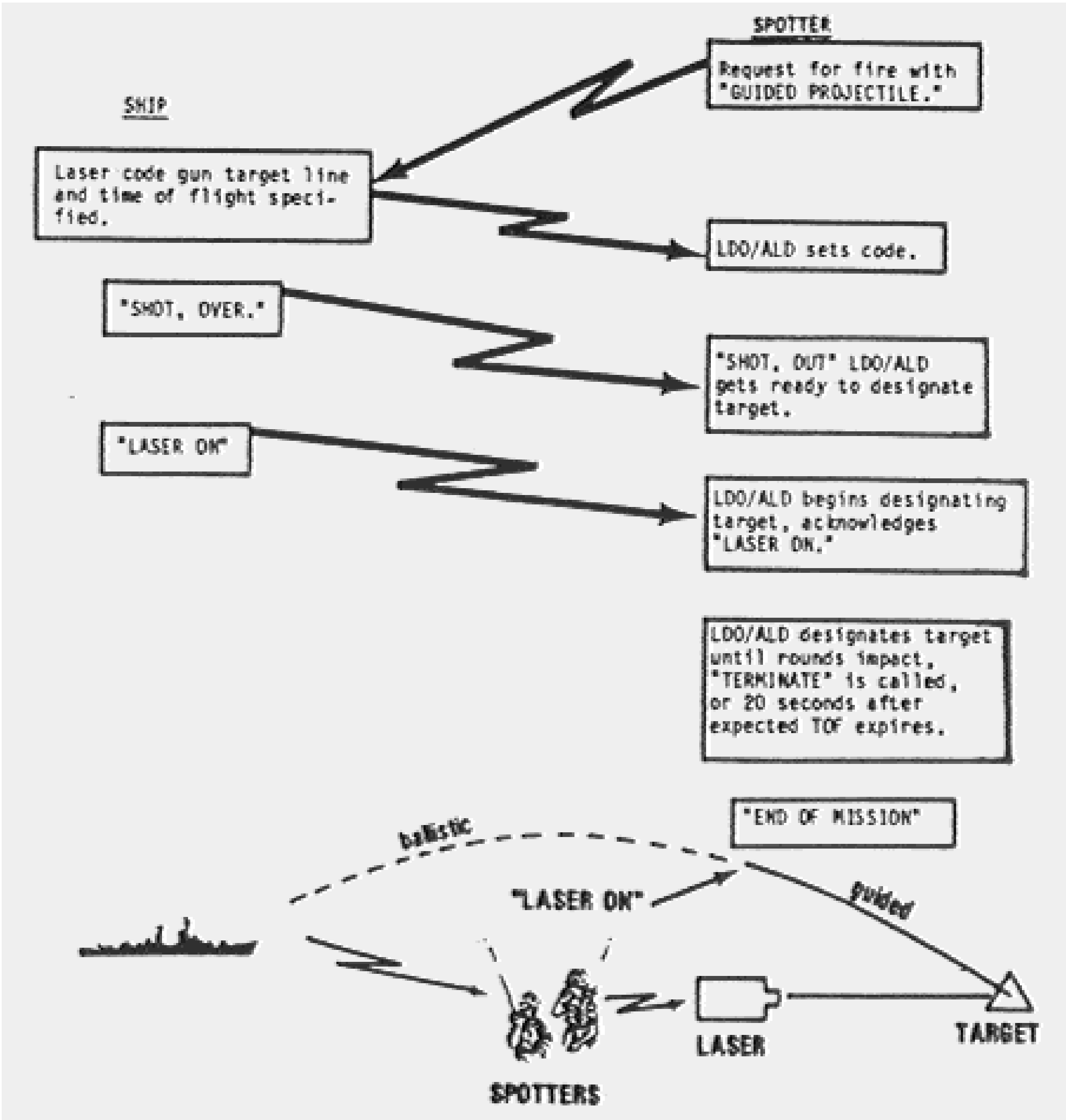

Figure B-3. Ground and Airborne Laser Designation Procedures for NGFS Call for Fire Mission

NOTE: There may be more designators than there are ANGLICO/USMC NGFS spot teams. Communications relay through FO, ANGLICO, NGFS spot team, or FAC may be needed.

SAMPLE LASER DESIGNATION CALL FOR FIRE BETWEEN THE NGFS SPOTTER AND SUPPORTING SHIP

NOTE: This sample fire mission only illustrates the manner in which a standard NGFS call for fire will be modified to call for laser-guided projectiles (currently, SAL GP). It DOES NOT attempt to teach NGFS techniques. It assumes that the NGFS spotter is sufficiently competent to modify the call for fire procedures to incorporate such variables as use of either map coordinates or polar coordinates, multiple targets, or mixture of laser-guided munitions and ballistic munitions.

FROM	TO	VOICE MESSAGE	REMARKS
Spotter	Ship	"ZX this is GB" "Fire Mission" HK1776" "Over"	
Ship	Spotter	"GB this is ZX" "Fire Mission" "Target Number HKl776" "Out"	Ship reads back elements of the spotter's call.
Spotter	Ship	"GRID 146250" "Altitude 45 meters" Direction:263 degrees true" "Tank:danger close,725 east" "Guided projectile" "Fire for effect, one salvo" "Over"	Needs GRID or polar coordinates because target number may not be preplanned and location may be unknown to ship.
Ship	Spotter	"GRID 146250" "Altitude 45 meters" "Direction: 263 degrees true" "Tank:danger close,725 east" "Guided Projectile" "Fire for effect, one salvo" "Out"	Ship repeats basic elements of the spotter's call.

FROM	TO	VOICE MESSAGE	REMARKS
Ship	Spotter	"Gun-Target line 315 degrees true; summit 34,000 feet" "Ready 52" "Code 328" "Over"	"Summit" is given so that the spotting aircraft can avoid the path of projectile along the gun target line.
		"52"	Means 52 seconds of flight for the projectile.
Spotter	Ship	"Gun-Target line 315 degrees true" "Ready 52" "Code 328" "Fire, over"	
Ship	Spotter	"Shot . . ." "LASER ON" "Over"	This is cue for laser designator to be turned on and designate the target.
Spotter	Ship	"LASER ON" "Out"	Laser designator operator designates target.

FROM	TO	VOICE MESSAGE	REMARKS
Ship	Spotter	"Splash" "Out"	Round should explode 5 seconds after "Splash" is transmitted. Laser designator is turned off 20 seconds after "Splash" is transmitted. If the impact of the laser-guided round is not observed within 20 seconds after "Splash," the round is presumed to have malfunctioned. Check code settings and operation of designator. Call for another round.
Spotter	Ship	"End of mission" "Tank destroyed" "Over"	
Ship	Spotter	"End of mission" "Tank destroyed" "Out"	

GROUND AND AIRBORNE LASER DESIGNATION FOR CAS WITH FAC NOT COLLOCATED WITH LDO OR ALD

PROCEDURES

1. Communications

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

b. Communications between FAC and aircraft: FM, UHF, or 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 FSO or FSC and passes to aircraft with LST. FAC obtains or passes laser code to FSO or FSC 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)

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

b. Pass laser-to-target-line 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.

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 TOF of the LGW being delivered.

5. Additions to FAC to LDO or ALD Calls

a. Confirm LST-, LGB-, or LGM-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.

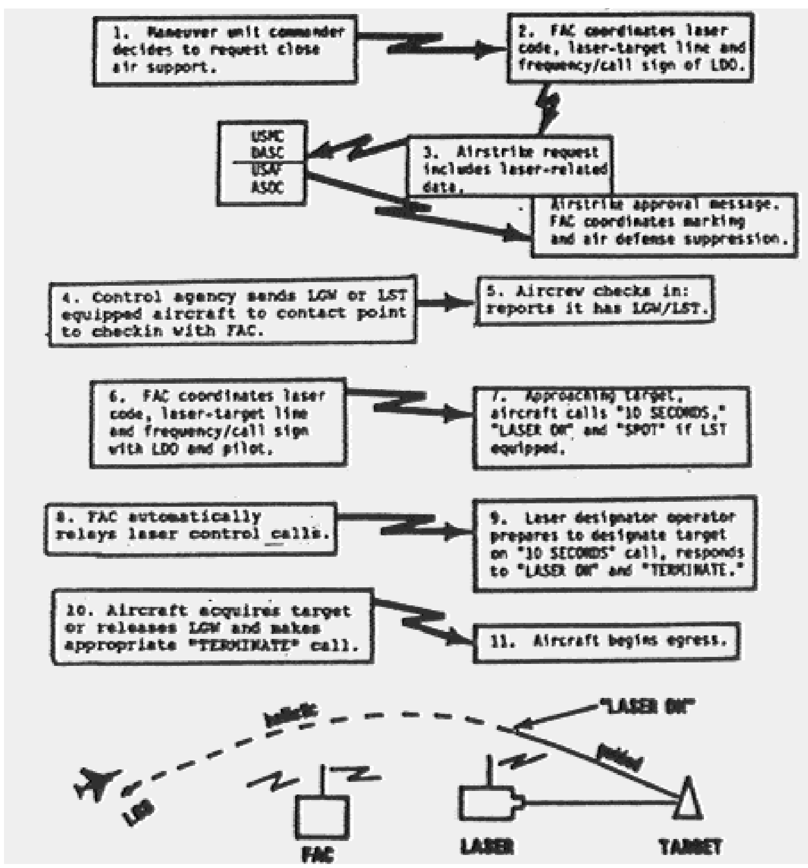

Figure B-4. Procedures for Aircraft with LST/LGW

PROCEDURES FOR GROUND AND AIRBORNE LASER DESIGNATION FOR HELICOPTERS

1. Communication--Designator (Controller) to Helicopter

   a. Ground--FM.

   b. Air--FM, VHF, UHF.

2. Target Handoff to LST-Equipped Helicopter

   a. Additions to FO or ALD briefing to helicopter.

      (1) Four-digit laser code (lxxx).

      (2) Laser-to-target line in degrees magnetic.

      (3) Laser spot offset, if applicable.

   b. Additions to aircrew to FO or ALD reporting procedures.

      (1) "10 SECONDS" warning call that the aircraft will need laser-on in 10 seconds.

      (2) "LASER ON" call.

      (3) "TERMINATE" call when designation is no longer required.

3. Target Engagement for LGM-Equipped Helicopters

   a. Additions to FO or ALD briefing to helicopter.

      (1) Four-digit laser code (1XXX).

      (2) Laser-to-target line in degrees magnetic.

      (3) Number of missiles, if applicable.

      (4) Firing mode, if applicable.

      (5) Time interval between launches, if applicable.

      (6) Radio frequency and call signs for laser calls, if applicable.

b. Additions to aircrew to FO or ALD reporting procedures.

(1) "10 SECONDS" warning call that the aircraft will need laser-on in 10 seconds.

(2) "LASER ON" call.

(3) "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:

(1) Lock-On After Launch (Direct Launch Mode). A 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.

(2) 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.

(3) 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 (Figure B-3) and indirect launch (Figure B-4) 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 (Figure B-5). These designator zones and their specific range requirements are provided below:

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

(a) 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.

(b) The probability of random missile failures is the highest within this zone.

(2) Protected Designator Zone. Designator operators are not vulnerable to a normally functioning missile tracking the laser backscatter energy in this zone. However, there is a possibility that the missile 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.

(a) 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).

(b) 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 time of flight to impact.

(c) Ground-designator operators must ensure that they do not inadvertantly lase through dust caused by other personnel, vehicles, etc.

(d) 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.

(e) 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. 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).

(3) 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.

(a) As a minimum, ground designator operators should wear flak jackets and military helmets.

(b) The requirements of subparagraphs 4c(2)(b) through (d) above also apply to the Unprotected Designator Zone.

(c) 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.

c. Two additional areas within the surface danger zones are:

(1) 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.

(2) 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.

d. General range requirements are:

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

(2) 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.

(3) 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.

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

(5) If the lock-on after launch (direct launch mode) is required, the target should be visible to the launch crew to assure proper aircraft alignment.

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

(7) 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.

(8) Designator codes 470-488 and 782 or greater will not be used for AHIP (OH-58D) designations.

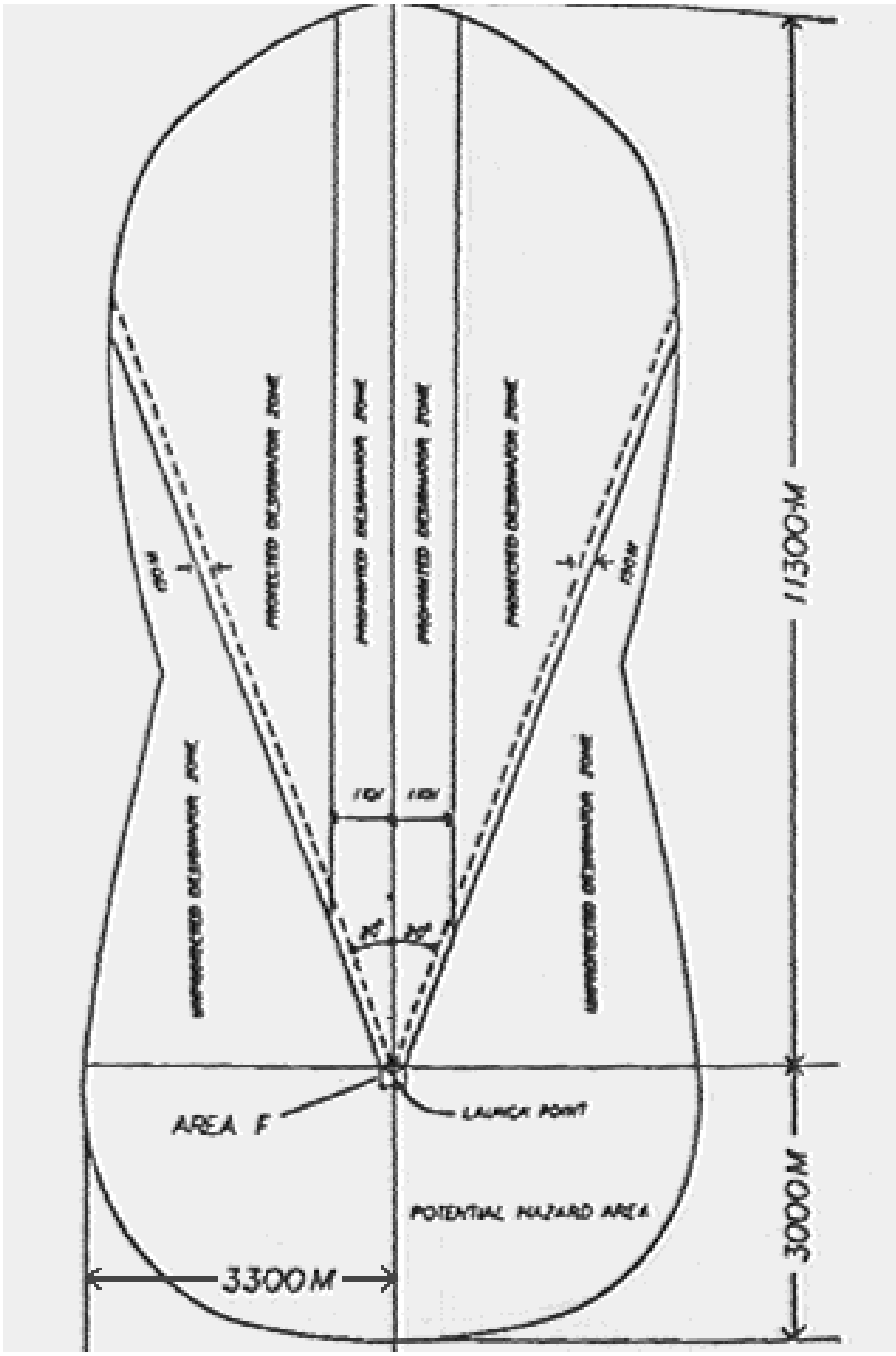

Figure B-5. HELLFIRE Missile Surface Danger Zone for Direct Launch

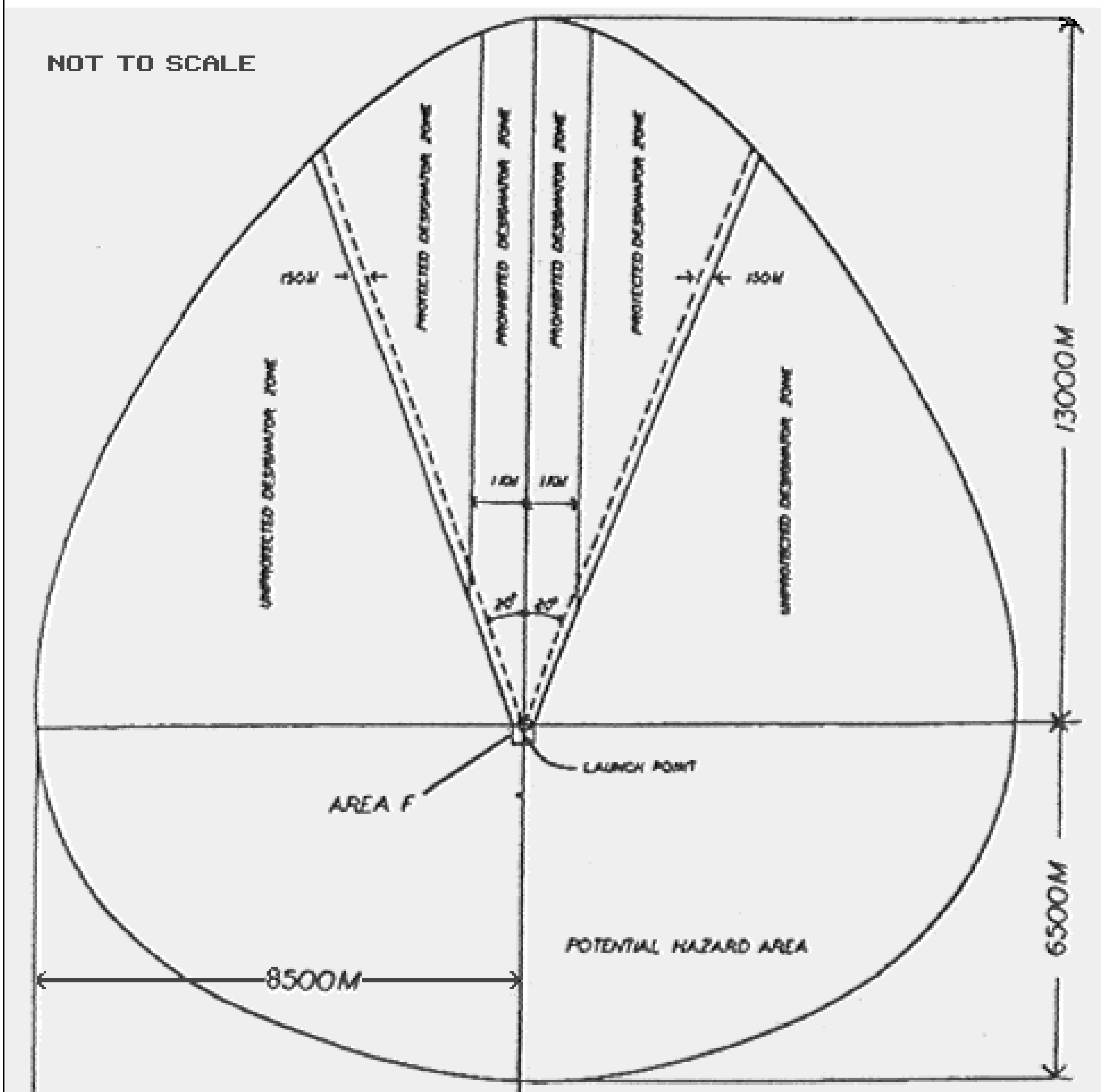

Figure B-6. HELLFIRE Missile Surface Danger Zone for Indirect Launch (Lock-On After Launch) at Fixed Target

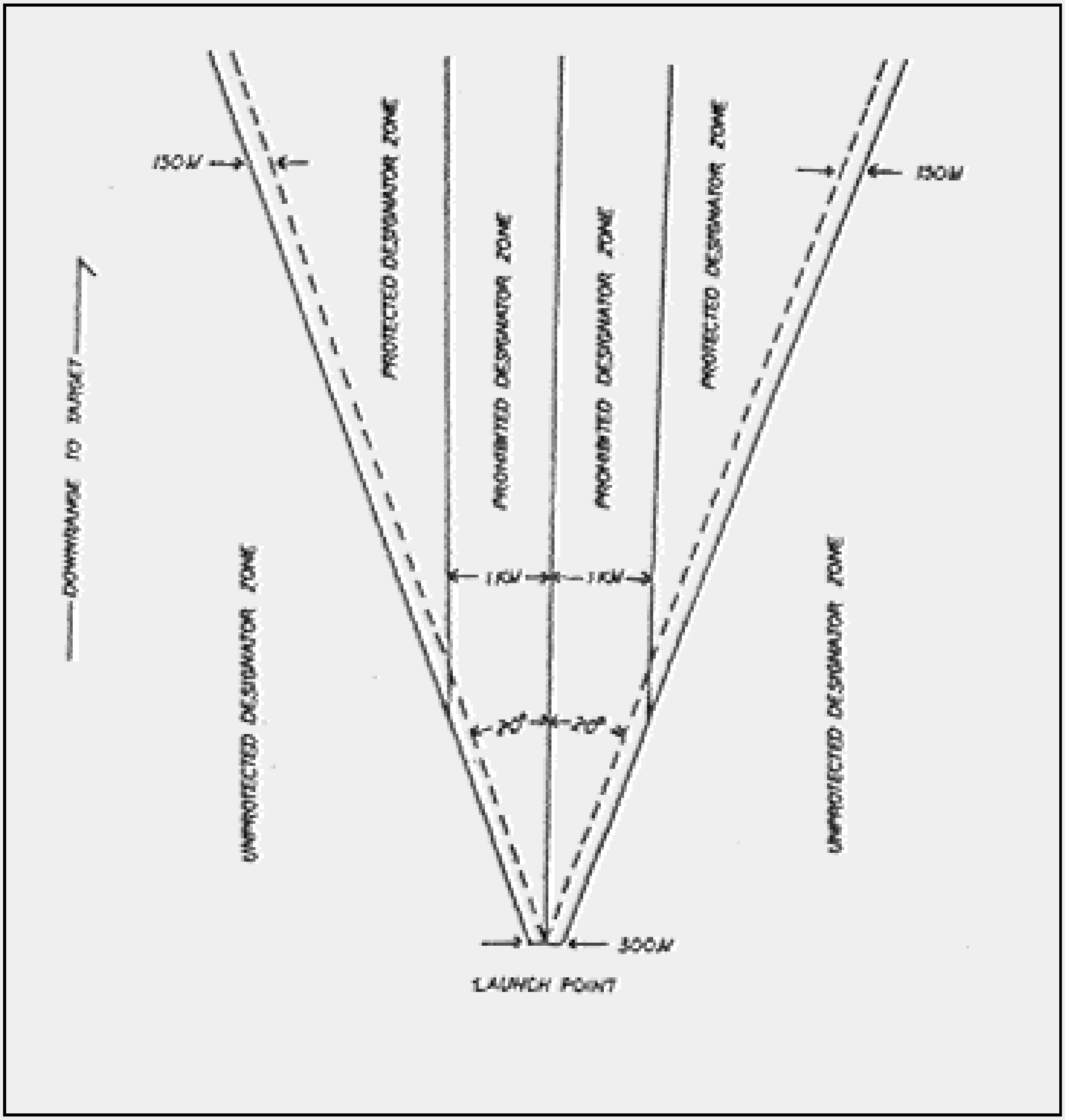

Figure B-7. Designator Zones for Use With HELLFIRE Surface Danger Zones

Figure B-7. Designator Zones for Use With HELLFIRE Surface Danger Zones

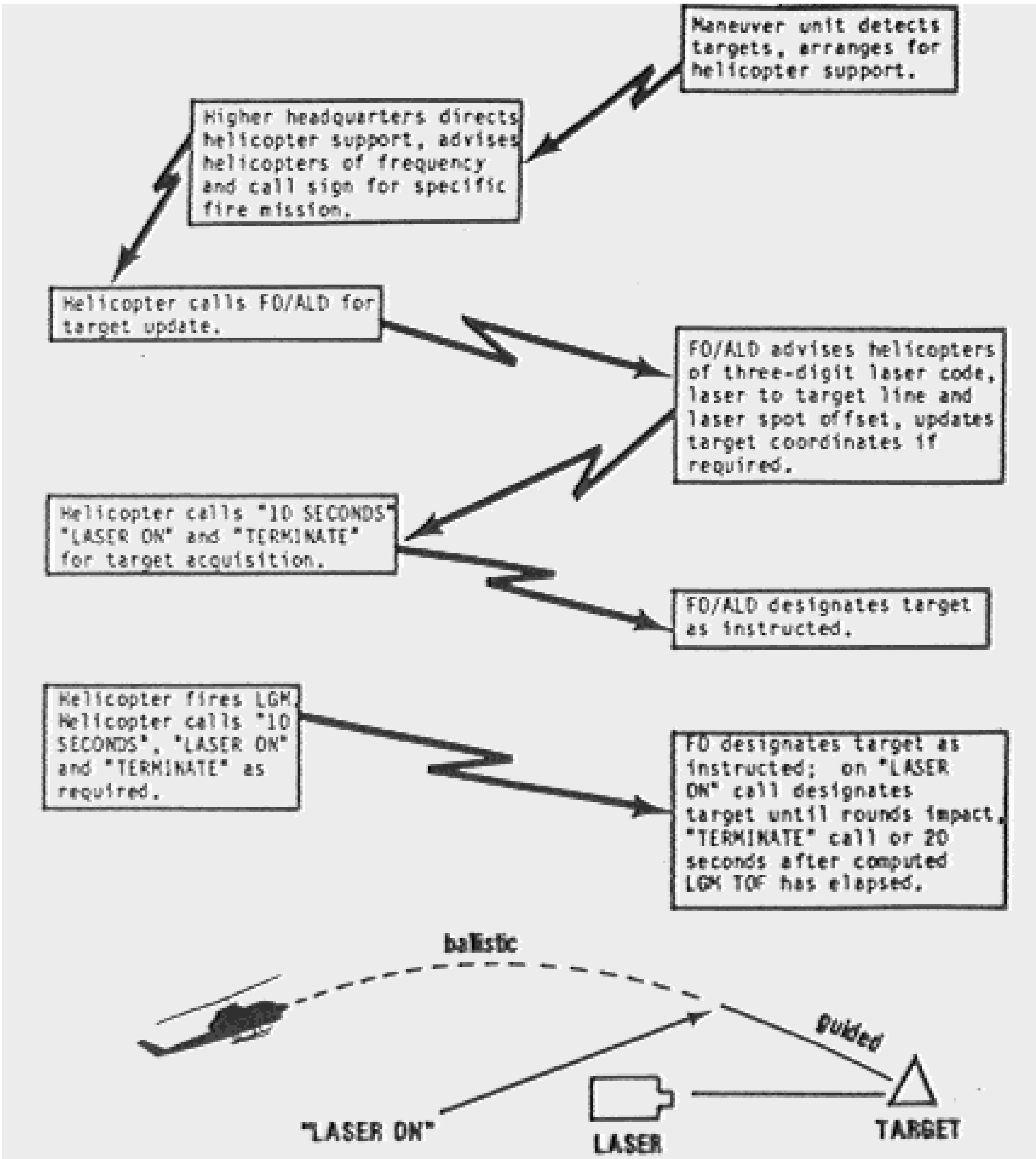

Figure B-8. Procedures for Helicopters with LST/LGM

APPENDIX C

J-FIRE CLOSE AIR SUPPORT BRIEF

(Given to the Aircraft)

(Aircraft Call Sign) This is a (Your Call Sign) CAS briefing as follows:

(1) INITIAL POINT (IP) " "

(2) HEADING (IP to Target [TGT])" "(MAGnetic)
(OFFSET:) "L / R"

(3) DISTANCE (IP to TGT) " " (Nautical Miles)

(4) TARGET ELEVATION " "(Feet-Mean Sea Level)

(5) TARGET DESCRIPTION " "

(6) TARGET LOCATION " " (LATitude/LONGitude or
(UTM or OFFSETS or VISUAL)

(7) TYPE MARK)" " (Code) " "
(WP, Beacon, Laser) (Beacon, Laser)

(8) LOCATION OF FRIENDLIES) " "

(9) "EGRESS "

(Additional line numbers apply to aircraft-specific data required for beacon bombing--see next page for specifics)

(REMARKS) "

"

(TIME ON TARGET) "TOT " or

(TIME TO TGT (TTT))"STANDBY PLUS HACK"
(Min) (Sec)

OMIT DATA NOT REQUIRED. LINE NUMBERS ARE NOT TRANSMITTED. UNITS OF MEASURE ARE STANDARD: SPECIFY IF OTHER UNITS OF MEASURE ARE USED.

"NOTE: This format varies slightly from NATO-approved procedures published in ACP 125, Supplement 2(A).

BEACON BOMBING CHART

Different aircraft require different information. Information on beacon bombing is to be transmitted only after confirming aircraft type. Beacon bombing data precedes remark/TOT or TTT. Line numbers are as follows:

USN/USMC A-6 Line Numbers

(10) (Beacon to TGT) "Bearing (MAGnetic)
or Beacon Grid "

(11) (Beacon to TGT) "Range (Meters)
or TGT Grid "

(12) "Beacon Elevation "(Feet-Mean Sea Level)

F111 Line Numbers

(10) (Beacon to TGT) "Bearing " (True)

(11) (Beacon to TGT) "Range " (Feet)

(12) "Beacon Grid "(LATitude/LONGitude)

(13) "Target Grid "(LATitude/LONGitude)

(14) "Beacon Delay " (Feet)

F-111A/E requires lines 10 and 11.

F-111F requires line 14 and either lines 10 and 11 or lines 12 and 13.

F-l6 Line Numbers

(10) (Beacon to TGT) "Bearing " (True)

(11) (Beacon to TGT) "Range " (Feet)

(12) "Beacon Elevation "(Feet-Mean Sea Level)

(13) "Target Elevation "(Feet-Mean Sea Level)

(14) (Beacon) "Time Delay "(Microseconds)

USAF F-4 Line Numbers

(10) (Beacon to TGT) "Bearing " (True)

(11) (Beacon to TGT) "Range " (Nautical Miles)

(12) "Beacon Grid " (LATitude/LONGitude)

(13) "Target Grid " (LATitude/L0NGitude)

(14) (Offsets) "North-South " (True Feet)

(15) (Offsets) "East-West " (True Feet)

(16) "Beacon Elevation " (Feet-Mean Sea Level)

(17) "Target Elevation " (Feet-Mean Sea Level)

F-4 AN/ARN-101 requires lines 10 and 11 or 12 and 13 or 14 and 15 and both lines 16 and 17.

All other F-4s require lines 14, 15, 16, and 17.

APPENDIX D

LGB/LLGB Delivery Profiles

a. General. LGBs/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. In a high threat environment, LGBs/LLLGBs will be employed in a range of missions from CAS to interdiction. The following section describes the basic delivery profiles used in LGB/LLLGB employment.

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

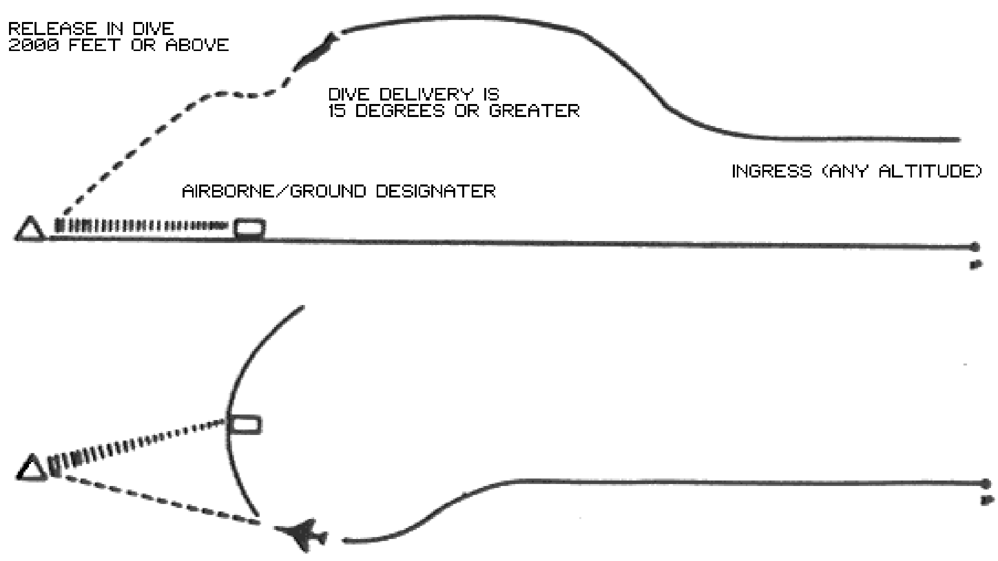

FIGURE D-1. LGB/LLLGB Dive Delivery Tactic (Permissive Threat)

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

c. Low-level Employment. Low-level LGB/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/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.

(1) Loft Delivery. Loft deliveries may be initiated prior to target acquisition or designation. This capability increases stand-off distance and generally requires a ground designator. Advantages of the loft option include minimum total response time, minimum nonmaneuvering 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 LGB/LLLGB low-level loft delivery tactic. The loft angle for the LLLGB will not be as great as for the LGB because the profile of the LLLGB will glide along a level profile to the target; the LGB must fly a ballistic path to get the target.

(2) Level Delivery. Generally, tactical considerations or weather limitations drive level deliveries from low altitude. The LGB 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.

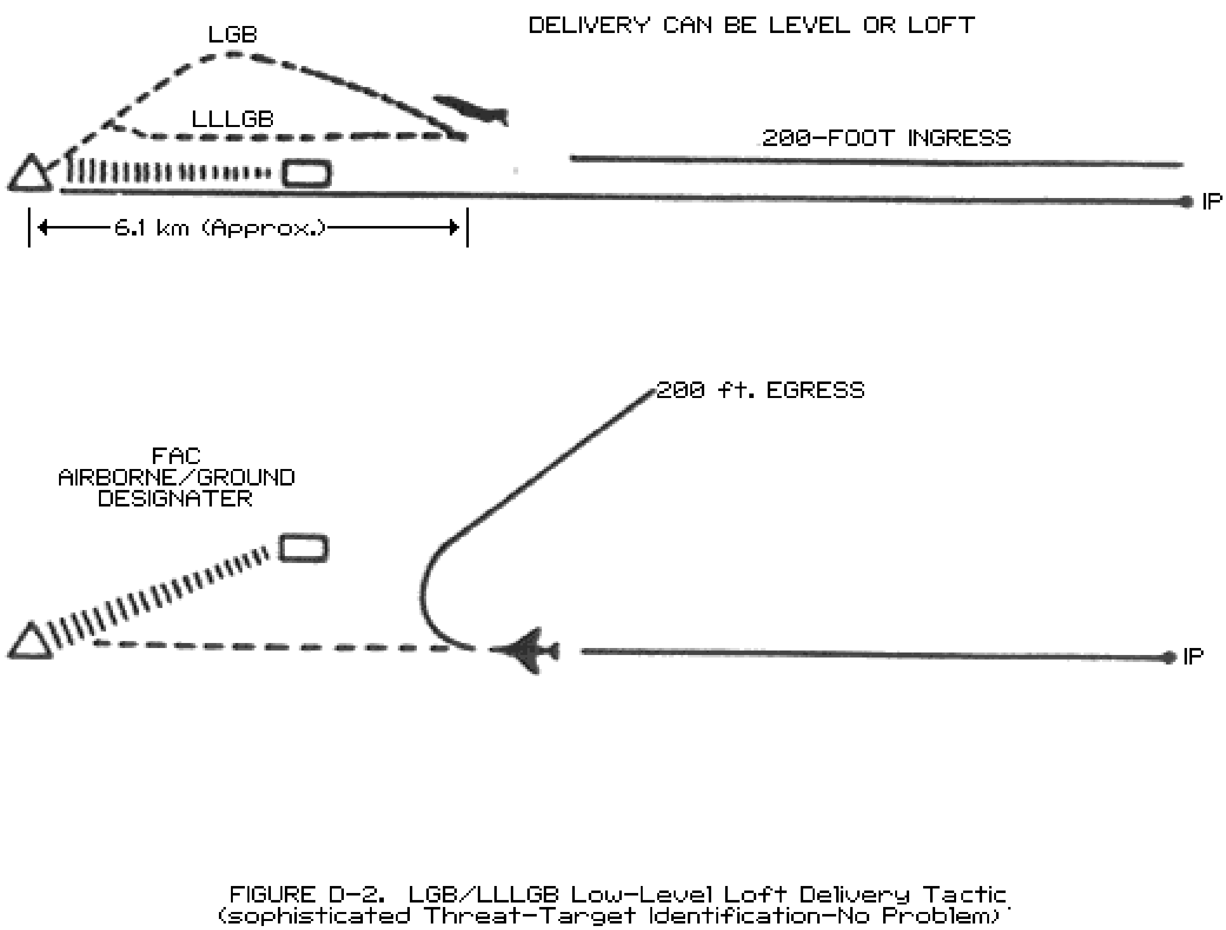

FIGURE D-2. LGB/LLLGB Low-Level Loft Delivery Tactic
(Sophisticated Threat-Target Identification-No Problem)

(3) Pop-up to Low-Angle Dive Delivery. Pop-up to low-angle dive deliveries offer advantages over level releases. Target acquisition and destruction are easier than 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-3 depicts the LGB/LLLGB pop-up delivery tactic.

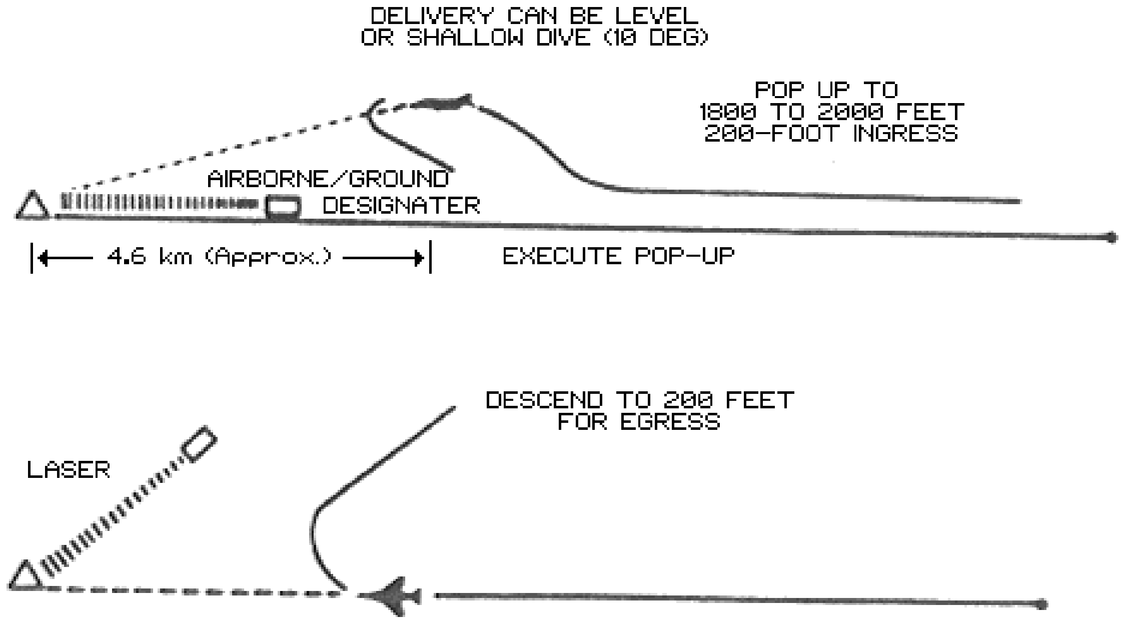

FIGURE D-3. 1GB/LLLGB Pop-Up Delivery Tactic
(Sophisticated Threat- Target Identification--Difficult)

FIGURE D-3. LGB/LLLGB Pop-Up Delivery Tactic
(Sophisticated Threat-Target Identification--Difficult)

(4) Pop-up to Long-Range Toss Delta. 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 nonmaneuvering 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 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.

APPENDIX E

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b. Joint Pub 1-02, 1 December 1989, "DOD Dictionary of Military and Associated Terms."

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a. FM 90-20/FMFRP 2-72/TACP 50-28/USAFEP 50-9/PACAFP 50-28, July 1989, "Multi-Service Procedures for the Joint Application of Firepower."

b. FM 90-21/FMFRP 5-44/TACP 50-20/USAFEP 50-20/PACAFP 50-20, February 1991, "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, 19 December 1986, "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, September 1988, "Tactical Air Control Party/Fire Support Team (TACP/FIST) Close Air Support Operations."

3. Service Publications

a. FM 6-30, 17 June 1985, "Observed Fire Procedures."

b. FM 6-20-30, 18 October 1989, "Fire Support for Corps and Division Operations."

c. FM 6-20-40, 5 January 1990, "Fire Support for Brigade Operations (Heavy)."

d. FM 6-20-50, 5 January 1990, "Fire Support for Brigade Operations (Light)."

e. NWP 22-2, July 1980, "Supporting Arms and Amphibious Operations."

4. Allied Publications

a. ATP-4 (8), June 1973, "Allied Spotting Procedures for Naval Gunfire Support," with change 3.

b. ACP-125 (E), 1 August 1987, "Communication Instructions Radio Telephone Procedures."

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GLOSSARY

PART I--ABBREVIATIONS

ACP	Allied Communications Publication
ALD	airborne laser designator
ANGLICO	air and naval gunfire liaison company
ARBS	angle rate bombing system
ASRT	air support radar team
ATP	Allied Tactical Pub
CAS	close air support
CLGP	cannon-launched guided projectiIe
DASC	direct air support center
DMD	digital message device
ECM	electronic countermeasures
EMCON	emission control
FAC	forward air controller
FCT	firepower control team
FDC	fire direction center
FIST	fire support team
FLIR	forward-looking infrared radar
FM	field manual
FO	forward observer
FSC	fire support coordinator
FSCC	fire support coordination center
FSE	fire support element
FSO	fire support officer
G/VLLD	ground/vehicle laser locator designator
HF	high frequency
HUD	heads-up display
IP	initial point
IR	infrared
J-7	Operational Plans and InteroperabiIity Directorate, Joint Staff
LANTIRN	low-altitude navigation and targeting infrared for night
LDO	laser designator operator
LGB	laser-guided bomb
LGM	laser-guided missile

LGW	laser-guided weapon
LLLGB	low-level laser-guided bomb
LMAV	laser MAVERICK
LOAL	lock-on after launch
LOBL	lock-on before launch
LOS	line of sight
LRD	laser range finder-detector
LST	laser spot tracker
LTD	laser target designator
LTD/R	laser target designator/ranger
M	meter
MACCS	Marine Corps air command and control system
MAGTF	Marine Air-Ground Task Force
MR	milliradian
MTO	message to observer
MULE	modular universal laser equipment
NGFS	naval gunfire support
PGM	precision-guided munitions
PRF	pulse repitition frequency
SAL GP	semiactive laser-guided projectile (Navy)
SALT	supporting arms liaison team
SASS	supporting arms special staff
SEAL	sea-air-land team
TRAM	target recognition attack multisensor
USAF	US Air Force
USMC	US Marine Corps
WP	Warsaw Pact

PART II--DEFINITIONS*

air and naval gunfire liaison company. An organization composed of Marine and Navy personnel specially qualified for shore control of naval gunfire and close air support. Also known as ANGLICO. (Joint Pub 1-02)

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. (Joint Pub 1-02)

air support radar team. A subordinate operational component of a tactical air control system which provides ground-controlled precision flight path guidance and weapons release. (Joint Pub 1-02)

Army air-ground system. The Army system which provides for interface between Army and tactical air support agencies of other Services in the planning, evaluating, processing, and coordinating of air support requirements and operations. It is composed of appropriate staff members, including G-2 air and G-3 air personnel, and necessary communication equipment. (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. 2. The assigned magnetic compass heading to be flown by aircraft during the delivery phase of an air strike. (Joint Pub 1-02)

attack helicopter. A helicopter specifically designed to employ various weapons to attack and destroy enemy targets. (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)

* Unless identified as extracted from Joint Pub 1-02, terminology herein is not standardized within the Department of Defense and is applicable only in the context of this document

combat information center. The agency in a ship or aircraft manned and equipped to collect, display, evaluate, and disseminate tactical information for the use of the embarked flag officer, commanding officer, and certain control agencies. Certain control, assistance, and coordination functions may be delegated by command to the combat information center. (Joint Pub 1-02)

direct air support center. A subordinate operational component of a tactical air control system designed for control and direction of close air support and other tactical air support operations, and normally collocated with fire-support coordination elements. (Joint Pub 1-02) (USMC only)

Firepower Control Team. An element of ANGLICO provided to US Army and allied company-size units to assist in controlling and spotting naval air and naval gunfire. Also called FCT.

fire direction center. That element of a command post, consisting of gunnery and communication personnel and equipment, by means of which the commander exercises fire direction and/or fire control. The fire direction center receives target intelligence and requests for fire, and translates them into appropriate fire direction. (Joint Pub 1-02)

fire for effect. 1. Fire which is delivered after the mean point of impact or burst is within the desired distance of the target or adjusting/ranging point. 2. Term in a call for fire to indicate the adjustment/ranging is satisfactory and fire for effect is desired. (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. (Joint Pub 1-02)

Fire Support Element (FSE). That portion of the force tactical operations center at every echelon above company or troop 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.

Fire Support Officer (FSO). Senior field artillery officer assigned to Army maneuver battalions and brigades. Advises commander on fire-support matters.

Fire Support Team (FIST). 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.

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. (Joint Pub 1-02)

forward observer. An observer operating with front line roops 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. (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 imaginery straight line from the gun(s) to the target. (Joint Pub 1-02)

heads-up display. A display of flight, navigation, attack, or other information superimposed upon the pilot's forward field of view. (Joint Pub 1-02)

infrared radiation. Radiation emitted or reflected in the infrared portion of the electromagnetic spectrum. (Joint Pub 1-02)

initial point (IP). 2. A well-defined point, easily distinguishable visually and/or electronically, used as a starting point for the bomb run to the target. (Joint Pub 1-02)

known datum point. A clearly visible point to which the azimuth and range are known.

Laser Designator. A device that emits a beam of laser energy which is used to mark a specific place or object. (Joint Pub 1-02)

Laser-Target/Gun-Target Angle. The angle between the laser-to-target line and the LGW/gun-target line at the point where they cross the target.

laser-guided weapon (LGW). A weapon which utilizes 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. (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.

laser-target line. An imaginary straight line from the laser designator to the target with respect to magnetic north.

laser 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. (Joint Pub 1-02) (Referred to as laser spot tracker (LST) in' this publication.)

linear terrain feature. A topographical feature, natural or manmade, that has recognizable straight-line characteristics.

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 predetermined point during the pullup, and tosses the bomb onto the target. (Joint Pub 1-02)

Marine air command and control system. A US Marine Corps tactical air command and control system which provides the tactical air commander with the means to command, coordinate, and control all air operations within an assigned sector and to coordinate air operations with other Services. It is composed of command and control agencies with communications-electronics equipment that incorporates a capability from manual through semiautomatic control. (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.

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.

point target. A target of such small dimension that it requires the accurate placement of ordnance in order to neutralize or destroy it. (Joint Pub 1-02)

polar coordinate. The location of a point in a plane by the length of a radius vector from a fixed origin in the plane, and the angle the radius vector makes with a fixed line in the plane. (Joint Pub 1-02)

polar plot. The method of locating a target or point on the map by means of polar coordinates. (Joint Pub 1-02) precision-guided munition (PGM). 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.

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.

pulse repetition frequency (PRF). 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.)

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)

run-in. Magnetic course direction from initial point to target.

shore fire control party. A specially trained unit for control of naval gunfire in support of troops ashore, consisting of a spotting team to adjust fire and a naval gunfire liaison team to perform liaison functions for the supported battalion commander. (Joint Pub 1-02)

shot. In artillery and naval gunfire support, a report that indicates a gun, or guns, have been fired. (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.

splash. 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. (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)

Supporting Arms Liaison Team (SALT). An element of ANGLICO provided to US Army and allied battalion- and brigade-sized units to provide liaison and assist in planning and controlling naval air and gunfire.

tactical air control party (TACP). A subordinate operational component of a tactical air control system designed to provide air liaison to land forces and for the control of aircraft. (Joint Pub 1-02)

target acquisition (TA). 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)