MCRP 3-10F.2

# Supporting Arms Observer, Spotter, and Controller




## U.S. Marine Corps

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# FOREWORD

Marine Corps Reference Publication 3-10F.2, *Supporting Arms Observer, Spotter, and Controller*, provides the techniques and procedures for requesting, adjusting, and controlling mortars, artillery, naval gunfire, and close air support. Changes in technology, equipment, organization, and methodologies have necessitated the update of this publication.

It is intended as a field reference for supporting arms observers, including mortar and artillery forward observers, naval gunfire spotters, and forward air controllers. Additionally, it serves as a study guide and field reference for personnel seeking information on supporting arms procedures.

This publication supersedes Marine Corps Reference Publication 3-10F.2, *Supporting Arms Observer, Spotter, and Controller*, dated 15 October 1998; and cancels change 1 dated 4 April 2018 and erratum dated 2 May 2016.

Reviewed and approved this date.



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# CHAPTER 1
# THE COMPANY FIRE SUPPORT TEAM

The Marine Corps provides a maneuver company with observers, spotters, and controllers who are specifically trained to plan, call for, adjust, and control supporting arms. The organization that provides maneuver companies with these observers, spotters, and controllers is the company fire support team (C-FST). The C-FST is the company commander's primary means of planning and employing combined arms in support of maneuver.

## RESPONSIBILITIES

The primary responsibilities of a C-FST are to—

- Locate targets.
- Plan and coordinate all fire support at the company level.
- Adjust artillery, rockets, mortars, and naval surface fire support (NSFS).
- Report battlefield/battlespace information.
- Operate within a maneuver element or from an artillery observation post (OP). The C-FST must occupy the best OP or other position that the tactical situation permits. See appendix A for more information about OPs.
- Assist the commander in overall fire support planning and coordination matters.
- Advise the commander on the employment of artillery.
- Plan fire support for the company, including both normal and quick fire planning that has been approved by the company commander.
- Be familiar with standing operating procedures (SOPs) of the supported and supporting unit, including fire support SOPs and the company's combat SOP.
- Know the tactical situation, including the scheme of maneuver or plan of defense, and the enemy situation.
- Maintain continuous observation of the zone of action of the supported unit.
- Determine and refine target locations, engagement criteria, and trigger points, as required.
- Make a terrain sketch of the area, when possible, to improve accuracy and speed in locating targets. When setting into a defensive position, the C-FST should construct a visibility diagram to pinpoint those areas where targets could remain unseen from its vantage point. See appendix B for more information about constructing a visibility diagram.
- Report all target and intelligence information by using the size, activity, location, unit, time, and equipment (SALUTE) format.

- Report actions of enemy aircraft.
- Report the results of fire.
- Conduct crater analysis (see appendix C).
- Ensure constant communication with either the battery or battalion fire direction center (FDC) and the battalion fire support coordination center (FSCC).
- Ensure that the FDC and battalion FSCC are informed of the tactical situation, plans, and location of the supported unit.
- Determine the C-FST location to within 100 meters (i.e., a 6-place grid) at all times.
- Transmit periodic position reports (POSREPs), coordinated with the company commander, to both the supporting FDC and the battalion FSCC.

> ***Note:*** In the absence of a unit SOP or special instructions, apply the following: report position changes of every 500 meters on foot or every 2,000 to 5,000 meters (considered a fast-moving operation).

- Provide security for the team by ensuring the proper use of cover, concealment, observation, and fire.
- Observe and direct other types of fire support when necessary (e.g., mortars, NSFS, close air support [CAS]).
- Assist in training Marines with nonsupporting arms military occupational specialties (MOSs) to request fire support, as required.

## TASK ORGANIZATION

Doctrinally, the C-FST contains a C-FST leader, a company fire support officer (FSO), a forward air controller (FAC), a joint terminal attack controller (JTAC), a joint fires observer (JFO), a fire support Marine, an 81-mm mortar forward observer (FO), and radio operators. The C-FST can be collocated with the combat operations center during operations, or its members may be distributed with forward elements or at an OP.

A C-FST's composition varies depending on the mode of operation, availability of personnel, and type of force supported (e.g., a mechanized unit with limited vehicle space, a foot-mobile unit). See table 1-1 for the personnel comprising a C-FST.

**Table 1-1. Company Fire Support Team Personnel.**

| Position/MOS | Number |
|---|---|
| C-FST leader/0302 | 1 |
| Company FSO/0802 | 1 |
| JTAC/8002 | 1 |
| JFO/0861 | 1 |
| Fire support Marine/0861 | 1 |
| 81-mm FO | 1 |
| Field radio operator/0621 | 2 |

### Company Fire Support Team Leader

The C-FST leader is the link between the supporting arms agencies and the company commander. The C-FST leader is responsible for the planning and execution of fires and receives advice and guidance from the team members who are considered resident experts in artillery, NSFS, mortars, and CAS. These individuals are the direct link to their respective supporting arms agencies and are heavily involved in the planning, coordination, and execution of fires.

During operations, C-FST personnel should be available to provide assistance to the C-FST leader as needed. The C-FST leader receives guidance for fires from the commander and information from all elements of the unit, which aids in decision-making. If the C-FST leader becomes separated from the commander, communication must be re-established and maintained.

It is imperative that the C-FST members understand the complex job of the C-FST leader and are prepared to assume this position if required. The C-FST leader has two primary responsibilities: managing fire support, which involves planning, integrating, and executing fire support, and operating the C-FST.

***Managing Fire Support***. The C-FST leader ensures that fire support planning is accurate and integrated into the scheme of maneuver and that fires are executed effectively.

*Fire Support Planning*. Fire support planning is the continual process of analyzing, allocating, and scheduling fire support. Once the C-FST leader determines the commander's intent for fire support, the fire planning process is begun with the supporting arms agencies. Supporting arms agencies representatives keep the C-FST leader informed of the capabilities and limitations of their various fire support assets. Fire support agencies prepare estimates of supportability and keep the maneuver commander updated on their respective agencies' current capabilities, specifically munitions availability (e.g., amount of smoke and illumination, types of fuzes) and priority of fires.

*Integrating and Executing Fire Support*. To ensure proper fire support integration and execution, the C-FST leader works concurrently with the company commander to plan fires in support of the developing maneuver plan. Once the plan is complete, the C-FST leader determines the task requirements for all of the fire support assets and ensures that the requests are forwarded to the appropriate fire support agencies. The C-FST leader must—

- Ensure that all fire support means are integrated into the company commander's maneuver plan.
- Construct the timeline for the fires to support the maneuver and synchronize those fire support elements into the plan.
- Separate the fire support elements by time or space to ensure the safety of friendly forces. This is accomplished by studying battlefield geometry (e.g., location of friendly, enemy, adjacent units; terrain), attack geometry (i.e., how the various fire support assets will attack their targets), and the company scheme of maneuver to attain a clear overall picture of the battlefield and efficient coordination of agencies.
- Ensure that the various supporting arms agencies are coordinated with maneuver for maximum combat power, mitigating the risks of numerous assets operating in the same battlespace.
- Construct and integrate a fire support plan that will support maneuver.

- Execute the fire support plan. The C-FST leader supervises the agencies involved to ensure that their responsibilities are properly executed. If problems arise during execution of the scheme of maneuver, the C-FST leader will revise the fire support plan and effectively deconflict fire support agencies.

***Operating the Company Fire Support Team***. To effectively operate the C-FST, the C-FST leader develops and maintains situational awareness, knows the capabilities and limitations of the team, synchronizes the efforts of the team, and establishes priorities of work and procedures to ensure smooth operation by—

- Ensuring that information is received from team members. All members of the C-FST should keep the C-FST leader informed of their actions to ensure good situational awareness.
- Positioning the C-FST near the company commander for optimum observation of the battlefield, whether centralized or decentralized, in order to—
  - Facilitate rapid coordination of fires with the company scheme of maneuver.
  - Allow C-FST personnel to observe as much of the battlefield/battlespace and as many targets as possible.
  - Allow C-FST personnel to see the company's lead trace elements and facilitate the safe, timely clearance of fires.
- Developing a routine for C-FST actions, or an SOP, to facilitate smooth execution. An effective C-FST leader will designate personnel and assign specific tasks to be accomplished. For example, when there is contact with the enemy, the following procedures may be used:
  - The fire support Marine determines grid and elevation to the enemy positions.
  - The 81-mm FO determines direction and distance to the enemy positions.
  - The JTAC requests air support and develops the 9-line brief.
  - The company FSO determines stay above or stay below parameters.
  - The 81-mm FO adjusts fire with the 81-mm mortars.
- Developing teamwork for CAS. The development of SOPs for CAS attacks is crucial because there are many tasks that must be accomplished simultaneously to facilitate the successful attack on a target. To ensure that the C-FST operates smoothly, the C-FST leader will designate tasks to each member. For example:
  - The company FSO spots and determines corrections from the mark.
  - The 81-mm FO acquires the aircraft and talks the rest of the team onto it.
  - The JTAC talks to the aircraft over the radio.
- Ensuring proper time management. Time management is all-encompassing and requires the C-FST leader to ensure that situational awareness is maintained through effective communication with the C-FST members. Accurate information must be passed to the C-FST leader quickly and clearly by all team members to ensure that timely decisions can be made. This is essential when aircraft check in with a very short time on station or when an emergent target must be engaged before it disappears.

### Company Fire Support Officer

The primary responsibility of the company FSO is to plan and coordinate supporting fires at the company level. The company FSO, assisted by a JFO/0861 and fire support Marine, performs the following duties:

- Plans, controls, and adjusts artillery, naval, and mortar fires onto targets. The company FSO should plan for priority targets, suppression of enemy air defenses (SEAD), and final protective fires (FPFs) when developing any plan.
- Provides the company commander and C-FST leader with all pertinent information regarding artillery and NSFS employment. The company FSO must know how much and what type of artillery and/or ammunition is available and should be prepared to advise on all types of indirect fire support, including naval surface fires, rockets, and mortars.
- Establishes and makes frequent contact with the other observers (i.e., artillery and mortar FOs) and any JTACs supporting the company.

### Joint Terminal Attack Controller

Although not part of the aviation combat element (ACE), the JTAC is an essential element of the Marine air command and control system and the tactical air control party (TACP). The JTAC–

- Provides direct air support to task-organized maneuver elements and is the primary terminal controller of aircraft.
- Maintains radio communications with assigned support aircraft from a forward ground position.
- Directs each CAS aircraft's attack on the target, which aids target identification and enhances troop safety.
- Employs a laser system for designating targets, as required.
- Controls aircraft during the terminal phase of CAS missions to assist in target identification and minimizing the danger to friendly troops.
- Operates with the assault units of the battalion.
- Observes and locates targets of opportunity.
- Directs air strikes against targets.
- Advises the supported company commander on the proper employment of aircraft assets.
- Gathers and reports all information of an intelligence nature, including target damage assessments.
- Stays abreast of the supported unit's plans, positions, and needs.
- Stays abreast of the enemy situation, location of friendly units, and current target list.
- Requests and controls aircraft in accordance with the Marine air-ground task force (MAGTF) master air plan.

### Joint Fires Observer

A JFO is a certified and qualified Service member who can—

- Request, adjust, and control surface-to-surface fires.
- Provide targeting information in support of type 2 and type 3 CAS terminal attack controls.
- Perform terminal guidance operations.
- Assist in fire planning.

Terminal guidance is different from terminal attack control. Terminal guidance operations are electronic, mechanical, voice, or visual communications that provide approaching aircraft and/or weapons additional information regarding a specific target location. Enemy targets, such as mobile, high-payoff targets that are difficult to locate from the air, are often more visible to ground forces. Small ground elements can sometimes search for, identify, and precisely report the location of targets and provide a precise battle damage assessment (BDA) of attacks on targets that may otherwise be obscured or hidden if using Global Positioning System (GPS), laser designators, or a combination of both systems.

> ***Note:*** Terminal guidance operations do not include the authority to clear aircraft to release ordnance and should not be confused with terminal attack control.

### Fire Support Marine

Duties of this position include the following:

- Assist the company FSO in the planning, control, and execution of all fires from indirect fire support systems (i.e., NSFS, artillery, mortars, and the multiple launch rocket system, [referred to as MLRS]).
- Provide the company FSO with all pertinent information regarding indirect fire support system employment.
- Provide targeting information.

Additional duties include operating from within an FSCC at the battalion, regiment, division, or MAGTF level and employing fire support command and control systems. Fire support Marines in an FSCC maintain status boards and plot updates on situational maps.

### 81-Millimeter Mortar Forward Observer

Duties of this position include the following:

- Plan, control, and adjust mortars onto targets.
- Provide the company commander and C-FST leader with all pertinent information regarding mortar employment.
- Provide targeting information.

## COMMUNICATIONS

Fire support personnel use several means of communication to ensure effectiveness in mission execution.

### Radio

***Company Fire Support Team Nets***. The C-FST uses radio traffic as its primary means of communication. All members of the team must be communications experts who are able to

maintain the equipment to the highest degree of performance, troubleshoot, and enhance performance with the use of directional antennas and other expedient methods. Several nets are employed by the C-FST.

*Artillery Conduct of Fire Net*. This very high frequency (VHF) net provides a means for observers to request and adjust artillery fire. The artillery battalion FDC establishes as many as three conduct of fire (COF) nets and acts as net control of each. The following applies:

- The battalion fire support team located at the battalion FSCC monitors and receives traffic on the COF net to coordinate requests for fires.
- The artillery battalion may identify a COF net for each maneuver battalion to facilitate continuity of fire support during battery displacements.
- The artillery battalion FDC receives all calls for fire and designates which firing battery or batteries will provide fire support to the maneuver battalion. This allows the artillery battalion to quickly mass on larger targets and manage the assets of the battalion as a whole.
- Each battery FDC maintains a COF net and acts as net control when conducting autonomous operations. Each net is monitored by the battalion FDC when present. Autonomous operations are also conducted by batteries attached to a battalion landing team.
- For coordination purposes, the battalion fire support team located at the battalion FSCC monitors all traffic on this net.
- The fire support coordinator at the infantry regiment may enter the net, as required.

The stations on this net include the following:

- Direct support artillery battalion FDC.
- Firing battery.
- Battalion FSCC.
- C-FSTs.
- Regimental FSCC, as required.
- Artillery units assigned reinforcing mission, as required.

*Division or Ground Combat Element Artillery Air Spot Net*. The artillery regiment, which is considered a battalion when operating independently, establishes this VHF net for aerial observers to adjust artillery fire. The artillery regiment is the net control; however, for a specific mission, control may be passed to the battalion or battery FDC conducting the mission. When this net is in use, company FSOs monitor for targets in their unit's zone. The company FSO may use this net to coordinate with an aerial observer for the attack of targets in the company's zone. The stations on this net include the following:

- Net control.
- Aerial observer.
- Artillery battalion, as required.
- Firing battery, as required.
- Company FSOs, as required.
- FSCCs, as required.

*Maneuver or Company Tactical Net*. Monitoring VHF maneuver tactical nets is not a requirement for the C-FST. However, the ability to monitor multiple channels with the current communications equipment enables the C-FST to use company nets to increase situational awareness without requiring additional radios.

*Infantry Battalion Mortar Net*. The VHF infantry battalion mortar net provides the means for requesting, adjusting, controlling, and coordinating the fires of the 81-mm mortar platoon. Stations on this net include—

- FOs.
- 81-mm mortar section FDC.
- 81-mm mortar representative located in the battalion FSCC.
- Mortar platoon commander (net control).

***Tactical Air Control Party Nets***. The TACP communicates by the radio nets described in the following subparagraphs, as well as by other means (such as landlines) when available.

*Tactical Air Request/Helicopter Request Net*. This high frequency (HF) net provides a means for units to request immediate air support from an air control agency. The FSCC at each echelon monitors this net and coordinates with the air control agency to approve, deny, or modify the requests. The following may be passed over this net:

- Target damage assessments and emergency helicopter requests.
- Preplanned air support requests if other means are not available.

The stations on this net include the following:

- TACPs.
- Direct air support center (DASC).
- FSCCs.
- Navy tactical air control center (TACC).
- Tactical air coordinators (airborne) (TAC[As]).
- Forward air controllers (airborne) (FAC[As]) or other terminal controllers.
- Assault support coordinators (airborne).
- Other MAGTF agencies, as required.

*Tactical Air Direction Net*. This net is a primary ultrahigh frequency (UHF) net, with a secondary VHF capability depending upon the aircraft. It provides a means for directing aircraft in CAS missions by the terminal controller and a means for the air control agency to brief support aircraft on target information and handoff to the terminal controller or TAC(A).

*Tactical Air Control Party Local Net*. This VHF net provides a means for coordination between the air officer in the battalion FSCC and the JTACs.

***Joint Terminal Attack Controller Nets***. The JTAC maintains communication with the air officer located in the battalion FSCC and the air control agency. Additionally, the JTAC establishes and maintains positive communications with assigned support aircraft from a forward position.

*Helicopter Request Net*. This HF/VHF net provides a means for TACPs of helicopterborne forces to request immediate helicopter support from the DASC or the helicopter direction center.

*Helicopter Direction Net*. This UHF/VHF/HF net provides positive control of inbound and outbound helicopters in the amphibious objective area.

### *Related Aviation Nets*

*Naval Surface Fire Support Ground Spot Net*. This primary HF/secondary VHF net provides a means for requesting and adjusting NSFS and passing vital information between stations. The following applies to this net:

- The naval gunfire liaison officer (NGLO) usually provides net control and monitors all traffic for purposes of coordination.
- Within the infantry, the regiment may monitor the net, as required.
- A frequency is allocated to each battalion that is assigned a direct support ship.
- A general support ship assigned to support the battalion will enter the NSFS ground spot net for the duration of the mission.

The stations on this net include the following:

- Infantry battalion FSCC provides net control.
- Separate infantry battalion FSCC, as required.
- Company FSO/NSFS spot team.
- NSFS ships.

*Shore Fire Control Party Local Net*. This VHF net provides direct communications between the NSFS spot team and the NGLO in the battalion FSCC. It provides a means for coordinating the employment of the spot team and for coordinating NSFS matters. It provides communications between the NSFS spotter and the spot team when separated. The following applies to this net:

- The NGLO exercises net control from the infantry battalion FSCC.
- The stations on this net include the infantry battalion FSCC and the C-FST/NSFS spot team.

*Naval Surface Fire Support Air Spot Net*. This UHF or VHF net, the frequency of which is dependent on the aircraft, is used by an aerial observer to request and adjust NSFS. The following applies to this net:

- The NGLO at the infantry battalion, regiment, and division enters this net. When an aerial observer is working in conjunction with ground units, the appropriate fire coordination agency will exercise net control.
- The supporting arms coordination center (SACC) is net control prior to control and coordination of responsibilities being transferred ashore.

The stations on this net include any aerial observers and the supporting ship as follows:

- Division FSCC (net control when an aerial observer is working in conjunction with ground units).
- SACC afloat (net control before control and coordination responsibilities have been transferred ashore).
- Navy TACC, as required.
- MAGTF force fires coordination center (FFCC), as required.
- Infantry regiment FSCC, as required.
- Infantry battalion FSCC, as required.
- Separate infantry battalion FSCC, as required.
- Company FSO or NSFS spot team.
- NSFS ships, as required.

### Automated Systems

Automated systems use a burst transmission capability, which minimizes vulnerability to enemy radio direction finding. The automated system is used by the C-FST to transmit calls for fire, fire plans, and battlespace information.

> ***Note:*** Manually-packed devices, such as the Target Location, Designation, and HandOff System Version 2 (commonly called THS V2), enable users to rapidly prepare, transmit, and receive both text and graphic messages over radios or field wires.

### Wire

The company FSO will use wire communications—to the extent permitted by the tactical situation, time, and personnel available—as follows:

- Static defensive posture allows the use of a land-line between the company commander and a remote OP.
- Wire may be used between the company FSO and fire support personnel when operating separately.
- Wire communications may be limited when acting in the capacity of an NSFS spotter. However, when the situation permits, a land-line may be established between the NSFS spotter and shore fire control party or between the spotter's OP and the NGLO.

### Messenger

The company FSO may use a messenger if the tactical situation permits. This method is a more secure method of sending fire plans as it reduces radio traffic and hampers enemy direction finding.

## EMPLOYMENT

The employment of observers, spotters, and controllers is coordinated by the battalion fire support coordinator, with the assistance of the battalion FSO, the NGLO, an air officer, and an 81-mm mortar representative at the supported battalion's FSCC. During operations, the C-FST should maintain communication with the company commander to provide assistance as needed because the commander receives reports from all elements of the unit and must decide where fire support is most urgently needed. If separated from the commander, communications must be immediately re-established.

### Offensive Operations

In offensive operations, supporting arms personnel should be in a position to maintain communications with the company commander and be able to observe the battlespace. Depending on the nature of the mission and the situation, specific supporting arms personnel, including the company FSO or JTAC, may need to be collocated with the commander to maintain voice communictions.

Personnel from the C-FST may be located with the company's lead elements. In a mechanized unit, special consideration should be given to where C-FST personnel are located in order to best support operations. Supporting arms personnel assist the supported unit commander in the offense by performing the following duties:

- Plan fires to support the company's attack and its reorganization following seizure of the objective. Fires are planned on both confirmed and suspected enemy positions and key terrain. Refer to Marine Corps Tactical Publication (MCTP) *3-10F, Fire Support Coordination in the Ground Combat Element*, for a detailed discussion on planning fires.
- Execute the fire support plan.
- Call for fire on targets of opportunity.
- Provide battlespace information regarding the enemy situation.
- Update SALUTE reports.
- Provide additional channels of communication.
- Aid in land navigation.

***Movement to Contact***. During movement to contact operations, supporting arms personnel perform the following tasks:

- Plan fires on critical points along the route of march (e.g., potential ambush sites, priority targets).
- Maintain their orientation by using land navigation skills and terrain features for reference points that are identifiable on both the ground and the map.
- Conduct immediate action drills on contact.
- Provide periodic POSREPs to the FDC, fire support officers, air officers, and other observers during movement, as required.

***Attack, Exploit, and Pursue***. When enemy contact has been established, supporting arms personnel position themselves in the most advantageous location to observe the actions of the supported unit, conduct fire missions, and coordinate fires for the company commander. Supporting arms personnel should—

- Be positioned on a terrain feature that offers the most advantageous observation of the company's advance.
- Be familiar with immediate action drills on contact, in accordance with the SOP, operation order (OPORD), or situational reporting.
- Ensure that fires support maneuvering elements by enabling elements to close with and destroy or bypass the enemy.
- Assess the benefit of fires versus their risk to friendly forces.
- Consider the effects of shell/fuze combinations.

***Consolidate***. When supporting arms personnel are consolidating on the objective, the following tasks apply:

- Send reports (e.g., new POSREPs, situation reports) to the battalion FSCC.
- Establish defensive fires and fires to disrupt an enemy counterattack in the fire plan.
- Continue fire planning and make revisions or changes for the tactical situation as necessary.
- Maintain continuous observation and fire support for follow-on operations, as directed by the company commander.

### Defensive Operations

Supporting arms personnel plan their fires to support the company's plan of defense. Artillery, rocket, mortar, NSFS, and air fires are planned to break up the attack, repel the assault, limit or destroy penetrations, and support counterattacks. During defensive operations, supporting arms personnel perform the following tasks:

- Plan fires forward of, on, and behind the supported unit's defensive positions, obstacles, and avenues of approach.
- Plan FPFs or priority targets for both artillery and mortars and make adjustments if the situation permits.
- Select an OP that provides good visibility of the company's area of responsibility. Fire support personnel may be positioned with the company FSO, NSFS spotter, platoon, or forward element.
- Execute the fire plan, including battalion targets, in the area of responsibility as follows:
  - Verify that the company fire plan has been received by the battalion FSO.
  - Verify the number of targets that were approved.
  - Verify establishment of target reference points (TRPs).
  - Establish a fire support plan for alternate and supplementary company positions.
  - Screen fires.

Additionally, the C-FST constructs a visibility diagram of the observed area from an established OP. The diagram is prepared in duplicate. The C-FST retains one copy and the other copy is forwarded through the battalion FSCC to the battalion intelligence officer. At the battalion level, coverage is planned for those areas that are not under ground observation (see appendix B for more information about visibility diagrams).

### Patrol Support

Providing fire support for patrols is an important function for supporting arms personnel, particularly the artillery and mortar observers. The C-FST keeps the battalion FSCC informed of friendly patrol plans, including routes and schedules. Supporting arms for the patrol are coordinated before the patrol begins. Planning by supporting arms personnel should include the following actions:

- Obtain the size of the patrol, times of departure and return, mission, routes and checkpoints, and any special instructions from the company commander and patrol leader.
- Assist the patrol leader in fire planning, following the guidance provided by the company commander. Fires are planned along the route of critical areas or key terrain by using priority targets when available.
- Process the fire plan. Provide a copy of the fire plan to the patrol leader and secure any special communications instructions or signals that may be used.
- Make arrangements to maintain communications, as required.

### Retrograde Operations

Supporting arms personnel (e.g., company FSO, JTAC, NSFS spotter) are selected depending on the situation. These personnel may remain with the company commander throughout retrograde operations. However, portions of the teams may displace with the withdrawing forces to maintain continuity of observation and fire. Fire support personnel may be employed in an overwatch position. Supporting arms personnel must perform the following tasks:

- Plan fires for the period when the company has control of fires.
- Plan fires for rearward passage of lines and handoff of fire plans, target lists, and terrain visibility diagrams.
- Acquire and pass control of fires through the battalion FSCC and air officer.
- Maintain observation of the area of responsibility during control of fires.
- Maintain orientation during movement.

# CHAPTER 2
# TARGET LOCATION

Providing the supported unit with effective fire support depends on the observer's ability to locate targets quickly and accurately. The elements of target location are direction, distance, and altitude. Terrain/map analysis is key to accurate target location. Because terrain/map analysis is applicable to the mortar FO, artillery observer/NSFS spotter, JFO, and JTAC, the use of the word "observer" in this chapter applies to all of them.

## FUNDAMENTALS OF TARGET LOCATION

Understanding and applying the skills of map reading are essential. Observers need these skills to perform terrain/map analysis because the map is used to determine what terrain observers expect to see in the battlespace. Observers—

- Scan the map and terrain continually and attempt to associate features that are observed on the ground with those located on the map.
- Use the map to determine the location of targets, friendly positions, and their own position and to remain oriented during movement.
- Determine direction, distance, and altitude for target location by using the map and other tools.

For an accurate terrain/map analysis, observers perform the following tasks:

- Locate within 100 meters of their actual location on the ground each time they move.
- Use prominent terrain features to relate potential target areas to grid locations on the map.
- Conduct a thorough study of the terrain by drawing a terrain sketch and associating distances and directions to prominent features that are indicated on the sketch.

Observers orient themselves and their maps utilizing a compass and declination diagram. The information in the following subparagraphs can also be applied to other common laser range finders (CLRFs).

### Direction

Direction is the most important element of target location and is an integral part of terrain/map association and adjustment of fire. Direction is a term used by observers to indicate the bearing from the observers' position to the target.

***Units of Measurement***. Direction can be measured in mils or degrees. Degrees can be converted to mils when required.

*Mil*. A mil is a unit of horizontal, clockwise, angular measurement that is equal to 1/6400th of a circle. The mil unit of measurement is used because of its accuracy and the mil-relation formula's ability to convert angular deviation into horizontal distance. Mils may be measured from the map (grid north) or by using a compass (magnetic north).

> ***Note:*** The standard unit of measurement is mils grid and need not be specified in the call for fire. Mils are transmitted as four digits to alleviate confusion; other units of measurement must be specified.

**Example: Mil unit of measurement**

*Direction 1600*. (Direction is expressed in mils grid.)

*Direction 1600 mils magnetic.* (Unit of measurement must be specified if different from the standard.)

*Degree*. A degree is a unit of horizontal, clockwise, angular measurement that is equal to 1/360th of a circle. Degrees can be measured from grid, magnetic, or true north. An observer using degrees in the call for fire must specify the type.

**Example: Degree unit of measurement**

*Direction 090 degrees magnetic.*

Degrees may be converted to mils by multiplying the number of degrees by 17.8.

**Example: Degrees converted to mils**

090 degrees x 17.8 = 1602 mils.

***Types of Direction***. There are several types of direction that can be used by an observer: an observer-target line (OTL), a gun-target line (GTL), cardinal or intercardinal directions, and an arbitrary reference feature (a known point).

*Observer-Target Line*. The OTL is an imaginary straight line from the observer to the target. It is the most commonly used direction for locating targets and conducting adjustments. The standard unit of measurement is mils grid. The measurement of the OTL's direction allows for the observer to determine observer-target (OT) direction. The OT direction is determined as accurately as possible and transmitted to the nearest 10 mils or nearest degree.

**Example: Observer-target line**

*Direction 0640.* (A direction of 0642 mils would be transmitted this way, with mils grid understood.)

***Gun-Target Line***. The GTL is an imaginary straight line from the guns to the target. The GTL is frequently used by aerial observers as a spotting line for adjustments of fire. It can also be used by ground observers, particularly when positioned on or near the GTL. When the GTL is used as a direction, the standard unit of measurement is mils grid. Observers who desire to use the GTL as a spotting line transmit *direction gun-target line* in the call for fire.

***Cardinal or Intercardinal Direction***. This type of direction involves the use of one of the eight cardinal/intercardinal directions (i.e., north, northeast, east, southeast, south, southwest, west, and northwest) and is often used by aerial observers. It can also be used by ground observers, but the accuracy in adjustment is reduced (see figure 2-1).

**Example: Cardinal or intercardinal direction**

*Direction northeast.*

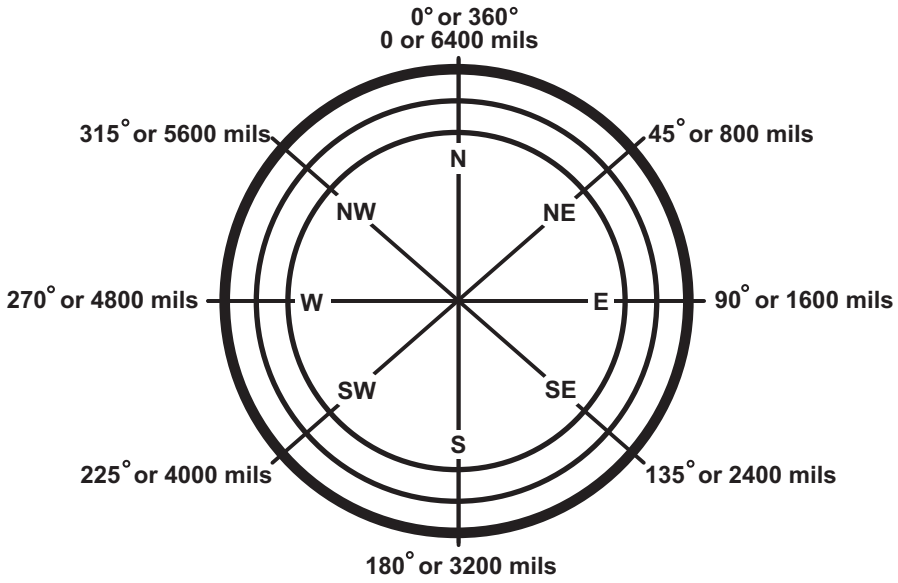



**Figure 2-1. Cardinal Direction.**

*Arbitrary Reference Feature*. Observers may use a natural or man-made feature (e.g., the point at which a bridge crosses the north-south river, the intersection of two roads) to reference target location and/or adjustment of fire. This type of direction may be used by aerial observers and in situations where the transmission of the OTL may compromise a ground observer's location. Observers may use an arbitrary feature to adjust fire by extracting a new direction from the arbitrary reference feature to the target.

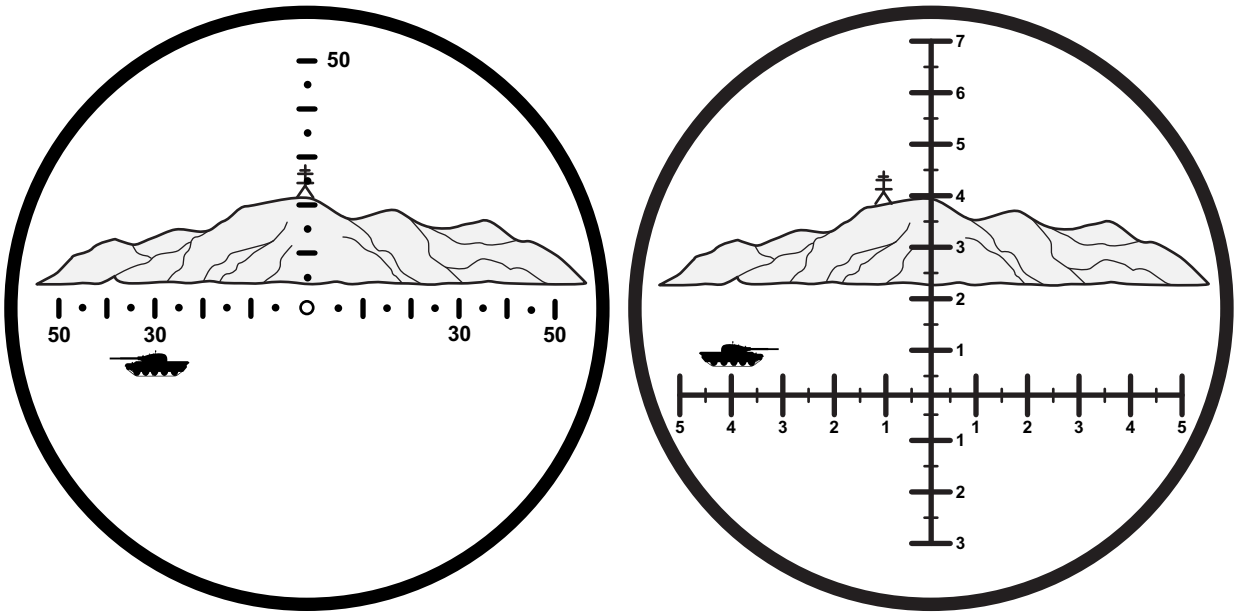
**Example: An arbitrary reference feature**

*Direction 1800.* The observer then references all adjustments from an imagined line originating at a road intersection and ending at the target. The actual OTL is different.

***Direction Determination***. Observers can measure direction by using a compass or an instrument that has been oriented for direction, a known reference point, a map, or the ground using—

- *Measuring devices*. Measuring devices include—
  - The lensatic and M2 compasses, which are graduated in 20-mil increments.
  - The CLRF, which is capable of providing both direction and distance to the observer. When calibrated, it provides directional readings in 1-mil increments.

- *A reference point with a known direction*. By determining the angular deviation in mils between the reference point and the target, a direction can be computed by applying the deviation to the known direction as follows (see figure 2-2):
  - Add the mils to the known direction if the target is to the right of the reference point and subtract if the target is to the left. This is referred to as the right, add, left, subtract (RALS) method.
  - Use any instrument with a reticle pattern to determine direction by measuring angular deviation and applying RALS.
- *Map scaling*. Observers may scale direction from a map to within an accuracy of 10 mils by using a protractor.
- *Ground estimating*. Estimating on the ground is the least accurate method, but it can be used when observers require speed or do not have a map and/or compass. Observers should be able to visualize a cardinal/intercardinal direction, realizing that the sun and moon rise in the east and set in the west.




Vector 21B Reticle Pattern
Target is 30 mils left of the reference point

M22 Reticle Pattern
Target is 40 mils left of the reference point

**Figure 2-2. Measuring Angular Deviation.**

***Angular Deviation Determination***. Observers must be able to determine direction by using angular deviation or measurement as described in the following subparagraphs. Angular deviation is used to determine horizontal and vertical distances to the target and to make corrections in adjustment.

*Reticle Patterns*. Reticle patterns are found on optical instruments and are the primary means of measuring angular deviation. Binoculars and laser CLRFs can measure angular deviation to an accuracy of +/- 5 mils. Any object within the field of view with a known direction can serve as a reference point.

*Hand Measurement of Angles*. Hands and fingers may be used for angular deviation or measurement in situations where speed is essential or when there are no other tools available. An observer fully extends an arm with the palm of the hand pointed toward the target area or reference point. By using the values contained in figure 2-3, the observer can determine an approximate angular deviation or measurement.

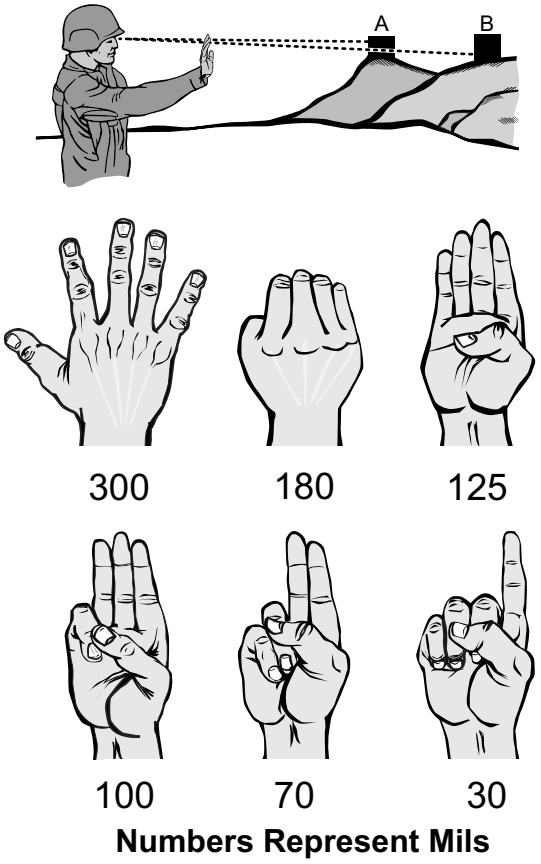


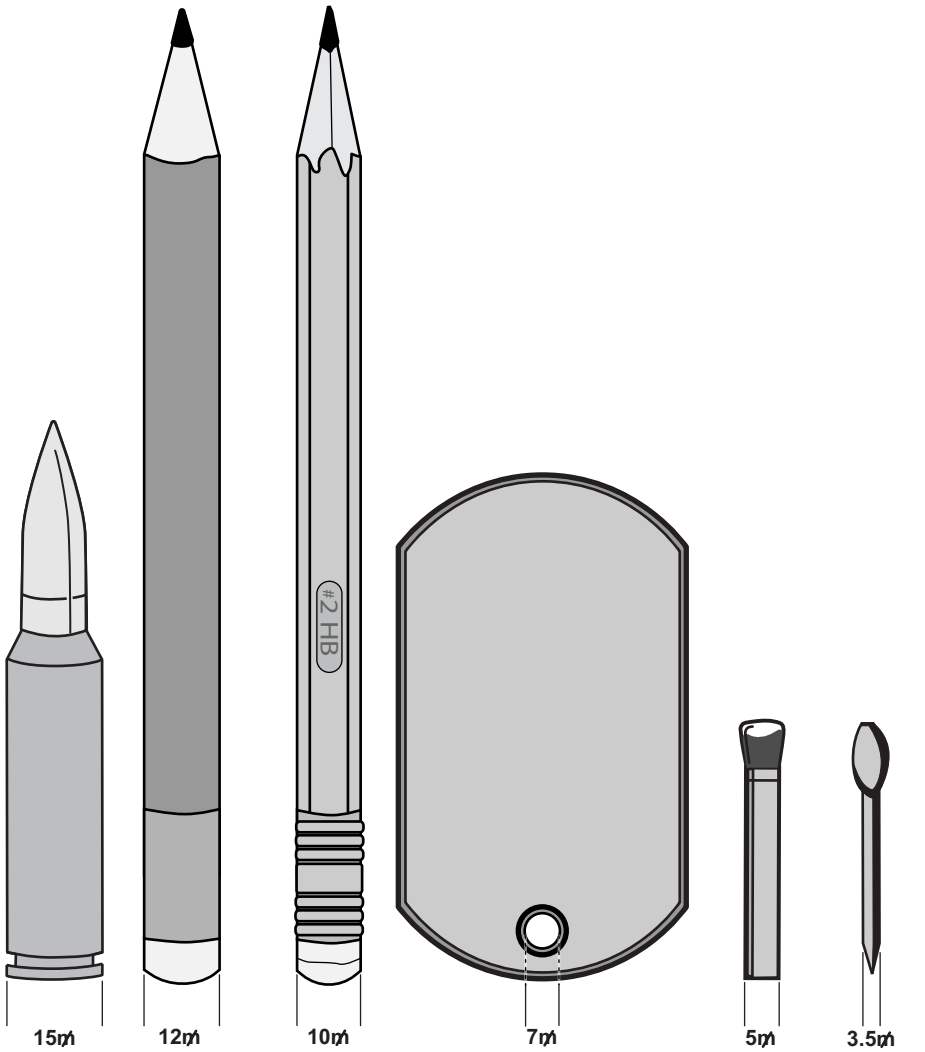

**Figure 2-3. Hand Measurement of Angular Deviation.**

The observer should determine the actual values of the hand and finger measurements to increase accuracy. The observer does this by comparing a known deviation between two objects with that derived from the hand or fingers.

*Object Measurement of Angles*. Observers may also use common objects to measure angles as shown in figure 2-4. Without a more accurate means available, and knowing the actual size of potential targets and the measurements shown in figure 2-4, observers can quickly determine range with reasonable accuracy (see figure 2-5).

### Distance

Once the direction has been determined, observers must determine distance to the target. Distance is the horizontal space between a reference point or a ground observer and a target. It is also used in adjustment of fire. The meter is the standard unit of measurement for distance. Other units of measurement may be used if specified in the call for fire. Though it is typically the most difficult variable to determine in target location, observers can employ CLRF, sound, or distance estimation.




NOTE:
By knowing the mil value at arm's length of various pieces of equipment and the actual size of targets, the range can be determined with a reasonable degree of accuracy.

**Figure 2-4. Angular Measurement With Common Objects.**

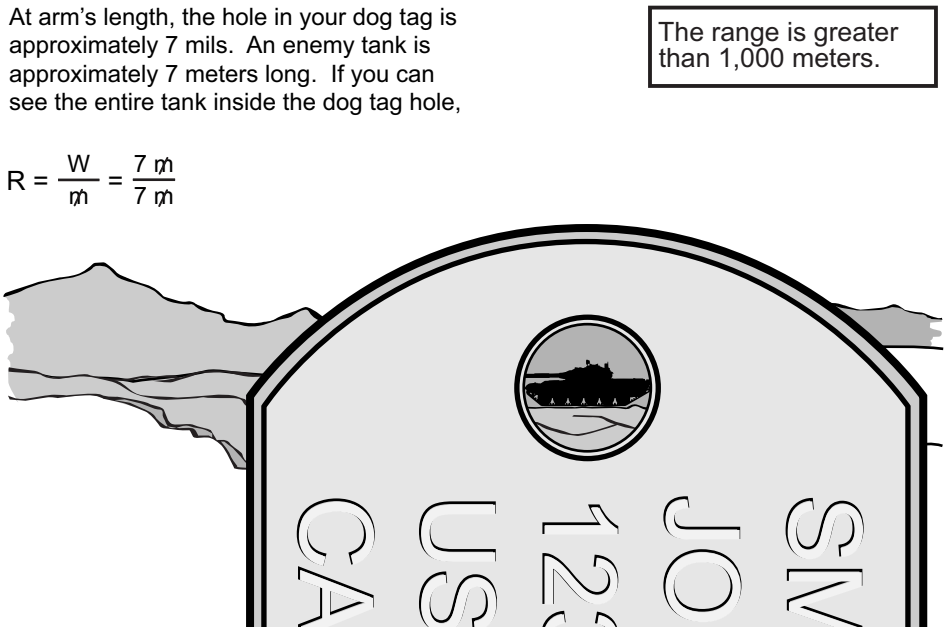



**Figure 2-5. Determining Range With Common Objects.**

***Common Laser Range Finder***. The CLRF provides the quickest, most accurate means of determining distance.

***Sound***. When determining distance by sound, two methods may be used: flash-to-bang and audible sounds.

*Flash-to-Bang*. To determine distance by using the flash-to-bang method for sound ranging, count the number of seconds between a round detonation (flash) and the sound of the impact (bang); multiply this time by the speed of sound (350 mps).

**Example: Formula to determine distance using the flash-to-bang method**

Flash-to-bang (seconds) x 350 = distance in meters.

By using the flash-to-bang distance to a round impacting in the battlespace, observers can associate this distance on the ground with a future target. For example, if the flash-to-bang distance is estimated at 4,000 meters and a target was seen between the observer and the previous point of impact used in the flash-to-bang method, the observer knows that the target must be closer than 4,000 meters. Similarly, the flash-to-bang method can be used to estimate the OT factor during adjustment.

This method can also be used to determine the distance to the muzzle flash of an enemy weapon. When combined with a good direction, observers can achieve accurate target location data.

*Audible Sounds*. There will be occasions when observers will not be able to see the flash of a weapon or a round detonation. To estimate distance in these situations, observers can use common, audible sounds. Table 2-1 provides frequently heard noises with estimated distances.

**Table 2-1. Audibility of Various Actions.**

| Maximum Distance (meters) | Sound |
|---|---|
| 100–200 | Human speech |
| 300 | Stakes being pounded into the ground by hand |
| 500 | Stakes being pounded into the ground mechanically |
| 500–1,000 | Trenches being dug (e.g., shovel striking rocks or iron) |
| 800 | Trees being cut or trees falling |
| 1,000–2,000 | Automatic gunfire |
| 3,000 | Single rifle shot |

***Distance Estimation***. Observers must estimate the distance if a more accurate method is not available. The degree of accuracy depends on several factors, including terrain relief, time available, and experience of the observer. Normally, the longer an observer remains stationary, the more accurate this method becomes. The following subparagraphs describe ways to determine distance by estimation.

*Mental Distance*. A mental distance estimate is made by using a known unit of measurement. Distance is estimated to the nearest 100 meters by determining the number of known units of measurement between the observer's position and a target. For example, a football field that is 100 yards long can be used as a known unit of measurement for determining the distance between an observer's position and a target, and it may be required to progressively estimate for longer distances. To use this distance estimation accurately, the observer determines the number of units of measurement to an intermediate point and doubles the value.

Conditions that make objects appear closer are as follows:

- Bright light.
- Clear air at high altitude.
- Background is in contrast with the color of the object.
- Observer is looking down from a height.
- Observer is looking over a depression, most of which is hidden.
- Observer is looking down a straight feature, such as a road.
- Observer is looking over water, snow, or a uniform surface, such as a cultivated field or desert.

Conditions that make objects appear more distant are as follows:

- Poor light or fog.
- Only a small part of the object can be seen.
- Background is similar in color to the object.

- Observer is looking over a depression, most of which is visible.
- Observer is kneeling or sitting, especially on a hot day, when the ground is moist.

*Good Visibility*. When visibility is good, distances can be estimated by using the appearance of tree trunks, their branches, and foliage as seen by the naked eye in comparison with map data. Tables 2-2 and 2-3 may be used as guides for wooded terrain and urban environments, respectively.

*Known Dimensions*. Distance can be estimated by using known dimensions of vehicles and the mil-relation formula: (W = R x *m*).

By using the width of a vehicle appearing perpendicular to an observer as the lateral distance (W) and measuring the width in mils (*m*), the distance can be determined by solving the formula for range in thousands (R), or (R = W) *m*. This data, when compared with map data, will assist an observer in estimating distances. The dimensions of selected equipment are provided in table 2-4.

**Table 2-2. Use of Trees and Foliage for Estimating Distance.**

| Distance (meters) | Tree Description |
|---|---|
| 1,000 | Trunk and main branches are visible<br>Foliage appears in a cluster-like shape<br>Daylight may be seen through the foliage |
| 2,000 | Trunk is visible<br>Main branches are distinguishable<br>Foliage appears as a smooth surface<br>Outlines of the foliage of separate trees are distinguishable |
| 3,000 | Lower half of trunk is visible<br>Branches blend with foliage<br>Foliage blends with adjoining trees |
| 4,000 | Trunk and branches blend with foliage and appear as a continuous cluster, smooth in appearance<br>Movement of foliage caused by wind cannot be detected |
| 5,000 plus | The entire area covered by trees appears smooth and dark |

**Table 2-3. Use of Various Objects for Estimating Distance.**

| Distance (meters) | Object Identified by the Unaided Eye |
|---|---|
| 1,000 | Lone tree trunk |
| 1,500 | Individuals and horsemen |
| 3,000 | Chimneys on rooftops |
| 4,000 | Windows in houses |
| 4,000–5,000 | Individual houses in a populated area |
| 8,000–9,000 | Villages and individual houses |
| 15,000–18,000 | Large houses, towers, and steeples |

**Table 2-4. Example of Estimating Distance by Using Known Dimensions.**

| Equipment | Dimensions (Meters) | |
|---|---|---|
| | Side View | Front View |
| Tank (T-80) chassis | 7.4 | 3.4 |
| Tank (T-62) chassis | 6.5 | 3.4 |
| Reconnaissance vehicle (BRDM-2) | 5.7 | 2.4 |
| Reconnaissance vehicle (BTR-60) | 7.5 | 2.8 |
| Armored personnel carrier (BMP) | 6.8 | 2.9 |
| Air defense weapon (ZSU-23-4) | 6.3 | 2.9 |

*Terrain Study*. The observer should always use a terrain/map analysis when estimating distances. When the observer is looking in a specific direction, the estimation of distance can be enhanced by studying the terrain to associate what is actually seen on the ground with what is seen on the map. The use of an observed fire (OF) fan helps the observer to associate map and compass direction, maintain orientation for direction, and refine distances. Particular emphasis should be given to color contrasts of terrain features seen along the OTL.

For example, the distance across successive ridgelines or depressions in the distance may only be identified by slight changes of color to the eye. Different colors of grass might reveal a hidden terrain feature, such as a stream.

**Example: How to estimate distance by using known dimensions**

An observer sees an armored personnel carrier (BMP) and measures its width as seen from a side view as 2 mils.

By using the following formula, the observer determines the distance:

R = W ÷ m where: m = 2 mils (measured by binoculars).

W = 6.8 meters (known dimension of side view).

R = 3,400 meters (6.8 ÷ 2 = 3.4).

### Elevation

The third element of target location is elevation. Elevation is the vertical distance of a level, a point, or an object considered to be a point, measured from mean sea level (MSL). The meter is the standard unit of measurement for elevation. There are three methods of measuring elevation:

- *Map spot*. If measured from a map spot, the elevation of a target is determined by use of contour lines and the contour interval of the map.

- *Vertical shift*. Elevation may be determined as a vertical shift in meters from the elevation of the observer or from a known point to the target. The vertical shift, presented as either up or down, uses the same principle of angular deviation in the mil-relation formula.
- *Vertical angle*. Laser polar missions specify the vertical angle in mils. This allows the FDC to incorporate the vertical shift with the associated distance for accurate target location.

**Example: Measuring elevation to determine a target location**

*Elevation 480, up 50, and vertical angle 3.*

## TOOLS TO ASSIST THE OBSERVER

The following tools are used by the observer in target location and terrain and map analysis: the M2 compass, binoculars, GPS, OF fan, terrain sketch, and visibility diagram.

### M2 Compass

The M2 compass is the most accurate compass for determining direction (+/- 10 mils). It is a multipurpose instrument used to obtain azimuth readings and vertical angles. The magnetic needle (i.e., the white end of the needle) shows magnetic north. The reading is taken from the black end when the bubble is centered in the circular level. The azimuth scale adjuster assembly rotates the azimuth scale to introduce the declination constant.

***Declinating the M2 Compass***. The steps for declinating the M2 compass from a surveyed declination station that is free from magnetic attractions are as follows:

**Step 1**. Set the M2 compass on a tripod over the orienting station and center the circular level.

**Step 2**. Sight on the known, surveyed azimuth marker.

**Step 3**. Use the azimuth adjuster scale and rotate the azimuth scale until it indicates the same as the known, surveyed azimuth.

**Step 4**. Recheck the sight picture and azimuth to the known point. Once the sight picture is correct and the azimuth reading is the same as the surveyed data, the M2 is declinated.

To establish a field-expedient declination of the M2 compass, use the azimuth adjuster to set off the grid-magnetic angle (this is shown on the bottom of all military maps). Once the grid-magnetic angle has been set off on the azimuth scale, the M2 compass is declinated.

***Note:*** Once declinated, the M2 compass measures grid azimuths.

***Measuring Azimuths***. The steps for measuring an azimuth are as follows:

**Step 1**. Hold the compass in both hands and at eye level. Brace arms against the body and the rear sight closest to your eyes to read the azimuth scale by reflection. Place the cover at an angle of approximately 45 degrees to the face of the compass so that the scale reflection can be viewed in the mirror (see figure 2-6).

**Step 2**. Level the instrument by viewing the circular level in the mirror.

**Step 3**. Sight on the desired object and read the azimuth indicated on the reflected azimuth scale by the south-seeking compass needle (the black end).

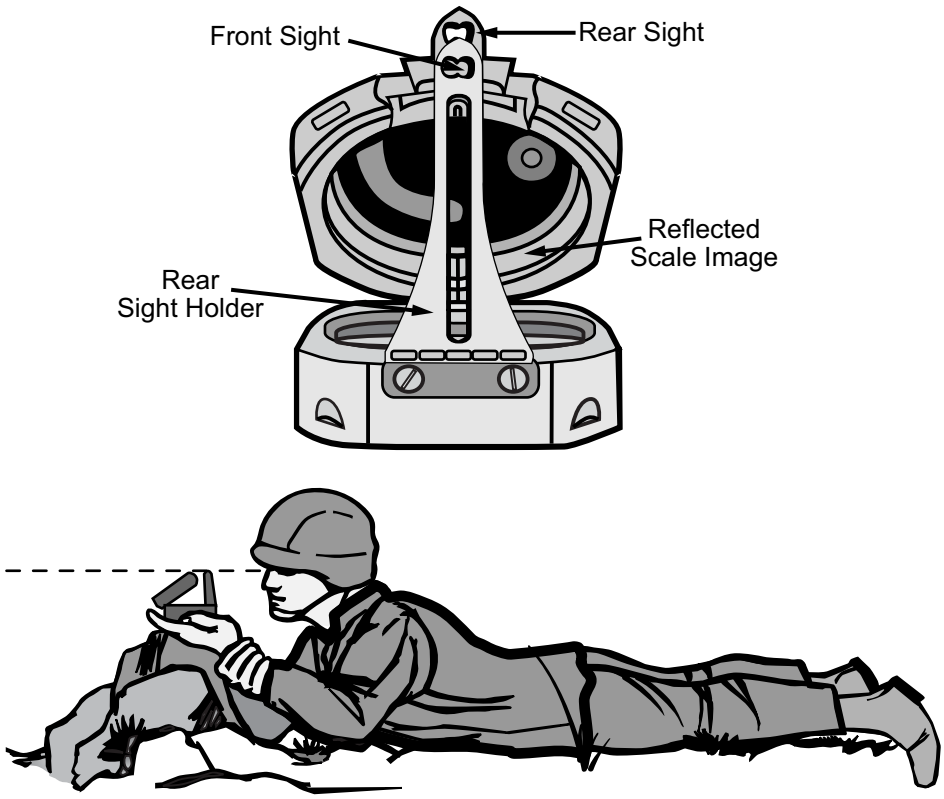



**Figure 2-6. Measuring an Azimuth With the M2 Compass.**

***Measuring Vertical Angles With the M2 Compass***. The steps to measure a vertical angle with the M2 compass are as follows:

**Step 1**. Hold the compass on edge with both hands and at eye level. Brace arms against the body and the rear sight closest to your eyes.

**Step 2**. Place the cover at approximately 45 degrees to the face of the compass so that the elevation scale reflection can be seen in the mirror (see figure 2-7).

**Step 3**. Sight on the target or crest. Center the elevation scale tubular level with the lever on the back of the compass by viewing the elevation scale in the mirror.

**Step 4**. Read the elevation in mils on the elevation scale, measure again, and record the average.

**WARNING**

**The M2 compass must be employed free of magnetic attractions. Below are the minimum distances that should be kept when using the compass to measure a direction:**

**High-tension power lines: 55 meters.**

**Artillery, trucks, or tanks: 10 meters.**

**Telegraph, telephone, or barbed wire: 10 meters.**

**Crew-served weapons: 2 meters.**

**Rifle or radio: 0.5 meters.**

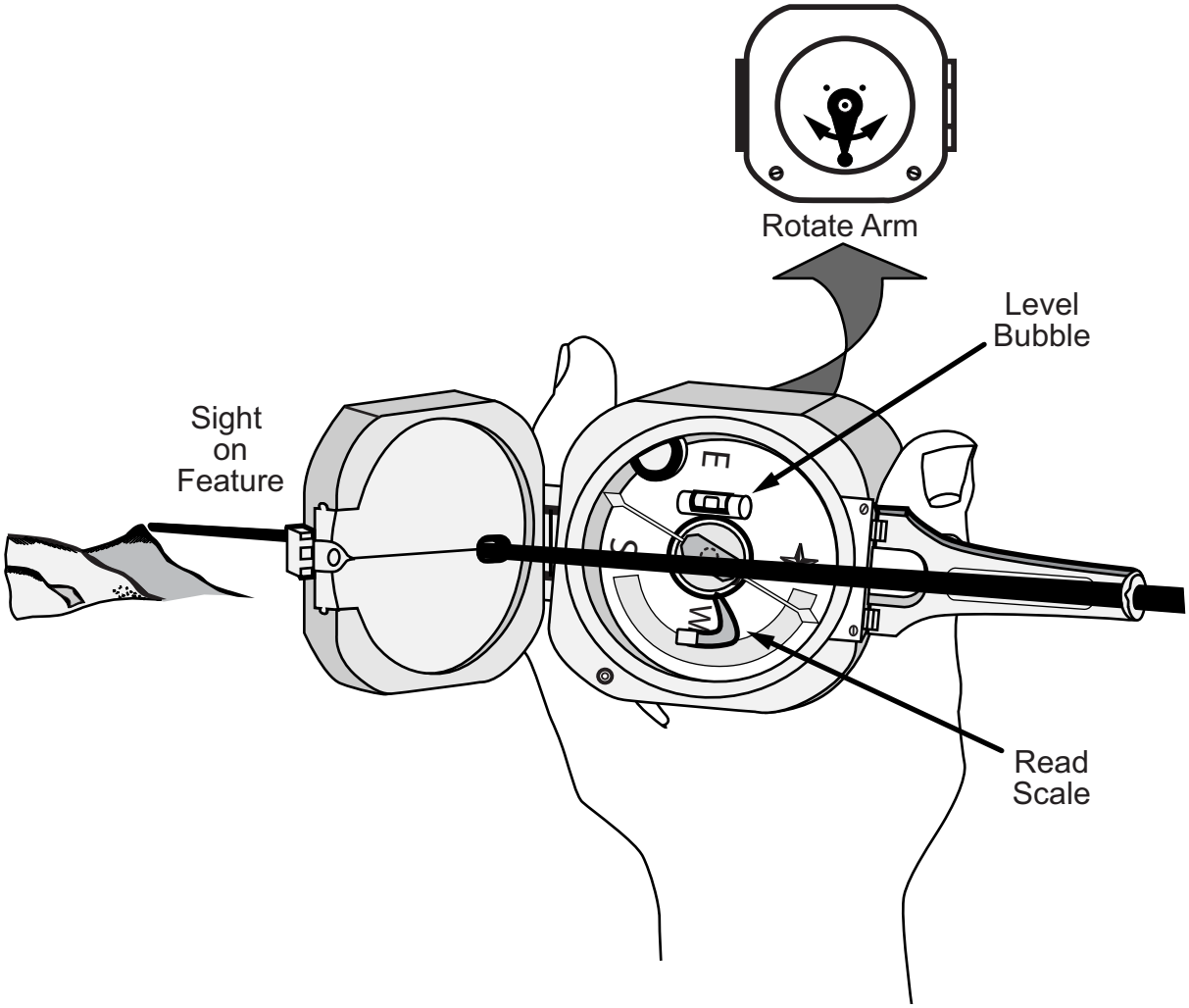



**Figure 2-7. Measuring the Vertical Angle.**

### Binoculars

In addition to measuring angular deviation, binoculars enable observers to focus on distant objects. When using binoculars, the following considerations apply:

- Binoculars must be held parallel to the deck and steadied against the body or other property.
- Observer should determine, memorize, and record the interpupillary and depth settings to allow for quick adjustment.
- Protective plastic lens cap on the binoculars can be removed to increase the field of vision for observers who wear glasses.
- Masking tape can be used on the metal retaining ring to prevent scratching the glasses.
- Diopter adjustment ring can be taped in the correct position so that the observer does not have to adjust the diopter setting at every use.

### Global Positioning System

The GPS is a space-based navigation system that provides worldwide, continuous, all-weather, three-dimensional (3D) position information. The GPS includes satellites and receivers. The current receiver is the AN/PSN-13 Defense Advanced Global Positioning System Receiver (DAGR). The DAGR can provide the observer with grid location and navigational information. To use the DAGR, the following should be observed and/or verified:

- *Cryptographic keys*. The proper cryptographic keys must be loaded into the DAGR to enable it to use the precise positioning system. The precise positioning system must be used to achieve the necessary accuracy and to avoid enemy electronic warfare measures. If the cryptographic variable is not loaded, DAGR is not as accurate.
- *Datum*. The map datum should be the same as the operational datum being used by all other maneuver, fire support, and target acquisition units. If the same datum is not used, significant position errors may occur.
- *Coordinates*. The military grid reference system (MGRS) format is preferred because it is the standard used by survey systems and most fire control systems.
- *Elevation*. Mean sea level is the preferred elevation because most military maps use it as the basis for the elevation scale.
- *Units of measurement*. Meters are the preferred selection for units of measurement because most military maps refer to distance and elevation in meters.
- *Almanac data*. Almanac data must be one day old. If almanac data is not one day old, satellite vehicle or timing errors not noted by the DAGR are a probability.
- *Figure of merit*. The figure of merit (FOM) is an accuracy estimation of the data displayed by the DAGR. The FOM ranges from one through nine. Figure of merit level one (called FOM one) is the best accuracy estimation displayed by the system, and FOM nine is the least accurate. For observer positioning, only coordinates determined with FOM one will be considered to be accurate.
- *Mode of operation*. The DAGR offers three choices as modes of operation—fixed, continuous, and averaging. The averaging mode yields the most accurate data and is preferred when determining a position for indirect-fire weapons employment.

- *Position*. Position verification to check for gross errors should always be performed by separate means. The DAGR does not relieve observers of their land navigation responsibilities. Observers must be able to establish their own location and that of targets without the aid of GPS for the following reasons:
  - GPS receivers rely on electronic line of sight with satellites. The DAGR must be able to acquire at least four satellites so that a 3D position can be determined. Dense foliage, buildings, mountains, and canyons will mask the GPS signal and cause the receiver to fail.
  - Multi-path distortion or reflected signals may occur if the receiver's antenna is tilted away from a satellite. This causes a reflected signal to be received that has more power than the direct signal. Coordinates determined under these conditions may be inaccurate by as much as several hundred meters.
  - Electronic warfare can jam GPS signals.

**WARNING**

**Azimuth determined with the DAGR is for navigation only. The DAGR azimuth is not accurate enough for use when establishing directional control and should never be used for orienting observation devices. Tests show that a DAGR-determined azimuth may be in error by as much as 200 mils.**

**For more information, refer to Technical Manual 11-5820-1172-13&P, *Operator and Maintenance Manual Defense Advanced GPS Receiver (DAGR) Satellite Signals Navigation Set.***

### Observed Fire Fan

The OF fan is a transparent overlay that can be used to refine distance on the map (see figure 2-8). The OF fan—

- Is not used to determine direction.
- Is used to assist the observer to identify on the map what is seen on the ground.
- Is available in the supply system as Graphic Training Aid 6-7-3, *Observed Fire Fan*.

> ***Note:*** The OF fan has 17 radial lines that are 100 mils apart and cover a total area of 1600 mils. The radial lines represent OT direction. The OT distance is represented by arcs marked on the fan every 500 meters and labeled every 1,000 meters, beginning at 1,000 meters and extending to 6,500 meters.

***Orienting the Observed Fire Fan on the Map***. To prepare the OF fan, perform the following steps:

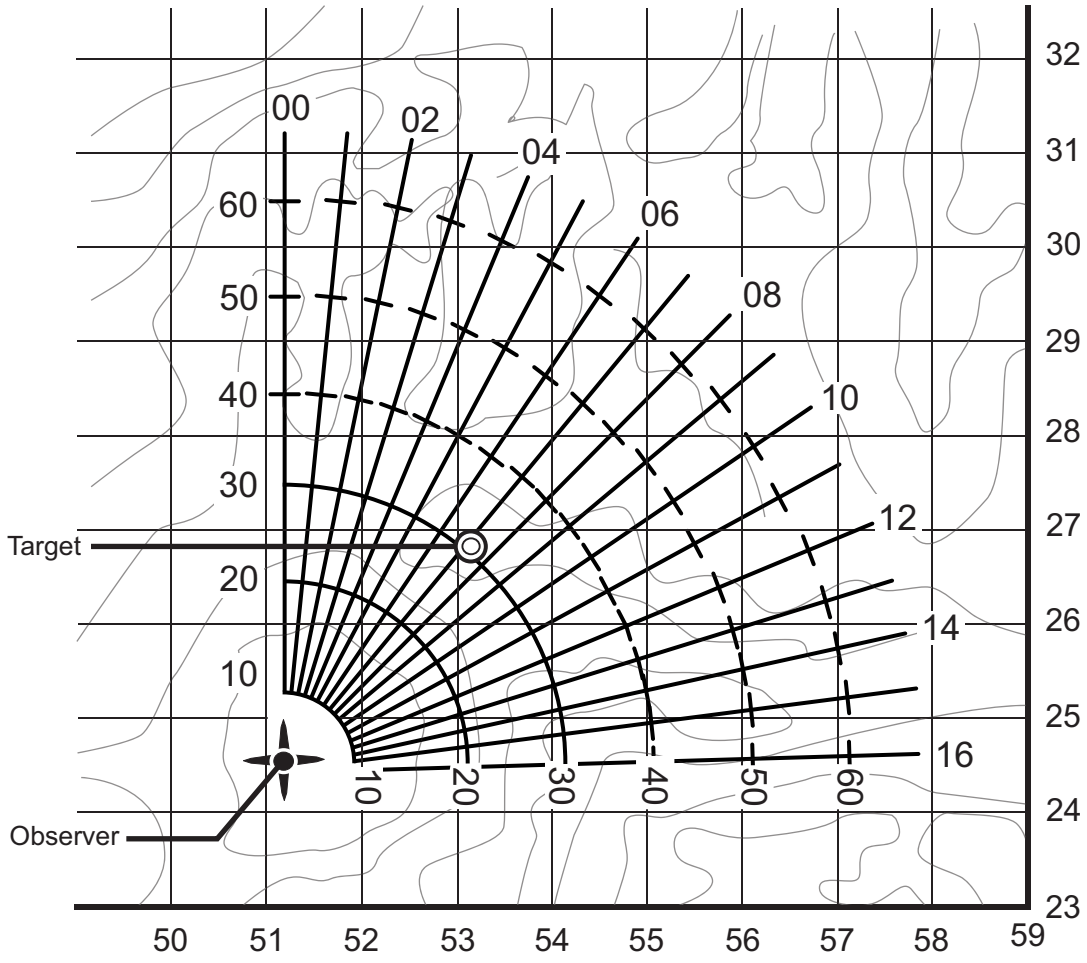
**Step 1**. Place the vertex of the OF fan over the observer's location.

**Step 2**. Place the center radial line in the direction of the center of the observer's sector of observation.

**Step 3**. Move the fan slightly until one of the radial lines is parallel to a grid line. The direction of that radial line is the same as that of the grid line. For example, a radial line parallel to a north-south grid line, with the OF fan oriented generally north, would be direction 6400 or 0.

**Step 4**. Attach the OF fan in position on the map by using a piece of tape along one edge of the fan. Now the OF fan can be lifted when required without disturbing its orientation.

**Step 5**. Number the radial line of known direction with a marker pen or grease pencil, dropping the last two zeros (e.g., 6400 would be 64). Then label every second radial line with the appropriate direction. Radial lines are 100 mils apart. Direction increases to the right and decreases to the left.




NOTE:
The target is approximately 3,200 meters from the observer in a direction of 0650 mils. The grid location is approximately 531 269.

**Figure 2-8. Target Location Using the Observed Fire Fan.**

***Using the Observed Fire Fan***. To determine target location, perform the following steps:

**Step 1**. Determine direction and distance by using a method previously discussed.

**Step 2**. Plot the data on the OF fan by finding a radial line corresponding to the OT direction. Visual interpolation is required if the direction plots between two radial lines. Follow the radial line or interpolated radial line until the estimated distance is scaled off.

**Step 3**. Compare the terrain near the target with the terrain of the estimated point on the map. If the terrain matches, the target location is accurate. If terrain does not match, search along the radial line until the terrain matched (see figure 2-8).

### Terrain Sketch

The terrain sketch is a rough panoramic drawing of the area of observation (see figure 2-9). It is used as a rapid means for the observer to record and/or identify predetermined directions to reference points. A properly constructed terrain sketch aids the observer in conducting an organized study of the terrain and provides a rapid means of orienting relief personnel. The terrain sketch should include the following:

- Skyline and/or horizon.
- Objects or features that are prominent, such as draws, hill masses, streams, wood lines, ridgelines, roads, buildings, battlespace debris, or other readily identifiable man-made items or features.
- Directions and distances to the prominent objects or features and labeling of reference and known points. If time permits, elevations and grid locations should also be recorded for these features.
- Name, date, and OP grid location should be placed in the lower right-hand corner of the terrain sketch with a north-seeking arrow prominently displayed for quick orientation.

### Visibility Diagram

To locate targets and report battlespace information effectively, the observer must be able to see within the area of observation. Because of terrain features, certain areas will not be visible from the observer's location. A visibility diagram is a sketch of the area of observation that is drawn to scale by the observer (see figure 2-10). It shows those portions of the terrain that cannot be observed from a given OP and will pinpoint those areas that cannot be seen by the observer.

***Constructing the Visibility Diagram***. The construction of the visibility diagram requires a detailed study of the terrain. Observers should construct visibility diagrams as soon as possible, but in a fast-moving operation this may not be feasible. In this case, observers will need to locate any areas that cannot be observed. Possible alternatives would be to use a verbal report that provides azimuths and distances to screening obstacles or to provide a grid location and radius of an area that cannot be observed. Appendix B provides the steps that are involved when constructing a visibility diagram.

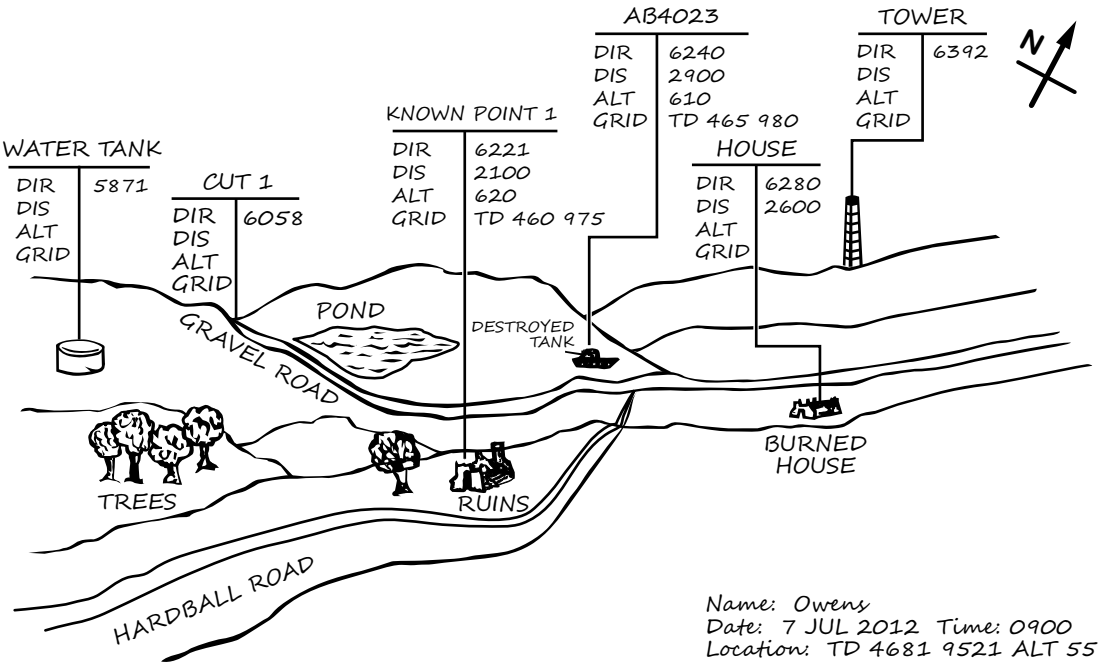



**Figure 2-9. Terrain Sketch.**

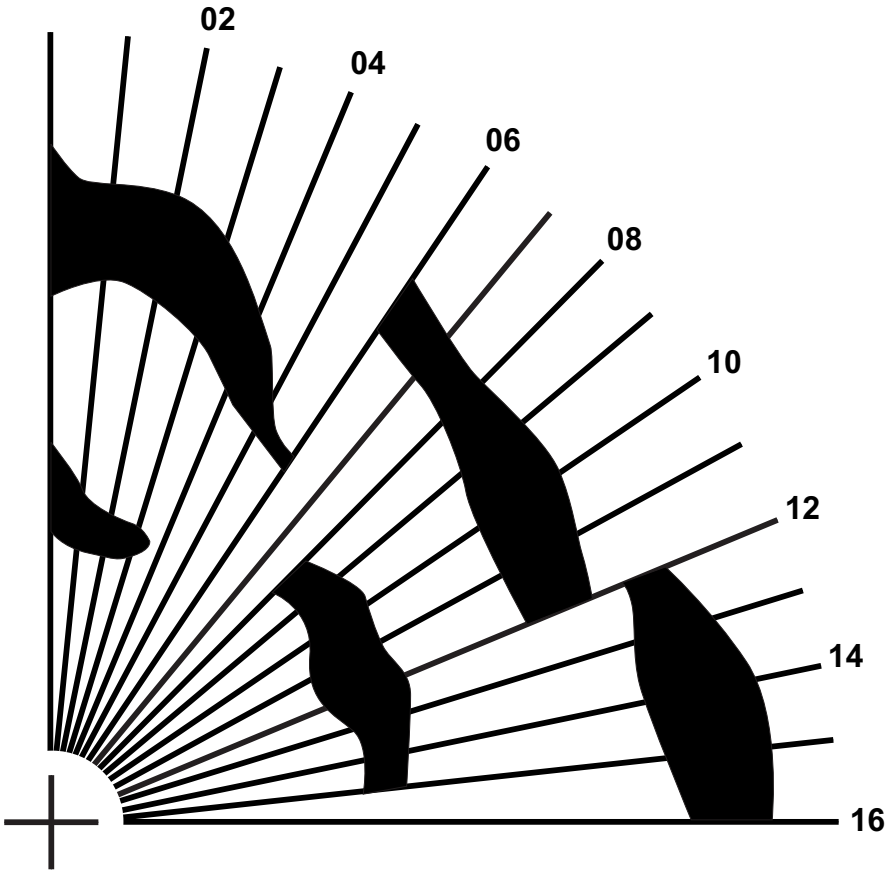



**Figure 2-10. Visibility Diagram.**

***Using the Visibility Diagram***. The most important use of the visibility diagram is that it helps to coordinate the complete visual coverage of the battlespace. Ideally, the visibility diagram is reviewed by the company commander and dispatched through the FSCC to the intelligence section. The visibility diagram is used to—

- Evaluate target area coverage to minimize and/or cover any gaps.
- Determine the best locations and orientations for other target acquisition resources.
- Reduce errors in reporting target locations.
- Aid in defensive fire planning and provide the company commander with a battlespace perspective for employment of organic weapons systems to cover dead space and identify concealed avenues of approach.

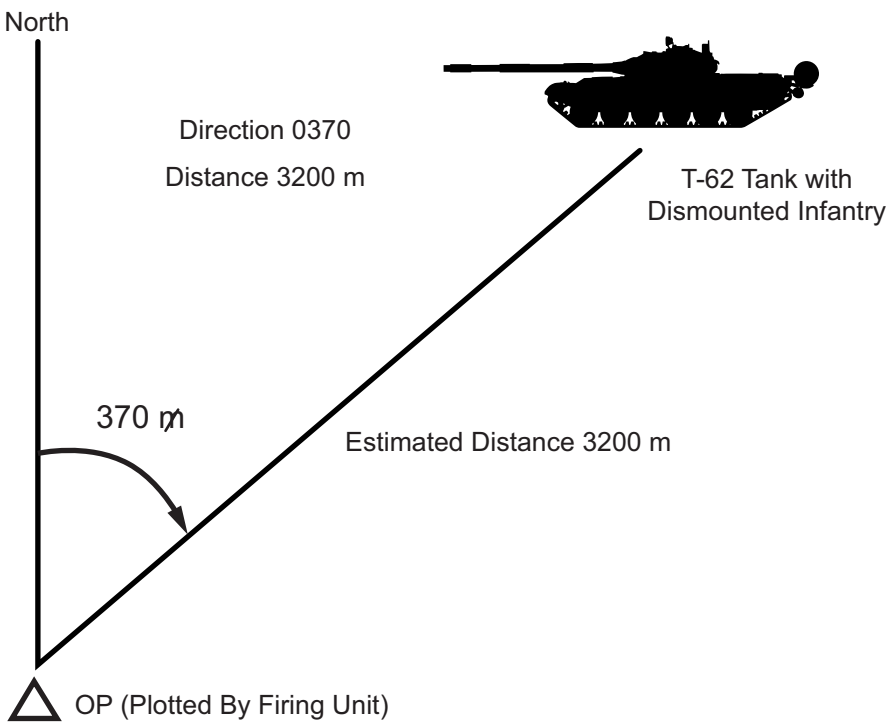
## METHODS OF TARGET LOCATION

Terrain/map analysis is essential when determining target location. The results of this analysis (i.e., direction, distance, and altitude) provide the basic data for determining a target's location. Observers select a method of target location based upon whether their position is known by the firing unit, the availability of known reference points in the battlespace, and tools that are available for target location. The methods of target location are polar plot, grid coordinates, and shift from a known point. Observers, using any of these methods, must locate targets within 200 meters of the actual target location.

> ***Note:*** Regardless of the method of target location, map datum information is a prerequisite to accuracy. The observers and the firing unit must be operating within the same ellipsoid, datum (e.g., World Geodetic System 1984, which is maintained by the National Geospatial-Intelligence Agency), and MGRS grid zone. This can be determined from the marginal information that is located on the observer's map before conducting a mission.

### Polar Plot

When using the polar plot method, the observer describes the target location in relation to the observer's own position. This method is fast and can be performed without a map, though CLRFs greatly enhance the accuracy of the polar plot.




NOTE:
The FO has determined that there is no obvious altitude difference.

**Figure 2-11. Polar Plot Method of Target Location.**

The primary disadvantage of this method is that the observer's position must be known by the firing unit (i.e., battery, mortar platoon, or ship). This may require transmission of the observer's location and elevation before sending the call for fire (see figure 2-11).

The steps to determine polar plot data are as follows:

**Step 1**. Determine the OT direction to the nearest 10 mils. Laser data will be determined to the nearest mil.

**Step 2**. Determine or estimate the distance to the target to the nearest 100 meters. Laser data will be determined to the nearest 10 meters.

**Step 3**. Determine the vertical difference between the observer and the target. The vertical difference will be transmitted in the call for fire as an *up* or *down* shift from the elevation of the observer to the elevation of the target if the shift is 35 meters or more. Any vertical shift that is determined will be transmitted to the nearest 5 meters or 20 feet. The vertical shift increases the accuracy of the target location and should always be given if possible.

***Note:*** When employing an instrument that provides greater accuracy than the minimum requirements, it is acceptable to determine and transmit the more accurate data.

Laser polar missions provide the quickest, most accurate means of target location. The preferred mission type for laser polar missions is fire for effect. If an observer's tactical situation precludes a fire for effect mission, a one-round adjustment is adequate prior to entering the fire for effect phase. In addition to the laser polar missions providing a more accurate target location, the subsequent corrections are also processed differently from regular missions. Target location is determined by the FDC using vertical angle to the nearest mil and incorporating distance as the slant range. Laser polar data determines direction to the nearest mil, distance to the nearest 10 meters, and vertical angle (versus shift) to the nearest +/- 1 mil.

### Grid Coordinates

Observers can locate a target by using the grid system of the military map. If an observer has conducted a thorough terrain/map study, the grid coordinate method of target location is recommended. There is no requirement for an observer's position to be known by the firing unit. Observers can locate targets to an accuracy of 100 meters using a 6-digit grid. When additional accuracy is required (e.g., known points), observers should locate targets to the nearest 10 meters with an 8-digit grid. Always include the 100km grid zone identifier in front of the grid. The steps to determine grid coordinates are as follows:

**Step 1**. Determine the OT direction to the nearest 10 mils.

**Step 2**. Determine or estimate the distance to the target to the nearest 100 meters. Laser data will be determined to the nearest 10 meters.

**Step 3**. Plot direction and distance on a map or imagery and use terrain association to determine the grid coordinates.

**Step 4**. Add grid zone identifier to the front of the grid.

***Artillery and Mortars***. The grid method of target location for artillery and mortars is transmitted in the call for fire as grid, followed by the coordinates. The OT direction can be transmitted after the call for fire has been sent, ideally when reading back the message-to-observer (MTO). Nevertheless, it must be transmitted before or with the first adjustment.

**Examples: Grid method of target location**

*Grid 452 677.*

*Grid 452 677, elevation 65, direction 0830.*

*Grid 452 677, elevation 65, direction GTL.*

***Naval Surface Fire Support***. The grid method of target location for NSFS is transmitted in the call for fire as *grid*, followed by the coordinates, and altitude, expressed as *elevation*, followed by the altitude of the target measured from sea level to the nearest 5 meters or 20 feet. Direction is also transmitted in the target location element if the method of control is spotter adjust.

### Shift From a Known Point

In shift from a known point, the observer locates the target in relation to a known point. Target location by shifting from a known point offers several advantages—it is accurate, it does not require the use of a map, and the observer's location is not required to be known by the firing unit. However, the firing unit must know the location and altitude of the known point. The known point may be a terrain reference point that was previously reported or a target that was previously fired on and recorded. For NSFS, it may also be a radar beacon position. The steps to locate a target by shift from a known point are as follows:

**Step 1**. Identify the known point to be used:

- *Artillery and mortars*. The known point is transmitted in the warning order element of the call for fire by using the words *shift known point (or target number)* _____.
- *NSFS*. The known point is transmitted in the target location element of the call for fire by using the words *from reference point (or target number)* _____.

**Step 2**. Determine the OT direction to the nearest 10 mils.

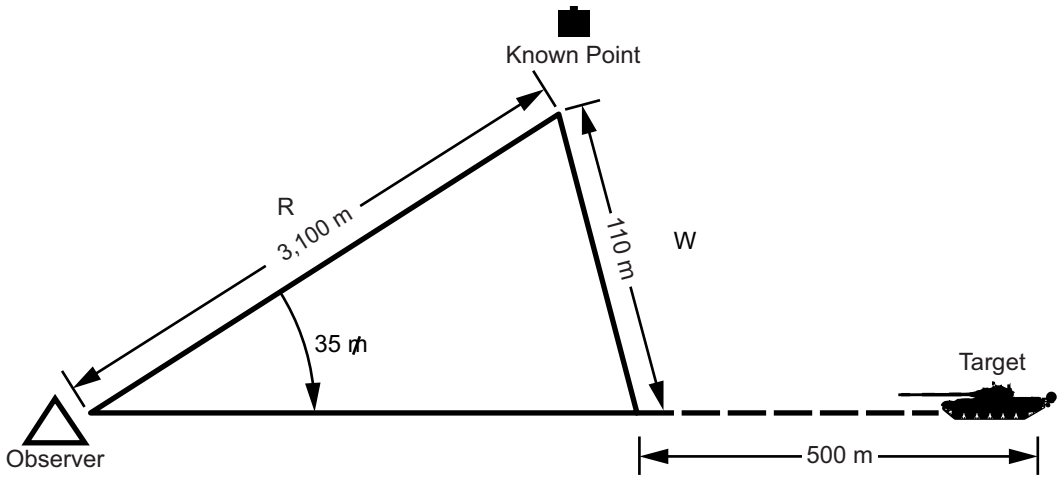
**Step 3**. Determine the lateral shift between the known point and the target to the nearest 10 meters. This is a two-step process:

- First, the observer determines the angular deviation (in mils) between the known point and the target.
- Next, by using the mil-relation formula (width = range x mils), the observer multiplies the angular deviation (**m**) by the range to the known point (R) to the nearest 100 meters expressed in thousands (called the shift factor) to determine the lateral shift (W) in meters (see figure 2-12). The lateral shift will be transmitted in the call for fire as a *left* or *right* in meters. The shift factor is used to determine only the initial lateral shift. The OT factor is used for all subsequent corrections.

**Example: Lateral shift**

*Right 110.*

***Note:*** If the angular deviation is greater than 600 mils, using the shift from a known point method of target location should be avoided because the mil-relation formula becomes inaccurate at angular deviations greater than 600 mils.




**Formula:** W = R x mils

| **Where:** | **Example:** |
|---|---|
| R = Observer-known point distance expressed in thousands to the nearest hundred meters | 3,100 = 3.1 |
| mils = Angular deviation in mils to the nearest mil | 35 |
| W = Lateral shift to nearest 10 meters | 3.1 x 35 = 108.5 (Right 110) |

**Figure 2-12. Mil-Relation Formula in Shift From a Known Point.**

**Step 4**. Determine the range shift in meters between the known point and the target to the nearest 100 meters. The range shift will be transmitted in the call for fire as an *add* if the target is farther away from the observer than the known point or as a *drop* if the target is closer. Meters are understood and do not need to be specified.

**Example: Range shift**

*Add 500.*

**Step 5**. Determine the vertical difference between the known point and the target. The vertical shift will be transmitted in the call for fire as an *up* or *down* shift from the elevation of the known point to the elevation of the target. Only vertical shifts of 35 meters or greater will be transmitted. In addition, any vertical shift that is transmitted will be expressed to the nearest 5 meters or 20 feet, if possible.

**Example: Vertical shift**

*Up 35.*

## MOBILE OPERATION TARGET LOCATION

Observers with motorized or mechanized units (e.g., mounted in trucks, amphibious assault vehicles) must be proficient in map reading and terrain association.

### Preparations

An observer's success depends upon preparations that are made before an operation begins, including the following:

- Becoming acquainted with the vehicle, crew chief, SOP, communications suite, position assigned, and positions of other team members.
- Ensuring that the assigned position will allow observation, communication, and coordination with other supporting arms representatives.
- Ensuring that the required equipment and information (e.g., maps, targets, radios, frequencies) are placed in an accessible location for quick reference.
- Studying the map to provide a mental picture of the operation (e.g., prominent landmarks). Points and features along the planned route should be identified to assist in determining orientation.

### Considerations

Observers must consider certain factors when conducting target location during mobile operations. The most important factors include direction, selection method of target location, and actions to be taken in the event of disorientation.

***Direction***. Because observers move, it is necessary to change OT direction frequently. Another factor to consider is the magnetic effect of vehicles on the compass. Observers need to move a minimum of 10 meters away from vehicles to avoid interference or use another method of determining direction (e.g., scaling from a map, estimating, using the GTL).

***Selection Method of Target Location***. The grid method is the fastest and most accurate method for mobile operations if observers have prepared a detailed terrain/map analysis. Observers can call for fire on planned targets or use these targets to shift to a target of opportunity. The accuracy of the shift depends upon the accuracy of the OT direction. The polar plot method is of limited use in mobile operations unless observers have short, static periods and constantly update their position. Polar plotting is feasible if GPS is used in these situations.

***Actions to be Taken if Observers Become Disoriented***. As a result of the tactical situation, observers may have difficulty maintaining adequate observation and orientation. This may make it difficult to self-locate or identify the target's location. In these situations, observers can call for fire on a planned target and shift from the burst location. If completely disoriented, observers can call for *mark center of sector*. If there is any doubt about the safety of the firing, a high air burst (e.g., 200 meters) with shell high explosive (HE) or white phosphorous (WP) can be used.

> ***Note:*** The tactical soundness of the high air burst must be considered. Knowledge of the tactical situation and disposition of friendly forces by the firing unit will prevent a fratricide.

# CHAPTER 3
# ARTILLERY AND MORTAR CALL FOR FIRE

The call for fire is a request for fire containing data necessary for obtaining the required fire on a target. It is a concise message prepared by an observer and transmitted as a request, not an order. It contains the information needed by the FDC to determine the method of target attack. The call for fire is sent quickly, but clearly enough to be understood, recorded, and read back without error by the FDC recorder. In the C-FST, the initial elements of the call for fire should be transmitted by the radio operator while the observer determines the remaining data (e.g., target location). The radio operator completes the call for fire as data becomes available. In artillery and mortars, direction is not included in the initial call for fire when the grid method of target location is used. When conducting a grid mission, the observer transmits the direction when reading back the MTO or with the first subsequent correction in adjustment.

The components of the call for fire and the number of transmissions required to communicate them depends on mission type: adjust fire, fire for effect, or suppressive fire.

## ADJUST FIRE AND FIRE FOR EFFECT CALL FOR FIRE

Regardless of the method of target location, the call for fire is transmitted in three parts, consisting of six elements with a break, and read back after each transmission:

- Transmission one:
  - Observer identification.
  - Warning order.
- Transmission two:
  - Target location.
- Transmission three:
  - Target description.
  - Method of engagement.
  - Method of fire and control.

### Observer Identification

The first element of the call for fire identifies to the FDC/FSCC who is calling for fire. The observer uses a call sign and a suffix. Once given, call signs are omitted from subsequent transmissions during the mission unless there is a chance of confusion (e.g., when missions are being conducted simultaneously by other observers).

### Warning Order

The second element, the warning order, is a preliminary notice of an action that is to follow. (*DOD Dictionary of Military and Associated Terms, hereafter referred to as DOD Dictionary*) The warning order consists of the type of mission, the size of the element to fire for effect, and the identification of the method of target location, described in the following subparagraphs.

***Type of Mission***. When the observer decides that an adjustment is needed because of a questionable target location or lack of registration corrections, the observer announces *adjust fire* in the warning order.

When the observer has an accurate target location and is certain that the first volley will have an effect on the target, the observer announces *fire for effect* in the warning order. The accuracy required to fire for effect depends on the target and the ammunition being used. The observer should strive for first-round fire for effect.

***Size of Element to Fire for Effect***. The observer may request the size of the unit to fire for effect (e.g., a battalion). Normally, this request is performed by announcing the last letter in the battalion FDC's call sign. For example, T6H24 will be announced H. The observer should never refer to a unit in the clear. If the observer does not specify a size of element to fire for effect, the FDC will make the decision based on the attack guidance received and the *Joint Munitions Effectiveness Manual* solution. Mortars may be employed by platoon or section, which must be specified.

***Identification of the Method of Target Location***. The observer identifies, in the warning order, the method that will be used to locate the target. The method of target location may be polar, grid, or shift from a known point:

- *Polar or shift method*. Observer announces *polar* or *shift* and the known point identified.
- *Laser polar plot*. Observer announces *laser polar.*
- *Grid method*. No requirement to announce *grid* in the warning order.

**Examples: Warning orders**

Situation 1: Grid

Observer: *R2S this is W2P31, adjust fire, over.*

FDC: *P31 this is R2S, adjust fire, out.*

Situation 2: Polar Plot

Observer: *R2S this is W2P31, adjust fire, polar, over.*

FDC: Reads back.

**Examples: Warning orders (Continued)**

Situation 3: Shift From a Known Point

Observer: *R2S this is W2P31, fire for effect, shift from AB 1037, over.*

FDC: Reads back.

***Note:*** The observer used the fire for effect type of mission in situation 3, because there was a good target location.

### Target Location

The second transmission of the call for fire contains the third element, which is target location. The observer provides the FDC with the target location data that was determined by using either the grid, polar, or shift method. The firing unit uses this data to determine firing data (see figure 3-2). The observer transmits the target location data as described below:

- *Grid*. The observer announces the word *grid* followed by the coordinates of the target.
- *Polar*. The observer announces the word *direction* followed by the azimuth to the target (to the nearest 10 mils); the distance from the observer to the target in meters (to the nearest 100 meters); and, when 35 meters or greater, an up or down vertical shift (to the nearest 5 meters).

  ***Note:*** When conducting a laser polar plot, the observer announces the word *direction* to the nearest one mil, *distance* to the nearest 10 meters, and the vertical angle (*up* or *down*) to the nearest 1 mil.

- *Shift from a known point*. The observer announces the word *direction*, followed by—
  - OT direction (to the nearest 10 mils).
  - Lateral shift, if any, transmitted as *left* or *right* (to the nearest 10 meters).
  - Range shift, if any, transmitted as *add* or *drop* (to the nearest 100 meters); and, if applicable, *up* or *down* vertical shift (to the nearest 5 meters, but never less than 35 meters).

**Examples: Target location**

Situation 1: Grid Method of Target Location

Observer: *Grid 347 689, over.*

FDC: *Grid 347 689, out.*

Situation 2: Polar Plot Method of Target Location

Observer: *Direction 1680; distance 3,500; down 35, over.*

FDC: Reads back.

Situation 3: Shift From a Known Point Method of Target Location

Observer: *Direction 0680, right 250, add 200, over.*

FDC: Reads back.

### Target Description

In the fourth element, target description, the observer describes the target by size, type, and degree of protection to enable the FDC to determine the amount and type of ammunition to be used. The observer's description should be brief, accurate, and contain the following:

- Number of elements in the target (e.g., squad, three trucks).
- Type of target (e.g., troops, supply dump, trucks).
- Target's action (e.g., digging in).
- Degree of protection (e.g., in the open, in fighting holes, in bunkers with overhead protection).
- Target's size and shape, if significant (e.g., length, width, attitude, radius):
  - *Rectangular targets*. Defined as greater than 200 meters in length and width and are described by length, width, and attitude (i.e., the azimuth of the long axis [0000–3200] of the target in relation to grid north, to the nearest 100 mils).

**Example: Rectangular target**

*Length 400, width 250, attitude 2800.*

- *Circular targets*. Irregular-shaped targets with a radius greater than 100 meters. They are described by using the radius of the target area.

**Example: Circular target**

*Radius 200.*

- *Linear targets*. Targets greater than 200 meters long but less than 600 meters long. They are described by length and attitude.

**Example: Linear target**

*Length 400, attitude 1300.*

- *Irregular-shaped targets*. Described by using the location of the target center, length, and attitude. Sufficient detail should be provided to enable the FDC to determine the appropriate method of attack. An irregular-shaped target can also be described by transmitting multiple grids to paint a picture for the FDC of the target to be engaged.

**Example: Irregular-shaped target**

*Grid 245 876, length 400, attitude 0700.*

### Method of Engagement

In the fifth element, method of engagement, the observer describes the attack of the target. The sub-elements of the method of engagement include the type of adjustment, danger close, mark, trajectory, ammunition, volume of fire, and distribution. Some of the sub-elements are standard and will be provided automatically unless the observer specifies otherwise; for example—

- Type of adjustment is area fire.
- Trajectory is low angle for artillery and high angle for mortars.
- Ammunition is shell high explosive/fuze quick (HE/Q).
- Distribution is a circular sheaf for artillery and parallel sheaf for mortars.

When required, nonstandard sub-elements must be addressed in the call for fire. For example, danger close for artillery fires is addressed if the target is within 600 meters of a friendly position. The following subparagraphs identify the sub-elements of the method of engagement and their sequence of transmission.

***Type of Adjustment***. Two types of adjustment are employed as either precision or area fire. Unless precision fire is specified, area fire will be used:

- *Precision fire*. Conducted with one weapon on a point target. It is used either to obtain registration corrections or to destroy a target. When the mission is a registration, it is initiated by the FDC with an MTO. If the target is to be destroyed, the observer announces *destruction*.
- *Area fire*. Used to attack an area target. Because many area targets are mobile, the adjustment should be made as rapidly and as accurately as possible to keep the target from escaping. A well-defined point should be selected at or near the center of the area to be attacked and used as an adjusting point. To achieve surprise, fire should be adjusted on an auxiliary adjusting point. After adjustment is completed, the fire for effect is shifted to the target. Typically, adjustment on an area target is conducted with one adjusting weapon.

***Danger Close***. "Danger close" is included in the method of engagement where the predicted impact of a round or shell is within 600 meters of friendly troops for mortars and artillery. When alerted that the target is danger close, the FDC will employ an added precaution in the delivery of fires. The observer will use the creeping fire method of adjustment. Omission of this sub-element indicates that the target is separated from a friendly position by at least 600 meters. Maintaining the minimum safe distance provides a 99-percent assurance that a casualty-producing hit will not occur on friendly troops. Once announced, danger close remains in effect until canceled.

***Mark***. The term "mark" is included in the method of engagement to indicate that the observer is going to call for rounds either to self-orient in the zone of observation or to indicate targets to ground troops, aircraft, or other observers. This term is only included in the method of engagement when needed.

**Example: Mark**

*Mark center of sector.*

***Trajectory***. There are two types of trajectory: low-angle fire and high-angle fire.

- For artillery, low-angle fire is standard and need not be specified. If high-angle fire is desired, it must be specified.
- For mortars, high-angle fire is standard and need not be specified. For more information on high-angle fire, see chapter 6.

**Example: Trajectory**

*High angle.*

***Ammunition***. Several types of ammunition are available to the observer. The standard ammunition for the request is HE/Q; however, the fire direction officer (FDO), based on ammunition availability and the target description, determines the ammunition/fuze combination to be fired and announces this in the MTO. The term "in effect" indicates that the projectile/fuze specified is desired during fire for effect. Nonstandard types of ammunition are specified in the call for fire. The observer must specify either a projectile or a fuze.

**Example: Ammunition**

When requesting HE and fuze variable time (VT) the observer announces *VT in effect.* Because it is the standard, *HE* is not announced.

Illumination, improved conventional munitions (ICMs), and M825 (smoke) can only be fuzed with fuze time. Therefore, when firing these projectiles, fuze time is understood and need not be specified. See appendix D for additional information regarding projectiles and fuzes.

***Volume of Fire***. The observer may request the number of rounds to be fired in adjustment and then in effect. For example, requesting three rounds in effect results in 18 rounds fired by a 6-howitzer battery. If not requested, the volume of fire is determined by the FDO and announced in the MTO.

**Example: Requesting volume of fire**

In adjustment: *2 rounds in adjust.* (Firing unit fires two rounds).

During fire for effect: *3 rounds in effect*. (Firing unit fires three volleys).

***Distribution***. In artillery, the observer may control the pattern of bursts in the target area. This pattern of bursts is called a sheaf. The sheaf denotes the lateral distribution of bursts of two or more pieces fired together. Special sheafs of any length and width may be requested. When target length and width are given, attitude must also be provided. When target length is equal to or greater than five times the target width, the Advanced Field Artillery Tactical Data System (AFATDS) assumes a linear target. Figure 3-1 depicts the various sheafs. In mortars, the mortar ballistic computer assumes that the target is linear and fires a parallel sheaf unless a special sheaf is requested.

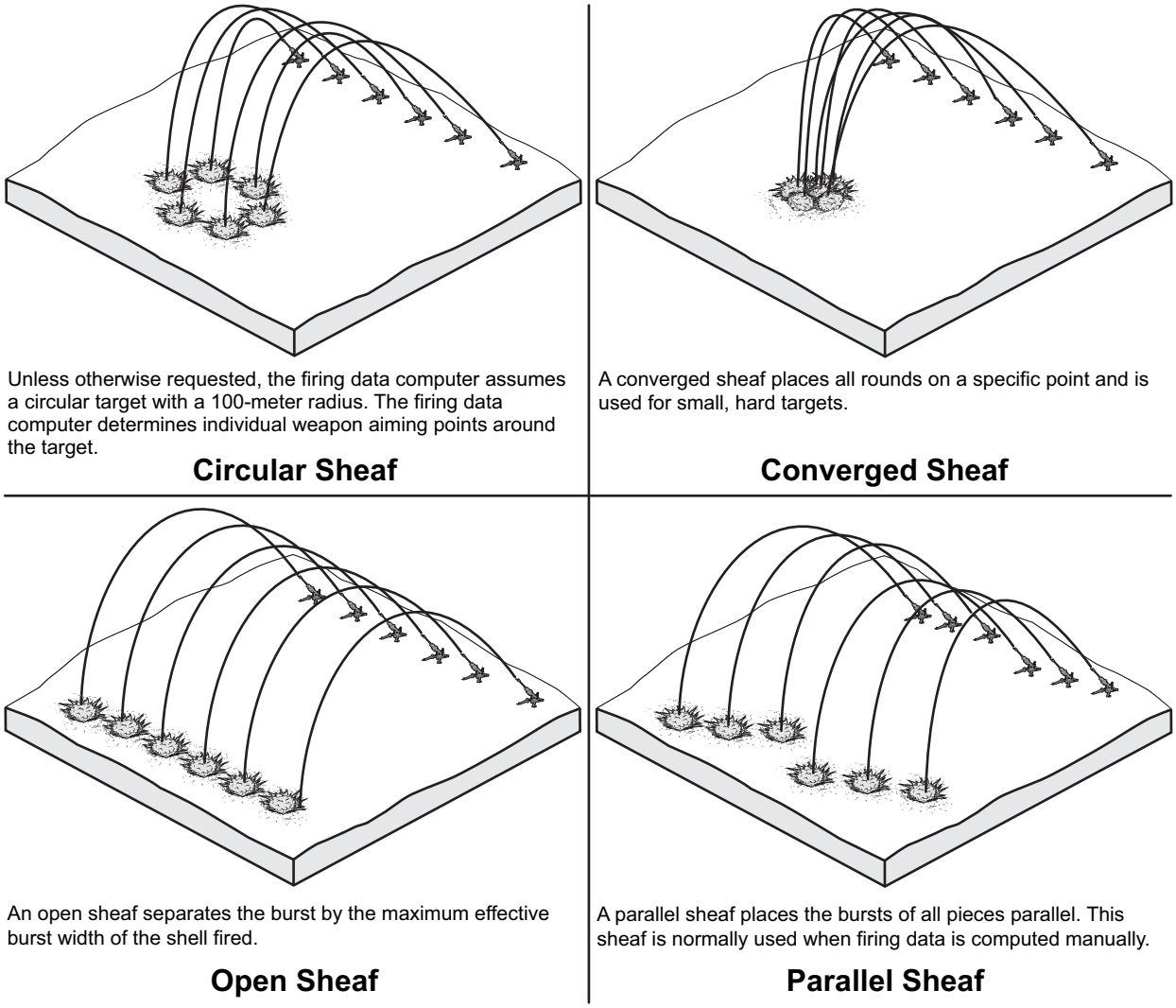



**Figure 3-1. Sheafs.**

### Method of Fire and Control

The sixth element of the call for fire, method of fire and control, indicates the desired manner of attacking the target: whether or not the observer wants to control the time of delivery of fire and whether or not the observer can actually view the target. The following subparagraphs identify how methods of fire and control are announced by the observer.

***Method of Fire***. In area fire, adjustment is normally conducted with one howitzer or with the center gun of a mortar platoon or section. However, adjusting at long ranges may sometimes be easier with two howitzers or guns firing. If the observer determines that a two-howitzer or gun adjustment is more appropriate for the mission, the observer may specify that either two guns adjust for artillery or a section adjusts for mortars. Whether for adjustment or effect, if the

observer wants the firing unit to fire by pieces from right to left or left to right, the observer specifies the unit and indicates *right by piece* (for left to right) or *left by piece* (for right to left).

**Example: Method of fire by piece**

*Battery right.*

The typical time interval between rounds fired in a platoon or battery right (left) is 5 seconds. The observer may specify a different time interval if desired.

***Method of Control***. In the absence of a specified method of control, fire missions are executed by the firing unit when ready using the following commands:

- *At my command*. If the observer wants to control the time of delivery of fire. When the pieces are ready to fire, the FDC announces *section/platoon/battery/battalion is ready, over*, and call signs are used. The observer announces *fire* when it is time for the pieces to fire. This only applies to adjusting rounds and the first volley of a fire for effect. *At my command* remains in effect during the mission until the observer announces *cancel at my command, over.*
- *By round at my command*. Controls every round in adjustment and every volley in the fire for effect phase.
- *By piece, by round, at my command*. Further combines method of fire with method of control and can include right or left or duration.
- *Cannot observe*. Indicates that the observer cannot see the target because of vegetation, terrain, weather, or smoke. Used when there is a reason to believe that a target exists at a given location, and the target is important enough to justify firing without adjustment.
- *Cease loading*. Used during the firing of two or more rounds to stop the loading of rounds into the guns. The gun section may fire any rounds that have already been loaded. This is not sent in the initial call for fire.
- *Check firing*. Used to cause an immediate halt in firing. Once *check firing* has been announced, the command *cancel check firing* must be given to resume firing. This is not sent in the initial call for fire. It is only used during emergencies or if a safety violation is noted.
- *Continuous fire*. Means loading and firing as rapidly and as accurately as possible within the prescribed rate of fire for the equipment. Firing will continue until suspended by the command *cease loading or check firing.*
- *Continuous illumination*. Indicates a type of fire where illumination projectiles are fired at specified time intervals to provide uninterrupted lighting on the target or specified area. The interval may be specified by the observer in seconds or determined by the FDC. If no interval is given by the observer, the FDC determines the interval by the burning time of the illumination ammunition that is in use. The *continuous illumination* command should be used with discretion to avoid excessive ammunition expenditure.
- *Coordinated illumination*. Indicates a type of fire where the firing of illuminating and lethal munitions is coordinated to provide illumination of the target and surrounding area, but only at the time that is required for spotting and adjusting fire. The observer may allow the FDC to

control the firing of the illumination and lethal munitions by marking the illumination round when it provides optimal illumination on the target, or the observer may control the firing of each round by using procedures of *by round at my command*.

- *Do not load*. Allows the howitzer or gun section to prepare ammunition and lay on the target without loading the howitzer. When the command *cancel, do not load* is transmitted, the section automatically loads and fires the weapon, with the exception of an *at my command* mission. *Do not load* is the recommended method of control for long waits or uncertain missions.
- *Time on target (TOT)*. Allows a unit to schedule its fire so that the initial round strikes the target at the time specified. The observer indicates TOT by using one of the techniques discussed in appendix E.
- *Repeat*. Means to fire the same number of rounds using the same method of fire for effect. Changes in the number of guns, previous corrections, interval, or ammunition may be requested.

**Example: Methods of control**

Situation 1: Grid Method of Target Location

The observer desires to adjust with HE/Q and then fire for effect with WP.

Observer: *5 trucks refueling in the open, WP in effect, over.*

FDC: Reads back.

Situation 2: Polar Plot

The target is danger close. Observer desires HE/Q or to let the FDC select the projectile/fuze.

Observer: *Infantry platoon in the open, danger close, over.*

FDC: Reads back.

Situation 3: Shift from a Known Point

The observer selects a sheaf to concentrate the fires on a specific point and when there is a desire to control the timing of the fires.

Observer: *Machine gun position, converged sheaf, at my command, over.*

FDC: Reads back.

## SUPPRESSIVE FIRE CALL FOR FIRE

Suppressive fires are fires on or about a weapons system to degrade its performance below the level needed to fulfill its mission objectives during the conduct of the fire mission. Suppressive fires are delivered as a suppression mission or as an immediate suppression mission. See chapter 9 for a discussion of SEAD missions.

Both suppression and immediate suppression mission types yield suppressive results only during the time when the fire is being delivered. Firing on a planned target is more responsive than firing on a target of opportunity. The maneuver unit should perform an action (e.g., maneuver against the target, position the observer to adjust fire to neutralize the target, bypass the target) while the suppressive fires are making impact.

### Suppression Mission

The call for fire consists of the observer identification, the warning order suppress, the target number of the planned target, and the duration and rate of fire. This call for fire is sent in one transmission.

**Example: Suppression mission**

Observer: *R2S this is W2P31, suppress AB 3104, 4 minutes, 4 shells per minute, over.*

FDC: *P31 this is R2S, suppress AB 3104, 4 minutes, 4 shells per minute, authenticate DELTA JULIET, over.*

Observer: *I authenticate DELTA, out.*

### Immediate Suppression Mission

An immediate suppression mission normally requires a minimum volume of fire. The type of ammunition, units to fire, and volume are established by unit SOP (e.g., two sections with one round of HE/point detonating [PD] and one round of HE/VT). The call for fire is sent in one transmission and consists of the observer identification, the warning order *immediate suppression,* and the target location.

***Note:*** The immediate suppression mission is not a self-ending mission.

**Example: Immediate suppression mission**

Observer: *This is W2P31, immediate suppression, grid 221 432, authentication is TANGO UNIFORM, over.*

FDC: *This is R2S, immediate suppression, grid 221 432, out.*

## MESSAGE-TO-OBSERVER

After receiving the call for fire, the FDO determines how the target will be attacked. That decision is announced to the observer in the form of an MTO, which the observer reads back verbatim. The MTO should be sent to the observer before the first subsequent correction. At a minimum, the MTO will consist of units to fire and any changes to the call for fire, including number of rounds and target number. The FDC will provide other information, as required.

***Note:*** The MTO is not transmitted for an immediate suppression mission.

### Units to Fire

Units to fire refers to the batteries or battalion that will fire the mission. If the battalion is firing for effect with one battery adjusting, the FDC designates the fire for effect unit (battalion) and then the adjusting unit (alpha battery) by using the last letter of the call sign.

**Example: Units to fire**

Alpha battery (R6G) will adjust and the battalion (A8T) will fire for effect.

The MTO would begin *message-to-observer, T, G . . .*

### Changes to the Call for Fire

Any changes to the observer's request in the call for fire are announced, including—

- Number of rounds per gun in fire for effect.
- Target number that is assigned at the FDC to each mission to facilitate the processing of subsequent corrections.
- Other information as required.

**Example: Changes in call for fire**

The observer requested ICM in effect, and the FDO decides to fire VT in effect.

The MTO would begin *message-to-observer, T, G, VT in effect . . .*

**Example: Rounds**

MTO: *T, G, VT in effect, 4 rounds, target AA 7732, over.*

### Probable Error in Range

The probable error in range ($PE_R$) is the distance in meters over or short along the GTL of a given point of aim where 50 percent of all rounds fired are predicted to fall (see figure 3-2). For example, for an M777A2 howitzer firing HE at a range of 6,000 meters (charge 4H, M232), one $PE_R$ is 22 meters. There is a 50-percent chance that any given round will impact 22 meters over or short of the point of aim when fired at this range. The majority of the remaining rounds will impact within four $PE_R$ or 88 meters over or short of the target (see figure 3-2). By contrast, one $PE_R$ for the same weapon firing at a range of 14,000 meters is 42 meters.

The $PE_R$ varies with several factors, including range, propelling charge, ammunition, and weapon. The FDC typically selects the optimal firing data to minimize $PE_R$; however, circumstances (e.g., intervening crests, counterfire threat) may require the selection of a less than optimal gunnery solution. The FDC reports the $PE_R$ when it is equal to or greater than 38 meters during an area fire mission and 25 meters or greater in a precision fire mission, such as registrations or destruction. This is to prevent the observer from attempting to correct the impact of a round caused by natural dispersion.

### Angle T

Angle T is the angle formed by the intersection of the OTL and the GTL, with the vertex of the angle at the target location. Angle T is sent to the observer when it is greater than or equal to 500 mils, or as requested. See chapter 5 for more information about angle T.

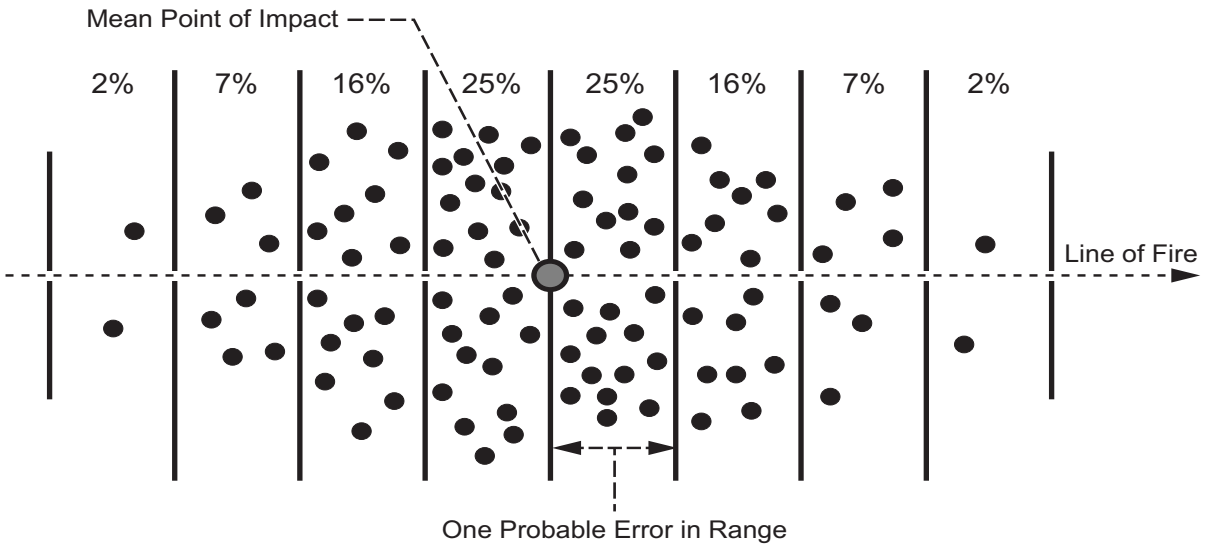



**Figure 3-2. Probable Error in Range.**

### Time of Flight

The time of flight (TOF) is the time in seconds measured from when a weapon is fired to when the round strikes or detonates. The TOF is sent to an observer when—

- Adjusting high-angle fire during a moving-target mission.
- Using precision-guided munitions.
- Firing for an aerial observer for shell HE in a coordinated illumination mission.
- Using *by shell at my command* or when requested.

***Note:*** The MTO for registrations is discussed in chapter 6.

## REPORT UPON FIRING

The firing unit will transmit *shot* after each round fired in adjustment and after the initial round in the fire for effect phase. The observer will acknowledge each transmission.

**Example: Transmission of shot**

FDC: *Shot, over.*

Observer: *Shot, out.*

When requested, the transmission of *splash* by the FDC informs the observer when the round is 5 seconds from detonation. Firing units should automatically report *splash* during high-angle firing, when the observer is airborne, and for other missions as requested by the observer. When reported, *splash* should be transmitted for each round in adjustment and for the initial round in each volley of fire for effect. In coordinated illumination missions, *splash* is reported for illumination rounds fired before the beginning of the HE adjustment phase of the mission and only for HE rounds thereafter. When in the assault, *splash* allows the supported unit to close with its fires and allows the observer to remain under cover and concealment while awaiting the fires, enhancing the observer's survivability. This transmission also helps differentiate an observer's own rounds if other fire missions are being conducted in the area.

**Example: Splash**

FDC: *Splash, out.*

***Note:*** The observer is not required to acknowledge the transmission.

## CORRECTION OF ERRORS

Sometimes errors are made by both the observer transmitting data and the FDC personnel reading back the data. An observer announces *correction* and transmits the entire corrected transmission when an error has been made. When an error has been made in a sub-element and the correction of that sub-element will affect other transmitted data, the word *correction* is announced. Then the correct sub-element and all affected data are transmitted in the proper sequence.

**Example: Correction of errors**

Observer: *Direction 4680; left 200; add 400; up 40; over.*

FDC: *Direction 4680; left 200; add 400; up 40; out.*

Observer: *Correction direction 5680; left 200; add 400; up 40; over.*

FDC: *Correction direction 5680; left 200; add 400; up 40; out.*

# CHAPTER 4
# NAVAL SURFACE FIRE SUPPORT CALL FOR FIRE

## FIRE UNIT STATUS

A ship is assigned a fire support area or a fire support station from which to fire. When a ship arrives in its assigned firing position and has completed its prefiring tasks, it reports *on station and ready to fire* as a part of the guns up ready to fire (GURF) report. The GURF report may include other pertinent information (e.g., types and quantities of ammunition available for NSFS support). The GURF report may be requested at other times by either the NGLO or the spotter.

## ELEMENTS OF THE CALL FOR FIRE

The spotter must communicate effectively with the ship to perform the primary duty of providing NSFS by employing a standard call for fire. The call for fire is transmitted to the ship in two transmissions consisting of seven elements, with a read back after each transmission. The first transmission includes spotter identification, warning order, and target number; the second transmission includes target location, target description, method of engagement, and method of control.

### Spotter Identification

The spotter identification informs the ship who is calling for fire. The spotter and the ship will use call signs. Once given, call signs are usually omitted from subsequent transmissions in the course of the mission.

### Warning Order

The warning order informs the ship that a call for fire is being transmitted and consists of the words *fire mission.* The warning order also clears the net and warns the ship that firing on a target is desired.

### Target Number

Before calling for fire, the spotter assigns a target number to each target. By using a target number, the ship and the NGLO monitoring the mission are able to keep track of each location being fired upon. The target number consists of two letters followed by four numbers. For targets of opportunity, the spotter assigns each fire mission a number in numerical sequence from the block of target numbers allocated by the FSCC, or the FSCC may assign the target number. The spotter uses previously assigned target numbers for planned targets.

***Note:*** The assignment of target numbers to fire missions in the call for fire does not cause the targets to be recorded as targets.

**Example: Assignment of target numbers**

Spotter: *A1B, this is C2D, fire mission, target number AB 2135, over.*

Ship: *C2D, this is A1B, fire mission, target number AB 2135, out.*

### Target Location

Target location provides the ship with the information needed to plot the target and determine firing data as described in chapter 2. The observer transmits target location data depending on the method being used.

For grid, the spotter announces—

- *Grid* followed by the coordinates of the target.
- *Altitude* followed by the altitude of the target, which is measured from MSL (meters understood).
- *Direction* followed by the spotting line if the method of control is spotter adjust.

For polar, the spotter announces—

- *Direction* followed by the spotting line.
- *Distance* followed by the distance from the spotter to the target (meters understood).
- *Up* or *down* if there is a vertical shift.

For shift from a known point, the spotter announces—

- *From reference point* or the target number.
- *Direction* followed by the spotting line.
- *Left* or *right* if there is a lateral shift.
- *Add* or *drop* if there is a range shift.
- *Up* or *down* if there is a vertical shift.

### Target Description

The spotter's target description includes the following:

- *Type of target*.What the target is and what the target is doing (e.g., trucks in convoy, troops digging in).
- *Size*. The number of elements in the target or physical dimensions in meters. For target attitude, mils grid is understood.
- *Degree of protection*. Whether the target has protection (e.g., whether the target is in the open or in bunkers with overhead cover).

**Example: Target size**

*5 trucks, 100 troops, 400 x 400 attitude 1600.*

### Method of Engagement

Method of engagement is the element that the spotter uses to describe how to attack the target. The sub-elements of the method of engagement include danger close, trajectory, ammunition, number of guns, number of salvos, and special instructions.

Some of the sub-elements are standard and will be provided automatically unless the spotter specifies otherwise. The standard method of engagement for trajectory uses a full charge, which produces a high muzzle velocity and a standard trajectory.

> ***Note:*** The standard methods of engagement are ammunition (HE/Q), armament (main), number of guns (one gun), and number of salvos (one salvo).

When required, nonstandard sub-elements must be addressed in the call for fire; for example, when the observer specifies danger close when the target is near a friendly position. The sub-elements of the method of engagement are transmitted in the sequence presented in the following subparagraphs and/or as required.

***Danger Close***. The term "danger close" is included in the method of engagement when there are friendly troops or positions within a prescribed distance of the target. Danger close is used for unobserved or initial salvos of NSFS projectiles that are smaller than 6 inches and where the target is closer than 750 meters to friendly positions.

The spotter reports *danger close*, followed by a cardinal or intercardinal direction (based on grid north) and distance (in meters) from the target to the nearest friendly position. The spotter also designates the place where the first salvo (i.e., round) is to impact. The first salvo can be either offset or directed at the target.

The first salvo may be offset to impact on the side of the target opposite the location of the friendly forces or a restricted target (e.g., class E). This is performed by indicating a normal correction (left/right, add/drop) made in relation to the spotting direction or a cardinal/ intercardinal direction and distance (in meters). The offset between the nearest friendly position and the first salvo can be any distance specified by the spotter, but it is typically at least 750 meters for 5-inch NSFS.

**Example: Danger close**

*Danger close south 350*. (South 350 indicates friendly position in relation to target.)

*First salvo at north 400*. (The correction *north 400* positions the offset at least 750 meters from the friendly position [e.g., 350 meters + 400 meters = 750 meters]. The first salvo may be directed at the target when the tactical situation does not permit an offset. An example would be *first salvo at target*.)

***Trajectory***. This sub-element applies to ships that are capable of reduced-charge or high-angle firing. The normal trajectory is standard, flat, and fired at full-charge propellant. If this sub-element is omitted in the call for fire, the ship will fire full charge. The spotter or ship may specify a nonstandard trajectory when required. Nonstandard trajectories are reduced charge and high angle.

*Reduced Charge*. A reduced charge is required when intervening terrain prevents the engagement of targets in defilade. The spotter or ship raises the trajectory to increase the angle of fall by announcing *reduced charge*. Reduced charge lowers the initial velocity of the projectile, which prevents the ripping of illumination parachutes and increases the accuracy at short ranges. Once reduced charge has been initiated, it may be terminated by the command *cancel reduced charge*.

*High Angle*. High angle is fired with a full charge. It is used to engage targets in defilade when extended range or other considerations prevent the use of reduced charge. The spotter or the ship announces *high angle*. Once initiated, it may be terminated by the command *cancel high angle*.

***Ammunition***. Several types of ammunition are available to the spotter, the standard being HE/PD. If no ammunition is specified in the call for fire, HE/PD is fired in the adjustment and fire for effect phases. The term *in effect* indicates that the projectile and/or fuze that was specified is desired during the fire for effect. Nonstandard types of ammunition are specified in the call for fire. The spotter must state either a projectile or a fuze.

When a mission requires a nonstandard projectile, sufficient warning should be provided to the ship. This will allow time to ready the ammunition in the gun mount. The quantities of nonstandard ammunition carried in the ship's magazine are limited. See appendix D for a discussion of projectiles and fuzes.

**Example: Nonstandard types of ammunition in call for fire**

Spotter: *Shell WP (projectile) or fuze controlled variable time (CVT)* (fuze).

***Note:*** When firing illumination, the fuze is understood to be fuze time and does not need to be specified.

***Number of Guns***. The spotter may specify the number of guns to be used in adjustment and fire for effect. If the number of guns in fire for effect is not specified, it is understood to be the same number as used in adjustment. One gun is considered to be the standard and need not be specified. If more than one gun is desired, the number of guns must be specified.

***Number of Salvos***. Salvo refers to the number of projectiles to be fired from each gun.

**Example: Number of salvos**

*5 salvos* (5 projectiles to be fired).

*2 guns 5 salvos* (10 projectiles fired).

The number of salvos is transmitted to the ship when entering fire for effect or when the spotter desires to adjust with multiple salvos. If the method of control is spotter adjust, the number of salvos is omitted until the spotter is ready to enter fire for effect. If omitted, the ship will fire one salvo.

**Example: Number of salvos sent**

*2 salvos in adjustment.*

***Special Instructions***. The spotter uses special instructions in the call for fire when the use of specific, nonstandard techniques is desired to attack the target. The following are special instructions that may be used in the call for fire:

- *Coordinated illumination*. Used to request simultaneous HE fire. This command informs the ship that an adjustment to illumination will follow.
- *Continuous illumination*. Used when the spotter requires constant light on a target. The spotter may specify an effective period of time for continuous illumination. The ship determines the interval for firing the subsequent illumination salvos on the basis of the burning time of the projectile. This command should be used with discretion to avoid excessive expenditure of ammunition.
- *Interval*. Used to cause fire for effect rounds to be fired with a specific time interval between each salvo (in seconds).

**Example: Interval**

*10 salvos, interval 30, fire for effect.*

- *Sustained fire*. Given if there is a requirement for fire for effect to be spread over a specific period of time. This command includes the number of salvos and the period of time that they are required to be fired.

**Example: Sustained fire command**

*20 salvos, sustained fire, 5 minutes, fire for effect.*

*TOT*. Used by the spotter when the initial salvos in fire for effect should impact the target at a specified time. The spotter may use any of the techniques described in appendix E.

### Method of Control

Method of control indicates the spotter's desire or ability to control the delivery of fire. The standard method of control is spotter adjust and is omitted in the call for fire. The nonstandard methods of control are fire for effect and ship adjust. Fire for effect can be modified by the command *cannot observe*. All methods of control can be modified by the command *at my command*.

***Spotter Adjust***. When there is doubt about target location or firing accuracy, the spotter will adjust salvos until sure that fire will impact the target. This method is understood to be standard and is omitted from the call for fire. The spotter may state this when there is a desire to revert to adjustment during a mission.

***Fire for Effect***. The spotter should strive for fire for effect with the first round or as soon as possible (ASAP) in the adjustment phase. When determining whether or not to fire for effect on the first round, the spotter must consider the target location, how accurately the ship has been firing its initial rounds during previous missions, and the dispersion pattern of NSFS. If the spotter believes that the first salvo will affect the target, the best results are normally achieved by surprise fire. When fire for effect is desired, the spotter specifies the number of salvos and the number of guns, if different from that used in adjustment, and announces *fire for effect.*

**Example: Fire for effect**

*10 salvos, fire for effect.*

Fire for effect can be modified by the command *cannot observe* when the spotter desires to fire on a suspected target or a target provided by intelligence sources. Cannot observe is used when neither the spotter nor the ship can see the target. The spotter must specify the number of salvos to be fired in the method of engagement.

**Example: Number of salvos to be fired**

*2 guns, 4 salvos, cannot observe, fire for effect.*

***Ship Adjust***. This method of control is employed when the spotter believes that the ship has a better view of the target than the spotter does. Because direct fire is faster and more accurate, this method is used whenever possible. After positively identifying the target to the ship, the spotter announces *ship adjust*. The ship takes the target under fire. The spotter may assist the ship by providing range spottings along the GTL, particularly when the spotter is looking perpendicular to the GTL.

***At My Command***. The spotter will include *at my command* in the method of control when the spotter wants to control the precise firing of each salvo in spotter adjust and the first salvo of fire for effect. When the ship is prepared to fire each round, the ship will transmit *ready over*. The spotter commands *fire* when ready for the ship to fire the round. At my command remains in effect throughout the mission or until the spotter announces *cancel at my command*. At my command is used frequently by aerial observers.

**Example: At my command**

*Fire for effect, at my command.*

After the ship receives the call for fire and determines firing data, a prefiring report will be made to the spotter before firing begins. The spotter reads back this transmission to the ship and commands *break . . . fire, over.*

**Example: Prefiring report**

Ship: *GTL 1680; ready 17; over.*

Spotter: *GTL 1680; ready 17; break . . . fire, over.*

Ship: *Fire, out.*

**Example: Target location and description with methods of engagement and control**

Situation 1: Grid method of target location; spotter adjust mission

Spotter: *Grid 786 543; altitude 05; direction 2680; 50 troops in open; fuze CVT in effect; over*.

Ship: Reads back.

Situation 2: Polar plot method of target location; at my command mission

Spotter: *Direction 2680; distance 3000; down 40; 50 troops in open; fuze CVT in effect; at my command; over.*

Ship: Reads back.

Situation 3: Shift from a known point method of target location; at my command mission

Spotter: *From target number AB 3772; direction 3,470; left 280; add 500; supply depot in defilade; radius 200; reduced charge; 2 guns 10 salvos; fire for effect; at my command; over.*

Ship: Reads back.

The ship reports its firing direction by using the same directional reference and units used by the spotter. The ship notifies the spotter of subsequent changes to the GTL of 200 mils (i.e., 10 degrees) or more. Other considerations and commands related to the ship adjust method are as follows:

- *Line of fire*. If the ship is firing illumination, the firing direction may not pass over the target because of the drift of the flare parachute. To indicate the illumination projectile trajectory, the ship will report *line of fire*, followed by the directional reference. The line of fire may be different from the GTL.
- *First salvo at point of aim*. When the spotter has reported a danger close situation, the ship confirms the point of aim that was previously ordered by the spotter.

**Example: Point of aim confirmation**

*First salvo at north 400.*

- *Summit*. If the spotter is airborne, the ship routinely reports the highest altitude above MSL that the projectile will reach on its flight path to the target. Summit may also be requested by ground spotters or the NGLO. Summit is reported in feet to aerial observers and in meters to ground units.
- *Changes to the spotter's fire request*. If the ship must change any portion of the spotter's fire request, the ship notifies the spotter of the change. For example, if the spotter requests *WP in effect* and the ship has none remaining, the ship announces cannot *comply with WP, HE in effect*.
- *Ready/TOF*. When the ship is prepared to fire the first salvo, the ship reports *ready*, followed by the TOF (seconds understood). The spotter reads back the entire prefiring report and commands *break . . . fire*. If the method of control included at my command, the ship also reports *ready* before firing each subsequent round. The ship informs the spotter when there is a TOF change of more than 5 seconds.
- *Authentication*. To avoid deception, the ship should initiate authentication procedures upon the establishment of initial communications with the spotter.

## REPORT UPON FIRING

The ship will transmit *shot* and *splash* after each salvo is fired in adjustment and after the initial salvo in the fire for effect phase. There is no requirement for the spotter to acknowledge these transmissions:

- Shot is transmitted at the moment the guns are fired.
- Splash is transmitted 5 seconds before the round is expected to detonate.

Splash is not reported during fire for effect when two or more ships are conducting a massed-fire mission. In coordinated illumination missions, splash is reported for illumination shells before the beginning of the HE adjustment phase; thereafter, it is reported for only HE rounds.

**Example: Transmission of splash**

*Shot . . . splash, out.*

## CORRECTION OF ERRORS

Sometimes errors are made by the spotter or the ship when transmitting data. The following procedures should be used to correct any data errors:

- *Correction*. The spotter should immediately transmit the word *correction*, followed by the corrected data when an error in transmission has occurred. If the correction affects other sub-elements, the correction should include a restatement of all affected data.

**Example: Transmission of correction**

*Correction, direction 0670, over.*

- *Wrong*. If an error is made during a read back, the word *wrong*, followed by the correct data, is transmitted at the end of the transmission. The word *wrong* is then read back, along with the corrected version.

**Example: Transmission of wrong**

*Wrong, direction 0670, right 300, add 400, up 15, over.*

# CHAPTER 5
# ADJUSTMENT OF FIRE

An adjustment of fire is the process used in artillery and naval gunfire to obtain the correct bearing, range, and height of burst (if time fuzes are used) when engaging a target by observed fire. After a round bursts, a spotting is made and a correction is transmitted to adjust the fires onto the target. Upon a satisfactory adjustment, the observer enters the fire for effect phase. The procedures and conditions observed during adjustment of fire are applicable to the artillery observer, the mortar observer, and the NSFS spotter; except where addressed separately, the word "observer" refers to all three.

## SPOTTINGS

A spotting is an observer's mental determination of the location of the artillery's burst or mean point of impact (MPI) of multiple bursts in relation to the adjusting point as observed along the OTL. Normally, spottings are not announced except in situations involving straddle NSFS and unobserved or lost spottings. Spottings must be made the instant that the burst occurs, except where delayed deliberately to take advantage of drifting smoke or dust.

Binoculars should be positioned before the burst appears. The observer holds the binoculars just below eye level, looking over the top of the binoculars with the naked eye until the burst is sighted. Then, the binoculars are raised to eye level and the spotting is made.

Spottings are made for height of burst (HOB), range, and deviation. In order to determine the most difficult spotting first, the observer should spot in that order.

### Height of Burst

Height of burst spottings are used to determine how high a burst is above the target and to determine any increase or decrease required in the HOB or altitude of impact of a round. These spottings are used for adjusting air bursts when firing fuze time and making adjustments to ground bursts when attacking a target on a steep slope or with a vertical face. Height of burst spottings, which are used to make HOB corrections, are categorized as air, graze, or mixed:

- *Air*. A round or group of rounds that bursts in the air. Binoculars are used to observe an air spotting and to determine the detonation height above the target measured to the nearest mil.

| **Example: Air spotting** |
| --- |
| *Air 12*. |

- *Graze*. A round or group of rounds that detonates or impacts. The spotting is made as *graze*.
- *Mixed*. A group of rounds that results in an equal number of air and graze bursts, with the following variants:
  - A mixed air spotting is a group of rounds that results in both air and graze bursts, with most of the bursts being air bursts.
  - A mixed graze spotting is a group of rounds that results in both air and graze bursts, with most of the bursts being graze bursts.

When attacking a target on a steep slope or with a vertical face, HOB spottings for ground bursts are the difference between the altitude (in meters) of the burst and the altitude of the target. The observer determines the difference by either a visual estimation or map measurements. These spottings are then used to make HOB corrections. If the initial rounds of a fire for effect are spotted as mixed, the subsequent correction or refinement of *up 20* will be sent, if required.

### Range

Definite range spottings are required to make a proper range adjustment. A graphical portrayal of range spottings is shown in figure 5-1. Typically, a burst on or near the OTL provides a definite range spotting. An observer can make a definite range spotting when the burst is not on or near the OTL by using knowledge of the terrain, drifting smoke, and shadows. However, even experienced observers must use caution and good judgment when making such spottings. Possible range spottings include the following:

- *Over*. A round that detonates beyond the target or adjusting point.
- *Short*. A round that detonates between the observer and the target or adjusting point.
- *Target*. A round that detonates on the target. This spotting is used in precision fire (i.e., artillery or mortar registration or destruction missions).
- *Range correct*. A round that impacts at the correct range.
- *Doubtful*. A round that is so far to the right or left of the OTL that a definite range spotting cannot be made.

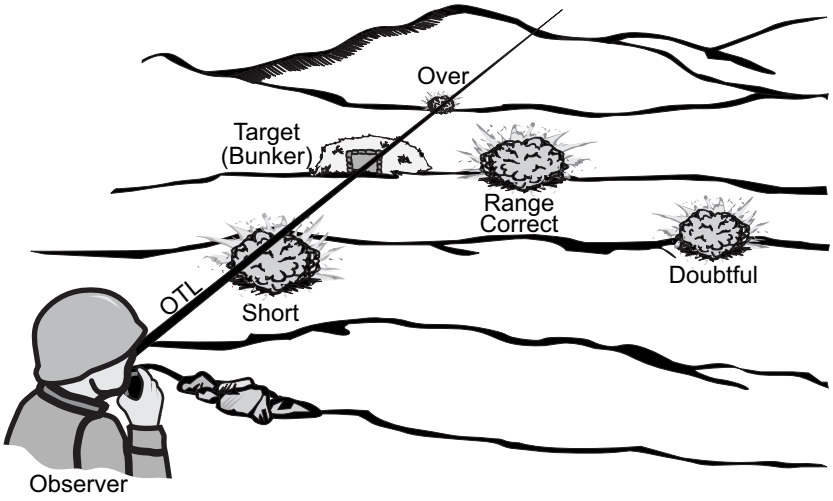



**Figure 5-1. Range Spottings.**

In NSFS, a spotting of straddle is made for a multi-gun salvo when some rounds fall short and some fall beyond the target. The spotter announces straddle followed by a correction to place the MPI on the target. The term is normally used during a ship adjust or a massed-fire mission.

### Deviation

A deviation spotting measures the angular deviation right or left of the OTL. During a fire mission, the observer measures deviation to the nearest 5 mils. For precision fire, the observer measures to the nearest mil. Deviation spottings may simply be a certain number of mils to the right/left of the OTL. For example, 30 right (see figure 5-2) or 30 left (see figure 5-3.

A spotting of on line is when the round bursts along the OTL. This usually means the observer has a good direction to the target or that the appropriate deviation corrections have been made to bring the impacts onto the OTL. There is no mil value associated with this type of deviation spotting (see figure 5-4).

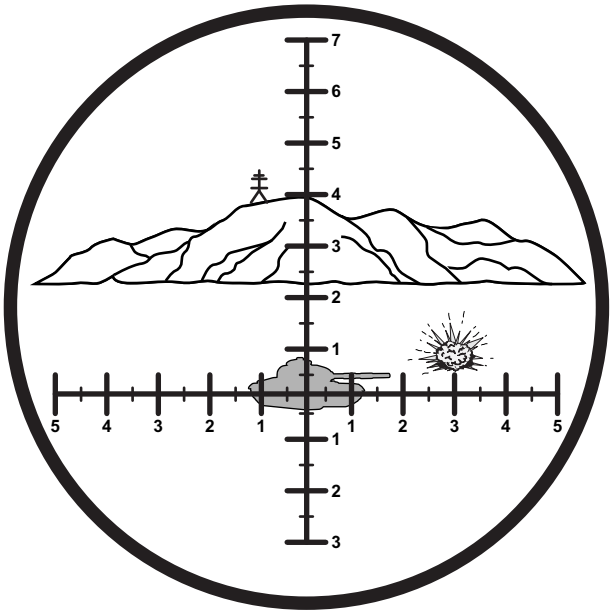



**Figure 5-2. Right Spotting.**

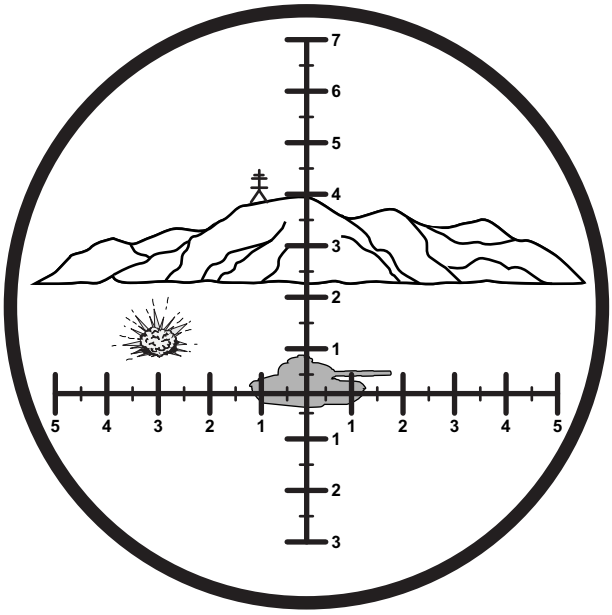



**Figure 5-3. Left Spotting.**

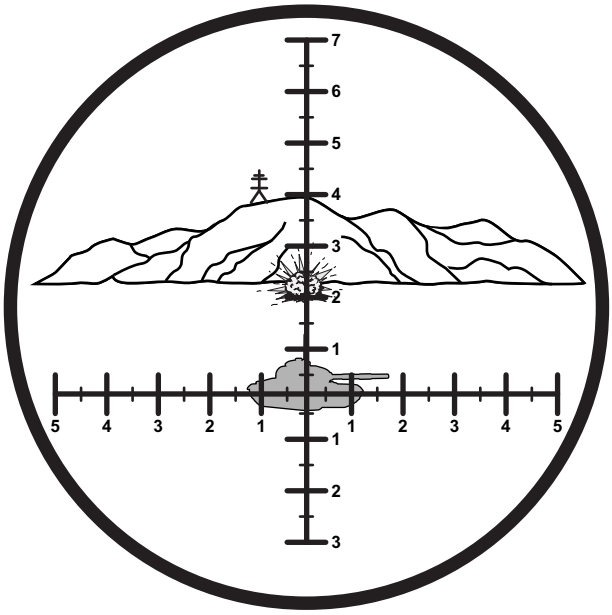



**Figure 5-4. On Line Spotting.**

### Unobserved Spottings

Under certain conditions, the observer may be able to make a spotting even though the round's impact cannot be observed. For example, the observer may hear, but not see, the round impact. By knowing the terrain, the observer determines that the only place that the round could have impacted without being seen is in a draw beyond the target. Although this is an unobserved spotting, the observer can make adjustments from the determined impact location.

***Visibility Impairment***.Visibility may be temporarily impaired if the observer has to take cover from incoming fire or if there is smoke or dirt obstructing the target area's visibility. This environment may also prevent identification of the observer's own round. If this occurs, the observer announces *repeat* to indicate the desire for another round to be fired with the same data.

***Lost Rounds***. If the observer is unable to locate the round either visually or by sound, the spotting is considered a lost round. This spotting is announced, followed by the appropriate corrective action. Rounds may be lost for several reasons, including fuze malfunctioning (i.e., a dud), terrain or weather that prevents the observer from spotting the round, or errors by the firing unit. When a round is lost, positive action must be taken. In selecting the course of action, the observer should consider experience, the firing unit's proficiency as demonstrated on previous missions, and the location of friendly elements with respect to the target. Corrective actions by the observer may consist of one or more of the following:

- Begin with a data check of the target location data and the call for fire.
- Request that the firing unit check their data. In NSFS, the spotter would announce *check solution*.
- Request *repeat*. In this instance the firing unit will fire the same shell fuze combination with the same data as before.
- Request *shell WP, 200-meter air burst with HE, or M825 smoke* (for artillery only) for the next adjustment.
- Make a bold shift, but ensure that friendly troops are not endangered

If the corrective actions fail, send an *end of mission* and transmit a new call for fire.

## CORRECTIONS

After spotting the burst, the observer determines and transmits a correction in meters to move the next round to be fired onto the target or adjusting point. Corrections are sent in the reverse order of the spotting (i.e., deviation, range, and HOB). The observer simultaneously corrects for deviation, range, and HOB as required. The observer should always specify the target number before sending the correction.

### Sequence of Subsequent Corrections

After the initial burst appears, the observer transmits subsequent corrections until the mission is terminated. These corrections include appropriate changes in elements that were previously

transmitted and the necessary corrections for deviation, range, and HOB. Table 5-1 provides a means for the observer to organize a transmission of multiple corrections in an orderly flow and as appropriate.

**Table 5-1. Sequence of Subsequent Corrections.**

| Artillery/Mortars | NSFS |
|---|---|
| Direction | Direction |
| Danger close | Danger close |
| Trajectory | Trajectory |
| Method of fire | Ammunition |
| Distribution | Deviation |
| Shell | Range |
| Fuze[1] | HOB |
| Volume of fire | Number of guns |
| Deviation[1] | Number of salvos |
| Range[1] | Method of control |
| HOB[1] | |
| Target description | |
| Change in type of mission/control[1] | |
| Splash | |
| Repeat[1] | |
| [1] These commands constitute a command for the firing unit to deliver another round unless modified by the command, *at my command*. | |

### Observer-Target Direction

Direction is the key element for adjustment of rounds and precedes all other subsequent corrections when announced. In NSFS, direction is sent as part of the call for fire. In artillery or mortars, if direction is not included in the call for fire, it may be sent immediately after the call for fire, while reading back the MTO, or with the first subsequent correction. Refinement of or changes to direction are made when the original direction changes by 100 mils (i.e., 5 degrees) or more. Elements of the call for fire that may require correcting and the sequence of these corrections are discussed in the following subparagraphs.

***Deviation Corrections***. Deviation corrections are determined by observing the following steps:

**Step 1**. Determine deviation spotting to the nearest 5 mils or 1 mil for precision fire.

**Step 2**. Determine the OT factor. When the distance is greater than 1,000 meters, the OT distance is determined to the nearest 1,000 meters. The distance is then expressed in thousands (drop the last two digits) as the OT factor. If the OT distance is less than 1,000 meters, then the distance is determined to the nearest 100 meters and expressed in thousands.

**Step 3**. Multiply the deviation spotting by the OT factor. Express to the nearest 10 meters. Deviation corrections are transmitted in multiples of 10 (meters understood), with the minimum correction being 30. The direction of the deviation correction is opposite that of the spotting. The computed deviation correction is announced as *left* or *right* (meters understood).

Table 5-2 provides examples of how deviation corrections are made.

***Note:*** Large deviation corrections (e.g., *right/left 400*) may indicate an error in direction. This could be attributed to errors in initial target location, improper orientation of the OF fan, or malfunction of direction-measuring equipment. When large corrections occur, the observer makes an appropriate check by verifying direction before continuing the mission. When necessary, the observer refines and transmits the new OT direction. Accuracy of adjustments depends, in part, on an accurate direction.

**Table 5-2. Example of Computed Deviation Corrections.**

| OT Distance (meter) | OT Factor | Spotting | Deviation Correction |
|---|---|---|---|
| 4,000 | 4 | 45 right | *left 180* |
| 2,500 | 2 | 100 left | *right 200* |
| 3,400 | 3 | 55 left | *right 160* |
| 1,500 | 2 | 20 right | *left 40* |
| 700 | 0.7 | 45 left | *right 30* |

The OTL's relationship to the GTL may influence the determination of deviation corrections. The natural dispersion along the GTL, which is more pronounced with NSFS, limits the accuracy of some corrections. An observer whose OTL is perpendicular to the GTL makes deviation corrections that are actually range corrections for the weapons system. When this occurs, the observer can over-correct by spotting and correcting what is actually natural dispersion along the GTL. As mentioned earlier, the angle formed by the intersection of the OTL and the GTL with the vertex of the angle at the target location is referred to as angle T (see figure 5-5). The observer is notified when angle T is significant enough to affect the adjustment of fire 500 mils or greater. When notified, the observer continues to make deviation corrections as shown in table 5-2. However, if the observer sees that the corrections do not have the proper effect (e.g., a right 200 correction appears to shift right 300), the observer may consider adjusting the corrections proportionately to compensate for dispersion resulting from angle T (i.e., cutting the correction in half).

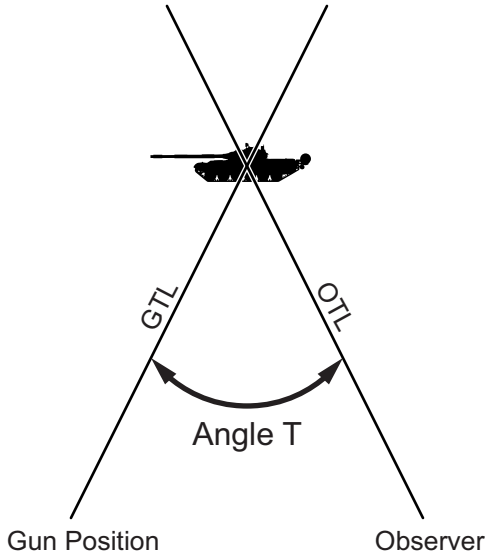



**Figure 5-5. Angle T.**

The spotter must remain abreast of the OTL/GTL relationship because the characteristic flat trajectory of NSFS results in a pronounced dispersion pattern along the GTL range dispersion. The spotter must derive the OTL/GTL relationship from the prefiring report and visualize the OTL/GTL relationship.

***Range Corrections***. The observer must aggressively adjust and should strive to enter fire for effect ASAP. When conducting an adjustment onto a target, the observer makes range corrections along the OTL. Range corrections consist of either the command *add* (move burst away from the observer) or *drop* (move burst closer to the observer). Range corrections are transmitted in multiples of 100 meters with the smallest correction being 100 meters. However, 50-meter corrections may be used when entering fire for effect. The methods for conducting range corrections are successive bracketing, hasty bracketing, one-round adjustment, and creeping fire.

*Successive Bracketing.* After a definite range spotting of over or short has been determined, the observer performs the following steps:

**Step 1**. Select a range correction that is large enough to ensure that the next round's impact is on the opposite side of the target from the previous round's impact. This brackets the target between the two rounds.

**Step 2**. Select a correction of add or drop 100, 200, 400, or 800 meters to achieve a bracket. Once a bracket has been established, corrections are made that successively split the bracket in half in multiples of 100-meter increments, always moving the next burst toward the target.

**Step 3**. Continue this process until a 100-meter bracket is established around the target or adjusting point.

**Step 4**. Add or drop 50, with a deviation correction as required, and enter the fire for effect phase.

***Note:*** The fire for effect phase is entered after a 200-meter bracket has been established when missions use a PER greater than 38 meters or when missions using shell dual-purpose improved conventional munitions (DPICM), M825, or family of scatterable mines (FASCAM).

In NSFS, once a 200-meter bracket is achieved, the spotter may enter fire for effect when engaging an area target, such as a supply depot. If the observer fails to achieve a bracket on the initial correction, another range correction is retransmitted until a bracket is achieved. Successive bracketing procedures are time consuming. This procedure should be used only when time is not critical and the situation requires this type of adjustment.

**Example: Successive bracketing**

The observer's spotting for the first round is over, 75 mils left.

Using an OT factor of 2 and an OT distance of 2400. The observer's first correction would be *right 150, drop 200*.

The next spotting is short, 15 mils right.

The observer transmits *left 30, add 100*. The round impacts short, 5 mils right. The observer transmits *add 50, fire for effect*.

No deviation corrections of less than 30 are made.

***Note:*** Large range corrections (e.g., add/drop 800) may indicate an error in the initial OT factor calculated by the observer. A new OT factor can be refined by combining the initial distance to target with subsequent range corrections. Determine a new OT factor with bold range corrections. Accuracy in adjustment depends on an accurate OT factor.

*Hasty Bracketing*. Effectiveness on the target decreases as the number of rounds used in adjustment increases because of the loss of surprise. An alternative to successive bracketing is hasty bracketing. In this technique, the observer uses an initial bracket as a yardstick to determine a correction necessary to move the next rounds onto the target in fire for effect. Hasty bracketing can achieve effective results depending on the nature of the target, the terrain, the firing unit's proficiency, and the observer's experience. However, hasty bracketing is difficult to use when adjusting NSFS because of its characteristic dispersion pattern.

*One-Round Adjustment*. Unlike successive and hasty bracketing, this method does not require the establishment of a bracket. The observer spots the location of the first round, calculates, transmits a correction that is necessary to move the next burst onto the target, and fires for effect. One-round adjustment requires an experienced observer who is familiar with the terrain. This method can be used when insufficient time exists for adjustment, when the observer is equipped with a CLRF, or

when the continued adjustment of fire may endanger the observer. The laser polar technique uses a one-round adjustment because of the accuracy of its measurements.

*Creeping Fire*. The creeping fire method of adjustment is used when the observer desires to make range corrections by creeping the rounds closer to the target instead of bracketing or making large corrections. This method of adjustment is always used in danger close missions. In danger close situations, the observer must remember the position of the friendly troops to ensure that a correction will not cause rounds to endanger them. This may be applicable in situations where lost rounds are likely, such as adjusting onto a target located on the topographic crest of a hill.

For artillery and mortars, the observer makes corrections for creeping fire in 100-meter increments or less when moving rounds toward friendly forces. All mortars that will fire for effect are used in adjustment. For battalion missions, firing batteries should be adjusted individually.

In NSFS, the spotter moves each round in creeping fire toward the target in increments of 100 or 200 meters until the effect is obtained. The combined effect of the correction should not exceed 200 meters toward friendly forces. If more than one gun is to fire for effect, the spotter should check the MPI of all guns to be used before entering fire for effect. Fires may be crept to within a minimum safe distance of the friendly position. Recommended minimum safe distances for adjusting salvos of a 5-inch gun are 200 meters when firing parallel to front lines and 350 meters when not firing parallel to the front lines. The ship will normally advise the spotter when the predicted fall of shot approaches the minimum safety distances.

***Height of Burst Corrections***. Height of burst corrections are used to adjust the difference in altitude between the impact of rounds and the target and to make corrections for air bursts. Height of burst corrections are needed when attacking targets that are located on a steep slope or presenting a vertical face. The observer uses up or down corrections (presented in meters) to move the impact of the round. These corrections allow the observer to deliver rounds on target with fewer adjustments than when using other corrections (i.e., right/left, add/drop). When using up or down corrections, the observer adjusts to the target and does not bracket (see figure 5-6).

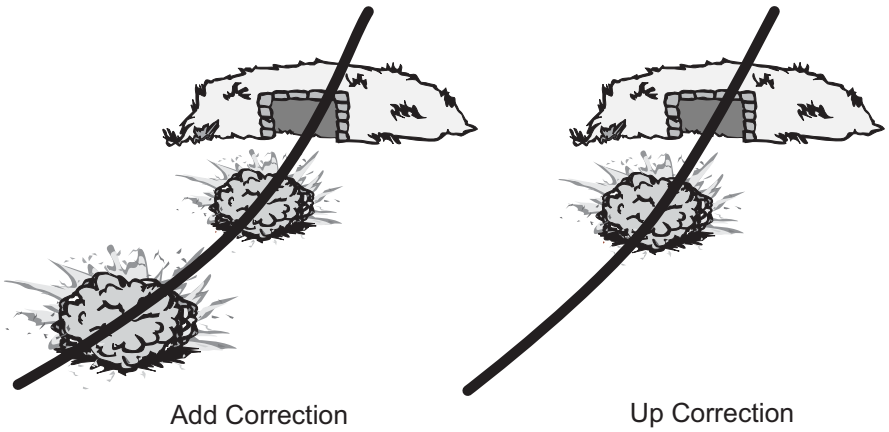



**Figure 5-6. Examples of Corrections.**

***Repeat***. During the subsequent correction phase, the command *repeat* means to fire another round using the same firing data that was used to fire the previous round. The observer may adjust for any change in ammunition. Repeat is not sent in the initial call for fire.

## FIRE FOR EFFECT PHASE

### Conditions for Entering the Fire for Effect Phase

The fire for effect phase is entered when the deviation, range, and HOB are correct or if effective fire will result when the range bracket is split. In artillery and mortars, the observer enters the fire for effect phase in the following situations:

- When an adjusting round has an effect on the target.
- When splitting a 100-meter bracket.
- When splitting a 200-meter bracket if notified by the FDC that the PER is 38 meters or larger or when firing shell DPICM, M825, or FASCAM.

During NSFS the spotter enters fire for effect in the following situations:

- When an adjusting round has an effect on the target.
- When splitting a 100-meter bracket for a point target.
- When splitting a 200-meter bracket for an area target.

### Procedures for Entering the Fire for Effect Phase

In artillery and mortars, the observer announces *fire for effect*, preceded by any corrections.

**Example: Fire for effect**

*Fire for effect, over*

or

*Right 30, add 50, fire for effect, over.*

During NSFS, the spotter transmits corrections as required, including the number of guns or salvos if different from that used in adjustment or stated in the call for fire, then *fire for effect.*

**Example: Transmission of correction**

*Right 30, add 50, 6 salvos, fire for effect.*

### Procedures for Obtaining Additional Fire After Fire for Effect

The observer analyzes the results of the fire for effect. The situation may require additional rounds to be fired on either the same or a different location. If additional fire is needed for artillery and mortars, the observer announces *repeat*, indicating that the observer desires to use the same volume of fire.

### Adjust the Mean Point of Impact (Artillery) of the Fires

If the location of the fire needs to be moved to achieve satisfactory results, the observer announces the appropriate corrections or refinement and *repeat or adjust fire*.

**Example: Adjust MPI of fires**

*Right 100, repeat, over.*

*Add 400, adjust fire* (spotter adjusts for NSFS), *over*.

For NSFS, the spotter distributes the fire over an area target by announcing *spreading fires,* followed by a correction or repeat.

**Example: Spreading fires**

*Spreading fires, right 100, repeat, over*.

### Refinement

Refinement is furnished for all missions. It is a term used in artillery to indicate a final correction to move the center of impact to the adjusting point. This correction may be less than 30 meters and is expressed to the nearest 10 meters.

**Example: Correction or refinement**

*Right 20, add 20.*

### End of Mission

Once the desired effects are achieved on a target, the observer should transmit an end of mission statement to the firing unit. Four items are needed in the end of mission statement: refinement, record as target, end of mission, and surveillance. With all artillery calls for fire, SEAD, immediate suppression, and other types of missions, the FDC should receive an end of mission statement from the observer. There are no self-ending missions.

***Refinement***. In artillery, if fires have been inaccurate but have produced sufficient results, the observer transmits a correction or refinement to the FDC.

**Example: Correction or refinement**

*Right 20, add 20, end of mission, RPG silenced, over.*

***Record as Target***. The observer announces *record as target* to plot the target for future use. In artillery and mortars, the FDC applies the refinement, conducts a replot when necessary, and announces the adjusted grid to the target. The target number should be the same number that is provided in the MTO. During NSFS, the target number is assigned by the spotter.

**Example: Assigned target number**

*Record as target, target number AB 1250, over*.

***End of Mission***. Announcing *end of mission*, followed by surveillance, is the last transmission in the course of the fire mission. Once it has been announced, the mission is considered to be terminated.

***Surveillance***. Surveillance should be brief, but it should provide casualty and/or damage information as accurately as possible. This requires the correct usage of the terms destroyed, neutralized, and suppressed, as addressed in appendix D.

**Examples: Surveillance**

*End of mission, BMP neutralized, estimate 6 casualties, over.*

*Right 20, add 20, record as target, end of mission, 3 trucks destroyed, estimate 15 casualties, over.*

## NAVAL SURFACE FIRE SUPPORT ADJUSTMENT PROCEDURES

The flat trajectory and high muzzle velocity of NSFS make the adjustment of NSFS difficult, particularly on flat terrain. The spotter must use accurate target location, bracketing, and the following procedures:

- *Identify the GTL relative to the spotter's own position and the target*. This will provide the basis for the spotter to identify round-to-round dispersion in adjustment.

- *Recognize the dispersion pattern of NSFS*. The fall of shot of NSFS can be described as a narrow, elongated pattern as seen along the GTL. The size of the pattern varies with range. For example, at 21,000 meters, the 5-inch gun mount will cause a round-to-round dispersion pattern that is approximately 150 meters long and 50 meters wide. Figure 5-7 displays the NSFS dispersion pattern.

- *Predict each fall of shot before impact*. While the ship is determining firing data for the next round, the spotter should visualize the fall of shot based on corrections. The spotter compares the actual impact of the round with the predicted fall of shot. Differences that occur along the GTL may indicate round-to-round dispersion.

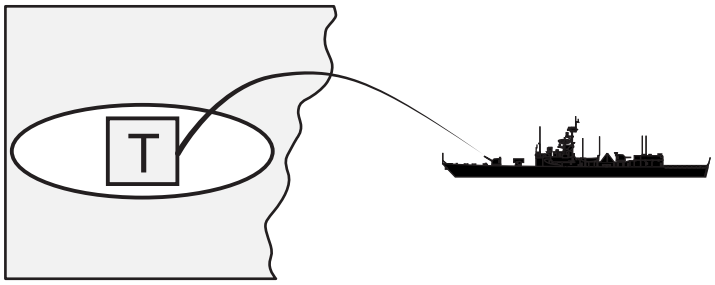



**Figure 5-7. Naval Surface Fire Support Dispersion Pattern.**

- *Ignore errors to the fall of shot attributed to round-to-round dispersion*. When a round has impacted contrary to its predicted fall of shot due to dispersion, the spotter makes a correction from the predicted point of impact instead of the actual point of impact. This correction should result in the next fall of shot impacting as predicted, keeping the spotter from getting a ping-pong effect in adjustment (see figure 5-8).
- *Correct from MPI*. When consecutive rounds impact differently from their predicted fall of shot, the spotter should make a correction from the average or MPI of the rounds (see figure 5-9).
- *Adjust multiple rounds*. There may be times when the spotter needs to adjust with multiple rounds, fire multiple salvos from a single gun, or use multiple guns in adjustment. Using

1. The spotter visualizes the GTL. The spotter's first spotting is short, 35 mils right (OT factor = 2).

2. The spotter transmits a correction of left 70, add 200. The predicted fall of shot is over, on line A.

3. The spotter's second spotting is over, 25 mils left. The apparent error is along the GTL. The spotter transmits a correction of drop 100.

The third spotting impacts as predicted, short on line B.The spotter's final corrections add 50, five salvos, fire for effect.

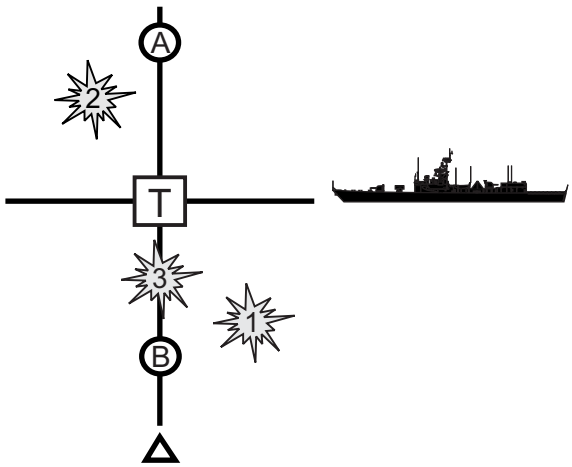



**Figure 5-8. Example of Dispersion.**

multiple rounds as an adjustment technique requires the spotter to adjust from the MPI of all rounds fired. This technique is typically used when firing on a large-area target or when visualizing the GTL. This technique can also be used by spotters who are experiencing difficulties in range dispersion during adjustment.

## ARTILLERY AIR BURST ADJUSTMENT AND CORRECTION

On steep terrain, up or down corrections are essential in the adjustment of fires. The spotter should—

- Use the corrections to bring the fall of shot to the same elevation as the target. Up or down corrections will be reflected on the ground concerning GTL.
- Transmit up or down corrections in increments of 5 meters.
- Use the map to help determine these corrections.
- Avoid mixing add or drop with up or down corrections for impact fires because both of these corrections involve an elevation change on the gun and the results would be unpredictable. Deviation and range adjustments along the OTL will usually equate to elevation changes on the gun when transformed to GTL corrections.
- Use up or down corrections to bring the impacts to the same altitude as the target, then switch to deviation and/or range corrections.

Fuzes that create an air burst with shell HE are either mechanical or time fuzes or they are proximity or VT fuzes. When firing fuze time, the observer must adjust the HOB. The adjustment of air bursts is made by using HOB spottings to determine a correction. The firing battery fires one gun in adjustment. Variable time fuzes do not require adjustment.

1. The first spotting is short, 35 mils right (OT factor = 2). The first correction is left 70, add 200. The predicted fall of shot is over, on line A.
2. The second spotting is over, 25 mils left. (The apparent error is along the GTL.) The spotter transmits a correction of drop 100. The predicted fall of shot is short, on line B.
3. The third spotting impacts short, 30 mils left. The spotter notes that two consecutive rounds have impacted left of their predicted points of impact, on line A and B.

The final correction is right 50, add 50, five salvos, fire for effect. Note that the spotter made this deviation correction from the MPI of the last two rounds 25, mils left and 30 mils left.

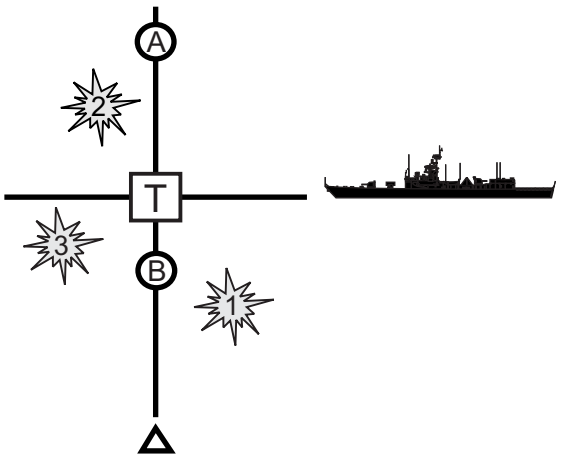



**Figure 5-9. Adjustment of Mean Point of Impact (Artillery).**

### Mechanical or Time Fuzes

***Adjustment***. After HE/PD is adjusted for deviation and range to within 50 meters of the target, the observer makes HOB adjustments by initiating the firing of an air burst. The observer announces *time repeat* or *time*, followed by a deviation and/or range correction. When an air burst detonates, the HOB spotting (to the nearest mil) is multiplied by the OT factor to determine a correction in meters. The correction is made to cause the next air burst to detonate 20 meters above the target. The correction is transmitted as an up or down correction followed by the number of meters. Deviation or range corrections are not made after entering the time phase.

***Correction***. When making HOB corrections, the observer must be aware of the gunnery solution and its effect on the round (see figure 5-10). When an HOB correction is given by the observer, the FDC converts the HOB correction to a fuze setting correction for the mechanical time fuze.

An up HOB correction will result in a decrease in the fuze setting. A down correction will result in an increase in the fuze setting. The change in fuze setting will change the point of detonation along the trajectory of the round. In addition to achieving a change in HOB, the observer will also notice a change in range. An up correction will result in the round detonating short of the target. A down correction will result in the round detonating closer to the target.

If the initial round is a graze spotting, then an automatic correction of *up 40* is made. Subsequent *up 40* corrections are given until an air burst is achieved. Consecutive graze spottings may indicate an error by the battery (e.g., improper fuze setting) or an error by the observer in target

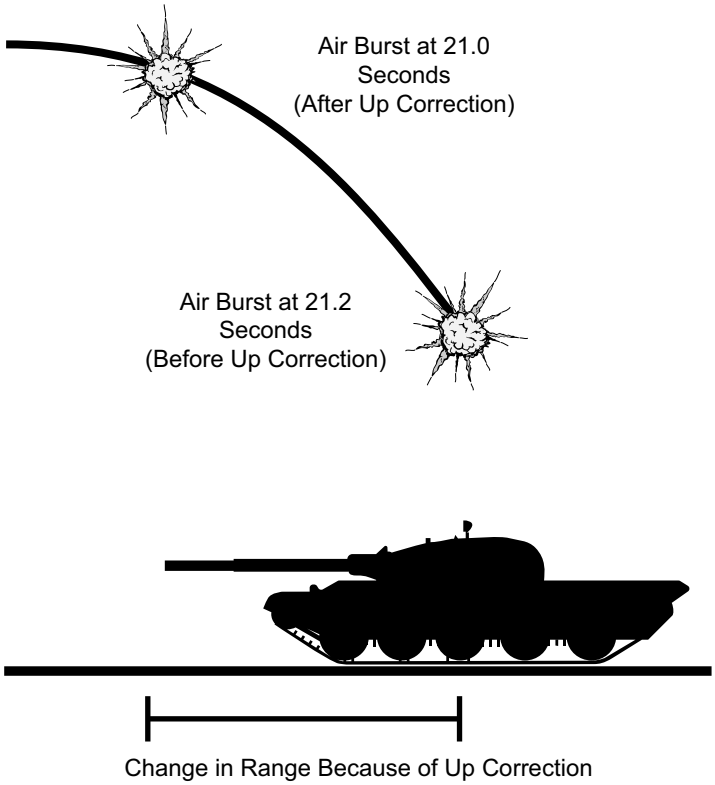



**Figure 5-10. Effect of Height of Burst Corrections on Burst of Round.**

location altitude. The observer must avoid making deviation and range corrections from a graze burst unless unable to achieve effects on target.

***Fire for Effect***. When an air burst is achieved, the fire for effect phase is entered if the observer believes that the HOB correction will result in a 20-meter HOB. Fire for effect is never initiated if the last round observed was spotted as graze or if the HOB correction is greater than 40 meters.

**Example: Fire for effect**

*Down 10, fire for effect, over.*

There are several possible spottings for both the initial fire and any needed corrections:

- *Air*. Adjust the mean HOB to 20 meters.
- *Mixed*. The correction given is *up 10*.
- *Mixed air*. The HOB is correct.
- *Mixed graze*. The correction given is *up 20.*

Time fuzes are normally selected for adjust-fire missions because of the requirements to achieve an effective HOB. However, it is possible to initially fire for effect with time fuzes if a registration has been conducted with that particular fuze lot. The closer the target is to the registration point, the greater the likelihood of achieving effects without adjustment.

#### Proximity or Variable Time Fuzes

***Adjustment***. Variable time fuzes require no adjustment before firing for effect. The fire for effect phase is entered after the appropriate bracket is established with the adjusting shell and fuze. Variable time fuzes should always achieve an air burst.

***Correction***. Variable time fuzes achieve their 7-meter HOB by using radar, not the time setting on the fuze. Graze bursts of an entire volley indicate one of the following:

- A computational error by the battery (e.g., improper fuze settings).
- An error by the observer in target location altitude.
- A malfunctioning lot of fuzes.

In the case of graze bursts with VT, the spotting of graze is transmitted to the FDC. The FDC will subtract 1 second from the fuze arming time in an attempt to overcome computational or observer error. Factors affecting the performance of VT fuzes and possibly creating premature air bursts may include snow, water, and intervening crests.

**Example: Fire for effect**

*Graze, repeat, over*.

## NAVAL SURFACE FIRE SUPPORT AIR BURST ADJUSTMENT AND CORRECTION

Time fires use special fuzes to achieve an air burst over the target. These fuzes include mechanical and electronic time fuzes that require a time setting before firing. Air bursts may also be delivered by proximity fuzes (i.e., VT or CVT) designed to explode at an optimal HOB (e.g., 7 meters for 5-inch NSFS) based on a radio-activated signal. Time fires using time or electronic time fuzes require adjustment to ensure detonation at an optimal HOB (i.e., 20 meters) in fire for effect. Proximity fuzes do not require adjustment.

### Adjustment of Time Fires

The observer announces *fuze time in effect* in the method of engagement element of the call for fire and conducts adjustment with fuze quick. The observer will enter the time phase of the adjustment process in the following situations:

- When splitting a 200-meter bracket for an area target.
- When splitting a 100-meter bracket for a point target.
- When an adjusting round has an effect on the target.

The transmission to enter into the time phase of adjustment is *fuze time,* followed by a correction or repeat.

**Example: Fuze time adjustment**

*Fuze time, right 30, add 50, over.*

*Fuze time, repeat, over.*

### Correction for Height of Burst

If the initial time round is spotted as a graze, then the correction given is *up 40*. A 40-meter HOB correction will be applied until an air spotting is obtained. Consecutive graze spottings may indicate either an error in the altitude of the target reported in the call for fire or an error by the mechanical fuze setter on the gun. The spotter must avoid making deviation and range corrections from a graze burst. Usually, a graze burst will be over the target on the GTL. Once an initial air spotting is achieved, the spotter measures the spotting to the nearest mil and computes an HOB correction by multiplying the spotting by the OT factor. The HOB correction is made to the nearest 5 meters to correct the HOB to 20 meters. If a correct HOB is expected, the spotter enters fire for effect. If the air spotting is abnormally high (i.e., 60 meters or greater), then the spotter should observe another salvo before entering fire for effect. Abnormally high bursts (HBs) are typically short on the GTL and out of the target area because the fuze functioned prematurely in the projectile's trajectory. If a graze burst is obtained after an air burst, the correction given is *up 20*. Fire for effect is never begun when the last burst observed results in a graze spotting.

# CHAPTER 6
# ARTILLERY AND MORTAR SPECIAL SITUATIONS

The C-FST may be required to perform artillery and mortar special situation missions. These special situation missions are usually designed for a specific purpose and are not the normal means of providing fires.

## HIGH-ANGLE FIRE

High-angle fire is fire delivered at angles of elevation greater than the elevation that corresponds to the maximum range of the gun and ammunition concerned. High-angle fire is employed in two instances: for artillery when the weapons fire out of defilade from within built-up areas or over high terrain features near friendly troops and against targets in defilade when the target is directly behind hill crests, in jungles, or in deep gullies or ravines and cannot be reached by low-angle fire.

The procedures for the adjustment of high-angle fire are the same as those for the adjustment of low-angle fire (see chapter 3). The observer must realize that small deviation corrections during adjustment may be unnecessary and time consuming because of the increased dispersion experienced during high-angle fire. Because the TOF is long in both adjustment and fire for effect, the FDC announces *shot* when the round is fired and *splash* 5 seconds before the burst occurs. Fuze time is not used with HE projectiles in high-angle fire because of the high probability of errors in HOB. If an air burst is desired, fuze VT provides excellent results.

## PRECISION FIRE

The use of precision fire places a heavy responsibility on the observer, who must consider the time required, ammunition expenditure, and signature of the firing unit in relation to the effect that may be gained from precision fire missions. When conducting a precision mission, an 8-digit grid should be used unless the observer is equipped with a CLRF. When so equipped, a near mensurated coordinate should be used. The two types of precision missions are registration and destruction.

### Registration

Registration is the adjustment of fire to determine firing data corrections. The observer is directed to conduct registrations when the firing unit has no other means to determine firing data corrections to improve its accuracy.

***Precision Registration***. A precision registration is conducted with a single weapon. The FDO may instruct the observer to conduct a registration on a designated point or may have the observer select the registration point. The registration point should be accurately located, semipermanent, near the center of the zone of fire, on fairly level terrain if possible, and on common survey with the firing unit. The registration may include an impact portion (i.e., adjustment of fuze quick) or an impact and time portion (i.e., adjustment of fuze quick and fuze time). The precision registration is initiated with an MTO.

**Example: Precision registration**

FDC: *H18 this is H44, register on known point 2, quick and time, over*.

Observer: Reads back.

Observer: *Direction 6400, over.* Transmission given when ready to observe.

FDC: Reads back.

FDC: *Shot, over.*

Observer: *Shot, out.*

The FDC may provide a general vicinity for the observer to select a registration point. If this occurs, the observer transmits the selected 8-digit grid, including altitude and direction.

**Example: Grid registration point**

*Grid 6124 3843, altitude 210, direction 6310, over.*

*Impact Portion: Adjustment of Fuze Quick*. The objective of the impact portion of a registration is to obtain spottings of 2 over and 2 short along the OTL from rounds fired with either the same data or 25 meters apart. Fifty meters is applicable when PER is greater than or equal to 25 meters. These rounds are called usable rounds and typically require spottings from four separate rounds. However, a target hit or a round that is spotted as *range correct* counts as a spotting of both over and short. Therefore, the objective could be achieved with two consecutive target hits or range correct spottings. The following applies in these situations:

- *Deviation*. The observer spots the rounds for deviation to the nearest mil and brings rounds onto the OTL before splitting a 200-meter bracket. Deviation corrections should not be made after a 200-meter bracket has been established. Once the rounds are brought onto the OTL, the observer measures and records deviation spottings but makes no correction. When a doubtful range spotting is obtained, the observer corrects for deviation only. If a deviation correction must be made after a 200-meter bracket has been established, the last round fired and all previous rounds cannot be considered usable for determining range and deviation refinement data.

- *Range*. The observer spots the rounds for range (i.e., over, short, or range correct) and makes range corrections by using successive bracketing until a 50-meter range bracket is established (i.e., add or drop 50). Once this round impacts, the observer makes a spotting, a range correction to fire 2 rounds with data 25 meters in the direction opposite that of the spotting, and transmits *2 rounds, add or drop 25*. If both rounds result in spottings of short or over, the observer changes the volume to one round and transmits *add 25 or drop 25*. Firing is continued until 2 definite range spottings have been obtained at the opposite end of the 25-meter bracket.
- *Refinement*. When the requirement of 2 over and 2 short with the same data or data fired 25 meters apart has been met, the impact portion of the registration ends with necessary refinement data. Refinement data may include a deviation correction, a range correction, or both to the nearest 10 meters.

When determining refinement data for range, the location of the registration point is determined with respect to the two sets of spottings, and then refinement data is determined and announced. If the registration point is closer to the last rounds fired, then no range refinement is necessary to move the impact toward the registration point (see figure 6-1).

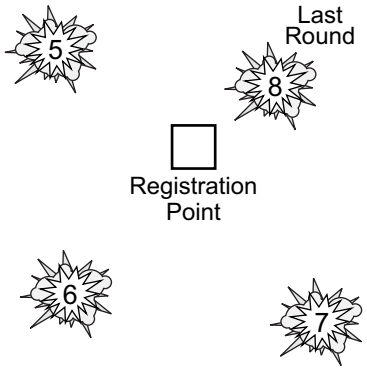



**Figure 6-1. No Range Refinement Necessary.**

If the registration point is equidistant between the two sets of rounds, then the observer determines the range refinement to be either add 10 or drop 10 from the last data fired (see figure 6-2).

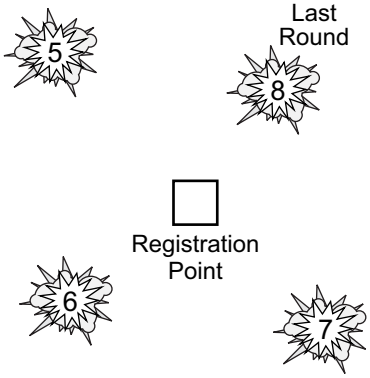



**Figure 6-2. Drop 10.**

If the registration point is closer to the pair of rounds at the opposite end of the bracket, then the observer determines the range refinement to be either add 20 or drop 20 from the last data fired (see figure 6-3).

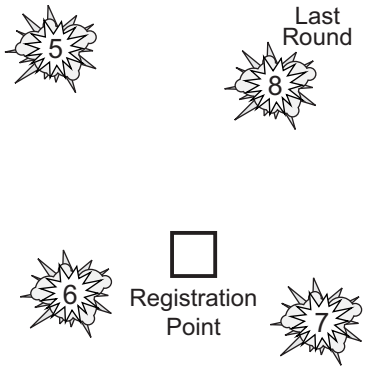
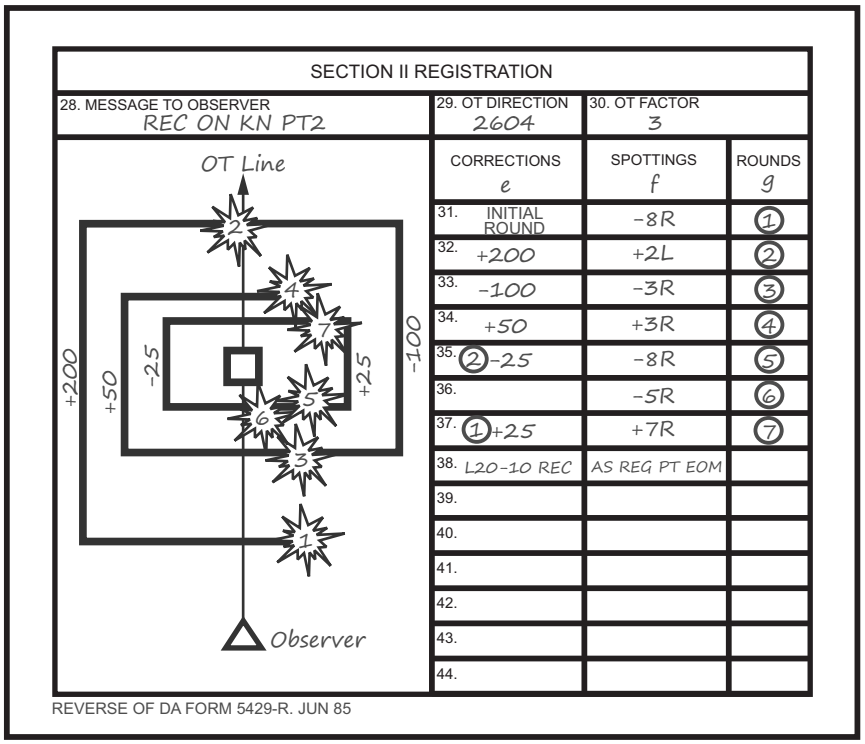



**Figure 6-3. Drop 20.**

The observer must monitor the rounds and how they are spotted in relation to the registration point. This is accomplished by drawing a registration diagram and numbering the rounds, as illustrated in figure 6-4.




**LEGEND**

| | |
|---|---|
| **EOM** | end of mission |
| **KN PT** | known point |
| **REC** | record |
| **REG** | register |
| **REG PT** | registration point |

**Figure 6-4. Example of Registration Diagram.**

Deviation refinement is determined by adding the deviation spottings of the rounds, establishing the 2 over and 2 short. This may include two, three, or four deviation spottings. This total is then divided by the number of rounds to obtain an average deviation, which is expressed to the nearest mil. The average deviation, multiplied by the OT factor, equals the correction, which is expressed to the nearest 10 meters.

**Example: Deviation corrections for impact registration**

The observer has determined four usable rounds with the following spottings:

| Round | Spotting |
|---|---|
| 4 | Over, 6 right |
| 5 | Short, 8 right |
| 6 | Short, 5 right |
| 7 | Over, 7 right |

The observer determines the sum of the deviation spottings to be 26 right (6 right + 8 right + 5 right + 7 right).

The average deviation of 6 right (26 right ÷ 4 rounds = 6.5 [6 right]) is multiplied by the OT factor (3) to determine the deviation refinement of left 20 (6 right x 3 = 18 meters right [left 20]).

The average deviation of 6R (26R ÷ 4 rounds = 6.5 [6R]) is multiplied by the OT factor (3) to determine the deviation refinement of left 20 (6R x 3 = 18 meters R [left 20]).

If the spottings include right and left spottings, the observer must algebraically compute the average deviation: 7 right and 3 left = 4 right.

If the calculated deviation refinement is less than 10 meters, it is omitted.

The registration point was equidistant between the two sets of rounds, as illustrated in figure 6-2. The observer determines the range refinement to be drop 10.

The observer transmits the following correction:

*Left 20, drop 10, record as registration point, end of mission.*

If the MTO specified only an impact portion of the registration, then the observer terminates the impact registration by transmitting refinement data, followed by the announcement of *record as registration point, end of mission*.

**Example: Impact registration termination**

*Left 20, drop 10, record as registration point, end of mission, over.*

If the MTO specified an impact and time portion, then the observer terminates the impact portion and initiates the time portion by transmitting refinement data followed by the announcement of *record as registration point, time, repeat*.

**Example: Time portion initiation**

*Left 20, drop 10, record as registration point, time, repeat, over.*

*Time Portion: Adjustment of Fuze Time.* The objective of the time portion of precision registration is to correct the mean HOB (4 rounds fired with the same data) to 20 meters above the registration point:

- *Adjustment*. If the first round is spotted as graze, then a correction of *up 40* is given. If the first air burst is extremely high, the observer may send a down correction and repeat. Once a measurable air burst (i.e., an HOB of 60 meters or less) has been obtained, the command given is *3 rounds, repeat, over*.
- *Refinement*. When 4 rounds have been fired with the same data, the registration is ended with the appropriate correction to achieve a 20-meter HOB. When 4 air bursts are spotted, the HOB is corrected to 20 meters.

The mean HOB is determined by adding the four spottings in mils, dividing by four, expressing the sum to the nearest mil, and then multiplying by the OT factor. This is the same technique used in determining deviation corrections. The sum is then expressed to the nearest 5 meters, and the appropriate correction is determined to achieve the desired 20-meter HOB.

**Example: Refinement to achieve HOB**

*Up 10, record as time registration point, end of mission, over.*

For mixed spottings, the following automatic corrections are used:

- Three air bursts and one graze—no correction required.
- Two air bursts and two grazes—*up 10*.
- One air burst and three grazes—*up 20*.

Check rounds may be fired to verify time registration validity; however, they are not necessary.

***Second-Lot Registration***. The FDC may direct the observer to conduct a second-lot registration. Second-lot registrations are conducted in a manner similar to that for first-lot (i.e., single) registrations. After the first-lot impact registration has been completed, a precision registration for fuze time is conducted if required. The FDC will announce to the observer *observe second-lot registration* after the observer has recorded the registration of the first lot. The observer must then establish the appropriate range bracket and complete the second-lot registration. The time portion of the registration is not fired with the second lot.

***Abbreviated Registration***. At times, the tactical situation or ammunition constraints may prohibit conducting a full-scale precision registration. Although not as accurate, an abbreviated precision registration can compensate for the effects of nonstandard conditions. Abbreviated registrations are more accurate and therefore more feasible if the observer is equipped with a CLRF. The FDO makes the decision to conduct an abbreviated registration. For this type of registration, the observer shortens the standard procedures of a precision registration.

> ***Note:*** Concerning impact portion-adjustment of fuze quick, normal adjust-fire procedures are followed until a 100-meter bracket is split. The correction sent is *add or drop 50*. The burst that is a result of an add or drop 50 correction is spotted. Minor corrections for both deviation and range to the nearest 10 meters are sent to the FDC, along with the announcement *record as registration point, (time repeat)*, as shown in figure 6-5.

> ***Note:*** Concerning time portion-adjustment of fuze time, normal adjust-fire time-adjustment procedures are followed in the time portion. An air burst is obtained and then corrected to a 20-meter HOB. Instead of firing for effect, refinement is sent to the FDC, the time registration point is recorded, and the mission is ended.

***Mortar Precision Registration***. Precision registration for mortars is conducted for impact fires only. The procedures are almost identical to the precision registration of fuze quick (i.e., impact) procedures for artillery. The exceptions are as follows:

- Only spottings of one round over and one round short are required.
- Once a 100-meter range bracket has been split and the last fired round is within 50 meters of the target, refinement corrections are sent to the FDC and the mission is ended.
- Range refinements are made to the nearest 25 meters.

The transmissions to the FDC after the last two rounds are similar to those used for artillery.

Adjustments for the mortar sheaf must ensure that all of the mortars fire parallel. The sheaf may be adjusted at any time during a fire mission but may be directed by the FDC after a registration. The FDC will announce *prepare to adjust sheaf, over.* The mortars will be positioned and numbered in sequence from right to left as seen from behind the tubes. For 81-mm mortars, numbers may be 1 through 8 when positioned as a platoon and 1 through 4 for a 2-section position.

> ***Note:*** In the 81-mm mortar platoon, the term “mortar section” refers to 4 tubes (i.e., squads).

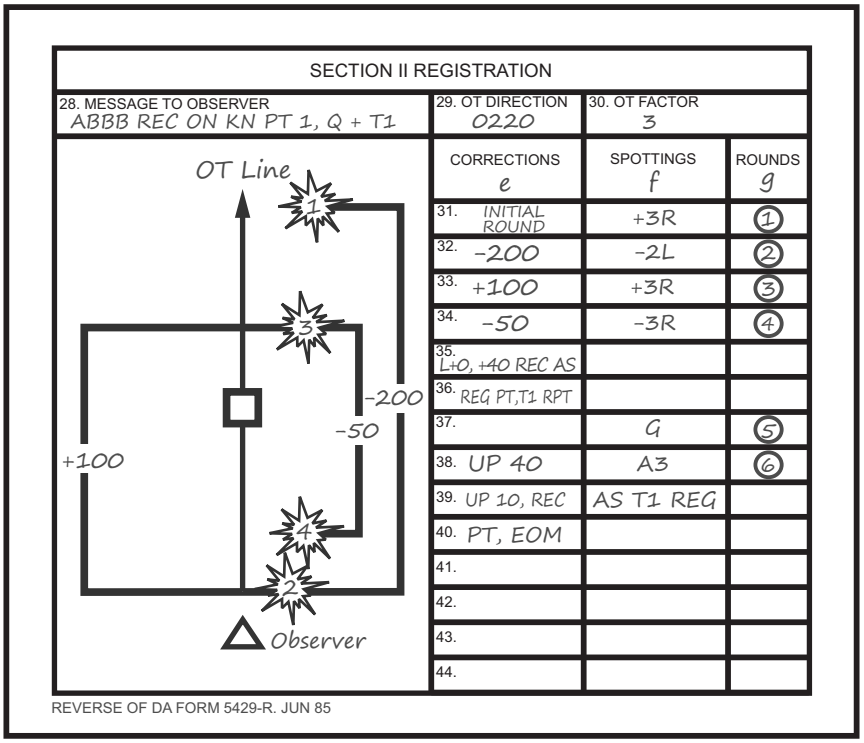
To adjust the sheaf, the observer requests section right or section left, repeat, over. Each squad will then fire, in order, from left to right or right to left, with 10-second intervals between rounds. The mortar that was used to register will not fire.

**Example: Sheaf adjustment**

If the observer requests *section right, repeat, over* and number two conducted the registration, then numbers one, three, and four would fire.

When adjusting the sheaf, all rounds must be adjusted on line at approximately the same range, within 50 meters, and with 40 meters of lateral spread between rounds. Range corrections for rounds impacting within 50 meters of the sheaf line are ignored. The sheaf is adjusted perpendicular to the GTL. If angle T is greater than 500 mils, each piece is adjusted onto the registration point and the FDC computes data for the sheaf. Lateral refinement corrections are made to the nearest 10 meters, but corrections of less than 50 meters are not fired. Once refinement corrections for all mortars have been determined, the sheaf has been adjusted.

In the figure 6-6 example, an 81-mm mortar platoon sheaf is being adjusted where the platoon is employed in two 2-section positions. Tube 2 conducted the registration. The observer requested *section right, repeat, over*. All rounds are within 50 meters of the correct range. Only number 3 is




**LEGEND**

| | |
|---|---|
| **EOM** | end of mission |
| **KN PT** | known point |
| **REC** | record |
| **REG** | register |
| **REG PT** | registration point |

**Figure 6-5. Example of Abbreviated Registration.**

more than 50 meters out on lateral adjustment, so the adjustment for tube 3 is transmitted first. Next, refinement data for tubes 1 and 4 is transmitted as follows: *Number 3, right 60, repeat; number 1, right 30, number 1 is adjusted; number 4, left 20, number 4 is adjusted, over*.

Number 3 fires, and the round impacts 10 meters right of the desired burst location. The observer transmits *number 3, left 10, number 3 is adjusted, sheaf is adjusted, end of mission, over*. See figure 6-7 for the adjusted sheaf.

### Destruction

Destruction fires are fires delivered for the sole purpose of destroying objects. The destruction mission is fired by using one weapon to destroy a point target. It is similar to the registration

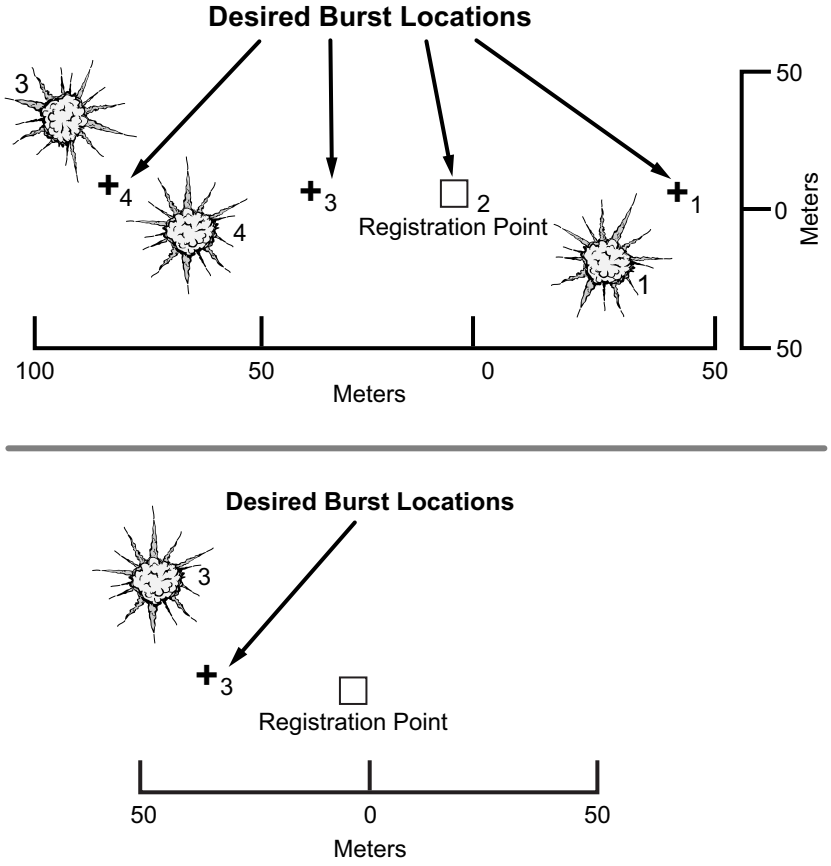



**Figure 6-6. Example of the Adjustment of a Mortar Sheaf.**

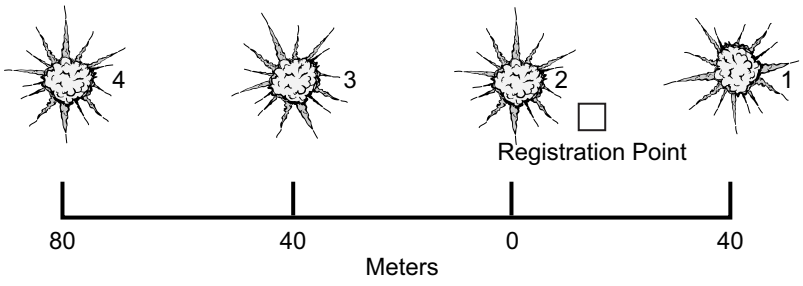
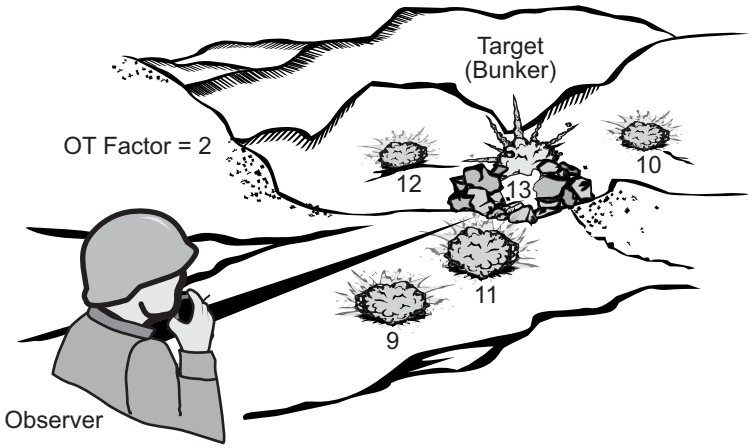



**Figure 6-7. Adjusted Mortar Sheaf.**

mission because the observer continues adjustments to establish a 25-meter bracket by adding or dropping 10 meters. The observer then continues to fire additional rounds, making corrections to the nearest 10 meters after every third round until the target is destroyed or the mission is ended. After every third round, an additional refinement is made, and firing is continued until the target is destroyed or the mission is ended. Corrections may be made after every round if desired. Because of the amount of time and ammunition required, destruction missions should be used only when required by the tactical situation. Only a target that is critical to an operation should be engaged in this manner and only if no other means exists to destroy the target. An example of a destruction mission is shown in figure 6-8.




FO: *H44 this is H18, adjust fire, over.*
FDC: Reads back.
FO: *Grid 4324 9684, altitude 100, over.*
FDC: Reads back.
FO: *Enemy machine gun bunker, destruction, over.*
FDC: Reads back.

| Round | Spotting | Correction |
|---|---|---|
| 1 | -30 left | Right 60, add 800 |
| 2 | +15 right | Left 30, drop 400 |
| 3 | -5 right | Add 200 |
| 4 | +4 right | Drop 100 |
| 5 | -4 right | Add 50 |
| 6 | +5 right | Drop 25 |
| 7 | -4 right | Add 10[1] |
| 8 | +5 right | Repeat |
| 9 | -4 right | Repeat |
| 10 | Range correct | Left 10[2] |
| 11 | Target | Repeat |
| 12 | | End of mission,[3] bunker destroyed |

**Notes:**
[1] Target was midway between the four spotting rounds.

[2] Preponderance was: 4 right + 5 right + 4 right = 13 right ÷ 3 = 4.3 right ≈ 4 right x 2 (OT factor) = 8 right ≈ 10 right. Correction is left 10.

[3] Mission ended because target was destroyed.

**Figure 6-8. Example of Destruction Mission.**

## HIGH-BURST OR MEAN POINT OF IMPACT REGISTRATIONS

The opportunities for artillery to execute a precision registration are limited because registration requires visual observation on a clearly-defined, accurately-located registration point within the target area. At night, visual adjustment of fire on a registration point is impossible without some type of illumination or night observation device. In desert, jungle, or arctic operations, clearly defined registration points in the target area are not usually available. Special procedures have been developed to provide for registration under these conditions: HB and MPI registrations.

The HB and MPI registrations are identical, except that the rounds for an HB registration are air bursts and the rounds for the MPI registration are impact rounds. Two observers, referred to as 01 and 02, are required to conduct these registrations. Each observer must occupy a surveyed OP and have a means to accurately conduct angular measurement, such as a CLRF. Directional control, or a line of known direction, must be established on the ground so that the observer can orient the instrument for direction. For night observation, this may require the prior orientation of instruments during daylight. The exact location of the instrument and the line of known direction should be marked so that they can be identified during darkness. Additionally, for HB registration, one observer must be prepared to measure vertical angles.

### High-Burst Registration Procedures

***Observing Instruments Initial Orientation***. To prepare the instruments for orientation, the exact location of the instrument and lines of known direction must be identified.

***Observing the High-Burst/Mean Point of Impact Registration***. For HB registration, the two observers simultaneously observe time fire aimed at a point that is located in the air above the target area. This location is determined as follows:

**Step 1**. The FDC selects the point where the fire will be aimed by selecting a point that is located on the ground in the area where the registration is desired and projects this point into the air with a prescribed HOB. This is the orienting point.

**Step 2**. The FDC controls the firing of the HB registration. One weapon is used to fire the registration. All rounds are fired with the same data.

**Step 3**. Each observer reports the direction from the observer's own position to the bursts. One of the observers will be directed to report the vertical angle after each round.

For MPI, the registration is the same, except the rounds are fired with fuze quick.

***Observing Instrument Orientation on the Orienting Point***. The FDC orients the observer by sending an MTO that tells each observer the direction and vertical angle from the observer's position to the selected orienting point. Each observer rotates a CLRF to the correct direction. The horizontal line

of sight of the instrument now coincides with the horizontal line of sight from each observer's position to the orienting point.

**Example: Observing instrument orientation**

*Message-to-observer, observe HB registration: 01 direction 1164, vertical angle plus 12. Measure the vertical angle. 02 direction 0718, vertical angle minus 3. Report when ready to observe.*

***Measuring and Reporting the First Round***. When the observers report *ready to observe*, the FDC directs the firing of the rounds, one at a time. The FDC reports *shot* and *splash* for each round. When the burst of the first round appears, each observer determines the actual observer direction to the round. The observers report their observations in turn.

***Determining the Vertical Angle***. The vertical angle is determined by measuring with a CLRF.

**Example: Observations**

*01 direction ____, vertical angle ____, over.*

*02 direction ____, over.*

***Reporting Unobserved Spottings***. If the observers do not observe the initial round within the instrument's field of view, this should be reported along with the location of the burst to the FDC.

**Example: Unobserved spotting**

*02 round unobserved, too far left, over.*

***Reorienting on the First Round***. Once the instrument is reoriented on the direction and vertical angle where the initial round burst, the observers report the direction and vertical angle, if applicable, of the first round to the FDC. This will allow for smaller deviation measurements for subsequent rounds.

***Measuring and Reporting Subsequent Rounds***. The procedures for measuring and reporting direction and vertical angle for subsequent rounds are the same as those for the first round. However, the observers typically do not reorient the instrument after subsequent rounds. Depending on proficiency, the observers may reorient on each subsequent round. When the FDC has obtained enough readings to compute the registration data, it terminates the registration by sending *end of mission* to 01.

### Mean Point of Impact Registration Procedures

In MPI registration, the FDC selects a ground location as the orienting point and uses impact fuzes in the registration. The establishment of the OPs and the procedures followed by the observer are the same as those in an HB registration.

## IMPROVED CONVENTIONAL MUNITIONS

Improved conventional munitions are base-ejection projectiles with a mechanical time fuze and a body assembly containing a number of submunitions. The submunitions (i.e., grenades) are ejected through the base of the projectile and scattered in the target area. There are two types of ICM rounds: the antipersonnel round and the dual-purpose round. Table 6-1 shows the number of grenades in each ICM round.

**Table 6-1. Improved Conventional Munitions Round Grenades.**

| ICM | Weapon | Projectile | Number of Grenades |
|---|---|---|---|
| Antipersonnel | 105-mm | M444 | 18 |
| | 155-mm | M449 family | 60 |
| | 105-mm | M915/6 | 42 |
| Dual-purpose | 155-mm | M483A1 | 88 |
| | 155-mm | M864 | 72 |
| | 226-mm multiple launch rocket system | M79 | 644 |

### Antipersonnel Round

The antipersonnel round is most effective against exposed personnel. When the fuze activates, an expelling charge forces the grenades out through the base of the projectile. Small vanes on each grenade flip forward, arming the grenade and stabilizing it in flight (see figure 6-9). When the striker plate on the base of the grenade makes contact with the ground, the grenade is hurled upward 4 to 6 feet and detonates. Antipersonnel improved conventional munitions (APICMs) are no longer manufactured, but they are still held in war reserve.

### Dual-Purpose Round

The dual-purpose round is most effective against personnel and lightly armored or thin-skinned vehicles. After the grenade is ejected, a ribbon streamer arms and stabilizes it during its descent (see figure 6-9). Upon impact, a shaped charge that can pierce 2.75 inches of rolled steel armor is detonated. The surrounding steel case fragments are very effective against personnel.

### Dispersion

All ICM projectiles are base ejecting. The fuze functions at varying HOBs, and an expelling charge is detonated that ejects the entire payload of submunitions out of the rear of the projectile. Centrifugal force disperses the grenades radially from the projectile line of flight. The size and shape of bomblet dispersion patterns are not constant and change over range. Also, the concentration of bomblets is not uniform over the entire surface area. There is a noticeable

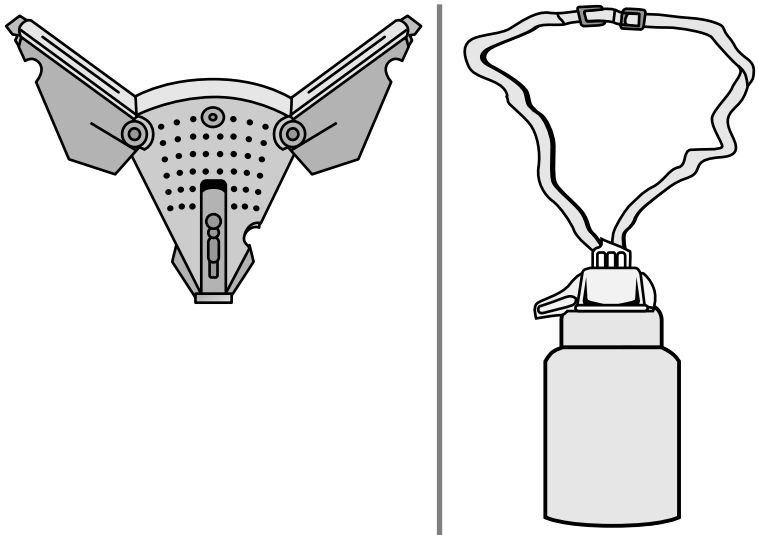
decrease of submunitions in the center of the dispersion pattern that is sometimes referred to as the doughnut effect. The different types of dispersion are discussed in the following subparagraphs.

***Antipersonnel Improved Conventional Munitions***. The M449 APICM dispersion is generally an elliptical shape. It disperses its submunitions approximately 100 meters by 60 meters. Depending on the observer's orientation to the GTL, a varying distribution of submunitions can be observed.

***Dual-Purpose Improved Conventional Munitions***. The M483A1 DPICM dispersion generally changes shape from elliptical at minimum ranges and lower charges, to almost circular at maximum ranges. This variation is because of the angle of fall and HOB. At minimum ranges, the dimensions are approximately 50 meters by 100 meters unless the observer is closer to the GTL. If this occurs, a bomblet dispersion of approximately 100 meters per projectile should be observed. At maximum ranges, they are approximately 100 meters by 120 meters.

***Base Burn Dual-Purpose Improved Conventional Munitions***. The M864 base burn dual-purpose improved conventional munitions (BBDPICM) are currently held in war reserve. Despite having fewer grenades, the dispersion pattern is larger than that of DPICM. However, because the M864 BBDPICM are designed for employment at higher ranges, which produce a steep angle of fall, the dispersion pattern is typically circular. At the designed range, the dimensions of dispersion are approximately 150 meters by 150 meters.

***Advanced Field Artillery Tactical Data System Special Circular Sheaf***. Based on the dimensions of a single projectile's dispersion, the dimensions of the typical sheaf can be predicted. The default AFATDS special circular sheaf is a 100-meter radius with aim points equally distributed on a concentric circle at half the target radius (i.e., 50 meters). Depending on the range, the DPICM sheaf is typically 200 meters by 200 meters. Figure 6-10 shows four guns firing DPICM at



105-mm/155-mm/203-mm APICM Grenade

155-mm/203-mm/MLRS DPICM Grenade

**Figure 6-9. Improved Conventional Munitions Grenades.**

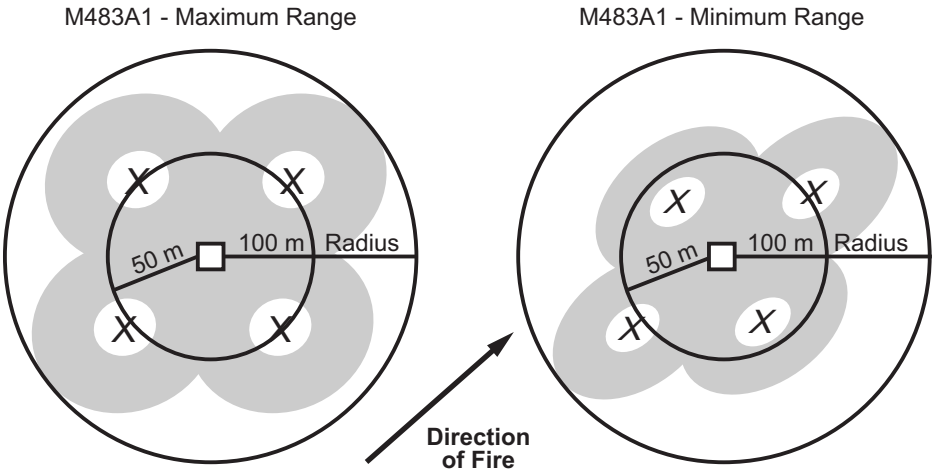



**Figure 6-10. M483A1 Dispersion Pattern at Maximum and Minimum Ranges.**

maximum range and at shorter ranges. Angle T can affect what the observer sees regarding the sheaf. The BBDPICM sheaf is consistently 250 meters by 250 meters. Figure 6-11 shows four guns firing BBDPICM. If errors occur as a result of the dispersion of the projectiles, a random gap or overlap within the sheaf may be observed.

### Improved Conventional Munitions Call for Fire

The ICM call for fire is the same as any other call for fire.The observer identifies the type of ICM that should be fired in effect by referring to APICM as APICM and DPICM as ICM. A BBDPICM is only employed at ranges beyond DPICM as determined by the FDC (see appendix E). Normal corrections for HE in adjustment apply; however, the fire for effect phase is entered once a 200-meter bracket is established. Procedures for the adjustment of ICM are addressed in the following subparagraphs.

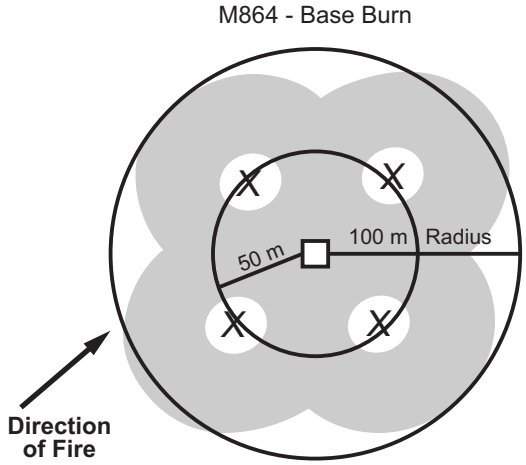



**Figure 6-11. M864 Base Burn Dual-Purpose Improved Conventional Munitions Dispersion Pattern.**

**Example: ICM call for fire**

**HOB adjustment DPICM in effect**

*P51 this is P87, adjust fire, over.*

*Grid 933 876, over.*

*Infantry company halted, APICM in effect, over.*

**Fire for effect with DPICM**

*P51 this is P87, fire for effect, over.*

*Grid 372 461, over.*

*Platoon assembly area, ICM, over.*

***Range and Deviation***. Because of the size of the effects pattern, deviation shifts of less than 50 meters and range corrections of less than 100 meters should not be made. Normal range and deviation corrections are used when adjusting DPICM in the self-registering mode.

***Height of Burst***. Because of the reliability of the round, no adjustment for HOB is required before firing for effect. However, errors in either target location or firing solution can produce effects other than the designed HOB. The result is bomblet dispersion that is either too large to be effective or too small to adequately cover the target area. If a repeat of fire for effect is required, HOB may be adjusted. The observer corrects the HOB in 50-meter increments—either up to increase dispersion or down to decrease dispersion.

***Danger Close***. When adjusting close-in fires with ICM, the observer must start the adjustment at least 600 meters from friendly troops, depending on the relative locations of weapons, the target, and friendly troops. Special consideration must be given to the direction and speed of the wind in the target area. The adjustment should be made with the entire battery. Corrections should be made from the near edge of the effects pattern. Use of a converged sheaf should be considered to decrease the size of the sheaf.

### Employment Considerations

Improved conventional munitions should not be fired into wooded areas, as grenades may become suspended in tree branches and later pose a threat to friendly forces. Discretion should be exercised when using ICM in an area that friendly forces must cross because the unexploded submunition rate is approximately 1.5 percent. Precautions should be taken when firing ICM rounds in snow, marshy areas, and loose sand. These types of terrain conditions do not increase the dud rate, but do pose more of a threat to friendly forces by concealing duds. Slopes of more than 60 degrees reduce the effectiveness of ICM. Because of the large area covered, limited use of ICM is recommended when in close proximity to unprotected friendly troops.

## FAMILY OF SCATTERABLE MINES

The FASCAM are time-sensitive, self-destructing mines that are emplaced by different assets, including aviation. Artillery FASCAM consists of antiarmor and antipersonnel mines in a base-ejecting projectile. These projectiles consist of the remote antiarmor mine system (RAAMS) and area denial artillery munition (ADAM).

### Remote Antiarmor Mine System Projectiles

The RAAMS minefields are effective against enemy armored vehicles.The RAAMS projectile is fired by a 155-mm howitzer, and 9 antiarmor mines are base ejected over the target area. After a short delay to allow for mine free-fall, impact, and roll, the magnetically-fuzed mines arm themselves. Some of the mines have an antidisturbance feature that causes the mines to detonate if they are moved or picked up. If the RAAMS mines are not detonated, they will begin to self-destruct after 80 percent of the factory-set, self-destruct time elapses:

- *M718 projectile*. Long duration, factory-set, self-destruct time of 48 hours.
- *M741 projectile*. Short duration, factory-set, self-destruct time of 4 hours.

### Area Denial Artillery Munition Projectiles

The ADAM mines are used against personnel—either dismounted personnel in an armored attack or on existing antitank obstacles to hinder dismounted breaching. When employed against an enemy that has a dismounted breaching capability, ADAM mines are delivered directly on top of a RAAMS minefield. The ADAM rounds are always the last rounds fired when used in conjunction with RAAMS or other munitions. This prevents the activation or destruction of the ADAM munitions by other means.

The ADAM projectile is fired by a 155-mm howitzer, and 36 antipersonnel mines are base ejected over the target area. When an ADAM mine comes to rest on the ground, several tripwire sensors are deployed out to a maximum distance of 20 feet. When a sensor is disturbed or tripped, a small, ball-like munition is propelled two to eight feet upward. The munition detonates and scatters approximately 600, 1.5-grain steel fragments in all directions. If the mine tripwire sensors are not disturbed, the mine will self-destruct after the factory-set time has elapsed:

- *M692 projectile*. Long duration, factory-set, self-destruct time of 48 hours.
- *M731 projectile*. Short duration, factory-set, self-destruct time of 4 hours.

### Types of Minefields

Three types of RAAMS/ADAM minefields may be used, depending on the amount of planning and coordination time available and the density of the mines: planned, target of opportunity, or other munitions.

***Planned***. These minefields are typically initiated and coordinated at higher level FSCCs. They are either scheduled or on-call targets that support barrier/obstacle plans and consist of long or short duration, self-destruct mines. Safety zones are computed before firing.

***Target of Opportunity***. These minefields are initiated through the call for fire and support the maneuver commander with an immediate minefield. They consist of only short duration, self-destruct mines. The standard minefield module is 400 meters by 400 meters. Target-of-opportunity minefields are typically low density with a combination of RAAMS and ADAM projectiles. The number of projectiles varies depending on the range, angle of fire, and minefield attitude. The safety zone is based on aim points and is computed immediately after firing. The safety zone contains 99 percent of the deployed mines and represents the effective friendly obstacle for maneuver elements.

***Other Munitions***. Minefields established in conjunction with an attack that is using other munitions are initiated through the target list or the call for fire. They support operations by harassing enemy targets within constraints set by the supported commander. These minefields are sized on the basis of the method of attack and use of RAAMS, ADAM, or a combination in the last volley. They consist of only short duration mines. The safety zone is computed immediately after firing.

### Target Location

Aimpoints must be established for both moving and stationary targets.

***Moving Targets***. The aim point for a moving target is placed directly in front of the enemy axis of advance. An aim point is placed 1,000 meters in front of the enemy target for every 10 km per hour of speed, as shown in figure 6-12. This allows enough time for mine delivery and arming before an enemy encounter.

***Stationary Targets***. The aim point for a stationary target is placed directly over the target center. Aim points are located to an accuracy of 100 meters for adjust fire and 10 meters for fire for effect. If adjustment is necessary, it will be conducted with shell M483A1 in the self-registering mode.

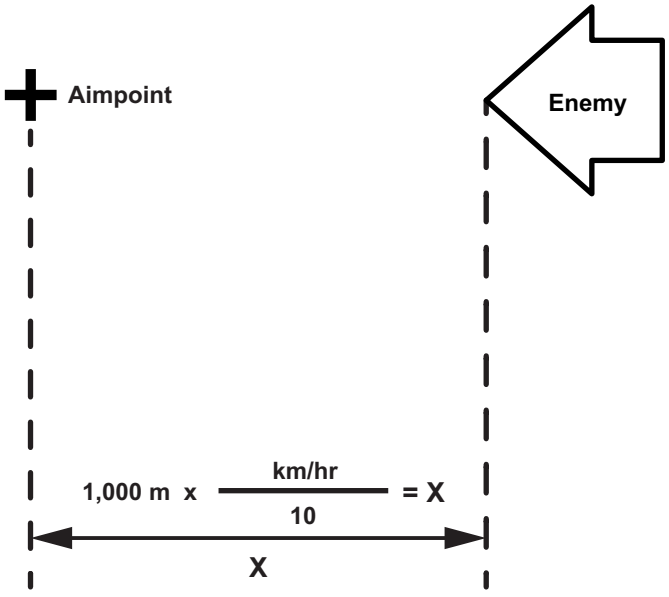



**Figure 6-12. Aimpoint Location for a Moving Target.**

### Call for Fire and Adjustment

The FASCAM call for fire is usually transmitted and processed in the same manner as other requests for target-of-opportunity fire missions. The adjusting shell is DPICM in self-registration mode and shell ADAM, which is always fired last. Targets of opportunity are either fire for effect or adjust-fire missions. Missions within 1,000 meters of friendly forces should be referred to the firing unit FDC for computation of the buffer zone before firing. Adjustment procedures for FASCAM are identical to those described for ICM.

**Example: FASCAM call for fire**

***Fire for Effect Mission***

Observer: *Z57 this is Z42, fire for effect, over.*

FDC: Reads back.

Observer: *Grid 1804 5132, over.*

FDC: Reads back.

Observer: *Platoon in the open, ADAM, over.*

FDC: Reads back.

***Adjust-Fire Mission***

Observer: *Z57 this is Z42, adjust fire, over.*

FDC: Reads back.

Observer: *Grid 180 513, over.*

FDC: Reads back.

Observer: *5 T-72 tanks attacking, RAAMS in effect, over.*

FDC: Reads back.

### Employment Considerations

Authorization for FASCAM employment is established in the OPORD and is usually held at the regimental level. Caution should be exercised when employing these mines in areas where friendly troops may be located. Although the mines have a self-destruct mechanism, the dud rate is comparable to that of DPICM.

## ILLUMINATION

Battlespace illumination provides friendly forces with enough light to aid them in ground operations that are conducted at night. Illumination also facilitates operations for both the observer and the maneuver unit. Characteristics of artillery illumination are contained in appendix D. See chapter 7 for NSFS adjustment procedures for illumination.

### Illumination Employment

Illumination should be used with caution to avoid the accidental compromise of, or interference with, a friendly unit by premature or inappropriate fires. These fires must be coordinated before delivery if it is suspected that the effects of these fires will cross the boundary of an adjacent unit.

***Volume***. The amount of illumination that is required for a particular mission depends on the OT distance; the conditions of visibility; and the size, width, and depth of the area to be illuminated. By selecting the proper illuminating pattern and controlling the rate of fire, the observer can illuminate an area effectively with a minimal expenditure of ammunition (see table 6-2).

**Table 6-2. Employment Factors for Illuminating Shells.**

| Howitzer/ Mortar | Projectile | Initial HOB (meters) | Distance (Spread) Between Bursts (meters) | Burning Time (seconds) | Rate of Continuous Illumination (rounds per minute) | Rate of Descent (meters per second) |
|---|---|---|---|---|---|---|
| 155-mm | M485A2 | 600 | 1,000 | 120 | ½ | 5 |
| 81-mm | M301A1 | 400 | 500 | 60 | 1 | 6 |
| 81-mm | M301A2 | 400 | 500 | 60 | 1 | 6 |
| 81-mm | M301A3 | 600 | 500 | 60 | 1 | 6 |

***Uses***. Illumination shells are used for the following:

- Illuminating areas of suspected enemy activity.
- Providing illumination for night fires.
- Harassing enemy positions.
- Furnishing directions to friendly troops for attacks or patrol activities.
- Marking targets for attack by CAS.
- Washing out enemy passive night-sight systems.

### Illumination Patterns

***One-Gun Illumination Pattern***. The one-gun illumination pattern is used when effective illumination can be obtained by firing one round at a time. To create this pattern, the observer calls for illumination as both the type of adjustment and type of projectile.

***Two-Gun Illumination Pattern***. The two-gun illumination pattern is used when an area requires more illumination than can be furnished by one-gun illumination. In two-gun illumination, two

rounds burst simultaneously in the same place. To create this pattern, the observer requests *illumination two guns*. This pattern is not necessary with the M485A2 155-mm projectile.

***Two-Gun Illumination Range Spread Pattern***. The two-gun illumination range spread pattern is used when the area to be illuminated has greater depth than width, as seen along the OTL (GTL for mortars) (see figure 6-13). An illumination that is spread causes less shadow than an illumination concentrated in one place. To create this pattern, the observer calls for *illumination range spread.*

The FDC centers the spread over the point indicated by the observer and orients the spread along the OTL for an automated artillery FDC equipped with AFATDS (see table 6-2).

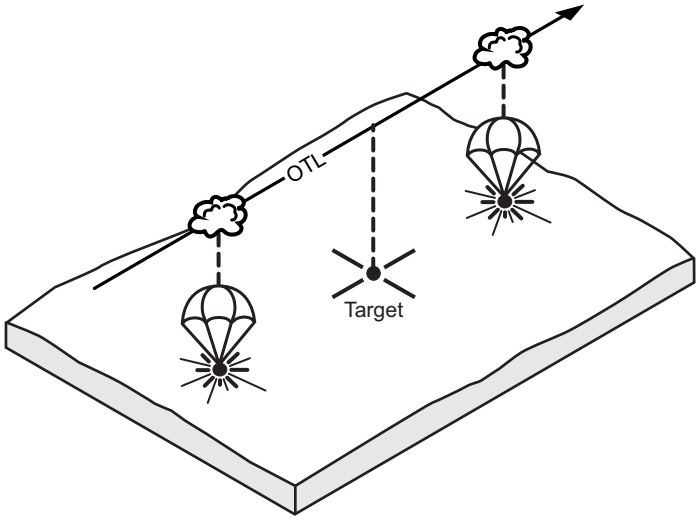



**Figure 6-13. Illumination Range Spread.**

***Two-Gun Illumination Lateral Spread***. The two-gun illumination lateral spread pattern is used when the area to be illuminated has greater width than depth (see figure 6-14). To create this pattern, the observer calls for *illumination lateral spread*.

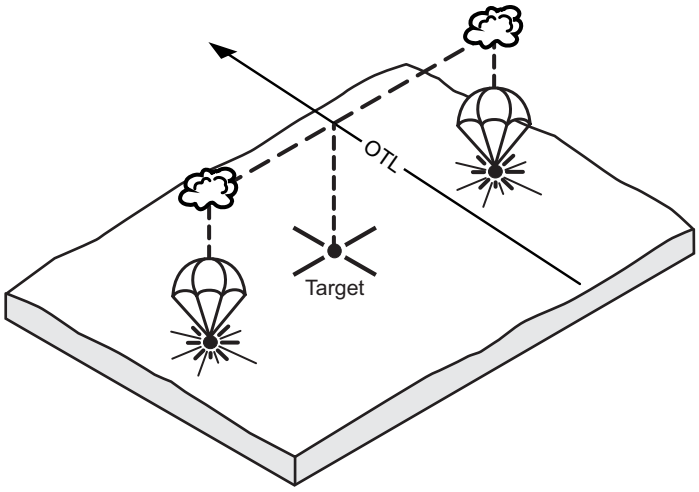



**Figure 6-14. Illumination Lateral Spread.**

The FDC centers the spread over the point indicated by the observer and orients the spread perpendicular to the OTL for an automated artillery FDC equipped with AFATDS. Distances between bursts are the same as those for a range spread.

***Four-Gun Illumination Range and Lateral Spread***. The four-gun illumination pattern is used to illuminate a large area (see figure 6-15). Four rounds burst simultaneously, both parallel and perpendicular to the OTL for artillery and GTL for mortars. This pattern illuminates an area with a minimum of shadows or dark spots. To create this pattern, the observer calls for *illumination range and lateral spread*. The pattern of bursts is the combination of range and lateral spreads.

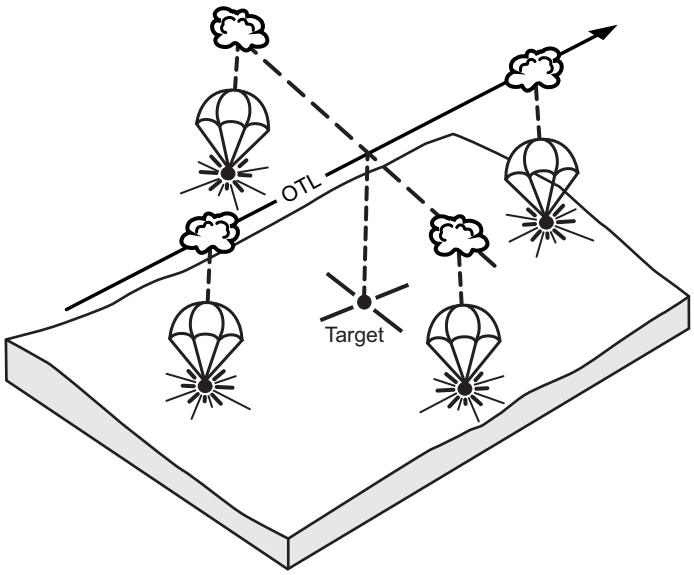



**Figure 6-15. Illumination Range and Lateral Spread.**

### Illumination Call for Fire

In the illumination call for fire, *illumination* is given as the type of projectile. If desired, the appropriate range or lateral spread is given as the distribution.

***Illumination Adjustment***. Considerations for adjusting illumination are as follows:

- *Range and deviation corrections*. These corrections are made in 100-meter increments. The adjustment of illumination to within 200 meters of the adjusting point is considered to be adequate because of the size of the area illuminated by the flare. Range and deviation corrections of less than 200 meters should not be made.
- *Position of the flare*. The correct position of the flare in relation to the area to be illuminated depends on the terrain and wind. Generally, the flare should be to one flank of the area and at about the same range. In a strong wind, the point of burst must be upwind from the area to be illuminated because the flare will drift. If the area is on a forward slope, the flare should be on the flank and at a slightly shorter range. When illuminating a very prominent object, visibility is better if the flare is placed beyond the object so that the object is silhouetted.
- *HOB*. The proper HOB is obtained when the flare burns out just as it strikes the ground. The HOB corrections are made in multiples of 50 meters. Variations in time of burning between

individual flares make any finer adjustment of the HOB impractical. When burnout occurs during descent, the HOB correction is made by estimating the height of the flare when it burned out. When visibility permits, the spotting (i.e., height of the burnout above the ground) may be measured with binoculars. The HOB spotting in mils is multiplied by the OT factor to determine the height of burnout in meters. The height is expressed to the nearest 50 meters and is transmitted as a *down* correction.

**Example: Obtaining proper HOB**

The flare burns out 20 mils above the ground.

The OT factor is 3.

The correction is *down 50* (20 mils x 3 = 60 [50 meters]).

When the flare continues to burn after it strikes the ground, a correction is required to raise the HOB. Multiply the number of seconds the flare burns on the ground by the rate of descent (refer to table 6-2). The result is expressed to the nearest 50 meters and transmitted as an *up* correction.

***Note:*** When using a night observation device, the observer should ensure that the flare burns out appreciably (i.e., 100 to 200 meters) above the adjusting point to keep the device from washing out.

**Example: Illumination mission**

*P53 this is P67, adjust fire, over.*

*Grid 616 376, over.*

*Vehicle noises, suspected tanks, illumination, over.*

This fires an illuminating round that bursts about 100 mils left of the suspected area and burns out 40 mils too high (measured with binoculars). Using an OT factor of 2, the observer transmits—

*Direction 5800, right 200, down 100, over.*

*Deviation (100 mils x 2 = 200 meters).*

*HOB (40 mils x 2 = 80 meters » 100 meters).*

The second round bursts short near the OTL, but is too low. The round burns for 6 seconds on the ground. The observer requests—

*Add 400, up 50, over.*

(6 x 5 = 30 meters » 50 meters).

The third round bursts at the appropriate height over the suspected area, but haze and the distance between the suspected area and the observer cause poor visibility when only one illuminating round is used. The observer believes that two rounds will be adequate to extend the visible area and reduce shadows. The observer requests—

*Lateral spread, over.*

Two rounds burst in a lateral spread over the suspected area. The observer notices two tanks and a number of infantrymen moving to the right of the extreme edge of the illuminated area. The observer prepares and transmits a second call for fire, moving illumination over to the adjusting point, and transmits *illumination mark* when maximum illumination of the target has been obtained:

*Right 400, coordinated illumination, over.*

*Adjust fire, over.*

*Grid 611 382, over.*

*Two tanks and platoon of infantry, ICM in effect, over.*

The observer may also transmit the target location by polar plot:

*Adjust fire, polar, over.*

Or by shifting from the center of the illumination:

*Adjust fire, shift, illumination, over.*

The observer transmits *illumination mark* when maximum illumination of the target has been obtained, adjusts the HE, and fires for effect.

***Illumination Coordination***. When the observer has located a target suitable for HE or other fire, a call for fire is initiated by announcing *coordinated illumination* and the mission data. If a better means of designating the location of the target is not possible, the burst center of the illumination can be used as a reference point.

**Example: Call for fire**

*Illumination right 200, HE add 100.*

Once the observer has adjusted the illuminating shell to the desired location, the rate of fire and the number of pieces firing should be controlled to reduce the ammunition expended to the minimum that is required for observation.

***Fire Direction Center Control***. The observer allows the FDC to control firing of both illumination and HE by announcing *coordinated illumination* in the call for fire. While adjusting the illumination to yield the best light on the target, the observer should announce *illumination mark* to the FDC to notify it of the exact time when the target is best illuminated. Several marks may have to be established because a new mark must be established each time the illumination is corrected. By marking the adjusting rounds, the observer avoids the need for a separate illumination round to mark. The FDC times the interval between the actual firing of the illuminating round and the receipt of the observer's *illumination mark*. By comparing this time interval with the TOF of the HE, the FDC can control the firing of the HE rounds so that they arrive at the target during the period of maximum illumination. If the observer adjusts the illuminating fire and the HE fire concurrently, the word *illumination* precedes corrections pertaining to illumination, and *HE* precedes those pertaining to HE.

***Observer Control***. As an alternate method, the observer may request *coordinated illumination* and announce the method of control as *by round at my command* for both missions. This indicates that both HE and illumination will be fired only at the observer's command. In this method, the observer is responsible for timing the mark and incorporating the HE TOF into the delivery of fires. As soon as the FDC reports that the illumination and HE fires are ready, the observer commands the firing of illumination. Then the observer commands the firing of the HE so that it will impact during maximum illumination of the target. The observer must request the HE TOF to better coordinate the firing of each round. An experienced observer and battery may be able to adjust more than one HE round under each round of illumination.

The least desirable method of coordinated illumination is continuous illumination because of the amount of ammunition that is expended. However, this is an acceptable method when illumination is enhancing the performance of optics to acquire direct-fire targets. During this method—

- The FDC fires illumination continually.
- The intervals between firing depend on the type of projectile.
- The observer adjusts the HE.

## SMOKE

The main objective of employing smoke is to create a one-way mirror so that forces may attack the enemy without being seen. Smoke is a combat multiplier that can be used in many ways to help the combined-arms team accomplish its mission. It can be used to conceal both friendly and enemy troop movements, slow attacking forces, disrupt command and control, and reduce exposure of critical friendly and enemy assets. Observers must synchronize, integrate, and sustain smoke to defeat enemy electro-optical systems. The force that most effectively employs smoke and functions better in limited visibility has the advantage in battle.

### Categories

Smoke is categorized as deliberate or hasty.

***Deliberate***. Usually, deliberate smoke is employed at the regimental level or higher. Any smoke source can provide deliberate smoke. Deliberate smoke can conceal forces or protect large areas several square kilometers behind the forward line of troops with smoke generators supplemented by smoke pots. This employment of smoke requires large amounts of fuel, fog oil, and munitions, as well as extensive use of artillery assets and scarce smoke generators. Point or small-area targets can be obscured by other smoke assets (e.g., artillery, mortars, NSFS, air-to-ground rockets).

***Hasty***. During hasty operations, smoke is often used by battalions and smaller units against immediate tactical threats. Hasty smoke employs the unit's basic load of both smoke-producing sources in addition to rapid-response assets (e.g., mortars, artillery). These operations typically require short planning and execution times, minimal coordination, relatively short duration of effects, and the use of organic assets. Hasty smoke obscurants are created to support small-unit maneuver or disengagement and must be carefully planned for operational and logistical support.

### Battlespace Applications

The battlespace applications for using smoke in deliberate and hasty operations are as follows:

- *Obscuring*. Degrades the enemy's combat effectiveness, minimizes their vision and/or their ability to command and control their forces, and suppresses enemy observers when placed on or near the enemy.
- *Screening*. Conceals friendly forces, positions, and activities from enemy ground or air observation when placed between friendly and enemy forces.
- *Marking*. Used to identify targets for aircraft, to identify friendly locations, or as a navigational aid. Also used to signal prearranged battlespace cues.
- *Deceiving*. Misleads the enemy about friendly force intentions. Supports the deception plan by drawing attention away from the main effort.

### Delivery Systems

Effective smoke delivery systems include mortars and artillery.

***Mortars***. Mortar units can deliver a high volume of smoke at short to medium ranges. Typically, mortars provide the most rapid and responsive fires for the commander. The various types of mortar smoke include WP and red phosphorous (RP) (see table 6-3):

- *WP smoke*. Available from company mortars (M224 60-mm) and battalion mortars (M252 81-mm). Mortar WP produces rapid smoke buildup, which can be used for marking targets. Its effects are of limited duration.
- *RP smoke*. Time-fuzed round (M819) that contains RP smoke pellets. At a preset time along the round's trajectory, the fuze functions to expel and ignite the RP pellets at an approximate HOB of 175 meters. The burning pellets produce a cloud of dense smoke after hitting the ground. A 3-round volley is required to develop the basic smoke screen. Red phosphorous smoke is only available from 81-mm mortars.

**Table 6-3. Smoke Munitions Data.**

| Delivery System | Type of Round | Time to Build Effective Smoke (minutes) | Average Burning Time (minutes) | Average Obscuration Length (m/round) | |
|---|---|---|---|---|---|
| | | | | Crosswind | Headwind/ Tailwind |
| 155-mm | WP | ½ | 1–1½ | 150 | 50 |
| | M825 | ½ | 5–8 | 350 | 100–200 |
| 81-mm | WP | ½ | 1 | 100 | 40 |
| | RP | ½ | 1½–2 | 90–150 | 40–50 |
| 60-mm | WP | ½ | 1 | 7–5 | 40 |
| 5"/54 | WP | ½ | 1 | 150 | 40 |

**Notes:**

Planning factors are meteorologically dependent.

Data is based on favorable conditions.

***Artillery***. Various smoke munitions can be fired by cannon artillery. The artillery provides smoke at short, medium, and long ranges. Artillery units can provide longer, more effective smoke effects than the mortar platoons. However, excessive use of smoke should be planned and coordinated so that artillery units can meet the commander's needs. The types of artillery smoke are WP and improved smoke (i.e., felt-wedge WP) (see table 6-3):

- *WP smoke*. Either PD or time fuzed. It is the primary marking round and builds quickly, but has little sustainment. With a time fuze, it disperses more for obscuring. It is not fired with a VT fuze.
- *Improved smoke*. A canister filled with WP-impregnated felt wedges that are expelled from the base. It is time fuzed and functions at a predetermined HOB that varies with the propellant and charge fired. The wedges build rapidly into an effective screen with lasting duration.

> ***Note:*** Soft sand or mud can prevent wedges from completely burning. This poses a nonlethal hazard to maneuvering forces when wedges are re-exposed to air.

### Planning Considerations

The factors to consider when planning smoke are weather, terrain, delivery means available, ammunition, the enemy, and command and control. On the basis of these factors, the observer can advise the company commander on the feasibility or likely performance of smoke.

***Weather***. Weather aspects are interrelated. The wind, temperature gradient, humidity, precipitation, and cloud cover will indicate the effectiveness of smoke and the volume required. Wind speed and direction are the primary factors in smoke performance.

*Wind speed*. Wind speed indicates whether smoke will be effective. High winds push smoke down, and effective smoke will not thicken until it has blown farther downwind. Low winds allow smoke to billow high and thicken closer to its source. The optimal wind speed for WP smoke is 9 to 14

knots, with the ranges of 5 to 9 knots and 14 to 17 knots being marginally effective. The equivalent wind speed scale, the grass drop or flag method, and the on-board computer of the M1A1 are valid methods to determine wind speed:

- *Equivalent wind speed scale*. Wind speed is the least accurate and most subjective method. Table 6-4 will aid the observer in determining wind speed.
- *Grass drop or flag methods*. The grass drop or flag methods are accurate methods that can be used to determine wind speed:
  *Grass drop method*:
  - Extend the arm downwind and parallel to the ground.
  - Drop some grass from the hand and point to the grass on the ground.
  - Estimate the angle formed by the arm and torso, in degrees, and divide by four to determine wind speed in knots.

  *Flag method*:
  - Use a flag or lightweight strip of cloth attached to a vertical object.
  - Estimate the angle of the flag or cloth and the vertical object, in degrees, and divide by four to determine the wind speed in knots.
- *On-board computer of the M1A1 tank*. The observer uses the on-board computer to determine the wind speed at the tank location. This is the most accurate method of wind measurement.

**Table 6-4. Equivalent Wind Speed Scale.**

| Knots | Observation |
|---|---|
| 1 | Smoke, vapor from breath, and dust raised by vehicles or personnel rise vertically<br>There is no leaf movement |
| 1–3 | Direction of wind is slightly shown by smoke, vapor from breath, or dust raised by vehicles or personnel<br>There is a slight, intermittent movement of leaves |
| 4–6 | Wind lightly felt on the face<br>Leaves rustle |
| 7–10 | Leaves and small twigs are in constant motion |
| 11–16 | Wind raises dust from the ground<br>Loose paper and small branches move |
| 17–21 | Small trees with leaves sway<br>Coastal wavelets form on inland waters |
| 22–27 | Large branches on trees are in motion<br>A whistle can be heard in telephone or fence wires |
| 28–33 | Entire trees are in motion<br>There is inconvenience when walking against the wind |

*Wind Direction*. Local area wind direction indicates where the smoke will travel. Wind direction is measured as a horizontal clockwise angle, in mils, from grid north. It extends from the direction that the wind is blown to the direction that the wind is blowing. A field-expedient method of determining wind direction is to face away from the wind and measure the actual wind direction with a compass.

*Temperature Gradient.* By itself, temperature has no direct impact on the effectiveness of smoke, but temperature gradients do directly affect smoke performance. Temperature gradients are determined by comparing air temperatures at 0.5 meters and 4 meters. Unstable, neutral, and stable are the three general temperature gradients:

- *Unstable (lapse)*. The air temperature decreases with an increase in altitude. An unstable condition is characterized by vertical air currents and turbulence. Smoke tends to break up and become diffused under these conditions. Unstable conditions should be considered by planners as marginal for smoke employment.
- *Neutral*. An increase in altitude is accompanied by little or no change in air temperature. Limited vertical air currents also cause neutral conditions when the wind speed is greater than 5 knots. Planners should consider neutral conditions as moderately favorable for smoke employment.
- *Stable (inversion)*. The air temperature increases with an increase in altitude. This condition limits vertical air currents. Smoke produced during inversion conditions remains low to the ground and may reduce visibility at ground level. Stable (inversion) conditions should be considered favorable by planners for smoke employment if there is enough wind to carry the smoke over the target area.

Table 6-5 is used to predict these conditions and how the smoke will perform under varied conditions.

**Table 6-5. Temperature Gradients.**

| Smoke Condition (Temperature gradient) | Time of Day/Weather Conditions (All conditions must be met) | Expected Smoke Behavior as the Smoke Drifts Downwind (Wind direction ➔) |
|---|---|---|
| Stable (inversion) | Night: until 3 hours after sunrise<br>Wind speed 5–10 knots<br>Sky cover total overcast | <br>Favorable for smoke employment |
| Neutral (favorable) | Mid-morning<br>Wind speed less than 5 knots<br>Sky cover is 50% or less | <br>Moderately favorable for smoke employment |
| Unstable (lapse) | Day: beginning 2 hours after sunrise<br>Wind speed more than 10 knots<br>Sky cover is no clouds | <br>Marginal for smoke employment |

*Humidity*. White phosphorous and RP smoke are hygroscopic and produce smoke particles that absorb moisture from the air. Moisture increases particle size and density and makes the smoke more effective. Smoke munitions usually produce denser, thicker smoke in high humidity than in low humidity; therefore, high humidity is more favorable for smoke employment.

*Precipitation*. Precipitation is a natural obscurant. Using smoke in mist or fog produces thicker smoke that is more effective against electro-optical systems. Light rain produces moderately favorable conditions for using smoke because the smoke might not rise high enough to produce effects. Heavy rain and snow are effective natural obscurants and will degrade electro-optical systems effectively. As a general rule, precipitation pushes smoke down to the ground and spreads it over larger areas.

*Cloud Cover*. Clouds will give an indication of how smoke will perform in the battlespace. As a general rule, the atmosphere is stable (favorable) when the sky is covered with clouds. Scattered clouds indicate moderately favorable conditions. No cloud cover indicates marginal conditions.

***Terrain***. Winds follow the contours of the Earth. The type of terrain that smoke travels over has a tremendous effect on how the smoke will cover a specific area:

- Flat, unbroken terrain creates effective smoke farther downwind.
- Trees and small buildings will break up smoke, which may then re-form to cover a larger area and create effective smoke near the source.
- Steep hills or mountains create volatile winds, usually resulting in gaps and uneven smoke.
- Slopes and valleys create thermal slope winds at different times.

Heating effects during the day cause up-slope winds. Cooling effects at night cause down-slope winds. Table 6-6 summarizes atmospheric and terrain effects on smoke operations.

**Table 6-6. Terrain and Atmospherics.**

| Factor | Unfavorable | Moderately Favorable | Favorable |
|---|---|---|---|
| Wind | More than 10 knots | Less than 5 knots | 5–10 knots |
| Atmospheric stability category | Unstable (lapse) (favorable for smoke curtain) | Neutral | Stable (inversion) (unfavorable for smoke curtain) |
| Humidity | Low | Moderate | High |
| Precipitation | None | Light rain | Mist/fog |
| Cloud cover | None | Scattered | Overcast, low ceiling |
| Terrain | Even | Gently rolling | Complex topography |
| Vegetation | Sparse or none (desert) | Medium to dense | Heavily wooded or jungle |
| Time of day | Late morning through late afternoon | Mid-morning | 1 hour before EENT to 4 hours after BMNT |
| **LEGEND**:<br>BMNT-beginning of morning nautical twilight<br>EENT-end of evening nautical twilight | | | |

***Delivery Means Available***. The observers will make recommendations to the maneuver commanders concerning the best delivery means for providing smoke. Higher level FSCCs must review and then approve, modify, or deny the maneuver commander's request based on the effects that the smoke will have on all maneuvers.

***Ammunition***. Smoke ammunition is a limited asset. Because ammunition requirements vary with each mission, observers should know the amount and types of smoke ammunition available and how many minutes of coverage it can provide. Extensive, planned smoke employment should be coordinated early with firing units to allow for redistribution or requisition of ammunition.

***The Enemy***. When considering smoke employment, the enemy's electro-optical capability should be known, and the likely positions for enemy weapons systems and observers that may threaten friendly forces should be anticipated. On the basis of the commander's plan, observers should determine when smoke employment will enhance friendly operations and hinder enemy operations.

***Command and Control Desired Effects***. Clearly stated guidelines, restrictions, desired effects against enemy electro-optical systems, and other smoke employment instructions should be part of the commander's guidance and unit SOP. Desired effects are specified as visible or infrared (IR). All types of smoke are capable of producing visible and IR effects. Table 6-7 shows the effectiveness of the types of smoke against enemy and friendly electro-optical systems. Figure 6-16, shows the effectiveness of all types of obscurants against enemy and friendly electro-optical systems.

*Visible*. The visible wavelength is relatively easy to defeat with smoke. Obscurants hinder enemy viewers (e.g., binoculars, weapons sights, night observation sights, CLRFs). Smoke can also degrade friendly visibility. Smoke that is sufficient to degrade less sophisticated electro-optical systems may be relatively ineffective against more sophisticated electro-optical systems. Infrared device-equipped observers have an inherent tactical advantage over observers who rely solely on the visible wavelength. Although observers can acquire targets more easily when using IR devices through smoke, positive target identification is more difficult.

*Infrared*. Visual obscurants may degrade the visibility of observers using IR devices. However, bispectral obscurants can defeat sophisticated battlespace viewers and weapon guidance systems, such as command line of sight or terminal homing systems on antitank missiles. Bispectral obscurants defeat or degrade both the visual and IR portions of the electromagnetic spectrum simultaneously. Firing units employing bispectral fires deliver sufficient amounts of smoke to degrade both less sophisticated and advanced electro-optical systems. Like visual obscurants, bispectral obscurants can degrade both enemy and friendly systems. Bispectral obscurants are required to defeat an enemy that is equipped with more sophisticated electro-optical technology.

**Table 6-7. Smoke Effects on Electro-Optical Systems.**

| Spectral Region | Electro-Optical System | Type of Smoke |
|---|---|---|
| Visible:<br>0.40–0.75 meters | Viewers:<br>Daylight sights<br>Naked eye<br>Camera lens<br>Binoculars/standard optics<br>Battlespace television<br>Manual command to line of sight missiles (e.g., AT-3)<br>Night sights | WP/RP/M825 |
| Near IR:<br>0.75–4 meters | Viewers:<br>Semiautomatic command to line of sight missiles (e.g., AT-4 and AT-5)<br>Night sights | |
| | Sensors:<br>Laser designators<br>CLRFs | |
| Mid IR:<br>4–14 meters | Viewers:<br>Passive thermal sights | |
| Far IR:<br>14–100 meters | Sensors:<br>Thermal imagers<br>Terminal homing missiles (e.g., AT-6) | |
| Millimeter wave and<br>lower frequency:<br>1.00 mm | Radar<br>Radio<br>Microwaves | WP<br>Developmental obscurants |
| X-ray and higher frequency | Directed electromagnetic pulse<br>Nuclear weapons | Oil smoke (attenuation only)<br>Developmental obscurants |

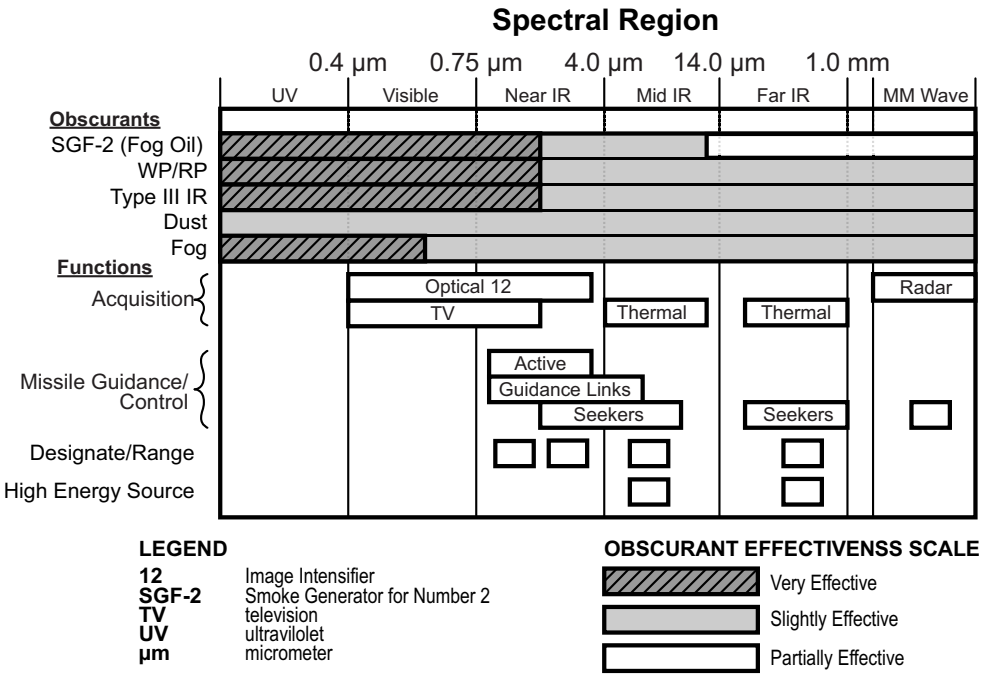



**Figure 6-16. Obscurant Effects on Electro-Optical Systems.**

### Types of Missions

Immediate smoke and quick smoke are the two types of smoke missions that are fired by artillery and mortars.

***Immediate Smoke***. Immediate smoke provides obscuring, protecting, or marking smoke over small areas. It is more responsive than quick smoke, but the duration and area of effects are limited. Immediate smoke is effective against point targets for short periods. Unit SOPs should state the amount and type of smoke ammunition to be fired and the number of guns to be used.

*Adjusting Point*. The adjusting point for immediate smoke is typically the target itself. However, the observer may determine that offsetting the adjusting point into the wind may produce more obscure conditions (see figure 6-17).

*Call for Fire*. The call for fire for immediate smoke consists of three elements sent in one transmission:

- Observer identification (the call sign identifying the observer to the FDC).
- Warning order (the observer announces *immediate smoke*).
- Target location (any method of target location may be used).

***Quick Smoke***. Quick smoke provides obscuring, screening, or deceiving smoke for larger areas. More planning and coordination are required for quick smoke than for immediate smoke. Smoke rounds for quick smoke missions are fired in a linear sheaf and cover larger areas than immediate smoke missions.

**Example: Requesting immediate smoke**

**Grid**

Observer: *W52 this is H24, immediate smoke, grid 628 545, I authenticate ROMEO DELTA, over.*

FDC: Reads back.

**Shift From Known Point**

Observer: *W52 this is H24, immediate smoke, shift target number AB 3058, direction 4360, left 130, add 300. I authenticate MIKE LIMA, over.*

FDC: Reads back.

**Polar**

Observer: *W52 this is H24, immediate smoke, polar, direction 4360, distance 2700, up 30. I authenticate PAPA KILO, over.*

FDC: Reads back.

**Laser Polar**

Observer: *W52 this is H24, immediate smoke, laser polar, direction 4362, distance 2730, vertical angle plus 11. I authenticate CHARLIE ALPHA, over.*

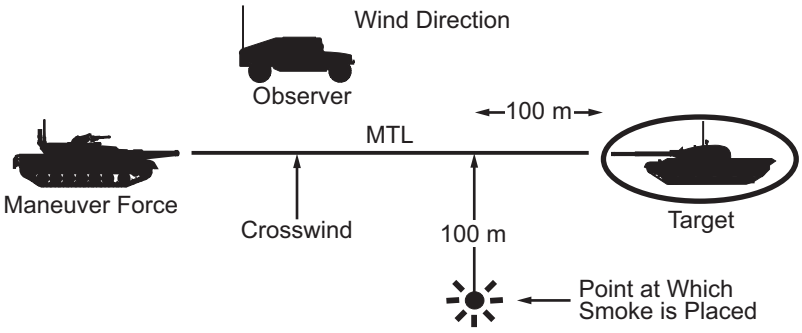
FDC: Reads back.

Quick smoke is effective against enemy positions and formations. A standard call for fire includes target location; target description; length of the sheaf; direction of the maneuver-target line (MTL); direction of the wind in relation to the MTL; and desired time, duration, and effects of the smoke. Fire for effect should be requested for planned targets or refined target locations. Adjust fire can be conducted when the method of target location is less accurate. When adjusting fire, the OT direction must be provided for grid missions.

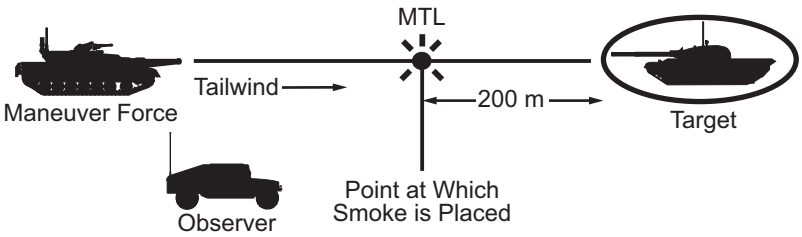
*Quick Smoke Call for Fire*. The standard call for fire includes the following:

- *Target location*. Any method of target location may be used. The target location is the center of the area where the screen needs to be most effective. Adjusting rounds are delivered to where the screen is planned; however, during the fire for effect, smoke rounds will be offset by the FDC for the effects of wind.

| Delivery Technique: | Wind Direction | | | Adjusting Point: |
|---|---|---|---|---|
| | Cross | Head | Tail | |
| Immediate (WP and Smoke) Point/Suppression | 100S-100UW | 100S | 200S | Point to Obscure on MTL |




**Placing Smoke in a Crosswind**




**Placing Smoke in a Tailwind**

**LEGEND**

| | |
|---|---|
| **S** | short |
| **UW** | upwind |

**Figure 6-17. Optional Adjusting Points for Immediate Smoke.**

- *Target description*. Announce *screen* followed by an accurate target description. The screen alerts the FDC that smoke mission data will follow. Avoid vague target descriptions such as open area, tree line, or hilltop. If the enemy situation is vague or unknown, transmit a description of the suspected target for screening.
- *Length of the smoke sheaf*. In coordination with the commander, determine the area to obscure, screen, protect, or deceive. The actual length of the smoke sheaf in meters is determined and a recommendation should be made to the commander regarding the length of the sheaf and the weapons system that should be used.
- *MTL*. The MTL is a horizontal clockwise angle measured from grid north. Depending on the situation, the MTL can extend from the observer's location to and through the target, or it can extend from the most vulnerable point along the route of march to and through the target. The MTL is determined to an accuracy of 10 mils.
- *Wind direction in relation to the MTL*. Determine whether the wind is a right crosswind, left crosswind, headwind, or tailwind in relation to the MTL. Figure 6-18 shows how to convert the wind direction in relation to the MTL to a right crosswind, left crosswind, headwind, or

tailwind and how to compute the difference between the actual wind direction and the direction of the MTL:

- A left crosswind blows from left to right across the MTL from the observer's perspective.
- A right crosswind blows from right to left across the MTL from the observer's perspective.
- A headwind blows along the MTL toward the observer.
- A tailwind blows along the MTL away from the observer.

- *Time and duration of smoke effects*. Consult with the commander to determine how long the smoke effects are required:
  - In the offense, the duration of required smoke effects is based on the friendly unit's average rate of speed and the distance of the friendly movement.
  - In the defense, the duration of required smoke effects is based on the enemy's closure rate and the distance that needs to be covered before an effective engagement can occur.
- *Desired effects of smoke*. Announce either *smoke* to request visible effects or *infrared smoke* to request IR effects.

> ***Note:*** During planning, the observer can provide mission information to the FDC and allow it to compute the number of rounds required for support. This allows feasibility assessment, as well as ammunition preparation. The FDO will select the appropriate smoke munition that will produce the requested effects.

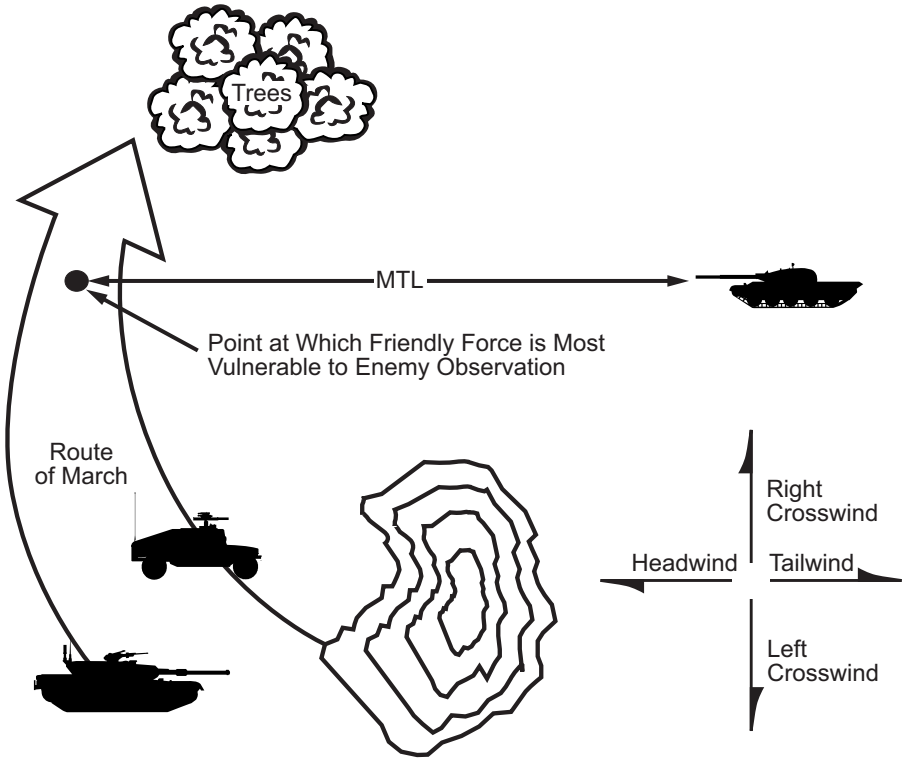



**Figure 6-18. Determining Wind Direction in Relation to the Maneuver-Target Line.**

*Requesting Quick Smoke*. Quick smoke is requested by using the six elements of the standard call for fire. These elements are sent in three transmissions:

- *Observer identification*. Identify the observer to the FDC.
- *Warning order*. Announce *fire for effect* or *adjust fire*.
- *Target location*. Use any of the methods of target location (see chapter 2).
- *Target description*. Announce *obscure* followed by the actual or suspected target description.
- *Method of engagement*. Announce the length of the smoke sheaf, MTL, direction of the wind in relation to the MTL, and desired time and duration of smoke effects. Use the memory aid L-M-Dir-T:
  - L—length of the linear smoke sheaf.
  - M—MTL direction.
  - Dir—direction of the wind in relation to the MTL.
  - T—desired time and duration of smoke effects in minutes.

Next, announce either *smoke* or *infrared smoke*.

- *Method of fire and control*. This is not typically requested. However, any method of control can be specified based on the tactical situation.

**Examples of Methods of Fire Control**

**Grid Method**

Observer: *W52 this is H24, adjust fire, over.*

FDC: Reads back.

Observer: *Grid 617 538, over.*

FDC: Reads back.

Observer: *Screen T-55 company dug in, length 600, MTL 1850, right crosswind, 5 minutes, smoke in effect, over.*

FDC: Reads back and challenges.

Observer: Replies.

FDC: Announces MTO.

Observer: Reads back MTO.

**Shift Method**

Observer: *R5M this is M24, fire for effect, shift target number AB 3062, over.*

FDC: Reads back.Observer: *Direction 4570, right 280, add 400, down 35, over.*

**Shift Method (Continued)**

FDC: Reads back.

Observer: *Screen suspected combat OP, length 200, MTL 0120, left crosswind, 5 minutes, IR smoke, over.*

FDC: Reads back and challenges.

Observer: Replies.

FDC: Announces MTO.

Observer: Reads back MTO.

**Polar Method**

Observer: *W5H this is H24, fire for effect, polar, over.*

FDC: Reads back.

Observer: *Direction 4420, distance 2700, up 45, over.*

FDC: Reads back.

Observer: *Screen BRDM-2 with AT-5, length 200, MTL 5240, tailwind, 10 minutes, IR smoke, time on target 0615, over.*

FDC: Reads back and challenges.

Observer: Replies.

FDC: Announces MTO.

Observer: Reads back MTO.

**Laser Polar Method**

Observer: *W5H this is H24, fire for effect, laser polar, over.*

FDC: Reads back.

Observer: *Direction 4514, distance 4170, vertical angle plus 6, over.*

FDC: Reads back.

Observer: *Screen BMP-2 platoon with AT-5s, length 400, MTL 4510, headwind, 10 minutes, IR smoke, at my command, over*.

FDC: Reads back and challenges.

Observer: Replies.

FDC: Announces MTO.

Observer: Reads back MTO.

*Adjusting Quick Smoke*. Shell HE is used in adjustments for quick smoke missions. When firing M825 smoke, use the same adjustment procedures as for DPICM. Height of burst adjustment rounds are not necessary; fire for effect when splitting the 200-meter bracket. Carefully analyze the behavior of the smoke to ensure effective smoke coverage. Make deviation, range, and HOB corrections from the center of the smoke sheaf as required. Because the smoke will cover a larger area, minimum corrections are as follows:

- *Deviation*. Left/right 50 meters.
- *Range*. Add/drop 100 meters.
- *HOB*. Up/down 50 meters.

White phosphorous, M825 improved smoke, and RP should be adjusted as follows:

- *WP smoke*. Adjusted for range and deviation only when it is fired with a PD fuze. When it is employed with a time fuze, it is adjusted for HOB to 20 meters.
- *M825 improved smoke*. Range, deviation, and HOB corrections are transmitted when necessary. Range and deviation corrections are used as stated in chapter 3. However, M825 improved smoke rarely requires HOB corrections. If the observer spots the M825 as graze, graze must immediately be announced to the FDC. The FDC must verify that the firing data was correct. The HOB corrections for M825 improved smoke are announced in 50-meter increments. The following HOB corrections are given for M825 improved smoke:

  - *Graze/firing data correct*. *Up 100 meters*.
  - *Thick/dense separated clouds*. *Up 50 meters*.
  - *Thin/uneven clouds*. *Down 50 meters*.

- *RP smoke*. Range, deviation, and HOB corrections are transmitted when necessary. Range and deviation corrections are used as stated in chapter 3. However, RP rarely requires HOB corrections. Use the M825 HOB adjustment criteria for RP smoke.

**CAUTION**

Personnel must wear respiratory protection (e.g., protective masks) when exposed to phosphorous smoke; all types of phosphorous munitions produce phosphoric acid, which is poisonous. The M825 felt wedges and RP smoke pellets sometimes do not burn completely. This is referred to as crusting over. Crusted-over felt wedges and pellets will reignite when disturbed and could cause serious burns. Personnel should be warned of their use within the area that they will be occupying.

## FINAL PROTECTIVE FIRES

An FPF is an immediately available prearranged barrier of fire designed to impede enemy movement across defensive lines or areas. (*DOD Dictionary*) Final protective fires consist of final

protective lines and principal directions of fire from direct-fire weapons and continuous indirect-fire barrages.

In artillery, a battery is assigned one FPF. In mortars, an FPF may be assigned to a squad, section, or platoon. The size of the FPF depends on the type and number of weapons (see table 6-8). Once assigned the FPF, the firing unit remains laid on that data in between missions and prepares ammunition. A unit cannot be laid on both an FPF and a priority target.

### Final Protective Fire Employment

The location of FPF is typically designated by the supported commander. It may be any distance from the friendly position that supports the current tactical situation within range of organic direct-fire weapons (i.e., 200 to 400 meters or danger close). The importance of accurate defensive fires and the danger close situation usually requires that each weapon firing the FPF be adjusted into place, if possible.

**Table 6-8. Final Protective Fire Dimensions.**

| Weapon | Size (m) |
|---|---|
| 60-mm mortar: | |
| 3-tube section | 90 x 30 |
| 81-mm mortar: | |
| 8-tube platoon | 280 x 35 |
| 4-tube section | 140 x 35 |
| 1-tube weapon | 35 x 35 |
| 155-mm howitzer: | |
| 6-gun battery | 300 x 50 |

### Final Protective Fire Procedures

An FPF can be either adjusted or unadjusted. Considerations include the tactical implications of adjusting the FPF (i.e., loss of surprise) versus the accuracy that is acquired for firing close to friendly troops. If adjusting, the initial target location transmitted is not the location of the center of the FPF, but a grid that is a safe distance (e.g., 400 to 600 meters) from friendly troops. Because this grid is part of a final defensive plan, it should be encrypted. The call for fire is similar to the normal call for fire with the exception of the third transmission. The attitude or direction of the long axis of the FPF is announced as follows:

- In target description, *final protective fires* is announced.
- In method of engagement, *danger close* is announced.

*Fuze delay* should be requested whenever possible to minimize the safety hazard to friendly units while providing close-in fires.

***Executing the Final Protective Fire***. Once established, the FPF is initiated by the company commander. The observer fires the artillery FPF using an established code or announcing *fire the FPF* with the appropriate authentication. To halt firing of the FPF, either the command *cease loading* or *check firing* is given. To terminate the FPF, *cancel FPF* is announced.

### *Adjusting the Final Protective Fire*

*Manual Fire Direction Centers*. The procedures for mortar FDCs and manual artillery FDCs are the same. The entire battery or mortar platoon fires one round (i.e., a battery or platoon fires one volley) centered on the initial grid sent by the observer. If the rounds impact as shown in figure 6-19, the observer begins adjustment with the flank piece impacting closest to the FPF line (in this case, number 1). Creeping fire adjustment procedures must be used in danger close situations.

**Example: Manual fire direction**

*Number 1, right 100, drop 50, over.*

Corrections are made and fired until the observer believes that a final correction can be made to within 50 meters of the FPF line. The observer sends a final correction, states that the weapon is adjusted, and calls for the next weapon to be adjusted. This final adjustment of 50 meters or less is computed and recorded, but not fired.

*Automated Fire Direction Centers*. If the artillery FDC is automated, only the center weapon will be adjusted onto the center grid of the FPF. The procedure is the same as for an adjust-fire mission. All corrections are automatically applied to the other weapons without firing.

***Note:*** Announcing *end of mission* ends the adjustment phase and *cancel FPF* terminates the FPF.

**Example: Adjusted FPF mission with a manual FDC**

Observer: *Number 1, drop 30. Number 1 is adjusted. Number 2, repeat, over.*

*H12, this is H18, adjust fire, over.*

FDC: Reads back.

Observer: *Grid 6732 8674, altitude 710, over.* Encoded when not radio encrypted.

FDC: Reads back.

Observer: *Final protective fire, attitude 1900, danger close, delay, over.*

FDC: Reads back.

The unit fires a battery one round with a sheaf. The observer observes that gun number one is closest to the FPF line and begins adjustment with number one.

Observer: *Direction 0810, number 1, right 100, drop 50, over.*

FDC: Reads back.

The unit fires the adjustment. The observer makes a final correction to within 50 meters of the FPF line.

Observer: *Number 1, drop 30. Number 1 is adjusted. Number 2 repeat, over.*

FDC: Reads back.

The FDC makes this adjustment, records the adjusted data as the priority target for gun number one but does not fire this adjustment, then fires gun number two. This procedure is continued until all guns are adjusted.

**Example: Adjusted FPF mission with an automated FDC**

Observer: *H12 this is H18, adjust fire, over.*

FDC: Reads back.

Observer: *Grid 5784 4893, altitude 475, over.* Encoded when not radio encrypted.

FDC: Reads back.

Observer: *Final protective fire, attitude 1900, danger close, VT, over.*

FDC: Reads back.

The unit fires one round with a selected howitzer. The observer observes and corrects the round just as in adjust-fire missions. The round represents the center of the linear sheaf.

Observer: *Direction 0810, left 80, drop 50, over.*

FDC: Reads back.

The unit fires the adjustment. The observer believes a final correction can be made to within 50 meters of the FPF line.

Observer: *Right 20, drop 50, end of mission, over.*

FDC: Reads back.

The FDC processes this adjustment but does not fire. Data is then determined for all howitzers. The data is passed to all howitzers, which remain laid on the FPF when not engaged in other missions.

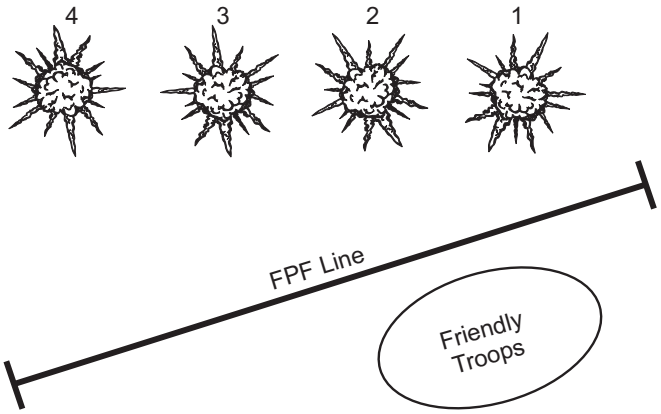



**Figure 6-19. Adjustment of an FPF.**

*Unadjusted Final Protective Fires*. In some instances, the tactical situation dictates against adjusting the FPF. In these cases, it is essential for the FDC to be automated. If this is not possible, then the observer should consider the proximity of the FPF to friendly troops. The observer will then establish the FPF and give the FPF location, including altitude and attitude.

**Example: Unadjusted FPFs**

Observer: *H12 this is H18, fire for effect, polar, over.*

FDC: Reads back.

Observer: *Direction 3160, distance 400, down 20, over.* Encoded when not radio encrypted.

FDC: Reads back.

Observer: *Establish as final protective fire, attitude 1900, danger close, delay, over.*

FDC: Reads back.

The FDC processes the mission and transmits data for the guns to lay on without firing.

*Laser Final Protective Fires*. Laser FPFs are unadjusted FPFs. They are similar to laser draw missions with one major difference—unlike laser draw missions, the lased points of the FPF each represent a howitzer aim point. The number of aim points must match the number of howitzers.

***Note:*** It is possible to create gaps in the FPF wall of steel with a laser FPF. Each point is lased and transmitted to the FDC as polar data or converted to a grid.

**Example: Laser FPF mission**

Observer: *H12 this is H18, fire for effect, laser draw, over.*

FDC: Reads back.

Observer: *Direction 1562, distance 380, vertical angle plus 3, over.* Encoded when not radio encrypted.

FDC: Reads back.

Direction, distance, and vertical angle to remaining points are transmitted and read back by FDC.

Observer: *Establish as final protective fire, danger close, VT, over.*

FDC: Reads back. The FDC processes the mission and transmits data for the guns to lay on without firing.

## NONSTANDARD PROCEDURES

Nonstandard procedures for artillery and mortars include adjusting fires by sound, multiple missions, and the auxiliary adjusting point; assisting the disoriented observer; calling for fire on irregular-shaped targets; and executing emergency observer procedures.

### Adjusting Fires by Sound

During operations where observer visibility is limited, fire may be adjusted by the use of sound alone. Target location may be reported to the observer by the supported unit or as determined by the observer. If the observer can hear noises at the enemy position (e.g., weapons firing, vehicles, troop movements) the enemy's direction and distance from the observer's position can be estimated.

***Procedures***. The observer must alert the FDC when planning to adjust fires by the use of sound. The battery FDC must plot the observer's location, and the observer executes the following:

**Step 1**. Determines the direction to the target and selects a target grid along the direction to the target.

**Step 2**. Sends a call for fire using that direction and target grid.

**Step 3**. Hears the burst of the adjusting round, estimates the direction to the burst, and compares it with the direction to the target.

**Step 4**. Converts the deviation to a lateral shift in meters. Distance to the adjusting point is difficult to judge; therefore, the observer may have to use creeping techniques to adjust onto the target.

**Step 5**. Determines distance by measuring the time it takes to hear the sound of the burst and multiplying the time interval by the speed of sound (i.e., 350 mps).

*Note:* To assist the observer in determining distance accurately, the FDC must announce the precise moment of impact, for example, with *splash*.

***Employment Considerations***. The following should be considered when adjusting fires by sound:

- The observer must exercise caution in broken terrain. In hills or mountains, the sound may travel around a hill mass before it arrives at the FO's position and may produce a false direction to the burst.
- If the observer's position is inaccurate, the initial round will be inaccurate. The initial round can be used to determine a resection.
- The observer may consider using a WP round with a 200-meter HOB as the first round in adjustment.
- The FDC may take the adjustments from two or more observers to increase accuracy in adjustments when using sound.
- Aerial observers may be used to assist the ground observer in making adjustments.

### Adjusting Multiple Missions

Contact with the enemy may be so intense that the observer must transmit two or more calls for fire and adjust all missions simultaneously. When this occurs, the observer should—

- Consult the maneuver unit commander, if possible.
- Consider previous guidance on target priorities and mission precedence.
- Use judgment to determine which of several important targets should be engaged first.
- Use target numbers assigned during the MTO (this assists the experienced observer when handling multiple missions).

The observer may also record the corrections determined for each target to eliminate any confusion that may arise in the heat of battle. If other observers are using the same COF net, observers should continue to use call signs during the mission.

### Adjusting the Auxiliary Adjusting Point

To achieve surprise, the observer may decide not to adjust directly on the target, but to adjust on a nearby point. This nearby point, which is the auxiliary adjusting point, must be far enough from the target (i.e., at least 500 meters) to obscure the real purpose of the adjustment (see figure 6-20).

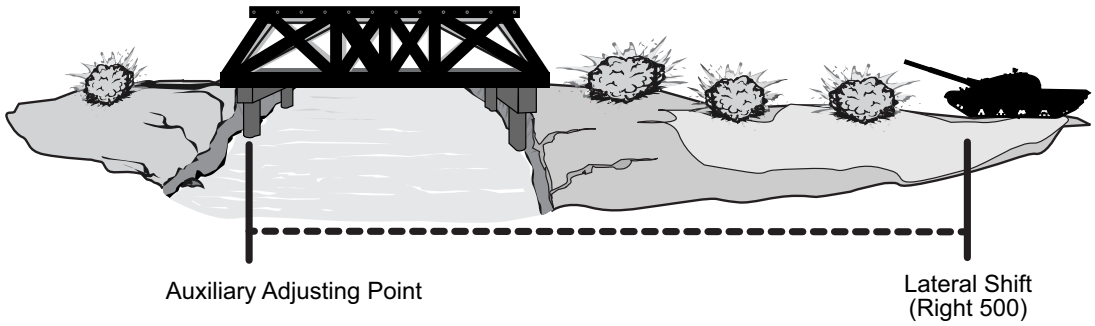



**Figure 6-20. Auxiliary Adjusting Point.**

Also, the auxiliary adjusting point must be selected so that an accurate shift to the target can be determined, preferably lateral. When the adjustment on the auxiliary adjusting point is complete, the shift to the target is made.

### Assisting the Disoriented Observer

Poor visibility, unreliable maps, deceptive terrain, or rapid movement through unfamiliar terrain sometimes makes it difficult for the observer to become and/or remain oriented. The observer may call for marking rounds to be fired on a known point, previously fired target, or prominent terrain feature.

**Example: Marking rounds**

*Mark hill 37.*

As a last resort, the observer may call for a round or rounds to be fired into the center of the target area.

**Example: Marking center**

*Mark center of sector.*

The observer usually requests a type of projectile that is easily identifiable (e.g., WP) or a higher burst with HE or WP. The unit may have an SOP for shell and/or fuze combinations. The FDC prepares data that will place the round at the point requested by the observer. If the observer fails to see the round, the FDC prepares data that will move the next round to a different point of impact or that will raise the burst higher into the air. This procedure is continued until the observer positively identifies the round. The observer then orders a shift from the point of impact (i.e., burst) of the identified round to a target or object that is permanent or semipermanent in nature (e.g., a road junction, the ruins of a building). Once this point has been located by the adjustment of fire and has been plotted at the FDC, the observer may use it as a known point to make shifts to subsequent targets.

### Calling for Fire on Irregular-Shaped Targets

When calling for fire on an irregular-shaped target, the observer must request the appropriate sheaf or describe the target in sufficient detail to allow the FDO to decide the best method of attack.

Irregular-shaped target choices include circular, linear, rectangular, and laser-drawn targets. For large targets that warrant multiple batteries or battalions, the target is segmented so that individual batteries provide coverage for a particular portion of the target.

Circular sheaves may provide the best coverage of an irregular target area. The circular sheaf is the default sheaf for automated FDCs and has a 100-meter radius. With a single battery, aim points are placed half the distance from the center grid and radius edge. Large targets are segmented for multiple units.

***Linear and Rectangular Targets***. Linear and rectangular targets require orientation in terms of direction. The observer sends the grid, size, and attitude of the target:

- The grid is the location of the center of the target.
- The size is the length and width of the target.
- The target attitude is described as a clockwise angle, in mils, measured from grid north to a line passing through the long axis of the target (see figure 6-21). Attitude is sent to the nearest 100 mils and is always less than 3200 mils.

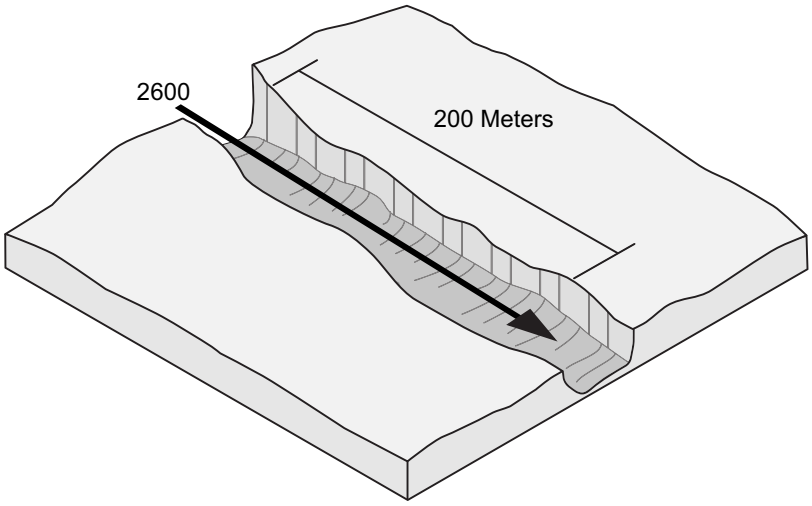



**Figure 6-21. Target Attitude.**

***Laser-Drawn Targets***. Laser equipment allows irregular targets to be drawn or traced by the observer. The AFATDS determines the appropriate distribution to cover the target area. The number of lased points does not correspond to howitzer aim points and therefore does not need to equal the number of howitzers that are firing. With a single battery, the first and last lased points are the only points that are also aim points for howitzers. All other howitzer aim points are equally distributed over the target nonlinearly. A laser draw mission can be used to create linear or rectangular targets by lasing two points and announcing the appropriate width.

### Engaging Moving Targets

Targets, both planned and opportunity, will often move on the battlefield or begin to move after being engaged during adjustment or fire for effect. Realistically, targets will not remain stationary for long periods of time. Therefore, observers must be proficient at engaging moving targets.

A target of opportunity is a target that appears during combat and against which no attack has been prearranged and these targets are expected to be more frequent in highly mobile situations. Requesting fire against a stationary target is a simple matter. The observer determines the target location and sends the call for fire. Requesting fire against a moving target is more complex. The observer must call for fire by using a grid in front of and on the intended path of the vehicle or vehicles and timed so that the rounds and the vehicles arrive at the desired location at the same time.

***Intercept Point.*** The point or grid at which the observer wants to engage the moving target is called the intercept point. To predict the intercept point, the observer determines the moving target direction and speed of travel. After acquiring the target, the observer tracks it until he/she is sure of the direction in which it is moving. As the target moves from point A to point B (see figure 6-22), the observer can use one of three methods to determine its speed:

- *Estimate the speed*. Common speeds are as follows:
  - Slow—3 mps (7 mph).
  - Medium—5 mps (11 mph).
  - Fast—8 mps (18 mph).
- *Use the CLRF to measure the distance the target moves during a certain time interval*. As the target moves, the observer lases it and converts the polar data to grid locations, points A and B. The observer then determines how far the target moved by measuring the distance between points A and B and rounding to the nearest meter. Target speed (in mps) can be determined by dividing the distance traveled by the time interval between points A and B.
- *Use the reticle pattern in the standard binoculars or CLRF to measure the distance the target moves during a certain time interval*. As the target moves across the reticle pattern, the observer measures the number of mils traveled to the nearest 5 mils. Multiplying that number by the OT factor allows the observer to convert the distance traveled by the target to meters. Target speed (in mps) can be determined by dividing the distance traveled by the time interval and then rounding to the nearest meter.

Once the speed and direction are determined, the observer must predict the intercept point by adding the total processing time (observer, FDC, and gun times) and the TOF, then multiplying that sum by the target speed. The product is the minimum distance to plot the intercept point in front of the moving target in the direction it is traveling.

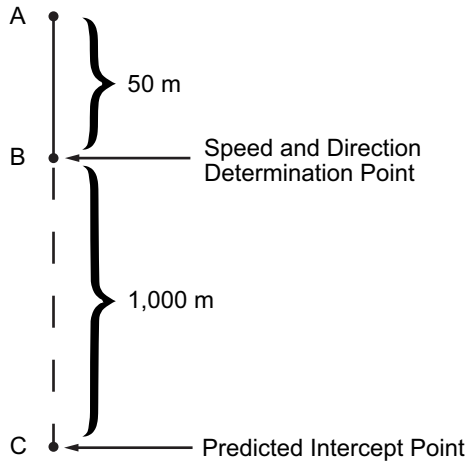



**Figure 6-22. Determining the Intercept Point.**

So that the target will not pass the intercept point before the round impacts, the observer must plot the intercept point distance well ahead of the moving target to allow enough time to get the grid and prepare the call for fire. Experience dictates how far ahead of the target to plot the intercept point. An untrained observer should add to the intercept distance half the distance determined to allow enough time. More time is better than not enough time. To simplify plotting, the observer can round up the intercept distance to the nearest 100 meters.

> ***Note:*** If the observer, through experience, knows how long it will take the firing unit to be ready to fire the mission, that is the time that should be used; otherwise, 200 seconds is a default time from the initiation of the call for fire to round impact. Intercept point can be determined by converting this time to distance, in meters, and applying the distance in the direction of movement.

**Example: Determining intercept point**

The distance measured between points A and B by using the CLRF is 50 meters.

The time interval between A and B is 10 seconds.

The speed of the target is 50 meters in 10 seconds, or 5 mps.

Total processing time is 180 seconds (3 minutes).

Time of flight is 20 seconds.

The distance at which to plot the intercept point is 5 mps x 200 seconds, or 1,000 meters.

> ***Note:*** Minutes must be converted to seconds for this to work.

***Trigger Point***. Once the intercept point is determined and the mission is sent to the firing unit, the observer must determine a point at which to "pull the trigger." This trigger point tells the unit when to fire. This point is determined to ensure the rounds and target arrive at the intercept point at the same time. Ideally, the trigger point will be an easily identifiable point. When the target passes over or near the trigger point, the observer commands the guns to fire.

To choose a trigger point, the observer must consider the intended path of the target, target speed, TOF, and call for fire transmission time, as follows:

**Step 1**. Determine the distance from the planned target location or intercept point to the trigger point. This is done by adding the transmission time (an average of 5 seconds) to the TOF received in the MTO and multiplying this sum by the speed of the target.

**Example**

Time of flight is 20 seconds.

Target speed is 5 mps.

Distance to trigger point = (transmission time + TOF) x target speed.

(5 seconds + 20 seconds) x 5 mps = 125 meters.

**Step 2**. Plot the trigger point by measuring the distance determined above from the planned target location or intercept point along the intended path toward the moving target (see figure 6-23).

If the target passes the trigger point before the battery reports *ready*, the observer should make a bold shift to a new target location by using the same trigger point and intercept distances. A grid for the new location should be sent to the FDC immediately.

***Timing of Fires***. If the observer does not intend to request *at my command or by round at my command*, the trigger point becomes the initiating point for the call for fire. In this case, mission

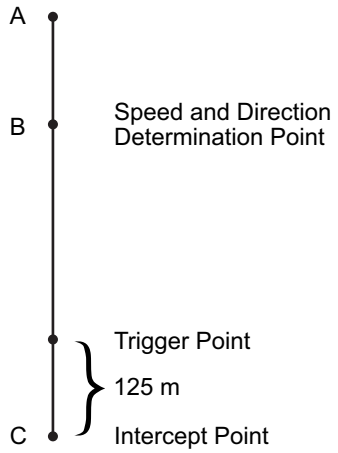



**Figure 6-23. Determining the Trigger Point.**

reaction time must be included in determining the distance to the trigger point. Normal mission reaction times are as follows:

- Priority targets: 30 to 60 seconds (plus TOF)
- On-call targets: 90 to 120 seconds (plus TOF).
- Targets of opportunity: 150 to 180 seconds (plus TOF).

### Engaging Moving Planned Targets

A planned target is a target upon which fires are prearranged. Planned targets may be further subdivided into scheduled on-call and priority targets. The degree of prearrangement varies, but some prior coordination or action is done to facilitate engagement.

Engaging planned moving targets is basically the same as explained for engaging targets of opportunity. However, a moving target may change its direction of travel and not travel over the initially planned intercept point. In this case, the observer must select a new intercept point and trigger point and engage the target as a target of opportunity.

The planned target location will be the intercept point. As soon as the vehicles to be engaged are visible, the observer must verify their direction and speed of travel and confirm the intercept and trigger point distances by using the procedures previously described. The planned intercept point and trigger point may not allow enough time for total processing time plus TOF. Then, the observer must determine a new intercept point and a new trigger point and engage the target as a target of opportunity.

# CHAPTER 7
# NAVAL SURFACE FIRE SUPPORT SPECIAL SITUATIONS

## ILLUMINATION

There are two methods of employing illumination in NSFS: continuous and coordinated. Battlespace illumination facilitates observation for both the spotter and the combat unit and restricts the enemy's freedom of movement. Illumination shells can be used to illuminate areas of suspected enemy activity, provide illumination during adjustment of night fire missions, and harass the enemy.

### Continuous

Continuous illumination is automatically used during the fire for effect phase of coordinated illumination missions and may also be used in surveillance missions. When firing continuous illumination, the ship fires one round approximately every 15 seconds. This results in one round bursting, one flare at midpoint of descent, and one flare near burnout. This technique should be used with discretion to avoid wasting the limited number of star shells (i.e., illumination projectiles) available in the ship's magazine.

### Coordinated

Coordinated illumination is the most common technique used by NSFS spotters to adjust fire during darkness and involves the following:

**Step 1**. The spotter transmits a call for fire for a suspected target when the location is not sufficiently accurate to fire for effect.

**Step 2**. The ship fires an illumination round over the initial target location.

**Step 3**. The spotter moves the illumination by subsequent adjustments. When the flare is adjusted to provide sufficient target illumination, the spotter informs the ship of the moment of best illumination by transmitting the command *stand by, mark.*

**Step 4**. The ship computes gun data to fire the initial round for HE adjustment to impact directly under the point of illumination burst at the moment of best illumination. There is a single salvo of illumination fire for each adjustment.

**Step 5**. When fire for effect begins, the ship fires adequate continuous illumination to ensure that the spotter can see the target.

## ILLUMINATION CALL FOR FIRE

The spotter uses the standard call for fire format and announces either *continuous illumination or coordinated illumination* in the special instructions sub-element of the call for fire.

The number of guns is omitted because one gun is standard. The ammunition (i.e., illumination projectile and fuze) is also omitted. The mission may require reduced charge to prevent ripped chutes, particularly when firing at ranges of less than 7,000 meters.

**Example: Illumination call for fire**

Spotter: *AlB this is C2D, fire mission, target number AF 1011, over.*

*Grid 344 677, altitude 55, direction 2680, suspected enemy activity, coordinated illumination, over.*

To differentiate between the illumination trajectory and the trajectory to be used for subsequent HE, the ship announces *line of fire*, followed by *ready*, and a TOF for the illumination projectile. The spotter must consider the path of the empty canister and its probable impact point along the line of fire. The spotter reads back the prefiring report and commands *fire*.

## ILLUMINATION ADJUSTMENT PROCEDURES

Spottings are made to determine the location of the flare at the midpoint of descent and the height of burnout of the flare. The flare is normally corrected to position it over (behind) the target and along the OTL to achieve a silhouette of the target. If the target is on a slope, the flare is normally positioned short of the target to allow the light to shine back onto the target. The direction and speed of the wind will also affect the positioning of the flare.

### Deviation and Range Corrections

These corrections are given in multiples of 100 meters, with the minimum correction being 100 meters. Because the illuminated area is large, bold corrections are normally used instead of bracketing.

### Height of Burnout

The height of burnout should be between zero and 50 meters above the deck. Corrections are given in multiples of 50 meters, with a minimum correction of 50 meters. If the flare burns on the deck, the spotter counts the number of seconds that it burns, multiplies that number by the rate of descent, and rounds up to the nearest 50 meters.

***Note:*** For the 5-inch illumination projectile, the rate of descent for the MK-88 illumination round is 10 mps; for the MK-91 illumination projectile, the rate is 2 mps.

**Example: Height of burnout**

A flare burns on the deck for 4 seconds.

The correction is *up 50* (4 seconds x 10 mps = 40 [round up to 50]).

If the flare burnout is in the air, the spotter must determine the height of burnout. This can be done by—

- Using binoculars and the formula: mils x OT factor.
- Using a technique that involves counting the number of seconds that it takes the flickering ember from the flare to reach the deck and then multiplying that number by the rate of descent.

After rounding down to the nearest 50 meters, a correction is supplied to cause the height of burnout to be between zero and 50 meters.

**Example: Flare burnout**

A flare burns out in the air.

The spotter counts 7 seconds from the burnout until the ember touches the deck.

The correction is *down 50* (7 seconds x 10 mps = 70 [round down to 50]).

## CONTINUOUS ILLUMINATION PROCEDURES

The spotter adjusts the illumination. Once the target has been properly illuminated, the spotter can begin the fire for effect phase of the mission. In the fire for effect phase, the ship fires illumination projectiles at a certain rate of fire to keep the target area continuously illuminated. The spotter may increase or decrease the rate of fire by ordering an interval of sustained fire.

Cease illumination should be transmitted when the spotter desires to terminate illumination early during the fire for effect phase. If the spotter acquires a target during a continuous illumination mission and desires to change to coordinated illumination, the command coordinated illumination should be transmitted. This command is followed by any desired illumination corrections, target description, method of engagement, or method of control changes.

The ship fires one illumination projectile and is prepared to mark following coordinated illumination procedures.

**Example: Entering the fire for effect phase**

**Example 1:**

Spotter: *10 salvos, fire for effect, over.*

The ship determines the rate of fire.

*Sustained fire, 5 minutes, fire for effect, over.*

*l0 salvos, interval l0, fire for effect, over.*

**Example 2:**

Spotter: *Continuous illumination, left 200, troops in the open, fuze CVT in effect, over.*

## COORDINATED ILLUMINATION PROCEDURES

A spotter's request for coordinated illumination may occur when a target is acquired during a continuous illumination mission or when it is a part of the spotter's method of engagement in the initial call for fire.

The request for coordinated illumination alerts the ship that the spotter will adjust the illumination and will subsequently request and adjust HE projectiles timed to impact at the moment of optimum illumination. During the illumination adjustment phase of the mission, the ship times every illumination projectile fired and is prepared to mark when commanded by the spotter. Then the spotter adjusts the illumination onto the target area by using the proper procedures.

### Establishing the Mark

Once the illumination flare has been positioned to yield the optimal light on the target, the spotter transmits *stand by . . . mark, over.* Mark informs the ship of the optimal illumination. The ship will time the firing of each HE projectile to impact at the optimal time.

### Adjusting High Explosives

Immediately after receiving the read back *mark out* by the ship, the spotter initiates the HE adjustment phase and transmits any subsequent corrections to improve the accuracy of the initial HE salvo. If no HE correction is sent, the ship fires the initial HE projectile at the point of flare deployment, which may be positioned off the target location for silhouette or wind purposes.

**Example: HE adjustment**

*HE left 200, drop 200, over.*

*HE repeat, over.*

### Transmitting the Prefiring Report

The ship will transmit a new prefiring report for the HE projectile. The spotter will read back and command *fire*. The ship will transmit *shot* for the illumination projectile and *splash*, *out* for the HE.

### Transmitting Subsequent Corrections

The spotter must preface each command with the type of projectile and correction that should be applied.

**Example: Correction**

*Illumination add 200, HE left 200, over.*

*HE add 50, l0 salvos, fire for effect, over.*

### Modifying the Mark

During the mission, the spotter may desire to change the timing between the illumination and the HE projectiles. To modify this interval, the spotter uses the command *advance or retard:*

- Advance shortens the time of firing between the illumination projectile and the HE projectile (i.e., the ship will fire the HE round sooner).
- Retard lengthens the time of fires between the illumination projectile and the HE projectile (i.e., the ship will fire the HE round later).

**Example: Modifying the mark**

*HE left 200, advance 5 seconds (understood).*

*HE retard 5 seconds (understood).*

### Illuminating During the Fire for Effect Phase

During the fire for effect phase, the ship will automatically fire limited continuous illumination to provide adequate illumination for surveillance. The ship will fire the last illumination projectile immediately after the last impact round in fire for effect unless the spotter issues the command *cease illumination.*

## ILLUMINATION PROJECTILE MALFUNCTIONS

Ripped chutes and dark star are special procedures used by ships and spotters to compensate for malfunctions that are unique to illumination rounds.

### Ripped Chutes

As a result of high muzzle velocity at shorter ranges, flare chutes may rip or separate upon deployment. Should this occur, the spotter reports to the ship either *ripped chute, repeat or ripped chute, reduced charge, repeat*. The procedure used depends on how often ripped chutes occur and whether or not the target area can be ranged by using a reduced charge. The spotter may also request that the ship increase the range.

### Dark Star

A dark star is an illumination round that fails to deploy or ignite. Such malfunctions are caused by either faulty ammunition or improper fuze settings. When a dark star occurs, *dark star, repeat, over* is reported. The ship should immediately check its time fuze settings and note the time fuze lot being used. Additional dark stars may indicate a malfunction in the time fuze lot.

## SMOKE

Ships can deliver only limited quantities of WP smoke. Early coordination with the ship will notify the ship of the amount of WP smoke that is required and to load it into the gun turrets and/or mounts.

## FRESH TARGET SHIFT

At any time during a mission, and before transmitting *end of mission*, a spotter may desire to shift fire to a higher priority target. To do this, the spotter uses the fresh target shift technique (see figure 7-1). The fresh target shift technique—

- Allows the ship to accomplish the shift to the fresh target more rapidly than if a call for fire with new target location data were introduced into the gunfire control computer.
- Allows the spotter to temporarily suspend the adjustment of fire for the original target, to bring fire onto a higher priority target, and then resume fire on the original target, if desired.

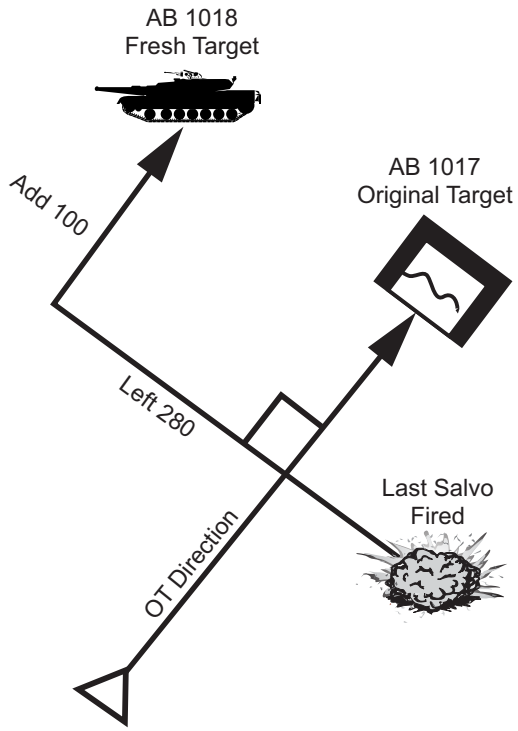



**Figure 7-1. Fresh Target Shift Technique.**

### Call for Fire

The spotter sends an abbreviated call for fire, applying a correction from the impact of the last salvo to cause the next impact to be on the fresh target. If initiated before the impact of the initial salvo, corrections are made from the target location data sent in the call for fire. The abbreviated call for fire omits the spotter's identification, but includes the following:

- *Warning order and target number*. Transmit as *fresh target, target number* and assign the next target number. There is no break in transmission.
- *Target location*. Expressed as a deviation, range, and/or altitude correction from the last salvo fired. The shift is based on the original OT direction. The direction to the fresh target is not transmitted until after the first salvo of the fresh target shift has been fired and then only if it differs from the original direction by more than 100 mils or 5 degrees.
- *Target description*. Must always be included.
- *Method of engagement*. Omitted unless a change from the initial call for fire is required. Because the essence of the fresh target shift is timeliness, changes that may cause a delay, such as changes in ammunition, should be avoided. The spotter may consider using a less preferred shell/fuze combination to obtain a timely response.
- *Method of control*. Omitted unless a change from the initial call for fire is desired. If the spotter was in the fire for effect phase on the original target, the fire for effect phase will continue unless the spotter announces *spotter adjust, over*.

### Adjustment

Once the initial salvo for the fresh target impacts, the spotter transmits a new OT direction if required and conducts adjustment onto the fresh target in the typical manner.

### Termination of Firing

The spotter continues adjustment until the desired effects on the fresh target have been achieved. If the spotter wants to resume firing on the original target, the fresh target technique should be used to return to the original target. The target is referred to by its original target number.

If the spotter wants the ship to record the target for future firing, *record as target, target number* ____ should be transmitted after fire for effect on that target is completed. When the spotter is satisfied with the effects on each of the targets (i.e., fresh and original), the mission is terminated in target number sequence. Each target must be referred to by target number when reporting the damage assessment.

**Example: End of mission**

*End of mission, target number AA 1001 (original target), 1 ammunition site destroyed, secondary explosions. Target number AA 1002 (fresh target), 3 T-72 tanks with dismounted infantry destroyed, estimated 30 casualties, over.*

## NEW TARGET SHIFT

At any time during a fire mission, the spotter may wish to attack another target that is not considered a higher priority. If the ship has the capability to conduct multiple missions (i.e., it has multiple mounts and an MK-86 gunfire control system), the spotter can send an abbreviated call for fire without interrupting the original mission. To accomplish this, the spotter uses a shift from the last salvo, similar to the procedure described for fresh target shift. The spotter then conducts adjustment on both targets. The difference between the fresh target shift and the new target shift is that for a fresh target shift, the spotter conducts adjustment for one target at a time; for a new target shift, adjustments are made on two targets concurrently. The call for fire and adjustment procedures for the new target shift are the same as those described for fresh target shift, with the following exceptions:

- Warning order and target number are transmitted as follows: *new target, target number* ____ (use the next target number). There is no break in the transmission.
- The spotter must preface each correction with the target number that is being corrected. The spotter may also use the last two digits of the target number for identification purposes.
- The spotter may record the target upon completion of fire for effect for the first completed mission. The mission is completed by the spotter reporting *end of mission*.

## SIMULTANEOUS ENGAGEMENT OF TWO TARGETS

If the ship has the capability to conduct multiple missions, the spotter can adjust fire on multiple targets simultaneously. The procedures for the simultaneous engagement of two targets differ from those of the new target shift because the target location will not be sent by using the shift from the last salvo. The call for fire for the second target in simultaneous engagement uses the standard six-element call for fire. The spotter must preface each correction with a target number. The ship will not transmit *splash*, providing more time for the spotter to transmit corrections.

## FIRING ON A RECORDED TARGET

If fires are desired on a previously recorded target or a planned target, the spotter sends an abbreviated call for fire consisting of the following elements:

- Spotter identification: Required.
- Warning order/target number: Consists of the words *fire mission and fire target number*. There is no break in transmission.
- Target location: Omitted because it is already known by the ship.
- Target description: Omitted unless changed from recorded description.
- Method of engagement: As required.
- Method of control: As required. When firing a recorded target from the same ship in the same firing track as when the data was recorded, a first salvo fire for effect may be feasible.

## DESTRUCTIVE FIRE

Destructive fire missions involve deliberate, accurate gunfire and normally employ a single gun against each target. The expenditure of ammunition can make this an expensive choice and may require a considerable amount of time to execute. During the mission, the gun/ammunition lot should not be changed. The ship should be positioned to allow for the optimum conditions and orientation with respect to the GTL and the terrain in the target area.

### Adjustment

Ship adjustment should be used if possible. When the spotter conducts the adjustment, normal adjustment procedures are used until the MPI is at the split of the l00-meter range bracket.

### Fire for Effect

Groups of rounds, usually five for a single gun, are fired, and the average deviation and range spottings are noted. Then a correction is sent based on the MPI of all the rounds. Five rounds are fired again. The correction is made to be as accurate as possible.

**Examples: Fire for effect**

*Right 10, drop 25, repeat, over.*

*Left 5, repeat, over.*

## MASSED FIRE

Massed fire is the fire of the batteries of two or more ships directed against a single target. (*DOD Dictionary*) On occasion, two or more ships are required to engage large or important targets simultaneously. If they have not already been tasked with a direct support mission, gunfire request procedures must be initiated using the following procedures:

- A collective call sign is used in the request. All orders from the spotter are read back by the senior ship. The other ships acknowledge the transmissions. The first ship to report *ready* is adjusted onto the target in the normal manner. The other ships are individually adjusted as they report *ready*. The spotter addresses individual ships (e.g., when conducting adjustment) by using each ship's call sign.
- To bring MPI into the required target area, usually one or two bold corrections are used. To facilitate spotter control, *at my command* may be employed.
- At the completion of adjustment, the spotter announces *cancel at my command*, *all guns* (number) *salvos, fire for effect, over*.

## SPECIAL NAVAL SURFACE FIRE SUPPORT COMMANDS AND REPORTS

The following are additional commands and reports common in an NSFS environment:

### Commands

***Check Firing***. Anyone can command *check firing* when an unsafe situation becomes apparent. This command causes the ship to instantly stop firing. The originator of check firing must announce *cancel check firing* for the fire mission to continue.

**Example: Spreading fires**

*Spreading fires, right 200, repeat, over.*

***Spreading Fires***. The command *spreading* fires indicates that fires for effect are about to be distributed over an area by corrections. The spotter announces *spreading fires*, followed by a correction and the command repeat, when pertaining to the volume of fire.

**Example: Trend**

*Trend, southwest 100 per salvo.*

***Trend***. A trend is the straying of the fall of shot from salvo to salvo. The spotter announces *trend* if one is noticed, along with an indication of direction and distance in meters. This is a correction to move the MPI back to the target.

***Check Solution***. If the spotter suspects an error in the gunnery solution for a salvo, *check solution* is transmitted after the spotter checks the target location data. The ship will respond with either *solution checks* or *neglect*.

### Reports

***Neglect***. This report is sent by the ship to indicate that the last salvo was fired with incorrect data. The ship corrects the settings and transmits *ready, over* when prepared to fire.

***Delay***. This report indicates that the ship is not ready to fire. The report is followed by an estimate of time in minutes, usually of short duration, that the ship is unable to fire. When the ship is prepared to fire, the ship reports *ready, over*.

***Will Not Fire***. This report indicates that the ship will not continue the mission for a stated reason (e.g., a gun mount malfunction, a higher priority mission or circumstance).

# CHAPTER 8
# REQUESTING AND CONTROLLING CLOSE AIR SUPPORT

This chapter provides procedures for requesting and controlling both fixed-wing (FW) and rotary-wing (RW) CAS. Typically, the terminal control of CAS aircraft is conducted by JTACs. However, in combat or emergency situations where a JTAC is not available, other Marines who are knowledgeable of these procedures, particularly observers and spotters, may request CAS and function as the terminal controllers for CAS aircraft. An understanding of these procedures by observers and spotters also enhances the coordination of missions that integrate indirect fires and CAS. See appendix F for a list of air brevity codes commonly used in CAS communications.

Because these procedures are applied by all Marines requesting or controlling CAS, including Marines who are not formally trained or designated as forward air controllers (FACs) or JTACs, this chapter will refer to the CAS requester and controller as the terminal controller. The CAS procedures discussed here are oriented to high-threat conditions, because these conditions are the most difficult to understand and the most demanding that may be encountered in the battlespace. In lower threat situations, these procedures may be streamlined. More detailed discussion of CAS terminal control procedures can be found in Joint Publication (JP) 3-09.3, *Close Air Support*.

## TYPES OF CLOSE AIR SUPPORT

There are two types of CAS requests that are available to support the ground forces: preplanned and immediate. The type of CAS used depends upon the time that is available for planning.

### Preplanned

A preplanned CAS is an air strike that is anticipated in advance and permits detailed mission coordination and planning via the air tasking order (ATO). Once the requirements are identified, CAS planners submit the request prior to the cutoff time as directed by higher headquarters (HHQ), to be included in the ATO. These missions are categorized as either scheduled or on call. A scheduled mission is executed at a specific time. An on-call mission involves aircraft placed in a ground and/or air alert status and preloaded with ordnance for a particular target or type of target.

### Immediate

Immediate CAS is an air strike on a target of opportunity that was not identified or requested sufficiently in advance to permit detailed mission coordination or planning and inclusion on the ATO. An immediate mission usually involves both the observer and the spotter and requires impromptu coordination.

## LEVELS OF THREAT

Some enemies may present an air defense threat that will affect the employment of CAS. The feasibility of using CAS on a specific target will be driven, in part, by the threat. Attack tactics selected by the aircraft pilot or flight leader will be influenced by the specific threat. For example, the greater the threat, the lower the altitude; the higher the dive angle, the more accurate the delivery. The threat to CAS may be high, medium, or low:

- *High*. The hostile force masses heavy combat power, including an integrated air defense system and electronic warfare capabilities that may seriously diminish the ability of the ACE to provide the necessary air support. In this type of threat, aircraft tactics are typically characterized as fast and low. This results in a minimal time for target acquisition, which may affect accuracy.
- *Medium*. The enemy possesses a limited radar or electro-optical acquisition air defense system that is not fully integrated. Specific aircraft performance and associated weapons systems permit tactics that allow acceptable exposure to those enemy defenses.
- *Low*. No known integrated or sophisticated surface-to-air or air-to-air capability exists. The threat is limited to visual target acquisition and fire control systems (i.e., small arms, large-caliber automatic weapons, and shoulder-fired IR missiles). In this type of threat, aircraft tactics may be fast or slow, at low to medium altitude, with ample time to acquire the target.

## AIRSPACE COORDINATING MEASURES

Airspace coordinating measures (ACMs) are procedural control measures designed to maximize the effectiveness of combat operations by promoting the safe, efficient, and flexible use of airspace. Airspace coordinating measures are used to delineate or modify hostile criteria, delegate target identification authority, serve as aids for fire control, and assert control of aircraft over the battlespace. Air control agencies, such as the DASC or Navy TACC, use these measures when directing aircraft to and from the target area. Terminal controllers and observers must understand the meaning of each ACM described in the following subparagraphs.

### Control Point

Control points route aircrews to their targets and provide a ready means of conducting fire support coordination. Control points—

- Must be easily identified from the air and support the MAGTF's scheme of maneuver. The MAGTF FFCC and the ACE select control points based on MAGTF requirements. The MAGTF commander approves control points.
- Are given names or numbers and are often used to facilitate the establishment of airspace coordination areas (ACAs) for aircraft operating in areas where flight routes or tactics can conflict with indirect-fire trajectories.

### Contact Point

A contact point is the position that an aircrew uses to establish radio contact with an air control agency. Typically, a contact point is outside the range of enemy surface-to-air weapons. The aircrew contacts the terminal controller at the contact point during ingress. A contact point allows coordination of final plans before heavily-defended airspace is entered.

### Initial Point

Aircrews use an initial point (IP) to begin the run to the target or the approach to a landing zone. The IP is well-defined and easily identified, both visually and electronically. Terminal controllers and aircrews use IPs to help position FW CAS aircraft delivering ordnance.

### Holding Area

Holding areas (HAs) are areas that are well forward in the battlespace and provide for helicopter dispersion, cover, and concealment from enemy observation and fires. To achieve this, HAs may be located at maneuver, regimental, or battalion headquarters or at the terminal controller's position. Rotary-wing CAS aircrews typically occupy HAs while awaiting targets or missions. While in the HA, RW CAS aircrews receive CAS briefings and perform final mission coordination with terminal controllers.

### Kill Box

A kill box is a 3D area used to facilitate the integration of joint fires. It is a permissive fire support coordination measure as described in JP 3-09, *Joint Fire Support*. When established, the primary purpose of a kill box is to allow a lethal attack against surface targets without further coordination with the establishing commander and terminal attack control. When used to integrate air-to-surface and surface-to-surface indirect fires, the kill box will have appropriate restrictions. The goal is to reduce the coordination required to fulfill support requirements with maximum flexibility while preventing fratricide.

### Battle Position

Battle positions (BPs) are maneuvering areas that also contain various firing points, both laterally and in depth. Helicopters maneuver in BPs while awaiting the TOT or time to target (TTT). They are coordinated and selected by the supported commander. Once the terminal controller approves RW CAS aircraft into a BP, these aircraft should not exit until authorized. Aircrews have freedom of movement within the BP unless restricted by the flight leader. To avoid enemy counterfire, aircraft may need to displace and resume the attack from a different BP; therefore, alternate BPs should be established. Terminal controllers should consider requesting ACAs around BPs. If an approved BP does not exist, aircrews can plan a hasty BP in coordination with the terminal controller. If there is not a properly placed or existing BP, the terminal controller may create a new BP. Terminal controllers identify the BP by grid, known point, prominent terrain, or by shifting an existing BP. The positions of new BPs must be given to the appropriate FSCC for fire support coordination. Battle position selection is based on the following factors:

- *Field of fire*. The BP should permit the sighting of targets throughout the kill zone.
- *Adequate maneuver area*. The BP must be large enough for RW CAS aircrews to maneuver between various firing points.

- *Effective range*. The BP should be located so that the kill zone is within the effective range of RW CAS aircraft.
- *Target altitude*. Typically the BP elevation should be equal to or higher than the target area.
- *Background*. Terrain features behind the BP should prevent RW CAS aircraft from being silhouetted against the horizon.
- *Sun/moon location*. If possible, the sun or moon should be located behind or to the side of the aircraft. This allows the RW CAS aircrews to view the kill zone and also prevents the enemy from seeing and targeting the aircraft.
- *Shadow cover*. If possible, terrain or vegetation should cover the BP with shadows.
- Rotor wash. The BP location should reduce the effects of rotor wash on the surrounding terrain (e.g., debris, leaves, snow, sand, dirt).
- *Backblast*. The BP location should reduce the effects of backblast on surrounding terrain.

## COORDINATION TECHNIQUES

### Run-in Heading

The run-in heading is the heading from the IP to the target. For RW CAS aircraft, this may be the heading from the center of the BP to the target. The terminal controller determines this heading from the map and converts it to a magnetic heading for transmission in the brief. The assignment of run-in headings facilitates fire support coordination by establishing a corridor for the aircraft between the IP and the target. Without a run-in heading, the aircrews may exercise a number of options for proceeding from the IP to the target. The decision to use run-in headings depends on other factors, such as target orientation, terrain, disposition of defense, and weather.

### Offset Direction

An offset direction is used to ease fire support coordination, safeguard friendly forces, aid target acquisition, or align aircraft for the attack or egress. The offset direction—

- Informs the aircrew which side of the IP-to-target line they can maneuver on for the attack.
- Aids fire support coordination by restricting aircrews from using airspace on the other side of the IP-to-target line. It keeps aircraft clear of enemy air defenses, reduces interference with GTLs, and reduces an aircrew's chance of being hit by either friendly direct and/or indirect fires.

> ***Note:*** During combat, the danger to aircraft from friendly direct and/or indirect fires is small compared to the threat from enemy air defenses. The offset direction regulates the attack quadrant without assigning a specific attack heading. This technique protects friendly ground forces from range errors in the delivery of ordnance without unduly restricting the attacking aircraft.

### Attack Heading

An attack heading is the assigned magnetic compass heading that an aircrew flies during the ordnance-delivery phase of the attack. Terminal controllers assign attack headings to—

- Improve ground troop safety.
- Aid in target acquisition.
- Ease fire support coordination.

Attack headings, particularly during visual attacks, may reduce the aircraft's flexibility and survivability.

### Attack Routes

Rotary-wing CAS aircrews use attack routes to move from the HA to the BP. Aircrews select primary and alternate attack routes. If an ACA is required, the aircrew or terminal controller coordinates with the appropriate FSCC. The ideal attack route is a corridor that allows aircrews to move into the BP undetected. Detection, even if beyond the range of enemy air defense weapons, removes the advantage of surprise. Terrain and vegetation should be used to conceal aircraft movement on the attack route, and SEAD fires may also be employed to conceal aircraft movement and prevent detection.

### Firing Points

A firing point is a specific point within a BP that a single aircraft occupies while engaging targets. The flight leader determines movement of aircraft within the BP. Although the supported commander coordinates and controls the location of the BP, aircrews choose their own firing points. Alternate firing points should be identified so that aircrews can displace after the initial engagement.

## AIRCRAFT ORDNANCE

Knowledge of aircraft ordnance is important to ensure the proper employment of CAS. This knowledge makes the terminal controller aware of the effects that can be produced on the target and how to make target marking and airspace coordination compatible with the type of delivery. See Marine Corps Reference Publication (MCRP) 3-31.6, *Multi-Service Tactics, Techniques, and Procedures for the Joint Application of Firepower (JFIRE)*, for the most current inventory of ordnance and munitions.

## CLOSE AIR SUPPORT REQUEST AND CONTROL PROCEDURES

Typically, the terminal controller follows a sequence that will provide the essential information needed by those who must approve, coordinate, and fly the mission. The sequence includes—

- Mission request.
- Request processing and routing.

- Briefs.
- Time to ordnance impact.
- Mark, adjust, and control initial and subsequent aircraft.
- Report of BDA.

### Mission Request

Requests for immediate CAS missions are made to support requirements that arise during battle and that cannot be identified far enough in advance to permit detailed mission coordination and planning. Immediate missions provide crisis response to unforeseen dilemmas and sacrifice detailed planning and tailored ordnance loads in return for timely response. The format used for immediate requests corresponds to the appropriate lines of the joint tactical air strike request (JTAR) (refer to Department of Defense Form 1972, *Joint Tactical Air Strike Request*, and JP 3-09.3). The request may be made in one transmission or in separate bursts, consistent with the communications security situation, and should include pertinent lines from the JTAR. See appendix G for a sample JTAR.

Requests for preplanned CAS missions are submitted by using the same JTAR format as for immediate requests, but are submitted to the appropriate FSCC for consolidation, approval, and forwarding to higher echelon FSCCs. Immediate requests contain the elements described in the following subparagraphs.

***Identification of Unit Called/Requester***. This element includes the call signs of the unit called and the requester, followed by the words *immediate CAS*. The transmission of *immediate CAS* prioritizes the mission for responsiveness.

***Mission Category***. The mission category for an immediate CAS mission is indicated by announcing *immediate* and the mission priority. The following numerical designations are used to define the tactical situation:

- 1—Alpha: targets that require immediate action and supersede all other categories of mission priority.
- 2—Bravo: targets that require immediate action and supersede routine targets.
- 3—Charlie: targets of opportunity that do not demand urgent execution.

***Target Description***. The target is described by type, size, and mobility. This information is used in mission processing to determine the type and number of aircraft and type and amount of ordnance needed for the mission.

***Target Location***. The target location is provided by using the UTM 100,000-meter square designation and grid coordinates (e.g., SS623 456) and the elevation in feet at MSL. The ordnance delivery systems of F-14, F/A-18A, older model F/A-18C, and some Air Force aircraft require latitude and longitude, rather than UTM grid (see app. H).

> ***Note:*** Although all pilots can manually convert UTM grid to latitude/longitude if necessary, it is usually easier for a trained terminal controller to make this conversion. Pilots who are distracted by threat conditions or other flight requirements may specifically request latitude and longitude if a UTM grid is given.

**Example: Immediate request**

**Transmission:**

Terminal controller: *Budworth, this is Tiger 14 with an immediate CAS request, over.*

Terminal controller: *Immediate, Bravo, 5 armored vehicles moving in column, SS623 546, elevation 55, ASAP, Tiger 14, Orange, Chevy, friendly troops 1,000 meters south, over.*

**Description of transmission:**

Unit called/request identification: *Budworth, this is Tiger 14 with an immediate CAS request, over.*

Mission category: Immediate, Bravo.

Target description: 5 armored vehicles moving in column.

Target location: SS623 546, elevation 55.

Time on target: ASAP.

Desired ordnance/results: Not typically transmitted.

Final control:

Call sign: Tiger 14.

Frequency: Orange.

Contact point: Chevy.

Remarks: Friendly troops 1,000 meters south.

***Time on Target***. The time that the ordnance should be on the target may be specified as—

- *ASAP*. Target is to be attacked as soon as possible.
- *TOT NLT*. Target is to be attacked not later than (NLT) the specified time on a synchronized clock.
- *TOT*. Target is to be attacked at a specified time on a synchronized clock.

***Ordnance Results***. This element is not typically transmitted in the immediate request because responsiveness overrides ordnance selection.

***Final Control***. This element identifies the terminal controller who will conduct the attack briefing and control the release of ordnance. The briefing includes the call sign of the terminal controller,

the frequency recommended for terminal control, and the contact point or IP to be used. The frequency is transmitted by using a pre-established color code pertaining to a selected frequency. The frequency modulation (FM) may be UHF or VHF, depending on the type of aircraft.

***Remarks***. This element provides any additional information that may assist the air control agency in mission processing (e.g., friendly location, weather, threats).

### Request Processing and Routing

Typically, requests for immediate CAS are transmitted on the tactical air request net directly to the air control agency, which is usually the DASC. The air officers at intermediate-echelon FSCCs monitor the requests for coordination purposes and indicate approval in the method prescribed by the commander—either positive or passive clearance. Requests for CAS beyond the fire support coordination line need not be cleared, but FSCCs must inform all other affected units (e.g., special operations forces, reconnaissance units) of these missions in sufficient time to allow necessary reaction to avoid friendly casualties. In exceptional circumstances, the inability to allow sufficient reaction time will not preclude the attack of targets beyond the fire support coordination line by CAS aircraft. However, failure to coordinate these missions increases the risk of friendly casualties and could waste limited resources through duplication of attacks. The MAGTF FSCC will establish procedures for exchanging this information with other components of a joint force.

The DASC begins processing immediate CAS requests upon receipt and completes mission processing upon receiving clearance from the FSCC where it is collocated. After examining assets and priorities and coordinating with the Navy TACC as required, the DASC identifies what aircraft are available for the mission. The aircraft assigned may come from multiple sources, including ground alert aircraft, airborne alert aircraft, or aircraft that have been diverted from another mission. The aircrews will be provided with the final control data. The DASC keeps the CAS requester informed of the status of the aircraft filling the request. The DASC assigns a request number for the mission.

Procedural control of assigned aircraft is provided by the DASC until control is assumed by the terminal controller. The DASC determines aircraft routing in coordination with the senior ground combat element FSCC based upon the tactical situation and the threat. Aircraft are typically routed by using pre-established control points throughout the area. The terminal controller provides routing for the aircraft until initial contact is made with the aircraft. Initial contact with the terminal controller is initiated by the aircraft on the assigned frequency

***Positive Clearance***. Under positive clearance procedures, each request for immediate CAS must be specifically cleared by the FSCC of the unit that will be impacted by the fires. The FSCC that is collocated with the DASC must advise the DASC that the mission is approved or disapproved before final mission processing is completed and control of CAS aircraft is passed to the terminal controller.

***Passive Clearance***. Under passive clearance procedures, FSCCs monitor the transmitted CAS request and either remain silent if the request is cleared (i.e., silence is consent) or interject if the request is not cleared or if more time is required to clear the request. In this case, the DASC processes the mission request unless the FSCC that is collocated with the DASC disapproves the request for immediate CAS.

To avoid inadvertent clearance resulting from loss of communications, commanders may modify passive clearance procedures by stipulating that immediate CAS requests are not cleared unless the appropriate FSCCs acknowledge that the request was monitored. For purposes of confirmation or when doubt exists, the DASC will coordinate with the FSCC air officer that is collocated with the DASC.

**Example: Transmission of immediate mission status to terminal controller by the DASC**

**Transmission:**

DASC: *Tiger 14, this is Budworth, mission 10-2, Check, 2 F/A-18s inbound with Rockeye ETA 15, contact on Orange.*

**Description of Transmission:**

Identification: Tiger 14, this is Budworth
Request number: mission 10-2
Call sign of flight: Check
Number of aircraft: two F/A-18s inbound
Type of ordnance: Rockeye
Estimated time of arrival in minutes: ETA 15
Frequency of terminal control: Contact on Orange.

**Legend:**

ETA-estimated time of arrival

***Note:*** The aircraft flight is referred to collectively by call sign. Individual aircraft in the flight are referred to as "lead" (flight leader) and "dash" (number) plus (remaining aircraft in flight). For example, dash 2.

### Briefs

The terminal controller provides a brief to the aircrew that contains essential information for execution of the mission. This brief may be transmitted in one transmission or in bursts of several lines, consistent with the communications security situation. The brief follows a numbered format sequence; therefore, reference to line numbers or elements is not required. Ideally, this brief is passed to the aircrew as early as communications can be established. As a last resort, the aircrew can receive the brief at the contact point or HA.

Due to recent technological advances in aircraft capabilities, weapons systems, and munitions, terminal controllers have more options when employing aircraft. These options mitigate the risks of fratricide when employing air power close to ground forces. As a result of these changes, there

are three types of terminal control available to the terminal controller. Each type follows a set of procedures with an associated risk. The ground commander chooses which option to employ based on recommendations from the terminal controller and the associated risks of the current tactical situation. These controls are risk-specific, not ordnance-specific.

Remarks may follow the CAS briefing, as required. Information may be provided concerning the threat, hazards, weather, ordnance delivery, attack heading, airspace coordination, and other appropriate subjects. This additional information is passed from the terminal controller to the aircrew to increase situational awareness. Typically, the first communication between the pilot and terminal controller is the check-in brief.

**Example: Check-in brief**

Flight leader: *Tiger, this is Meat 11.*

Terminal controller: *Roger, Meat, proceed to Chevy, hold 13-15, you are the only aircraft on station.*

Flight leader: *Advise when ready to copy check-in brief.*

Terminal controller: *Ready to copy.*

Flight leader: *Tiger, this is Meat 11; mission number 10-2; two AV-8B currently 10 nautical miles north of Chevy, block 13-15; ordnance, 300 rounds 25mm, 1 GBU-12, 1GBU-54; laser codes: Meat 11 1688, Meat 12 1731; 25 minutes time on station; Meat-11 is FAC(A) capable; Meat 11 VDL code 4927, Meat 12 VDL 4977; we have SITREP C and GRG 15-7 on board; abort code none.*

**Description of Transmission:**

Identification: Tiger (controller) Meat 11 (flight call sign).

Mission number: 10-2.

Number and type of aircraft: Two AV-8Bs.

Position and altitude: 10 nautical miles north of Chevy, 13-15,000 ft.

Ordnance and laser codes: 300 rounds 25mm, 1 GBU-12, 1 GBU-54; laser codes: Meat 11 1688, Meat 12 1731.

Time on station: 25 minutes.

Capabilities: FAC(A) capable, Meat 11 VDL code 4927, Meat 12 VDL 4977; we have SITREP C and GRG 15-7 on board.

Abort code: no code required.

**Legend:**

GRG-gridded reference graphic

SITREP-situation report

VDL-video down-link

***Type 1 Control***. Type 1 control is when the FAC/JTAC must visually acquire the attacking aircraft and the target for each attack. This ensures that the aircraft is oriented at the correct target and engaged from a safe direction in relation to friendly troops to prevent fratricide. The terminal controller will always announce the type of control upon aircraft check in.

**Example: Type 1 control**

**Transmission:**

*Check 21 de B1D, Type 1 in effect, advise when ready for 9-line. Snake 045, left 12.3, 55, 5 armored vehicles moving north to south in column, SS623 456, WP, south 1000, egress south to Ford.*

**Description of Transmission:**

IP or BP: Snake.

Heading and offset: 045 left.

Distance: 12.3.

Target elevation: 55.

Target description: 5 armored vehicles moving north to south in column.

Target location: SS623 456.

Type of mark: If beacon or laser, include the appropriate code. WP.

Location of friendly forces: South 1000.

Egress: South to Ford.

***Note:*** "de" means "this is."

***Type 2 Control***. Type 2 control is used when the terminal controller desires control of individual attacks but cannot visually acquire the attacking aircraft or target at weapons release or when attacking aircraft are not in a position to acquire the target or mark prior to weapons release. Examples of such situations include night attacks, periods of adverse weather or low visibility, and high altitude or standoff weapons employment. When employing guided munitions in Type 2 control, the aircraft will confirm targeting locations with the terminal controller prior to launch by plotting the location on a map and cross-checking that this designation coincides with the expected target area. When employing unguided munitions, careful consideration of the weapons systems' accuracy and aircraft navigation systems must be made. Detailed planning and communications are necessary between the terminal controller and aircraft to ensure a safe delivery of ordnance.

**Example: Type 2 control**

**Transmission:**

*Hog 11 de A3C, type 2 in effect, advise when ready for 9-line. Mazda, 360 right, 9.0, 450, T-80 dug-in, NB865 427, none, south 1000, troops in contact, egress east to Chevy, final attack heading 300-345.*

**Description of Transmission:**

IP or BP: Mazda.

Heading and offset: 360 right.

Distance: 9.0.

Target elevation: 450.

Target description: T-80 dug-in.

Target location: NB 865 427.

Type of mark: If beacon or laser, include the appropriate code. None.

Location of friendly forces: South 1000, troops in contact.

Egress: East to Chevy.

Remarks: The final attack heading is 300-345.

***Note:*** "de" means "this is."

***Type 3 Control***. Type 3 control may be used when tactical risk assessment indicates that CAS attacks pose a low risk of fratricide. When authorized in this control option, aircraft are given a blanket weapons release clearance to attack targets that meet the prescribed restrictions set by the terminal controller. The terminal controller continues to monitor the conduct of the attack by voice or digital communications and retains abort authority at all times. The terminal controller may or may not see the target area.

### Time to Ordnance Impact

Immediately following the 9-line brief, the terminal controller gives the aircrew the desired time for ordnance to impact on the target and any other required information.

**Example: Type 3 control**

**Transmission:**

*Razor 11 de A3C, type 3 in effect, advise when ready for 9-line. Mazda, 360 Right, 9.9, 450, mechanized company in the open, NB 922 556, laser 1111, southeast 3000, egress south to Mazda. You are cleared to engage from time 45-55. Execute attacks north of the river. Cobra team is currently 3000 S in position to lase. Contact on this TAD [tactical air direction]. Report attack complete.*

**Description of Transmission:**

IP or BP: Mazda.

Heading and offset: 360 right.

Distance: 9.9.

Target elevation: 450.

Target description: Mechanized company in the open.

Target location: NB 922 556.

Type of mark: (If beacon or laser, include the appropriate code.)
Laser 1111.

Location of friendly forces: Southeast 3000.

Egress: South to Mazda.

Remarks: You are cleared to engage from time 45-55. Execute attacks north of the river. Cobra team is currently 3000 S in position to lase. Contact on this TAD [tactical air direction]. Report attack complete.

***Note:*** "de" means "this is."

***Time on Target***. If both the terminal controller and aircrew are on a synchronized clock, this time should be expressed as a TOT. Using TOT eliminates the need for a hack and eases coordination of target marking and SEAD. See appendix E for more information.

**Example: Time on target**

Terminal controller: *Time on target 30.*

Flight leader: *Roger, 30.*

***Time to Target***. If a synchronized clock has not been established or is not maintained by either the terminal controller or flight leader, TTT may be used to coordinate the timing of the mission. The TTT—

- Is the number of minutes and seconds to elapse before the ordnance impacts the target.
- Is followed by the word *hack*.
- Must allow sufficient time for the aircrew's response and flight time. Typically, a TTT of 6 to 8 minutes is used.

The aircrew must determine whether they can comply with the desired TTT. The terminal controller passes the TTT to the aircraft as shown in the following example:

**Example: Time to target passed to aircraft**

Terminal controller: *6 plus 0, 0 . . . hack.*

Flight leader: *Roger, 6 plus 0, 0.*

When the flight leader reads back the hack time, this indicates a good copy of the brief, that the hack was accomplished, and that the hack allows sufficient time for the aircraft's response. If the time is too short, the flight leader transmits *negative* and states a required TTT to allow aircraft positioning for ordnance delivery. The countdown continues from the original hack.

**Example: Countdown from original hack**

*Negative, 8 plus 0, 0.*

The terminal controller then re-examines the situation and determines whether the required TTT indicated by the pilot is acceptable. If it is acceptable, the terminal controller restates the TTT to the flight leader.

**Example: Restate time of target to flight leader**

*8 plus 0, 0.*

If the flight leader fails to copy all of the brief but can comply with the hack, the flight leader—

- Notifies the terminal controller and indicates the specific lines of the brief that was not copied.
- Acknowledges the hack. The countdown continues from the hack.

**Example: Acknowledgment of compliance**

Flight leader: *Tiger 14, Check 10-2, say again line 2, roger, 6 plus 0,0.*

Terminal controller: *045, left.*

If the flight leader missed parts of the brief and missed the hack, then transmissions are made as shown in the following example:

**Example: Flight leader transmits correct brief and hack**

Flight leader: *Tiger 14, Check 10-2, say again line 2, negative hack.*

Terminal controller: *045, left, 6 plus 0, 0 . . . hack.*

Flight leader: *Roger, 6 plus 0, 0.*

At the end of the mission brief, the flight leader repeats the TOT/TTT to notify the terminal controller that the flight leader received and understood the entire mission brief.

***Additional Information***. Additional information to pass along with the time of attack includes extended information on marks, threats to the aircraft, and final attack headings:

- *Laser target line*. Line from observer's laser to target.
- *Ordnance delivery*. Special instructions concerning ordnance delivery.
- *Threat, location, and type of suppression*. Any type of air defense artillery (ADA) and if any SEAD missions are active.
- *Any active GTLs*. Given in degrees magnetic.
- *Final attack heading*. The aircraft will orient when dropping ordnance on the target. This may be a single heading different from the run-in heading or a pair of headings.
- *Hazards to aviation*. Any additional hazards, including terrain and man-made features.
- *ACAs*. Both formal and informal, ACAs include SEAD altitude deconfliction.
- *Weather*. Any weather conditions that may affect the aircraft, such as fog or significant precipitation.
- *Restrictions*. Any additional information that was not briefed in the special instructions.
- *Additional target information*. Increased target information that will allow the aircraft to better attack the target.
- *Night vision capability*. Conditions that may affect night vision capability, such as ambient light from cities or flares.
- *Danger close*. Lets aircraft know the terminal controller will be dropping within the minimum safe distance and will require the on-scene commander's initials.

### Mark, Adjust, and Control of Initial and Subsequent Aircraft

***Initial Aircraft***. A laser, IR, or munitions mark may be required to assist aircraft in identifying the initial aircraft or target. The preferred method of marking a target is by laser if the aircraft has a laser seeker or airborne passive laser spot tracker. A WP munitions mark, if required, will be timed to impact 20 to 30 seconds before the established TOT or TTT. An illumination mark that is fuzed to burn on the ground should impact 45 seconds before the TOT or TTT.

If the attacking aircraft is in a low-level approach, it will start to climb at a pull-up point to gain sufficient height to observe the mark and execute the attack. The pilot will establish the pull-up point somewhere between the IP and the target. Positive clearance from the terminal controller for the aircraft to drop or fire is typically required before delivery of any ordnance. Before clearing the aircraft, the terminal controller should have both the aircraft and target in sight and ensure that the aircraft's wings are level and pointed in the correct direction.

*Laser Mark*. A laser mark is the most effective means of improving accuracy of aircraft-delivered ordnance. The combination of a laser mark and laser-guided weapon (LGW) provides the best results. If the aircraft is equipped with a laser spot tracker, the pilot can also employ a laser mark to visually locate the target and conduct an accurate attack with unguided ordnance.

In a preplanned mission—

- The laser-on time may be specified in the JTAR, and the terminal controller turns the laser on and off as scheduled.
- The pilot will typically initiate *laser on* in immediate and on-call missions.
- The pilot transmits a *10 second* warning call (i.e., the aircraft will need laser on in 10 seconds) and then commands *laser on* when ready to acquire the laser.
- The pilot may also use this technique to initiate laser on in preplanned missions. Typical laser designation time is 20 seconds, although pilots may request longer laser-on time by specifying a time after transmitting *laser on* (e.g., *laser on, 30 seconds*). If communications are unreliable, the terminal controller should begin designating 30 seconds before TOT or TTT.
- The terminal controller alerts the pilot when the laser is turned on. If the aircraft's wings are level and pointed in the right direction, the terminal controller clears the pilot to attack by saying *cleared hot*.
- The pilot confirms visual identification of the designated laser spot by transmitting spot and acknowledges the clearance by repeating *cleared hot*. Minimizing laser-on time is important in a laser countermeasures environment and when employing battery-operated laser designators.
- The terminal controller turns off the laser designator when the pilot transmits *terminate*, when the weapon hits the targets, or after 20 seconds of laser designating (longer if specifically requested or if communications are unreliable).

Offset designation procedures may also be used in a laser countermeasures environment and, if required, are indicated by the terminal controller in the remarks section of the CAS briefing. At the laser-on call—

- The terminal controller designates an offset position near the target to avoid alerting the target.
- The pilot then transmits *shift* to direct the terminal controller to shift laser energy from the offset position onto the target itself. The shift transmission can replace the spot transmission.

Refer to chapter 11 for more information on laser operations.

**Example: Laser mark**

Flight leader: *10 seconds*. (No response is required.)

Flight leader: *Laser on, 30 seconds*. (Terminal controller may elect to turn the laser on 10 seconds after the 10-second call without hearing the *laser-on* call if communications problems are expected. Flight leader may request longer laser-on time.)

Terminal controller: *Laser on, 10-2. The aircraft is wings level, on heading, pointed at the target, and cleared hot.*

Flight leader: *Spot, 10-2, roger, cleared hot.*

Flight leader: *Terminate.*

*Infrared Mark*. Infrared pointers and other IR devices that can assist a terminal controller in marking a target at night are now becoming available. Although these IR devices can be effective in identifying targets to pilots who are wearing night vision devices, they cannot be used to guide or improve the accuracy of aircraft ordnance. These IR devices should be used only in situations where the enemy is unlikely to also have night vision devices. Infrared marks should be initiated 20 to 30 seconds before the TOT/TTT, or when requested by the pilot, and should continue until the pilot transmits stop or the weapon hits the target.

**Example: Infrared mark**

Flight leader: *Sparkle on*. (Terminal controller may elect to turn IR pointer on 30 seconds before the TOT/TTT without hearing the *sparkle-on* call if communications problems are expected.)

Terminal controller: *Sparkle on, 10-2. The aircraft is wings level, on heading, pointed at the target, and cleared hot.*

Flight leader: *Contact sparkle, 10-2, roger, cleared hot.*

Flight leader: *Stop.*

*Munitions Marking*. Marking with artillery, NSFS, or mortar fires is an effective means of assisting pilots in visually acquiring the target, but unlike laser marks, these means do not improve the accuracy of aircraft ordnance. Before choosing to mark by artillery, NSFS, or mortars, observers should consider the following:

- The ability of these munitions by themselves to achieve the desired effects on the target.
- The prudence of diverting these supporting arms from other missions.
- The danger of additional exposure of these supporting arms to the enemy's indirect-fire acquisition devices.
- The additional coordination between supporting arms required for this mission.

If the decision is made to mark the target with another supporting arm, WP marking rounds will be timed to impact 20 to 30 seconds before the established TOT or TTT, and illumination marks fuzed to burn on the ground should impact 45 seconds before the established TOT or TTT.

When marking rounds appear, the terminal controller transmits an adjustment, and if the aircraft's wings are level and pointed in the right direction, clears the aircraft to attack. An adjustment orients the pilot's eyes in the vicinity of the target. Speed in adjustment is more important than accuracy, because this gives the pilot more time to identify the target. The terminal controller makes the adjustment by using a cardinal direction and distance (in meters) from the marking round to the target. The terminal controller may need to specify the marking round to help the pilot differentiate it from other munitions exploding in the battlespace (e.g., *from the mark WP, west 200*). If there is a prominent ground reference available, the terminal controller can use it in the adjustment (e.g., *from the mark, west 200 in ravine*). The pilot acknowledges the adjustment by transmitting *tally mark* and the clearance by transmitting *cleared hot* (see figure 8-1).

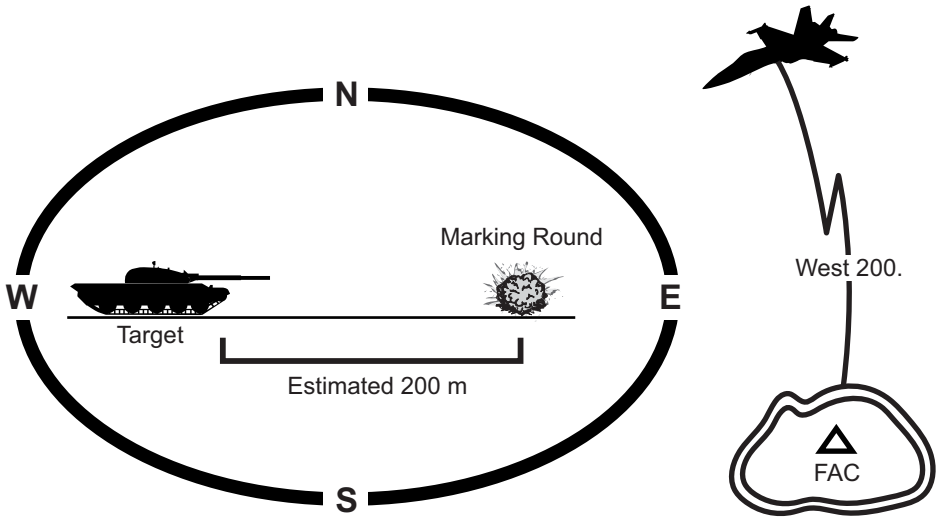



**Figure 8-1. Adjustment From Marking Round.**

**Example: Munitions marking**

Terminal controller: *10-2, from the mark, west 200. The aircraft is wings level, on heading, pointed at the target, and cleared hot.*

Flight leader: *Tally mark, roger. The aircraft is wings level, on heading, pointed at the target, and cleared hot.*

The following conversation applies if the pilot needs help identifying the mark.

**Example: Identifying the mark**

Terminal controller: *10-2, from the mark, illumination on deck, west 200. The aircraft is wings level, on heading, pointed at the target, and cleared hot.*

Flight leader: *Tally mark, roger. The aircraft is wings level, on heading, pointed at the target, and cleared hot.*

The following conversation applies if a prominent ground reference is available.

**Example: Prominent ground reference**

Terminal controller: *10-2, from the mark, west 200 on north side of dirt road. The aircraft is wings level, on heading, pointed at the target, and cleared hot.*

Flight leader: *Tally mark, roger. The aircraft is wings level, on heading, pointed at the target, and cleared hot.*

***Note:*** When secure communications are not available, an abort code is given in the initial check-in brief from the aircraft to the terminal controller as a challenge-reply authentication. If it is necessary to discontinue an aircraft's run on a target, the terminal controller will transmit the word *abort* and the authenticated code letter to initiate the abort procedure. If secure communications are available or no challenge-reply authentication is used, the terminal controller ceases the attack by announcing *Abort, abort, abort*.

**Example: Abort procedure**

*Abort Tango.*

***Subsequent Aircraft***. When the flight consists of multiple aircraft, each aircraft may be individually adjusted onto the target. Subsequent aircraft typically trail preceding aircraft by approximately 30 seconds. This lapse allows protection of aircraft from fragmentation.

The adjustment for subsequent aircraft (see figure 8-2) is made from the preceding aircraft's hit or from the impact of the marking round, whichever is closer to the target, by using the same procedure (i.e., cardinal direction and distance). The terminal controller provides clearance to attack in the same manner for both subsequent and initial aircraft.

**Example: Subsequent/multiple aircraft adjustment**

Terminal controller: *From lead's hit, east 200, cleared hot.*

Wingman: *Roger, cleared hot.*

(The following applies if the mark is closer than the lead's hit.)

Terminal controller: *From the mark, west 200, cleared hot.*

Wingman: *Tally mark, roger, cleared hot.*

As a general rule, a goal of CAS is to complete a successful attack against all targets on the first pass, but in a low or medium threat environment, reattacks may be an option if this does not occur. The reattack should ensure the desired effect on the target, allow visual orientation by the pilot, and increase responsiveness to the ground commander. If a reattack is conducted—

- The terminal controller will give the pilot an egress direction and may assign different attack headings.
- Additional marks or a narrative description of target location in relation to the last mark, last hit, landmarks, terrain features, or friendly positions may be given.
- The aircraft may also be returned to the IP for reattack.

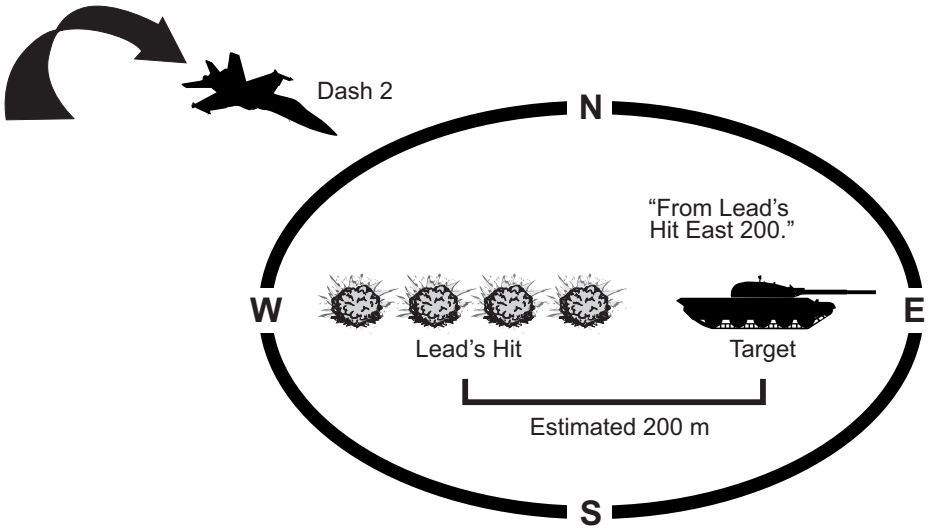



**Figure 8-2. Adjustment for Dash 2.**

### Report of Battle Damage Assessment

Following completion of the attack, a BDA report is provided by the terminal controller. The report may be transmitted to the pilot and/or the DASC. At a minimum, the SALUTE report should include a BDA.

**Example: Report on immediate close air support mission**

**Transmission:**

*Check 21 de A3C, inflight report, over.*

*Check 21, T6G, SS619 456, 0905, 4 armored vehicles destroyed, 1 turning east, 10 killed in action, mission successful.*

**Description of Transmission:**

Call sign: Check 21.

Mission number: T6G.

Location: SS 619 456.

Time-on-target: 0905.

Results: 4 armored vehicles destroyed, 1 turning east, 10 killed in action, mission successful.

"de" means "this is."

## AIR-DELIVERED ORDNANCE NEAR FRIENDLY TROOPS

The accuracy of air-delivered ordnance is subject to many variables. Therefore, unlike indirect-fire weapons, a danger close distance for the safe separation of air-delivered ordnance is difficult to establish. When air-delivered ordnance is to be delivered near friendly forces (i.e., danger close), a careful analysis must be made concerning the following:

- The air control agency must consider the situation when selecting and assigning aircraft.
- The pilot must incorporate this situation when selecting attack tactics.
- The terminal controller must provide data/instructions to assist the pilot in ensuring safe separation.

As with all CAS missions, the supported commander must approve its delivery. Factors that may be considered when delivering air-delivered ordnance in the vicinity of friendly troops include the following:

- *Type and size of ordnance*. The accuracy of air-delivered ordnance varies with the type, size, and method of delivery of the ordnance; the type of aircraft; and the pilot's proficiency.
- *Type of aircraft and weapons system*. The accuracy of air-delivered ordnance varies with the type of aircraft and weapons system being employed. Sophisticated weapons enhance delivery accuracy and reliability. Generally, high-angle delivery enhances accuracy.
- *Attack heading*. The most common inaccuracies in delivering ordnance occur in low dive angles, which result in errors in range along the attack heading of the aircraft. Therefore, in proximity to friendly forces, an attack heading that is parallel to friendly troops enhances safety and is preferred.
- *Weather in the target area*. Low ceiling restricts aircraft tactics and acquisition of the target.
- *Terrain in the target area*. The position of the target on terrain features (e.g., in a draw, on a hill) will influence the aircraft's attack tactics and accuracy.
- *Threat*. The threat level and type of threat influence attack tactics. In a high threat environment, low-level, high-speed tactics may reduce accuracy. The characteristics of the threat weapons (e.g., range, method of acquisition) will influence tactics as well.
- *Target/mark availability and visibility*. The availability of a mark and its acquisition by the pilot enhance the safe delivery of air-delivered ordnance.
- *Terminal controller proficiency*. The availability of an experienced JTAC with the ability to control the air strike will enhance the safe delivery of ordnance. The ability to control depends on the terminal controller's ability to see the target, mark, and aircraft during its attack and communications.
- *Type and degree of friendly cover*. Risk estimate distances allow the commander to estimate risk in terms of friendly casualties that may result from fires near friendly troops along the forward line of the commander's own troops. Friendly forces outside the 0.1 percent probability of incapacitation distance may still be at risk from fragments, but at a lower risk. Taking steps to reduce risk, such as placing troops behind cover in the prone, may mitigate the risk.

See MCRP 3-31.6 for the most current inventory of ordnance, munitions, and corresponding risk estimate distances.

## EMERGENCY PROCEDURES FOR REQUESTING CLOSE AIR SUPPORT

During a combat emergency situation, the need may arise for an untrained Marine to request and adjust CAS. After providing identification, the Marine requester must specify on what type of target CAS is desired, where the target is located, when the air strike is desired, and whether or not the delivery can be controlled.

**Example: Emergency transmission of a request for close air support**

**Transmission:**

*I have 5 armored vehicles moving in column on the road. Coordinates SS623 456, elevation 55. Need support ASAP. I cannot control.*

**Description of Transmission:**

What (target description): I have 5 armored vehicles moving in column on road.

Where (target location): Coordinates SS623 456, elevation 55.

When (time that the air strike is required) (e.g., ASAP, NLT, at a specific time): Need support ASAP.

Whether (statement of whether the requester can control, observe, mark, correct): I cannot control.

## AC-130 CALL FOR FIRE

The AC-130 is a CAS platform that provides unique capabilities to the terminal controller. Its extended loiter time during the hours of darkness and precision fire control systems offer the ground maneuver unit some distinct advantages. Due to the accuracy of the fire control system, ordnance can be delivered very close to friendly positions. Additionally, sensor target acquisition capabilities, coupled with ground beacon position marking give the AC-130 a limited adverse weather capability. Before the AC-130 attack can commence, the terminal controller's position must be identified. Various methods to identify position include strobe lights, flares, GLINT [gated laser intensifier] tape, and electronic beacons.

### Format

The call for fire is a specific format for the AC-130 and is different from the 9-line briefing format. In addition to standard briefing items, additional information, such as a detailed threat description, marking of friendly locations, identifiable ground features, and the ground commander's willingness to accept danger close, must be included. Because the AC-130 is capable of extended loiter, the aircrews can work a series of targets with a single ground party. When this occurs—

- The format may be abbreviated, but must include the magnetic bearing and range to target in meters, from the friendly position to the target.
- A brief description of the target must be included.

Transmission of the fire mission is clearance to fire unless fires will impact danger close. Danger close is 165 meters for the 105-mm cannon, 75 meters for the 40-mm cannon, and 65 meters for the 25-mm gun. To authorize danger close, the terminal controller will announce *danger close* in the remarks after the call for fire and provide the ground commander's initials.

**Example: AC-130 call for fire format**

AC-130 C/S: *Spooky-90, this is W3T, fire mission, over.*

Observer C/S: *My position grid NB 411 252* (e.g., TRP, grid).

*Marked by*_____ (e.g., strobe, beacon, IR strobe) *over.*

*Direction 275, distance 200* (magnetic bearing & range in meters, TRP, grid).

*Marked by*_____ (e.g., IR pointer, tracer), *over.*

Insurgents with SA-7s 500 meters to the east, danger close BAL, over.

(e.g., threats, danger close clearance, restrictions, at my command).

**Description of Transmission**

Observer ID/warning order: _____, this is _____ (e.g., AC- 130 C/S), fire mission, over (observer C/S).

Friendly location/marked: My position _____ (e.g., TRP, grid).

Marked by _____ (e.g. strobe, beacon, IR strobe).

Target location: _____, (magnetic bearing, range in meters, TRP, grid).

Target description/mark: Marked by _____, (e.g., IR pointer, tracer).

Remarks: _____, over (e.g. threats, danger close clearance, restrictions, at my command).

**Legend:**

BAL-initials required from the ground commander to drop ordnance danger close

C/S-call sign

ID-identification

### Adjustments

Typically, adjustments are made using cardinal directions and distances. The AC-130 cannot distinguish colors because the display is black and white; however, light and dark colors are distinguishable. Additional considerations include the following:

- Do not reference clock positions for adjustments, as the aircraft flies a circular orbit.
- Do not give run-in headings.
- Do not give no fire headings. Only give no fire areas.

**Example: Adjustments**

*Northeast 200, over.*

### General Rules

Although it is an accurate and reliable weapons system, there are certain limitations on the AC-130. Firing down an incline can cause considerable miss distances. Due to the accuracy of the weapons system and the proximity of fires to friendly troops, lethal areas of fragmentation should be considered.

# CHAPTER 9
# SUPPRESSION OF ENEMY AIR DEFENSES

Suppression of enemy air defenses is the activity that neutralizes, destroys, or temporarily degrades enemy air defenses in a specific area by physical attack or electronic attack. Suppression of enemy air defenses should be considered when friendly or unmanned aircraft cannot complete their missions without critically exposing themselves to enemy air defenses. Although typically associated with offensive air support (OAS) missions, SEAD may be employed to protect any type of aircraft or unmanned aerial vehicle mission, including air reconnaissance, assault support, antiair warfare, and electronic warfare. When determined to be appropriate, SEAD fires are delivered during the critically vulnerable portions of friendly flight profiles. Although SEAD can be provided by various destructive and disruptive means from either ground or aviation forces, this chapter will focus on the delivery and coordination of artillery and NSFS SEAD fire missions.

## COORDINATION

Because aircrews may rely predominately on closely delivered SEAD fires for protection, all details of SEAD missions must be closely coordinated between aircrews, terminal controllers, spotters and observers, and fire support coordinators. When coordinating timing for SEAD missions, everything is based on the timing of the air mission. Supporting indirect fires will be scheduled based on a specific aircraft event time (e.g., CAS TOT/TTT, assault support L-hour, unmanned aerial vehicle mission area arrival time). Coordination should ensure that aircraft are protected not only from enemy fires, but also from friendly SEAD fires. Protection from friendly fires is achieved by separating aircraft from SEAD fires by time and/or distance. Munition marking rounds may be incorporated into SEAD fires to aid target identification by OAS aircraft. Depending on the type of air mission supported, SEAD fire missions are either planned or immediate.

### Planned Missions

Planned SEAD missions are scheduled during fire planning to support preplanned or on-call air missions. Units that request these types of air missions must consider the air defense threat and submit requests for SEAD support as appropriate. Typically, known ADA targets will be attacked immediately; however, support for suppressing undetected systems must be planned. Planned SEAD missions are the result of coordinated planning by the air support request, the appropriate FSCCs, and the unit providing aviation or unmanned aircraft support. See MCTP 3-10F for more information on the fire support planning process.

### Immediate Missions

Immediate SEAD missions are conducted to support immediate air missions. Because of the urgency of immediate air requests, planning and coordination for immediate SEAD missions are abbreviated. Critical SEAD decisions are made primarily by the requesting unit under the supervision of the battalion FSCC. Requests for immediate artillery, mortar, or NSFS SEAD fires are made as calls for fire.

## DECISION MAKING

### Validating Requirements

Suppression of enemy air defenses fire missions do not guarantee safety from enemy air defenses. These fire missions divert indirect-fire weapons from other fire support tasks and may expose those weapons to enemy counterfire. Therefore, terminal controllers should first attempt to route aircraft away from enemy air defenses rather than automatically request SEAD fires. If aircraft cannot be routed away from enemy air defenses, then fire support personnel must balance aircraft vulnerability against the risk of exposing indirect-fire weapons to determine whether SEAD fires are appropriate for that air mission. The temporary diversion of fire support and the consumption of fire support resources must also be considered. Before requesting OAS that would require SEAD support, fire support personnel must first consider whether artillery or NSFS could range the mission target and achieve the desired effects. If so, an artillery or NSFS attack would be more efficient than an OAS attack supported by SEAD. If the mission target cannot be ranged by indirect fire or is more efficiently attacked by aircraft, OAS supported by SEAD fires may be appropriate.

### Selecting Targets

Targets should be selected based on aircraft flight tactics, routing, and enemy air defense capabilities. The prerequisite to selection is target location. Often, enemy ADA is not detected until aviation enters the area; therefore, observers must be able to acquire ADA based on its battlespace signature. Suppressive fires are placed as accurately as possible on enemy air defense sites that can engage aircraft.

### Selecting the Appropriate Weapons System and Firing Unit

An available weapons system and a firing unit that is capable of firing the appropriate ordnance when and where required must be selected. Requirements include accuracy, range, ordnance availability, and state of training. The selection of a particular weapons system and/or firing unit should not adversely affect other fire support requirements. Although several indirect-fire systems are capable of delivering SEAD fires and target marks, artillery is usually the most appropriate system based on range, responsiveness, ordnance, and fire direction capabilities.

### Determining Marking Requirements

Specific aircraft missions, such as CAS, may require a mark to orient the aircrew onto the target.

### Selecting the Appropriate Ordnance

Ordnance must be selected based on its ability to most effectively suppress SEAD targets without endangering the aircrew or hindering future maneuvers. When firing a munition marking round, select the ordnance that will best identify the target to the aircrew. Refer to table 9-1 for more information on the vulnerability of enemy air defense systems and suitability of specific ordnance.

### Determining the Method of Separation

To prevent fratricide, aircraft must be separated from SEAD fires and trajectories. Separation may be by distance (i.e., lateral, altitude, or a combination of altitude and lateral) or by time (i.e., interrupted or nonstandard). Separation techniques are discussed in further detail later in the chapter.

**Table 9-1. Vulnerabilities of Selected Air Defense Weapons.**

| Weapon | Vulnerabilities |
|---|---|
| ZPU-3/ZU-23 | Exposed personnel |
| ZSU 57-2/S-60 | Optics<br>Exposed personnel and gunners |
| ZSU 23-4 2S6 | Thin armor plating<br>Optics<br>Exposed radar and antennas |
| SA-7/14, SA-16 | Exposed gunners |
| SA-9/13 | Exposed missiles<br>Optics |
| SA-6, SA-8 | Thin armor plating<br>Exposed radar and antennas<br>Exposed missiles<br>Susceptibility of radar to jamming |

### Determining Duration and Volume of Fires

The duration and volume of fires required to protect friendly aircraft during vulnerable periods of flight must be determined by consideration of the following:

- Vulnerability, resiliency, range, and method of acquisition of the targeted enemy air defense weapons.
- Number and type of friendly aircraft.
- Aircraft flight tactics and the separation required between aircraft and SEAD fires.
- Type of ordnance used for suppression.
- Vulnerability of the SEAD firing unit.

If aircraft must fly near SEAD trajectories or effects, SEAD fires must be separated to prevent fratricide.

### Timing the Delivery of Fires

Use of a synchronized clock to coordinate timing, such as CAS TOT 05, is the desired means of timing fires. As an alternate method, elapsed time can be used (e.g., *CAS TTT 6 plus 0, 0 . . . stand by, hack*). When selecting a synchronized or elapsed time to coordinate ground and air activities, terminal controllers and observers must allow sufficient time for all units to prepare for the mission and for FSCC coordination. Observers should send calls for fire as early as possible during aircraft routing (e.g., before the aircraft departs the IP to ensure that firing units can deliver SEAD fires on time).

### Preparing the Call for Fire

When all SEAD decisions have been made, the appropriate call for fire should be prepared and transmitted, ensuring that all required coordination is completed.

## SEPARATION TECHNIQUES

Separation by distance permits the continuous attack of SEAD targets and usually requires less coordination than separation by time. If distance separation is too restrictive on aircraft routing, time separation may be used to protect aircraft from friendly fires.

Time separation is the least flexible and often precludes suppressive fires at critical moments. If an aircraft must fly near the effects or trajectories of SEAD fires, SEAD fires may need to be interrupted to ensure aircraft safety, which is a form of time separation. The technique that requires the least coordination while still providing adequate flexibility and protection to the aircraft should be selected.

### Distance Separation

***Lateral Separation***. Lateral separation is effective for coordinating SEAD fires against targets that are safely separated from flight routes and when aircraft can be routed away from SEAD trajectories and targets (see figure 9-1). For low-level CAS attacks, lateral separation should be used when aircraft and firing units engage safely-separated targets and when aircraft will not cross GTLs (see figure 9-2).

The minimum separation distance between SEAD targets and aircraft routes varies based on SEAD ordnance and its fragmentation pattern. Terminal controllers or the FSCC must know the GTL so that they can restrict aircraft from crossing trajectories. Establishing a temporary informal ACA is one method of maintaining lateral separation (e.g., *stay out of quadrant northeast of grid 6215, stay west of river*).

***Altitude Separation***. Altitude separation is effective when aircraft can safely remain above or below indirect-fire trajectories.

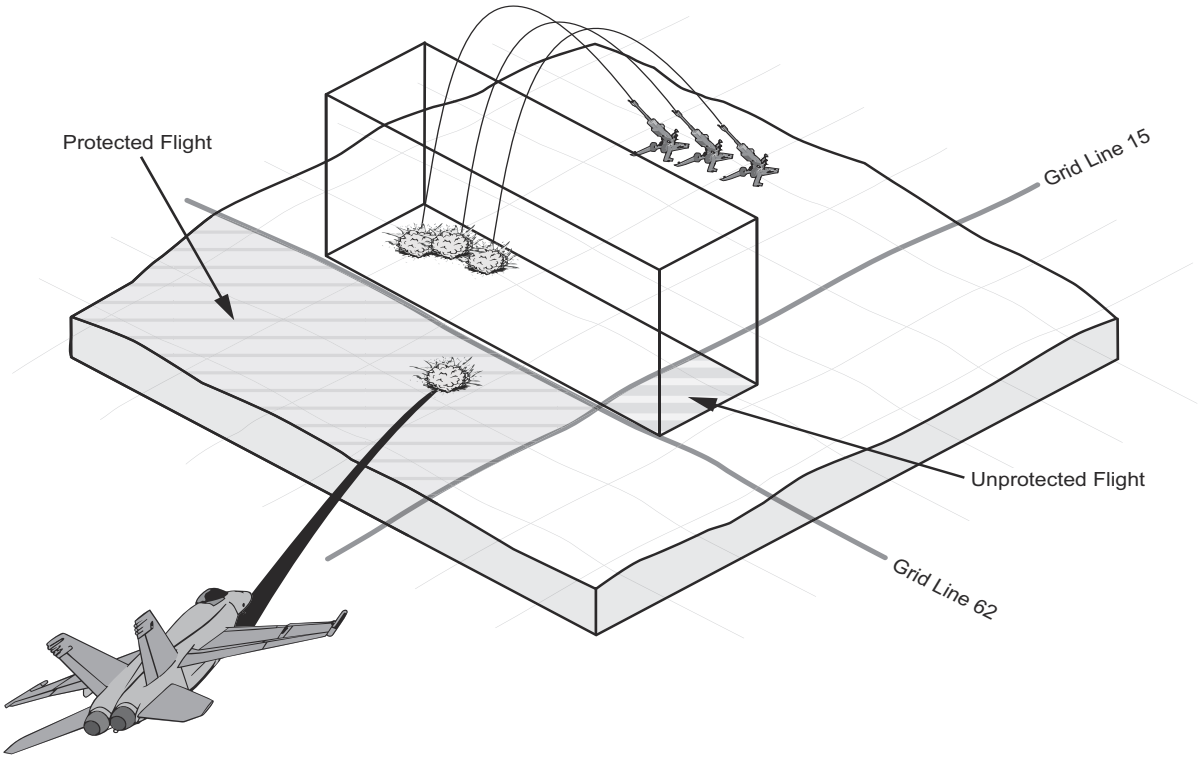



**Figure 9-1. Artillery/Assault Support Aircraft Lateral Separation.**

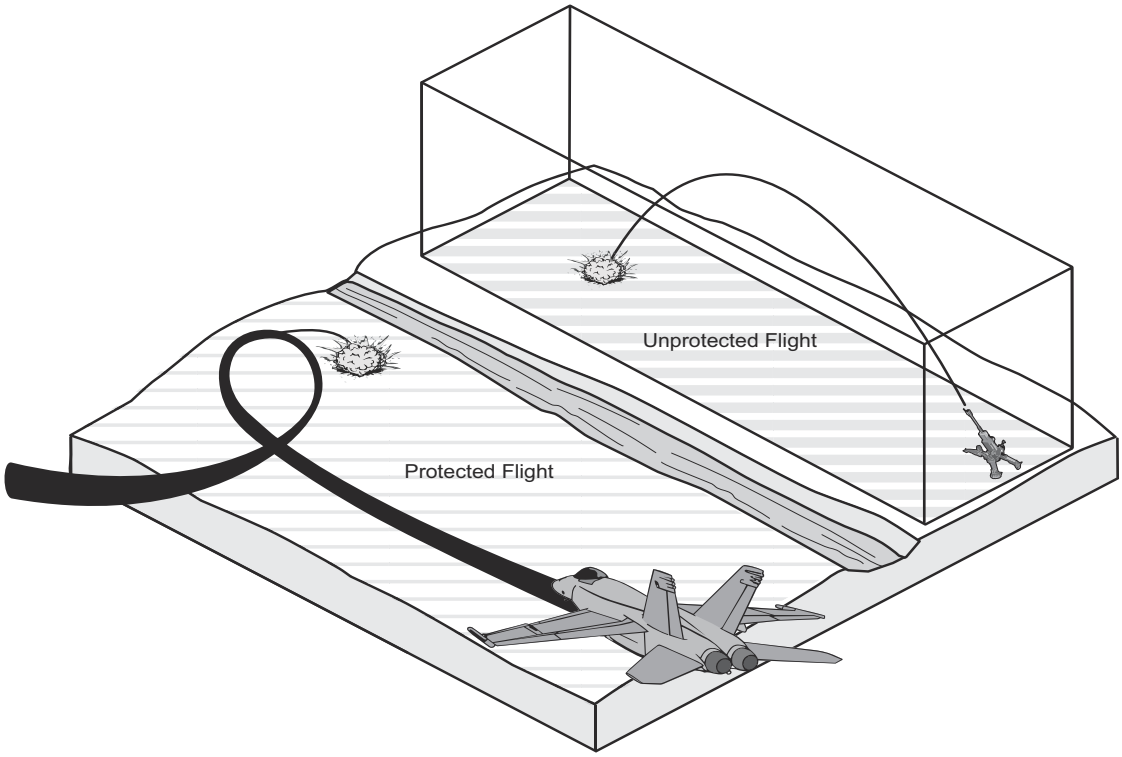



**Figure 9-2. Artillery/Close Air Support Aircraft Lateral Separation.**

Establishing a temporary informal ACA is one method of maintaining altitude separation (e.g., *stay above 3,000 ft MSL*) (see figure 9-3). This technique can be used to support high-level CAS attacks. Altitude separation can also be limited to a specific area to give aircraft more freedom to maneuver (e.g., stay below 500 ft MSL in quadrant northeast of grid 6215) (see figure 9-4). See MCTP 3-10F for more information on computation of altitudes.

***Altitude and Lateral Separation***. Altitude and lateral separation is the most restrictive technique for aircraft routing but may be required when aircraft must cross the firing unit's GTL. This technique requires aircraft to remain above or below indirect-fire trajectories at certain points. For low-level CAS attacks, this technique is effective—

- When aircraft and firing units engage safely separated targets, but the CAS target requires crossing the GTL (see figure 9-5).
- If helicopters can be protected by routing them to fly under SEAD indirect-fire trajectories and away from SEAD targets (see figure 9-6).

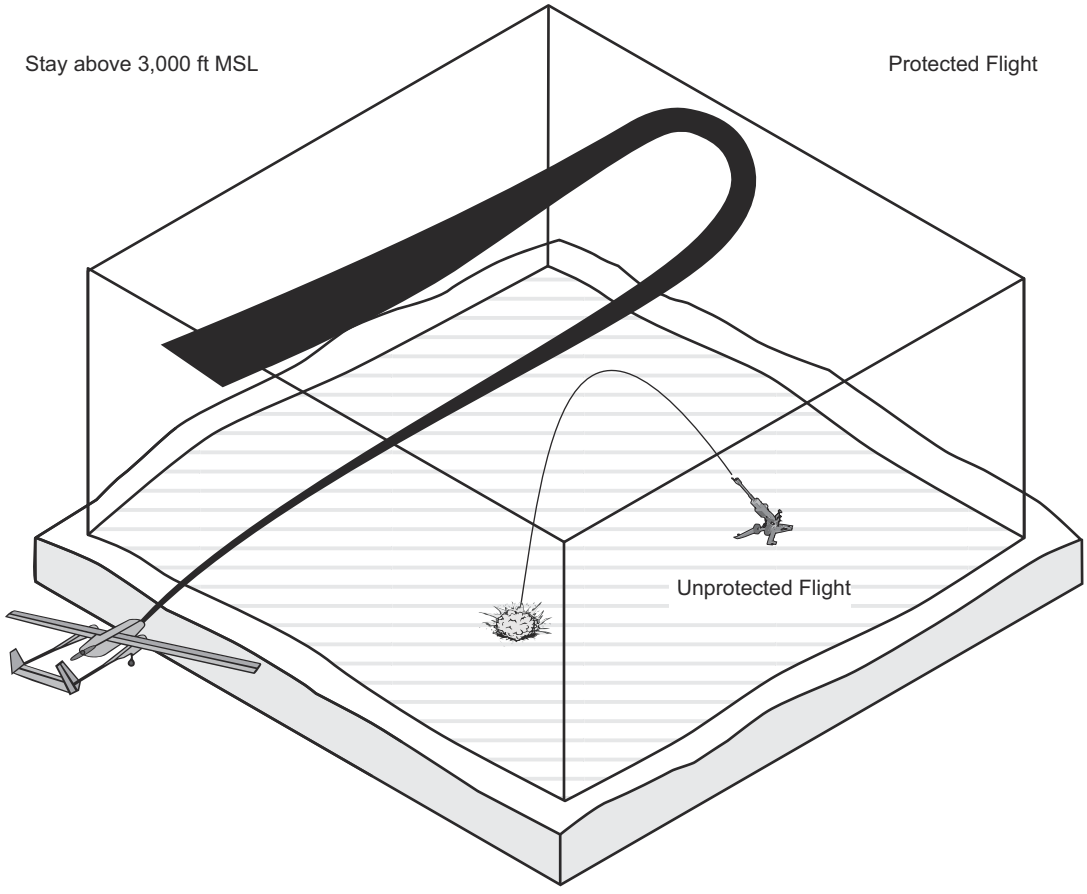



**Figure 9-3. Artillery/Unmanned Aircraft Altitude Separation.**

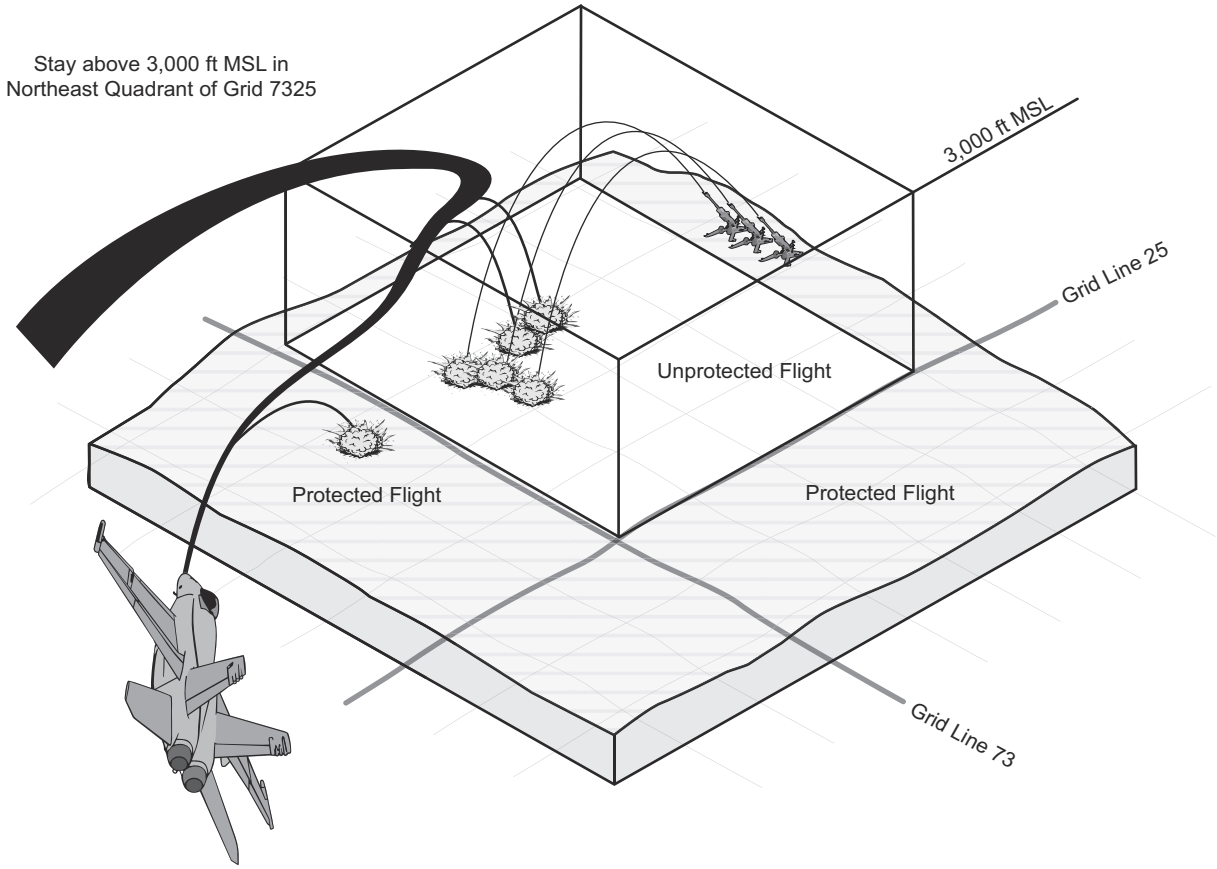



**Figure 9-4. Artillery/Close Air Support Aircraft Altitude Separation.**

Separation may be increased by firing a high-angle or reduced charge. Establishing a temporary informal ACA is one method of maintaining altitude and lateral separation (e.g., *stay below 1,000 feet MSL and between easting grid lines 58 and 62*).

When CAS and indirect fires engage the same target, a stay-above altitude incorporating the fragmentation effects can be determined (refer to MCTP 3-10F). A lateral offset in the form of a final attack heading or cone prevents premature crossing of the GTL.

### Time Separation

Time separation, interrupted or nonstandard, may be required when aircraft cannot be routed away from indirect-fire trajectories or SEAD targets. This technique requires the timing of SEAD fires to be coordinated with the routing of aircraft so that even though aircraft and SEAD fires may occupy the same space, they do not do so at the same time (see figure 9-7). For low-level CAS attacks, time separation can be used when aircraft are attacking targets just short of indirect fires along the GTL (see figure 9-8). All timing for SEAD fires is based on a specific aircraft event time (e.g., CAS TOT/TTT, assault support L-hour, unmanned aircraft mission area arrival time). In immediate SEAD fire missions, the aircraft event time becomes the zero hour or H-hour for scheduling. The preferred method for coordinating timing is the use of a previously established synchronized clock. If a synchronized clock has not been established or is not universally available, an elapsed time may be used to coordinate timing. See appendix E for instructions on establishing and communicating synchronized and elapsed times.

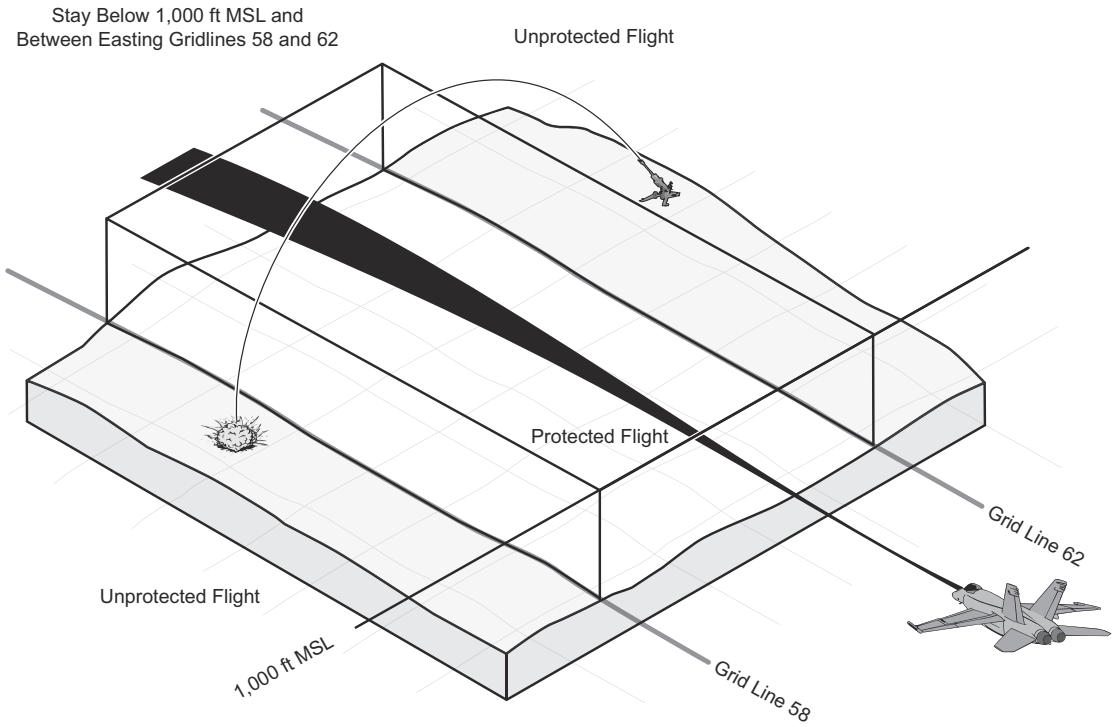



**Figure 9-5. Artillery/Close Air-Support Aircraft Altitude and Lateral Separation.**

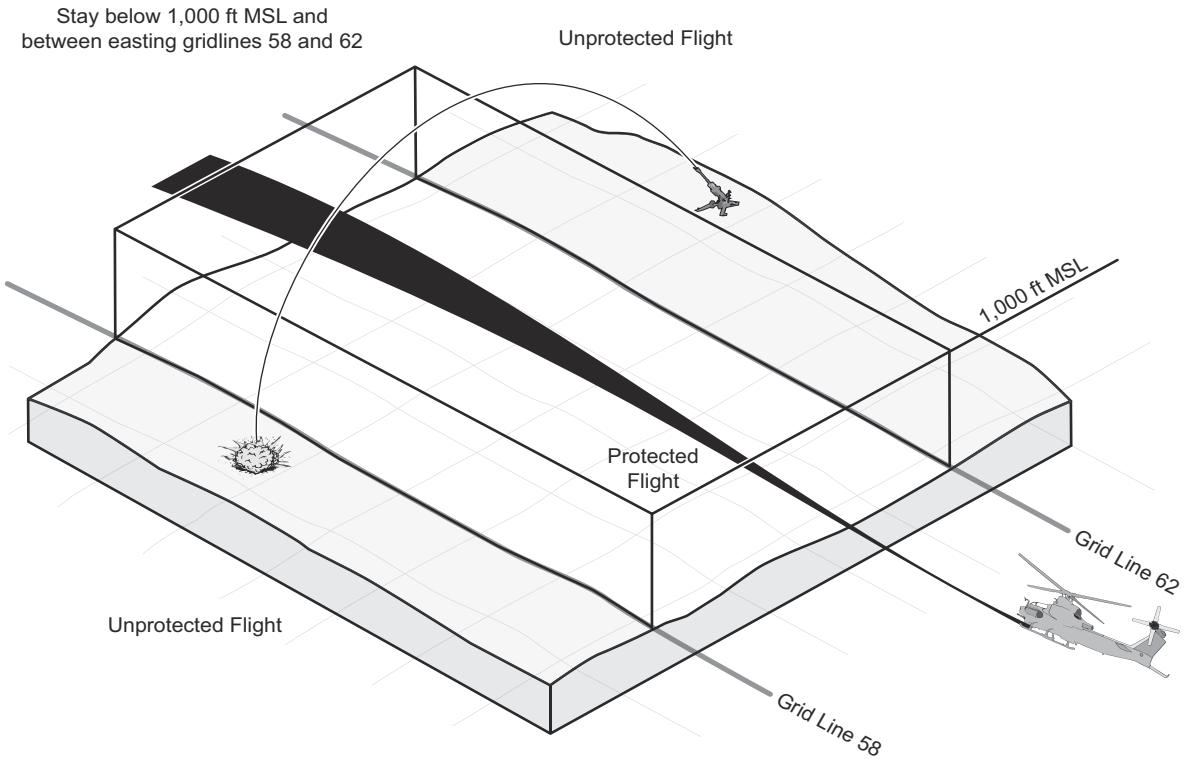



**Figure 9-6. Artillery/Assault Support Aircraft Altitude and Lateral Separation.**

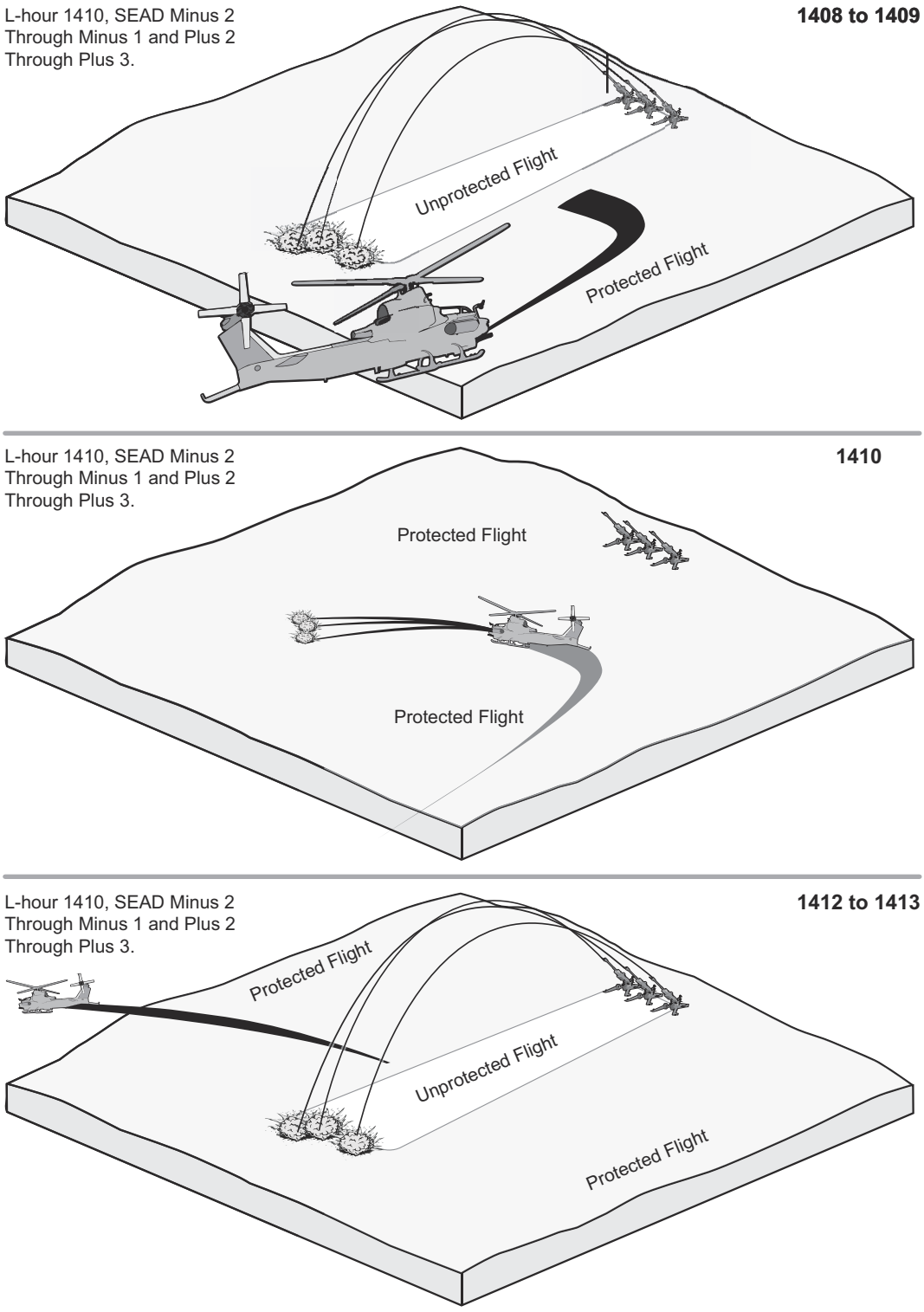



**Figure 9-7. Artillery/Tactical Recovery of Aircraft and Personnel Aircraft Timed Separation.**

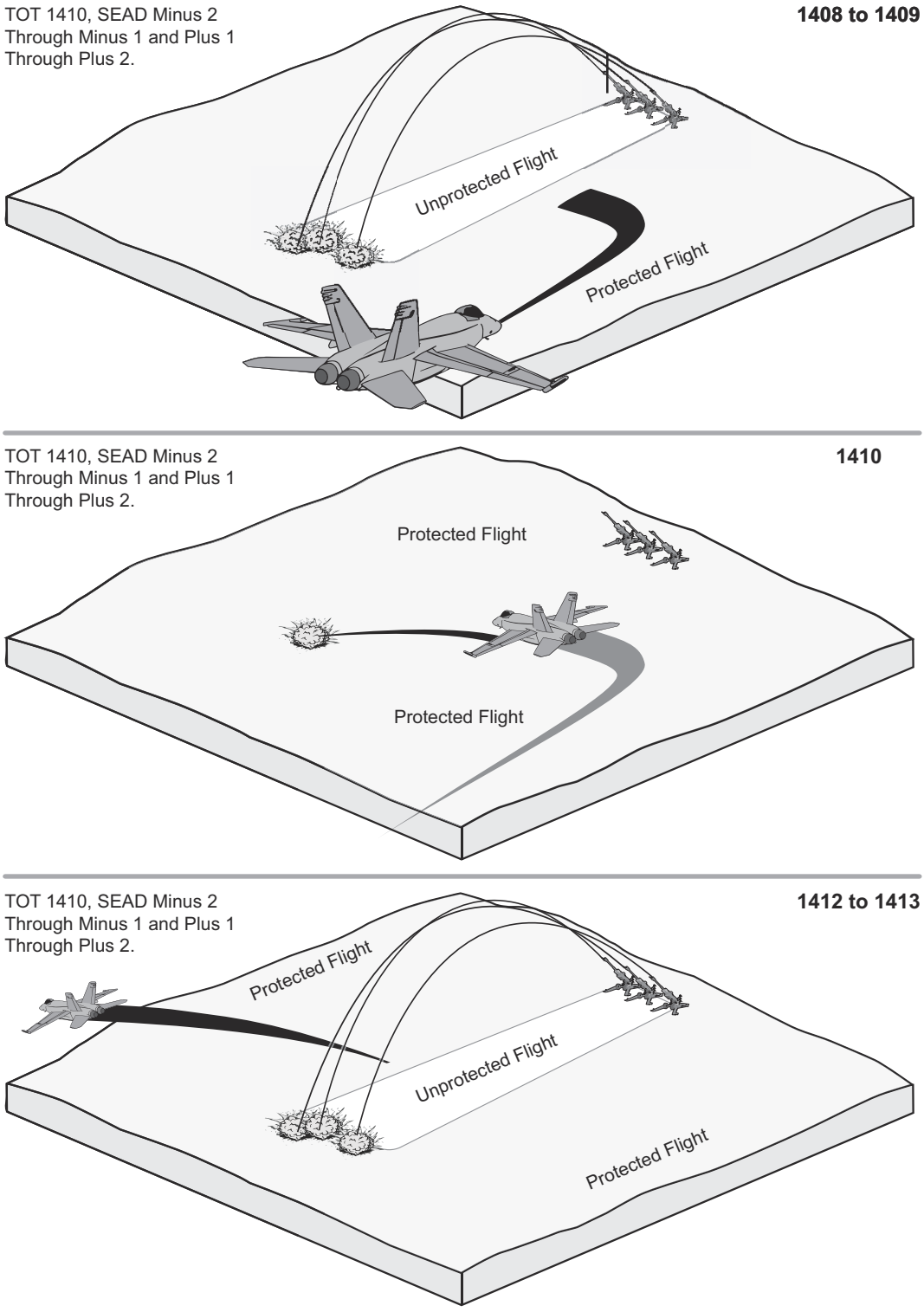



**Figure 9-8. Artillery/Close Air Support Aircraft Timed Separation.**

### Suppression Timing Methods

***Interrupted***. The interrupted SEAD program separates aircraft and SEAD fires by halting indirect fires before the aircraft event. Interrupted SEAD fires are delivered during the first critical portion of the aircraft's approach phase—specifically from 1 minute before the CAS TOT/TTT until 30 seconds before the CAS TOT/TTT. This program is requested by stating *interrupted* as a method of fire and control (see figure 9-9).

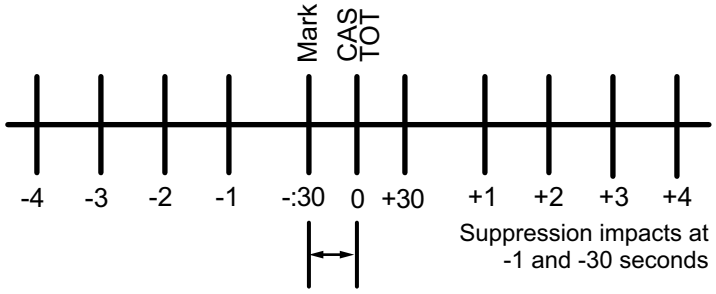



**Figure 9-9. Artillery/Close Air Support Aircraft Timed Separation.**

***Continuous***. The continuous SEAD program is used when providing suppressive fires throughout the aircraft event. Continuous SEAD fires are delivered during the critical portions of the aircraft's approach and egress, specifically from 1 minute before the CAS TOT/TTT until 1 minute after the CAS TOT/TTT. This program is requested by stating *continuous* in the method of fire and control (see figure 9-10).

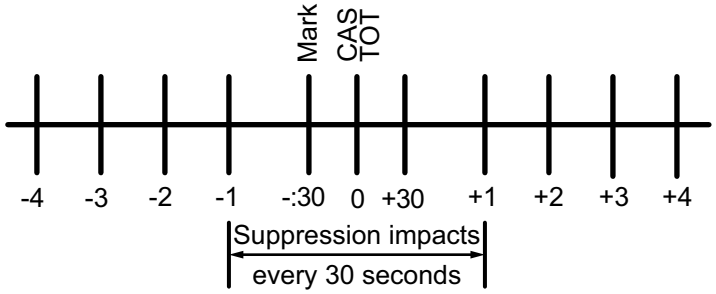



**Figure 9-10. Continuous Suppression of Enemy Air Defenses Example.**

***Nonstandard***. The nonstandard SEAD program is used when suppressive fires other than interrupted or continuous are desired, specifically for fires that begin sooner, last longer, or are intermittent. In addition to requesting *nonstandard*, desired times are specified in the method of fire and control (see figure 9-11).

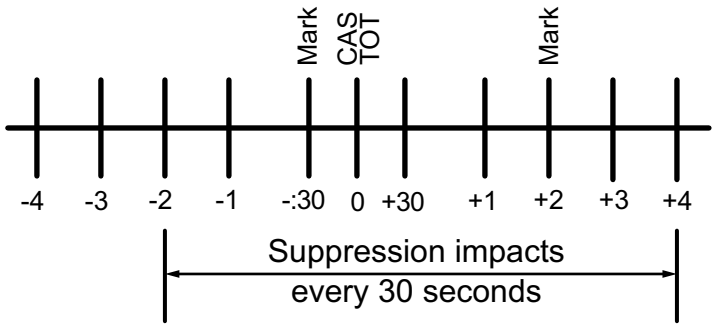



**Figure 9-11. Nonstandard Suppression of Enemy Air Defenses Example.**

### Separation Techniques

Table 9-2 summarizes the appropriate separation techniques for typical CAS scenarios.

**Table 9-2. Separation Techniques.**

| Attack | CAS Target Same as/Near SEAD target | CAS Target Distance From SEAD Target | CAS Crosses GTL |
|---|---|---|---|
| High level | Altitude separation | Altitude separation | Altitude or time separation |
| Low level | Time separation | Lateral separation | Altitude and lateral separation |

## AIRSPACE COORDINATING MEASURES

### Fixed-Wing and Rotary-Wing Close Air Support

When coordinating SEAD fires or target marking for FW or RW CAS aircraft, terminal controllers, spotters, and observers must be familiar with the use of contact points, IPs, HAs, and BPs. See chapter 4 and MCRP 3-20F.7, *Marine Air Traffic Control Detachment Handbook*, for more information on these ACMs.

### Other Mission Support

Aircraft and unmanned aircraft conducting deep air support, air reconnaissance, assault support, offensive antiair warfare, and electronic warfare missions, may use contact points and IPs.

When air reconnaissance and assault support aircraft prepare to begin a run on a reconnaissance target or landing zone, initial, en route, and orbit points are used:

- *IP*. The IP is where the aircrew establishes communication with the ground control agency (i.e., DASC or TACP) for coordinating instructions.
- *En route point*. Aircrews use en route points to define routes of flight to and from specific areas. En route points allow specific routing of aircraft for command and control, airspace limitation, and rules of engagement requirements.
- *Orbit point*. The orbit points represent geographic or electronic positions and are used to station aircraft while they await further routing instructions.

## TARGET MARKING FOR CLOSE AIR SUPPORT AIRCRAFT

A mark should be provided for CAS aircraft whenever possible. When one of the following marking methods is not possible, the CAS target may be identified by a narrative description.

### Laser Marking

The preferred method of marking a target is by laser if the CAS aircraft has a laser spot tracker. The laser marking ensures the accurate engagement of the target by LGW and assists the CAS aircrew in more accurate delivery of unguided ordnance. Laser marks require coordinating the approach of the aircraft to correspond with the direction of the reflected laser energy.

### Infrared Marking

Infrared pointers and other IR devices can be used by terminal controllers to mark targets at night for pilots who are wearing night vision devices. Unlike laser designators, these IR devices cannot be used to guide or improve the accuracy of aircraft ordnance. Infrared pointers should be used with caution because they may expose the terminal controller to an enemy with night vision capability. Infrared marks should be initiated 20 to 30 seconds before the CAS TOT/TTT or when requested by the pilot and continue until the pilot transmits terminate or the weapon hits the target.

### Indirect-Fire Marking

Artillery, NSFS, and mortar munitions—specifically WP or illumination fuzed to impact on the deck—are excellent means of visually marking targets for CAS aircraft. Munition marking rounds should be delivered as close to the CAS target as possible with—

- WP marks timed to impact 20 to 30 seconds before the CAS TOT/TTT.
- Illumination marks timed to impact 45 seconds before the CAS TOT/TTT.

These lead times ensure the munition marking round is in position early enough and remains visible long enough for the terminal controller to provide final control instructions and for the pilot of the lead aircraft to acquire the target. Based on the CAS aircraft's TOT/TTT given in the SEAD call for fire, the firing unit will determine the time to fire to ensure the marking round impacts as required. Munition marking rounds delivered within 300 meters of the CAS target are generally considered effective enough to direct CAS aircraft. If the munition marking round is not timely or accurate, terminal controllers should be prepared to use a backup marking technique or rely on verbal instructions to identify the target to CAS pilots. If the situation requires precise marks, observers or spotters can adjust marking rounds early to ensure accurate marks, as well as SEAD fires, are delivered to meet the CAS schedule. This may, however, alert the enemy to an imminent attack.

### Direct-Fire Marking

Direct-fire weapons, such as the MK-19, can be used to deliver a mark. While this method may provide more responsiveness than indirect-fire marks, its use may be limited by range and the visibility of the burst in the battlespace. The MlA1 tank has no WP round and cannot be used for marking.

### Other Aircraft Marking

Another aircraft, such as an F/A-18D or AH-lW/Z, can be used to deliver a marking round.

### Backup Marking

When firing marks, backup marks should also be planned. For example, artillery may be tasked to deliver the primary mark while a mortar or other aircraft may be assigned the responsibility of being the backup mark. One consideration for planning backup marks is the difference between the TOFs of the primary and backup weapons systems. If a mortar is tasked as backup for an artillery mark, it cannot have a longer TOF than the artillery.

### Other Means of Target Marking

Other means that may be used to identify a target include the following:

- The requesting unit may give a narrative description of the target in relation to their own position.
- The target may be marked by devices such as strobe lights, mirrors, or air panels.
- The target may be marked in relation to prominent landmarks.

## ARTILLERY SUPPRESSION OF ENEMY AIR DEFENSES

For artillery SEAD support of air missions, the terminal controller (e.g., FAC) coordinates aircraft routing, required suppression and marking, and timing with the artillery FO. The observer determines the artillery firing requirements to protect aircraft from both enemy air defenses and friendly fires and passes this information to the artillery FDC in the form of a call for fire. The FSCC monitors these radio transmissions and ensures that the timing and effects of these SEAD fires are coordinated with other operations being conducted by the unit.

### Call for Fire

The artillery SEAD call for fire is based on the standard artillery call for fire format (see figure 9-12, figure 9-13, figure 9-4, and figure 9-15). Calls for fire may include instructions for marking rounds if required.

***Warning Order***. The SEAD fires requests that may be identified in the warning order include SEAD, SEAD polar, SEAD laser polar, and SEAD shift from a known point. The observer identification and warning order constitute the first transmission of the call for fire.

**Example: Laser polar**

*Suppression direction 6300, distance 2413, vertical angle plus 05, over.*

***Target Location***. When determining target location, the most accurate method of target location that is appropriate for the situation should be used. The target location element of the call for fire must include the suppression target locations and, if required, the location for a munition marking round. Target locations are specified by stating *grid to suppress*, followed by the location, and then stating *grid to mark,* followed by the location. If no mark or suppression is desired, the requisite portions are omitted. The target location constitutes the second transmission of the call for fire.

**Examples: Target location**

Grid: *Grid to suppress 456 123, grid to mark 462 129, over.*

Shift: *Suppression direction 6300, right 180, add 600, up 45, over.*

Suppression direction 6300, distance 2400, up 40, mark direction 6340, distance 2500, up 45, over.

**Example: Immediate SEAD decision 1**

Mission: Unmanned aircraft high-level flight target damage assessment and reconnaissance.

Targets: One suspected ZSU 23-4; location by shift method.

System/unit: One suspected ZSU 23-4; location by shift method.

Mark: None

Ordnance: DPICM.

Separation method: Artillery/battery one (W6T).

Duration/volume: Altitude.

Timing: From 1 minute before until 5 minutes after mission area arrival time.

TOT on synchronized clock.

**Example: SEAD call for fire 1**

Observer: *W6T this is D2R, SEAD, shift known point one, over.*

FDC: Reads back.

Observer: *Suppression direction 3500, right 180, up 40, negative mark, over.*

FDC: Reads back.

Observer: *Suspected ZSU 23-4, DPICM, minus 1 through plus 5, unmanned aircraft arrival time 1430, over.*

FDC: Reads back.

FDC: *D2T this is W6T, MTO, platoon, 13 rounds, VT, TOF 45, over.*

Observer: Reads back.

***Target Description***. Target description is provided as in the standard call for fire. Enemy air defense positions should be identified as known or suspected to assist in developing enemy intelligence information. Target description is only given for suppression missions.

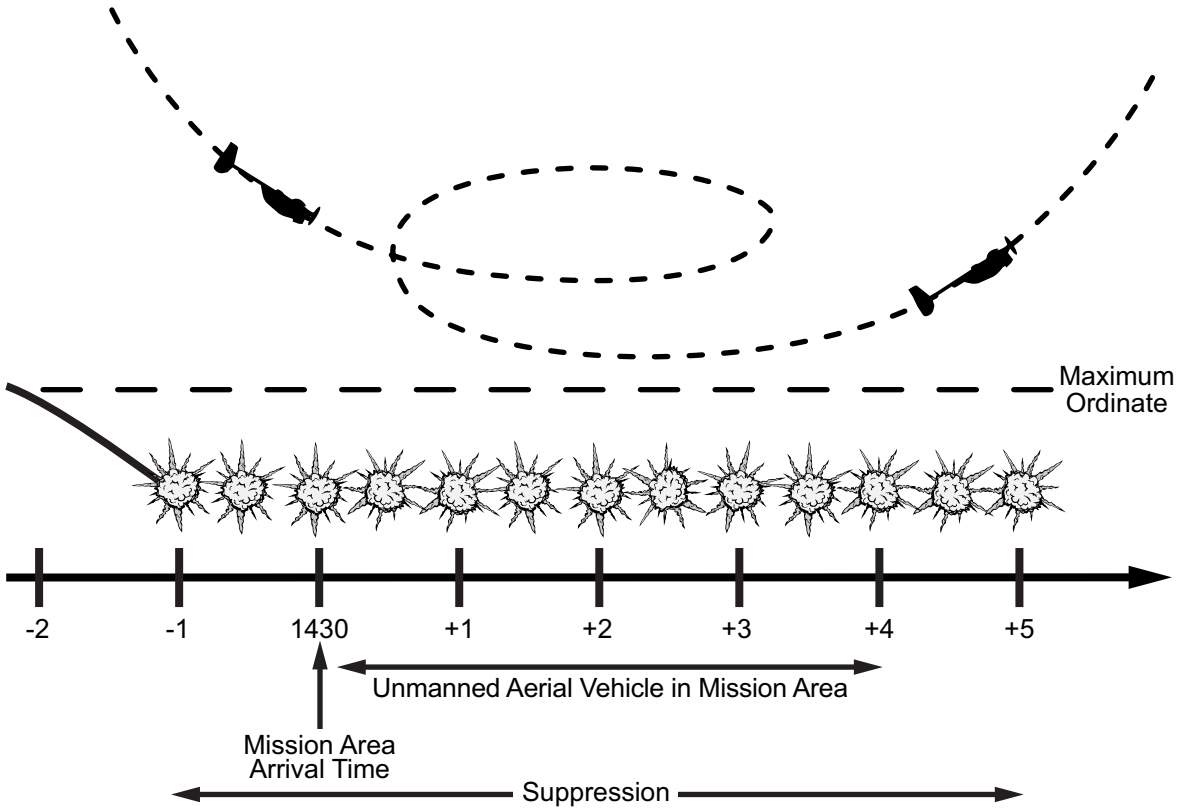



**Figure 9-12. Example of Suppression of Enemy Air Defenses Call for Fire Using Altitude Separation and Synchronized Clock.**

**Example: Immediate SEAD decision 2**

Mission: CH-46 assault support insert away from GTL.

Targets: One suspected ZPU-4 800 meters from landing zone; location by polar method.

System/unit: Artillery/battery one (W6T).

Mark: None.

Ordnance: HE/VT.

Separation method: Lateral.

Duration/volume: From 2 minutes before until 2 minutes after L-hour.

Timing: L-hour on synchronized clock.

**Example: Immediate SEAD call for fire 2**

Observer: *W6T this is D2R, SEAD, polar, over.*

FDC: Reads back.

Observer: *Suppression direction 5640, distance 3600, up 40, negative mark, over.*

FDC: Reads back.

Observer: *Suspected ZPU-4, VT and WP, minus 2 through plus 2,*

L-hour 1510, over.

FDC: Reads back.

FDC: *D2T this is W6T, MTO, 9 rounds, VT and WP, TOF 37, over.*

Observer: Reads back.

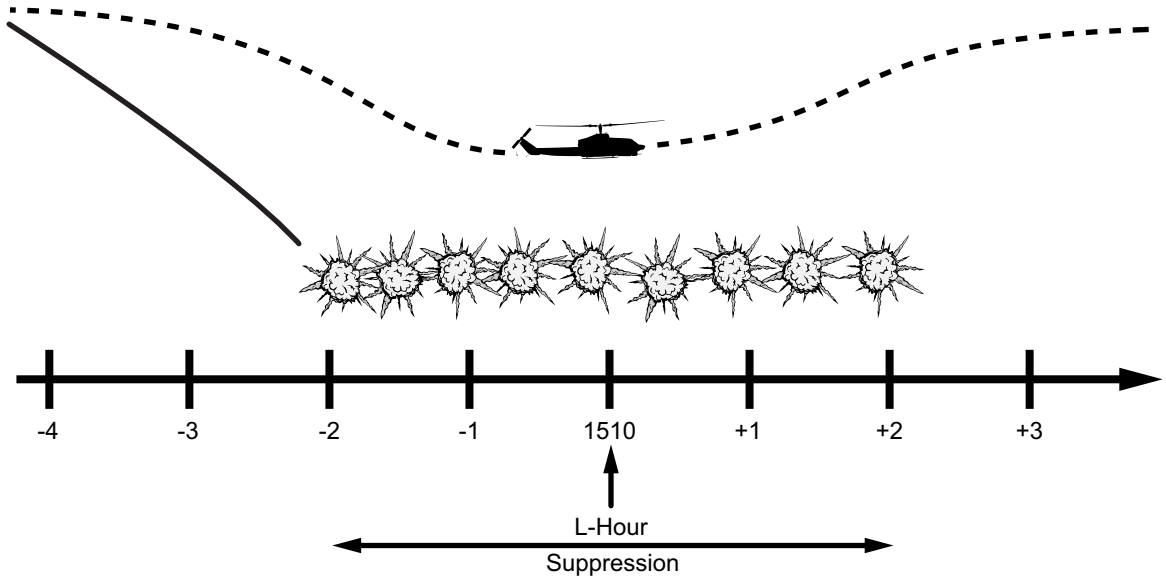



**Figure 9-13. Example of Suppression of Enemy Air Defenses Call for Fire Using Lateral Separation and Synchronized Clock.**

**Example: Immediate SEAD decision 3**

Mission: F/A-18 CAS low-level attack.

Targets: Suspected antiaircraft artillery (AAA) site near CAS target; location by laser polar method.

System/unit: Artillery/battery one (W6T).

Mark: Artillery.

Ordnance: SEAD HE/VT; Mark WP/PD (SOP).

Separation method: Timing

Duration/volume: From 1 minute before until 30 seconds before CAS TOT (i.e., a standard interrupted SEAD program).

Timing: Elapsed TTT.

**Example: Immediate SEAD call for fire 3**

Observer: *W6T this is D2R, SEAD, laser polar, over.*

FDC: Reads back.

Observer: *Suppression direction 4170, distance 2935, vertical angle plus 07, over.*

FDC: Reads back.

Observer: *Mark direction 4820, distance 2450, vertical angle plus 02, over.*

FDC: Reads back.

Observer: *Suspected AAA site, interrupted, CAS TTT 6 plus 0, 0, over.*

FDC: *Suspected AAA site, interrupted, CAS TTT 6 plus 0, 0, out.*

Observer: *CAS TTT 6 plus 0, 0…stand by…hack, over.*

FDC: *CAS TTT 6 plus 0, 0, out.*

Observer: *D2T this is W6T, MTO, 2 rounds, VT, TOF 42, over.*

FDC: Reads back.

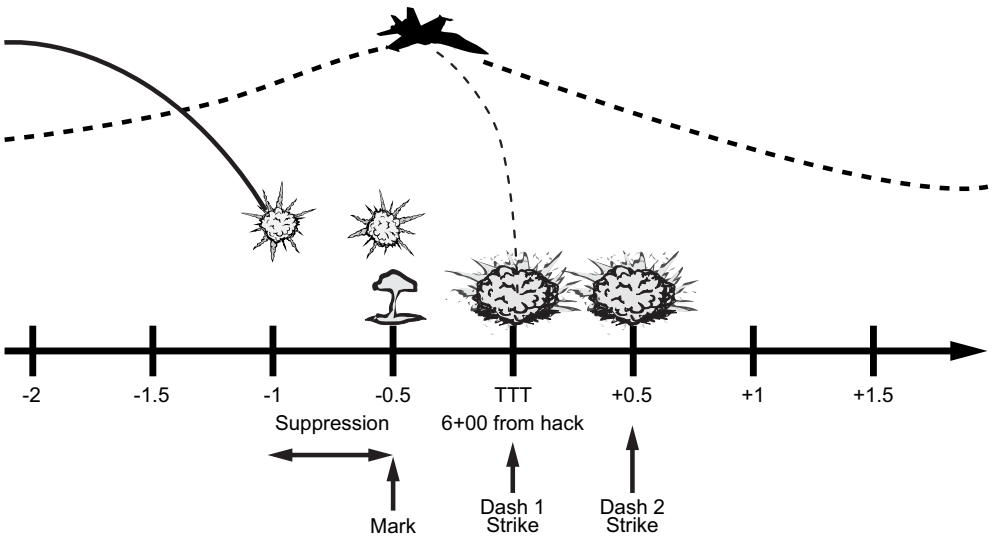



**Figure 9-14. Example of Suppression of Enemy Air Defenses Call for Fire Using Timing Separation and Elapsed Time.**

**Example: Immediate SEAD decision 4**

Mission: CH-53 tactical recovery of aircraft and personnel mission low-level flight crossing.

Targets: Two suspected ZU-23s 1,000 meters beyond landing zone; location by grid method.

System/unit: Artillery/battery one (W6T).

Mark: None.

Ordnance: HE/VT high angle.

Separation method: Altitude and lateral.

Duration/volume: From 2 minutes before until 1 minute after L-hour.

Timing: L-hour on synchronized clock.

**Example: Immediate SEAD call for fire 4**

Observer: *W6T, this is D2R, SEAD, over.*

FDC: Reads back.

Observer: *Grid to suppress 465 729, negative mark, over.*

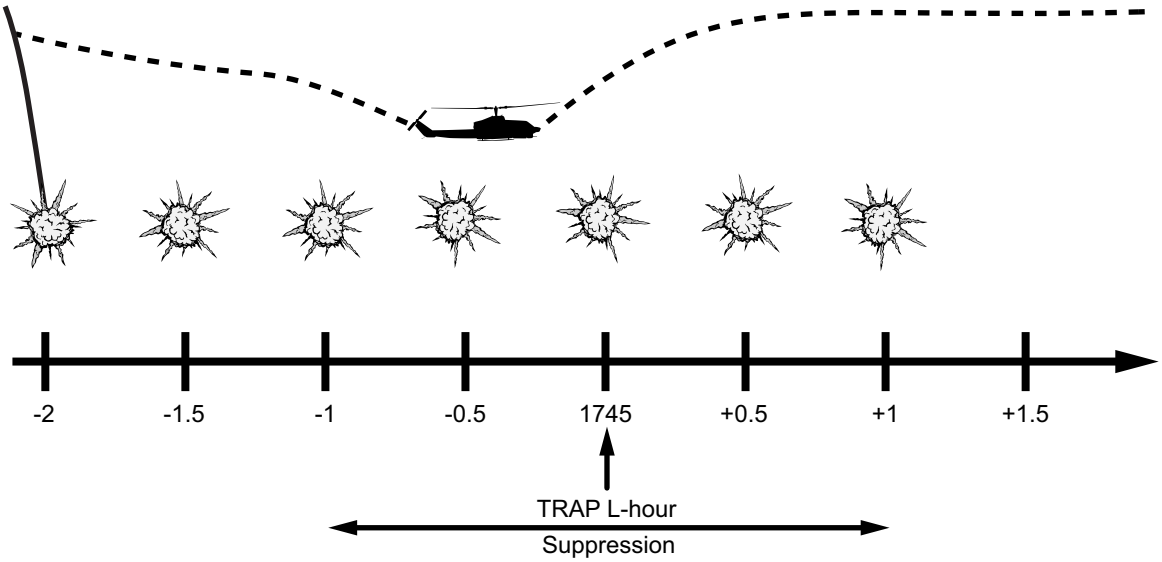
FDC: Reads back.

Observer: *Suspected ZU-23, high angle, minus 2 through plus 1, L-hour 1745, over.*

FDC: Reads back.

FDC: *D2T, this is W6T, MTO, 7 rounds, VT, TOF 67, over.*

Observer: Reads back.




**LEGEND**
**TRAP** tactical recovery of aircraft and personnel

**Figure 9-15. Example of Suppression of Enemy Air Defenses Call for Fire Using Altitude/Lateral Separation and Synchronized Clock.**

***Method of Engagement***. The munition for SEAD suppression will be standardized and fired unless another shell/fuze combination is requested. Depending on the terrain and maneuver requirements, either DPICM or HE/VT will be used. Both are effective against—

- Personnel in the open (e.g., air defense gunners).
- Air defense fire control and radar devices on AAA.
- Surface-to-air missiles (SAMs).

Concerning size and probability of area coverage, DPICM is more effective. However, HE/VT may be preferable in future maneuver areas and HE/delay may be preferable in forested areas. WP/PD (i.e., fuzed to impact on the ground) is the standard munition for marking and will be fired unless another shell or fuze combination is requested. White phosphorous is a good general-purpose marking munition, because it provides a reliable, quick-building burst; is distinguishable from HE bursting in the battlespace; and remains visible for several seconds. Other shell or fuze combinations that may be effective in SEAD and marking CAS targets include those discussed in the following subparagraphs.

*Illumination*. Illumination fuzed to burn on the deck is an effective mark. The following should be taken into consideration when employing illumination during SEAD missions. Illumination—

- Can affect forward-looking infrared (FLIR) systems.
- Is generally too intense for aircrews operating with night vision devices.
- Can also be employed for suppression to confuse the acquisition systems of heat-seeking missiles, such as the SA-7/14, SA-9/13, and SA-16.

- Can produce some confusion for radar guidance systems. Illumination flares in the air during an aircraft's ordnance delivery can confuse antiair radar and IR-seeking missiles. The optimum HOB of the illumination flare for suppression is 300 to 400 meters above ground level in between CAS and the suspected ADA position.

*Smoke*. Smoke can be used to hinder optical acquisition of CAS aircraft by the enemy, but must be positioned so that it will not hinder the pilot's ability to acquire the target or marking round. The use of smoke will interfere with optical acquisition systems of small arms, machine guns, and most AAA and tactical SAMs.

***Method of Fire and Control***. The method of fire and control includes instructions for timing and duration of SEAD fires.

For immediate SEAD fire missions, the aircraft event time (e.g., CAS TOT/TTT, assault support L-hour, unmanned aircraft mission area arrival time) serves as the basis or zero hour to schedule artillery fires. Fire and control instructions include the start and end times for suppression fires and the aircraft event to determine time of fires.

The standard suppression times are expressed as either interrupted or continuous. Nonstandard suppression includes plus or minus minutes from zero hour (e.g., minus two through plus one). More than one interval of suppression fires may be specified if SEAD fires are nonstandard (e.g., minus two through minus one, plus one through plus two). Aircraft event times should be expressed as a time on the synchronized clock (e.g., *CAS TOT 1305*). If a synchronized clock is not available, aircraft event time is expressed as an elapsed time. For example, "*CAS TTT 6 plus 0, 0. Stand by, hack,*" or in relation to another event, "*H-hour plus 10 minutes*." Refer to appendix E for instructions on establishing and communicating synchronized and elapsed times.

#### Message-to-Observer

Once the call for fire has been received by the artillery battery, the battery FDC transmits the MTO. The MTO includes the following unless the observer requests otherwise:

- Unit to fire.
- Number and type of rounds in suppression.
- Number and type of rounds for mark.
- Target number.
- Fire request changes.

## NAVAL SURFACE FIRE SUPPORT SUPPRESSION OF ENEMY AIR DEFENSES

For NSFS SEAD, the terminal controller (e.g., FAC/JTAC) coordinates aircraft routing, required suppression and marking, and timing with the NSFS spotter. The spotter determines the NSFS requirements to protect aircraft from both enemy air defenses and friendly fires and passes this information to the NSFS ship in the form of a call for fire.

The NSFS SEAD call for fire is based on the standard call for fire format (see figure 9-16 and figure 9-17). The spotter tailors it for each specific mission. Calls for fire may include instructions for marking rounds if required. The FSCC monitors these radio transmissions and ensures that the timing and effects of the SEAD fires are coordinated with other operations of the unit.

### Call for Fire

***Warning Order and Target Number***. The SEAD fire requests are identified in the warning order (e.g., *SEAD fire mission*). The spotter identification, warning order, and target number constitute the first transmission of the call for fire (see figure 9-18).

**Example: Warning order and target number**

*T4R this is E3P, SEAD fire mission, target number NZ 3101, over.*

***Target Location***. When determining target location, the most accurate method of target location that is appropriate for the situation should be used. The target location element of the call for fire must include the suppression target locations and, if required, the location for a munition marking round. In the call for fire, all suppression target information, which includes target location, target description, method of engagement, and method of control, should be stated before information is given on a second suppression target or the mark target. Target locations are specified by stating *suppression*, followed by the location, and *mark*, followed by the location, or *negative mark* if no mark is desired.

**Example: Immediate SEAD decision 5**

Mission: CH-46 assault support inserted away from GTL.

Targets: One suspected ZPU-4 along flight route; 1 suspected AAA site 800 meters from landing zone; location by grid method.

System/unit: NSFS/USS O'Bannon DD-987 (V4G).

Mark: None.

Ordnance: HE/CVT. This is standard.

Separation method: Lateral.

Duration/volume: First target: 3 minutes before to 2 minutes before L-hour; second target: 1 minute before to 1 minute after L-hour.

Timing: L-hour at 1510 on synchronized clock.

**Example: Immediate SEAD call for fire 5**

Spotter: *V4G this is C5E, SEAD fire mission, target numbers AF 0015 and AF 0016, over.*

Ship: Reads back.

Spotter: *Suppression grid 716 532, altitude 90, suspected ZPU-4, nonstandard, minus 3 through minus 2, suppression grid 765 567, altitude 80, suspected AAA site, continuous, negative mark, L-hour 1510, over.*

Ship: Reads back.

Ship: *AF 0015 GTL 1140, summit 1000 feet, ready TOF 16, over.*

Spotter: Reads back.

Ship: *AF 0016 GTL 1420, summit 1100 feet, ready TOF 19, over.*

Spotter: Reads back.

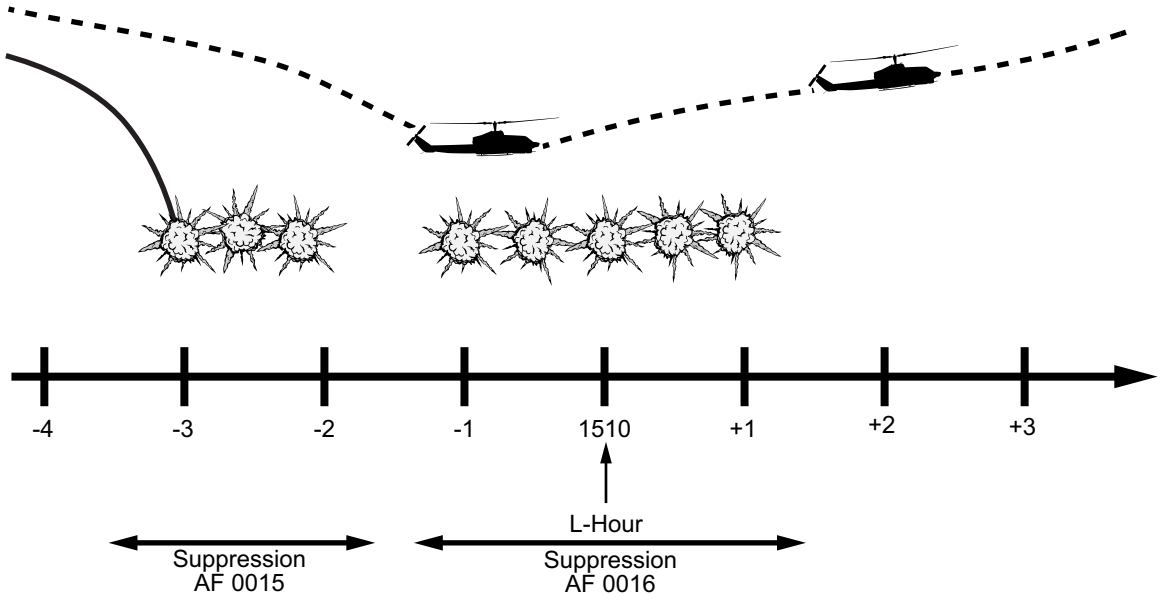



**Figure 9-16. Example of Suppression of Enemy Air Defenses Call for Fire Using Lateral Separation and Synchronized Clock.**

**Example: Immediate SEAD decision 6**

Mission: F/A-18 CAS low-level attack.

Targets: Suspected AAA site near CAS target; location by polar method.

System/unit: NSFS/USS Leftwich DD-984 (Y2P).

Mark: NSFS.

Ordnance: SEAD HE/CVT; mark WP/PD. This is standard.

Separation method: Timing.

Duration/volume: From 1 minute before until 30 seconds before CAS TOT for a standard interrupted SEAD program.

Timing: Elapsed TTT.

**Example: Immediate SEAD call for fire 6**

Spotter: *Y2P this is C5E, SEAD fire mission, target number AF 0017, over.*

Ship: Reads back.

Spotter: *Suppression direction 5640, distance 3600, up 40, suspected AAA site, interrupted, mark direction 5670, distance 3800, up 40, CAS TTT 10 plus 0, 0, over.*

Ship: Reads back.

Spotter: *CAS TTT 10 plus 0, 0…stand by…hack, over.*

Ship: *CAS TTT 10 plus 0, 0, out.*

Ship: *Suppression GTL 1310, summit 900 feet, ready TOF 12, over.*

Spotter: Reads back.

Ship: *Mark GTL 1290, summit 900 feet, ready TOF 11, over.*

Spotter: Reads back.

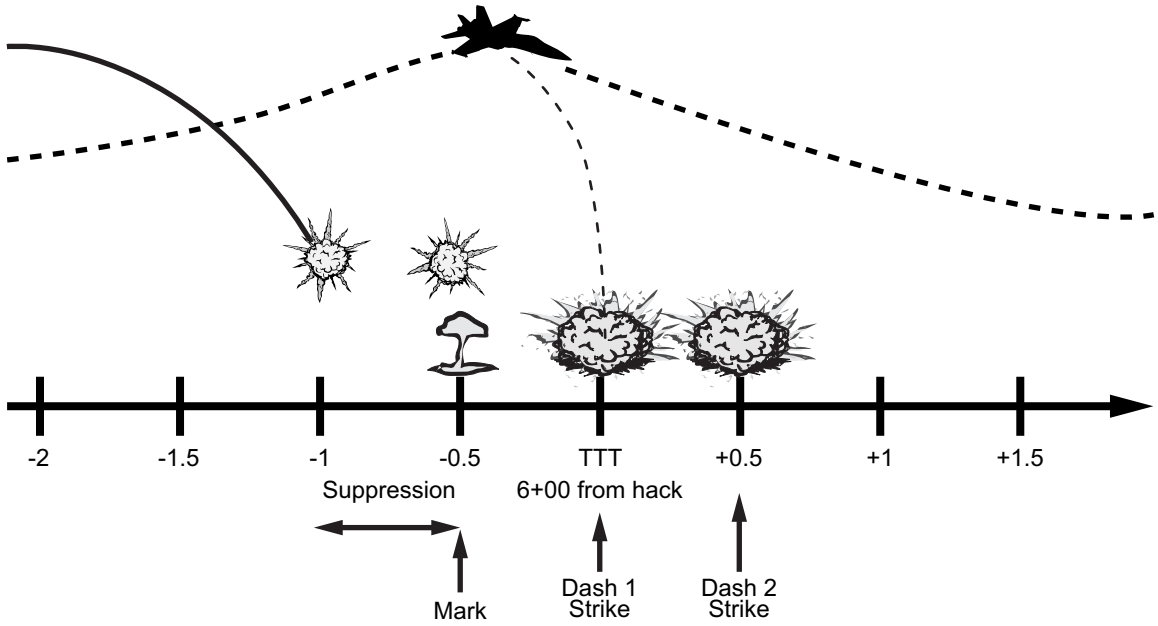



**Figure 9-17. Example of Suppression of Enemy Air Defenses Call for Fire Using Timing Separation and Elapsed Time.**

**Example: Immediate SEAD decision 7**

Mission: F/A-18 CAS medium-level attack.

Targets: Suspected AAA site near CAS target; location by grid.

System/unit: NSFS/USS Leftwich DD-984 (Y2P).

Mark: NSFS.

Ordnance: SEAD HE/CVT; mark WP/PD. This is standard.

Separation method: Altitude.

Duration/volume: From 1 minute before until 1 minute after CAS TOT. This is a standard continuous SEAD program.

Timing: Synchronized clock TOT.

**Example: Immediate SEAD call for fire 7**

Spotter: *Y2P this is C5E, SEAD fire mission, target number AF 0018, over.*

Ship: Reads back.

Spotter: *Suppression grid ND 516 368, altitude 478, suspected AAA site, continuous, mark grid ND 456 359, altitude 500, CAS TOT 1030, continuous, over.*

Ship: Reads back.

Spotter: *Suppression GTL 1600, summit 800 feet, ready 18, over.*

Ship: Reads back.

Spotter: *Mark GTL 1700, summit 900 feet, ready 19, over.*

Ship: Reads back.

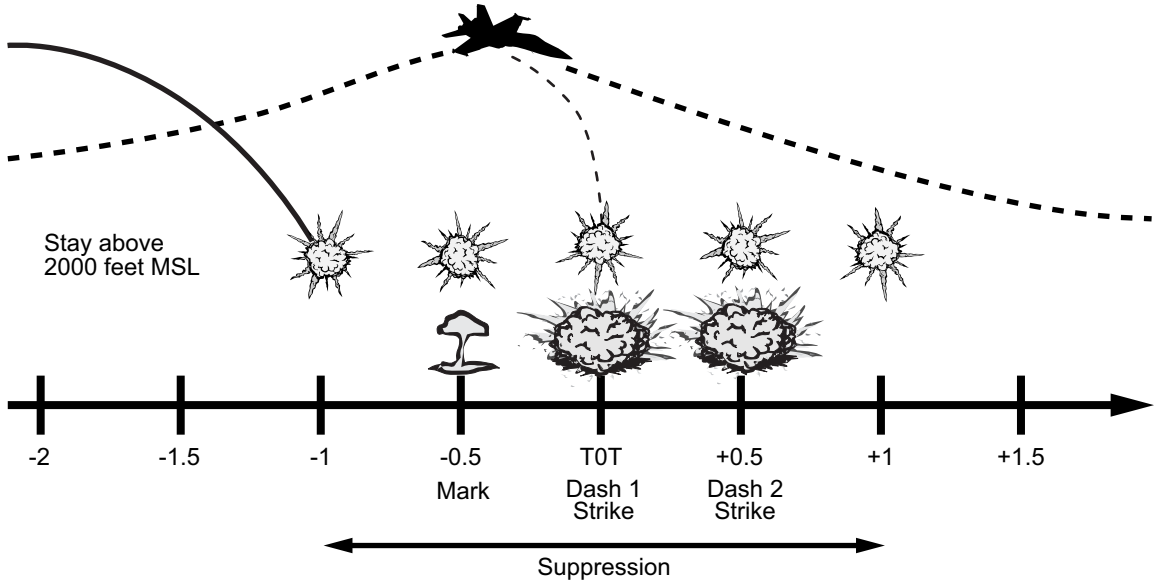



**Figure 9-18. Example of Suppression of Enemy Air Defenses Call for Fire Using Altitude Separation and Synchronized Clock.**

***Target Description***. Target description is provided as in the standard call for fire. Enemy air defense positions should be identified as known or suspected to assist in developing enemy intelligence information.

***Method of Engagement***. The standard method of engagement for SEAD suppression is HE/CVT, 1 gun, sustained fire, interval 10 seconds for suppression.

For NSFS marks, the standard is WP/PD fired to impact at 20 to 30 seconds before the aircraft event time.

These standards will be fired unless another method of engagement is specifically requested. The effects of NSFS HE/CVT are similar to those of artillery HE/VT. Because some ships may not carry WP, illumination may need to be used as a mark. Illumination marks should be timed to burst 45 seconds before the aircraft event time and fuzed to burn on the deck. The effects of NSFS illumination are similar to those of artillery illumination.

Each method of engagement includes instructions for timing and duration of SEAD fires. Engagement instructions include the starting and ending times for suppression fires relative to the aircraft event time. The aircraft event time is stated in the method of control element of the call for fire. Suppression times are expressed as plus or minus minutes from zero hour (e.g, *minus two through plus one*). More than one sequence of suppression fires may be specified if fires on that target must be broken up (e.g., *minus two through minus one, plus one through plus two*). To abbreviate the SEAD call for fire to support CAS missions, two standard programs are established for typical SEAD scenarios.

*Continuous*. The continuous SEAD program may be used when separating aircraft and SEAD fires by distance. This program is usually effective when the SEAD target is in the vicinity of the CAS target and SEAD fires will not endanger CAS aircraft. Continuous SEAD fires are delivered during the critical portion of the CAS aircraft's attack phase and egress; specifically, from one minute before the CAS TOT/TTT until 1 minute after the CAS TOT/TTT. This program is requested by stating *continuous* instead of desired suppression times.

*Interrupted*. The interrupted SEAD program may be used when separating aircraft and SEAD fires by time. This program is usually effective against SEAD targets that are the same as or close to the CAS target and where SEAD effects or trajectories may endanger CAS aircraft. Interrupted SEAD fires are delivered during the critical portion of the CAS aircraft's attack phase; specifically, from 1 minute before the CAS TOT/TTT until 30 seconds before the CAS TOT/TTT. This program is requested by stating *interrupted* instead of the desired suppression times.

***Method of Control***. For immediate NSFS SEAD missions, control instructions must include the aircraft event time (e.g., CAS TOT/TTT, assault support L-hour, unmanned aircraft mission area arrival time), which serves as the basis or zero hour from which NSFS is scheduled. Aircraft event times should be expressed as a time on the synchronized clock (e.g., *CAS TOT 1305*). If a synchronized clock is not available, express aircraft event time as an elapsed time; for example, *CAS TTT 6 plus 0, 0 . . . stand by, hack,* or in relation to another event, *H-hour plus 10 minutes*.

The target location, target description, method of engagement, and method of control constitute the second transmission of the call for fire. Once instructions for a target have begun in this transmission, spotters should complete the location, description, and method of engagement for that target before providing instructions for another suppression target or a mark target.

For example, stating *suppression* for the first target location, description, and method of engagement; and *mark* for the location and method of engagement. Because of the length of this transmission, information should be transmitted as it is determined, and elapsed times (i.e., TTT and hacks) should be sent as a third transmission.

**Example: Suppression**

*Suppression grid 765 567, altitude 80, suspected SA-6, nonstandard, minus 2 through plus 2, mark grid 762 575, altitude 50, CAS TOT 1305, over.*

### Prefiring Report

The NSFS ship will transmit a normal prefiring report that includes the GTL, summit, and TOF. In addition, shot and splash should be transmitted to assure spotters that fires will impact as desired.

# CHAPTER 10
# AERIAL OBSERVATION

This chapter concerning aerial observation will detail the unique aerial observer procedures for calling for and adjusting artillery and NSFS.

## AERIAL OBSERVER

Aerial observers—

- Are trained to observe the battlespace from aircraft in order to conduct reconnaissance and adjust artillery and NSFS.
- May also perform the duties of a FAC(A) or TAC(A).
- Are also referred to as air spotters when adjusting NSFS.
- Use procedures and terminology for adjusting fires similar to those employed by the ground observers or spotters. Some variations are imposed by the observers' perspective from the aircraft. Marine aerial observers operate primarily from the F/A-18D FW aircraft and the AH-1W/Z or UH-1N/Y helicopter.

## PRELAUNCH CONSIDERATIONS

The aerial observer and pilot are given a thorough briefing that addresses the current friendly situation, including infantry objectives, locations, front lines, zones of action, patrol plans, and coordinating measures. In addition, the following information should be also obtained during mission preparation:

- Enemy locations, organization, and equipment.
- Battery positions.
- Known points.
- Targets/suspected target areas.
- Reference lines available for making corrections.
- Areas to be searched.
- Ordnance available.
- Maps and photographs of obstacles and checkpoints.
- Communications details (e.g., frequencies, call signs, prearranged signals, authentication sheets).

- Established operational procedures or SOPs, such as the method of fire for immediate suppression, special munitions, and SEAD.
- Fire support areas/fire support stations.
- NSFS ship disposition, availability, and radar beacon positions.
- Specific mission preparation, which includes time of takeoff and return, routes, mission, check-in times, control measures, known fires and air strikes, restrictive fire plans, weather, and relief on station.
- Message drop-off and pickup stations.
- Panel code.
- Location of ground radios.
- Pulse repetition frequency (PRF) code words.

## REPORT IN AND OUT

The pilot reports in and out to air control agencies when airborne or over an assigned orbit point by using the UHF radio. The aerial observer reports in and out with ground agencies by using either the UHF or VHF radio.

### Communication Nets

In addition to the division artillery air spot net or the NSFS air spot net (see chapter l), the following nets and frequencies may be used.

***Ship Air Spot Reporting In and Out Net***. When arriving on station, the aerial observer must check in with the SACC or the appropriate FFCC or FSCC. For NSFS, the ship air spot reporting in and out net (UHF) is employed for the following:

- To assign air spotters to specific gunfire support ships and shore fire control parties, as directed.
- To direct NSFS air spotters to guard other air spot frequencies, if required.
- To brief spotters on the location of targets, friendly front lines, and zones of action, as directed.
- To release air spot planes when relieved and return them to the tactical air traffic control net controller or senior air observer for departure from the area.

The stations on this net include parent carriers, land bases, tactical air commanders, the commander of the landing force, and all airborne NSFS spotting aircraft that report in and out.

***Marine Air-Ground Task Force Air Observation Net***. This UHF/VHF net provides a means for—

- Controlling air observation.
- Transmitting information from landing force aerial observers to landing force headquarters and other landing force units.
- Adjusting artillery or NSFS on an emergency basis.

Multiple air observation nets may be required, depending on the scope of the operation. The stations on this net include the SACC, the FFCC, the FSCCs, and the senior artillery FDC.

***Marine Air-Ground Task Force Artillery Air Spot Net***. This VHF/UHF net provides the landing force headquarters, FFCC or senior FSCC, artillery regiment, artillery battalions, and fire support officers with an air spot net for conducting fire on deep and difficult targets. The stations on this net include landing force aerial observers, the force command element, ground combat element artillery aerial observers, and landing force artillery units, as required.

***Division Air Observation Net***. This VHF/UHF net provides a means for controlling air observation, for the transmission of information from division aerial observers to division headquarters and other division units, and for adjusting artillery or NSFS on an emergency basis. Stations on this net include the division headquarters, aerial observers, and subordinate division units, as required.

***Tactical Air Traffic Control Net***. This UHF/VHF net provides a means for the Navy TACC/tactical air direction center, tactical air operations center, and DASC to exercise airspace control of all tactical aircraft and itinerant aircraft in the objective area. The stations on this net include the Navy TACC/tactical air direction center, the tactical air operations centers, the DASC, FW aircraft, and helicopters.

***Tactical Air Request/Helicopter Request Net***. This HF/VHF net provides a means for requesting immediate air support from the DASC. The stations on this net include the DASC, TACPs, FFCC/FSCCs, the helicopter direction center, the FAC(A), the TAC(A), and the assault support coordinator (airborne), as required. In amphibious operations, a dedicated net (i.e., helicopter request [HF/VHF]) may be activated during ship-to-shore movement for immediate helicopter requests.

***Tactical Air Direction Net***. This UHF/VHF net provides a means to direct aircraft in the conduct of CAS missions, for the DASC to brief support aircraft on target information, or for the DASC to assign missions to aircraft.

There are multiple tactical air direction nets available for the DASC to assign to terminal control agencies (e.g., TACPs, FAC[A]s). The tactical air direction net is not a planning net and should not be used for extraneous traffic.

### Available Radios

Table 10-1 displays the radios that are available for communication by aerial observers.

**Table 10-1. Radios Available to the Aerial Observer.**

| Aircraft | Communications Means |
|---|---|
| F/A-18D | Two ARC-182 transmitters/receivers with the capability to monitor any 2 frequencies in UHF/VHF/AM/FM<br>Capable of operating when covered |
| AH-1W/Z | Two ARC-182 transmitters/receivers with the capability to monitor any 2 frequencies in UHF/VHF/AM/FM<br>Capable of operating when covered |
| UH-1N/Y | UHF and VHF (with the ASC-26 communications package installed—one additional UHF and 2 additional VHF radios with a retransmission capability)<br>May also have HF capability |
| **LEGEND**:<br>AM amplitude modulation | |

## CALL FOR FIRE

The call for fire is used by the aerial observer for both artillery and NSFS in the same manner as discussed in chapters 3 and 4. The following are special considerations for the aerial observer who is making a call for fire.

### Target Marking

The aerial observer may mark the target for a firing ship and use the ship adjust method of control. This technique should be used only in a low-threat environment.

### Method of Control

The command *at my command* allows the pilot time to position the aircraft for observation.

### Target Location

Target location is determined by either the grid or shift from a known point method. Although the methods are the same as discussed in chapter 2, obtaining an accurate target location is difficult because targets are normally acquired by the naked eye. The use of gyro-stabilized, low-light capable binoculars (i.e., the Fujinon Stabiscope S-40) facilitates accurate target location and adjustment of fire and increases aircraft survivability. Non-gyro-stabilized binoculars are difficult to use because of the distortion that is caused by the windscreen and vibration of the aircraft.

Hand measurements or estimations can be used to determine angular deviation. The aerial observer should seek an object to use as a yardstick for assistance in estimation. For example, a bridge span that is measured on the map to be 200 meters can be used as a yardstick in target location and adjustment of fire. The aerial observer's capability to determine an accurate target location may be limited by the enemy situation. Because of the enemy acquisition capability, the aerial observer may be afforded only a short exposure time. The aerial observer can offset the enemy's acquisition capability by using an FLIR receiver.

### Direction

The aerial observer selects one of the following types of direction based on the battlespace environment, terrain, type of aircraft, experience, and training:

- *Gun-target line*. The GTL provides an effective type of direction for the adjustment of fire. In artillery, if the aerial observer has knowledge of the firing unit's location, the GTL can be used for adjustment. The FDC will assume that the GTL is being used unless otherwise specified by the observer. In NSFS, if the aerial observer can see both the ship and the target or can clearly visualize the GTL on the ground, GTL direction can be used. The aerial observer must specify *direction GTL* if this type of direction is used.
- *Arbitrary reference line*. The aerial observer—
  - Can use visible terrain or a man-made feature as a reference line and use this line or a corresponding parallel line and project it through the target.
  - Must be able to see both the target and the reference line feature simultaneously from all angles of approach. Roads, rivers, power lines, and railroads are examples of good reference lines.
- *Observer-target line*. The OT direction is an excellent reference for an aerial observer who is observing from a helicopter. The bearing-distance heading indicator on the aircraft instrument panel can be used to determine OT direction in degrees magnetic. The aerial observer may need to transmit a new OT direction for subsequent adjustments. Aerial observers have a difficult time using the OT direction while performing the observation from an FW aircraft. The FW aircraft will not normally head directly for the target on every pass; therefore, the aerial observer may have to estimate OT direction from the sides of the aircraft. The clock method using the nose of the aircraft can facilitate this estimation.
- *Cardinal direction*. Cardinal direction, although less accurate, can be used for direction.

### Summit or Maximum Ordinate

The aerial observer may wish to know the summit or maximum ordinate for use in aircraft positioning and flight path selection. In artillery, the aerial observer may request the maximum ordinate from the firing unit. In NSFS, the summit is automatically reported in the prefiring report (see chapter 4).

### Time of Flight

The aerial observer automatically receives TOF in the artillery MTO or NSFS prefiring report. This allows the pilot time to position the aircraft for observation.

## ADJUSTMENT OF FIRE

Adjustment of fire involves spottings, corrections, and adjustment techniques from a helicopter:

- *Deviation and range spottings*. The aerial observer determines spottings by map spot, estimation, or hand measurement; depending on the aircraft positioning, the threat, and the type of aircraft.

- *HOB spottings*. The aerial observer cannot readily determine HOB; consequently, adjustments to HOB for HE with fuze time are difficult. The aerial observer must rely on the fragmentation pattern on the ground as a means for determining spots. The use of VT or CVT eliminates this problem.
- *Corrections*. Because of the aerial observer's elevated view, the one-round adjustment method is preferred; however, the ground observer may use other methods as discussed (see chapter 5).
- *Helicopter adjustment techniques*. When the aerial observer is adjusting from a helicopter, either the stationary hover or pop-up technique may be used for adjustment:
- *Stationary hover technique*. In a stationary hover, the pilot positions the aircraft behind trees or other terrain features that conceal the aircraft and still permit observation of the target.
- *Pop-up technique*. In the pop-up technique, the pilot will unmask the aircraft 2 to 3 seconds before impact of the round. After the aerial observer observes the burst, the aircraft returns to the original hide position or moves to another hide position. The aerial observer sends corrections as the pilot remasks the aircraft.

## FORWARD-LOOKING INFRARED RECEIVER

The FLIR receiver is a passive device used to detect targets by their IR radiation. The FLIR receiver views the terrain in the vicinity of the aircraft. Infrared energy is converted into electrical signals and displayed on a terminal in the cockpits of the F/A-18, AV-8B (night attack version), AH-1W, AH-64A, AC-130, F-15E, F-16, and OH-58D aircraft. The FLIR—

- Allows for the recognition, identification, and classification of targets that would otherwise go undetected as a result of darkness or camouflage.
- Provides the aircrew with an excellent target during either day or night, although usually better at night.

The FLIR receiver, in conjunction with the laser, makes night adjustment of artillery, mortars, or NSFS possible without illumination and the inherent time delays associated with illumination missions. The call for fire using the FLIR receiver is the same as discussed in chapters 3 and 4.

# CHAPTER 11
# LASERS, LASER DESIGNATORS, AND LASER-GUIDED WEAPONS SYSTEMS

Laser-guided weapons systems consist of ground and/or airborne designators used with surface- or air-delivered laser-guided munitions. These systems include laser designators or range finders, laser acquisition devices or seekers, laser-guided munitions, and delivery platforms. Laser-guided weapons systems are used by artillery observers, NSFS spotters, reconnaissance personnel, FACs, aerial observers, and aircraft pilots. This chapter focuses on the LGW systems employed by the ground observer, spotter, or terminal controller in support of the MAGTF. See MCRP 3-31.6 for the most current inventory of aircraft, ordnance, munitions and LGW systems.

## PURPOSE OF LASER-GUIDED WEAPONS SYSTEMS

Laser-guided weapons systems—

- Provide combat units with a means of accurately locating and engaging high-priority stationary and moving point targets with first-round hit probability.
- Allow for faster location and attack of the target.
- Provide artillery, ships, and aircraft with accurate target data to attack effectively with conventional munitions.
- Provide positive control between the air and the ground with the coded laser beam.

## BASIC REQUIREMENTS FOR USING LASER DESIGNATORS

The five basic requirements for using laser designators with laser acquisition devices or laser-guided munitions are as follows:

- *Line of sight*. A line of sight must exist between the designator and the target and between the target and the laser acquisition device.
- *PRF codes*. A PRF code is used for the laser designator, the laser seeker, and the laser-guided munition. Each must use the same code when operating together.
- *Direction of attack*. An agreement on a direction of attack is necessary. The laser seeker or laser-guided munition must be able to sense the reflected energy from the laser designator.

- *Target designation*. The laser designator must be designating the target at the correct time.
- *Munition delivery envelope*. The delivery system must release the munition within the specific munition delivery envelope.

## CAPABILITIES OF LASER EMISSION SYSTEMS

Laser target ranging and designation systems provide accurate range, azimuth, and elevation information for use in locating enemy targets or other positions. These systems vary from hand-held range finders and pointers to aircraft-mounted designators. Laser designators provide the energy source that is reflected from a designated target to provide terminal guidance for laser-guided munitions. These systems emit discreet pulses of IR energy that are invisible to the naked eye. The characteristics of these pulses are determined by a PRF code of laser energy, which can be set by a series of switches on the equipment. The following are characteristics of common laser emission systems:

- *Vector 21-B*. A hand-held, battery-operated, eye-safe CLRF, the Vector 21-B is an updated version of the PTS-180 VIPER that includes a DAGR GPS and an AN/PVS-14 night vision device that—
  - Can provide range, azimuth, and vertical angle to a target.
  - Can measure horizontal and vertical shift from two objects in addition to angular shift.
  - Cannot designate targets for laser-guided munitions.
  - Has a 7-power binocular sighting system and an included 10-power binocular enhancer that attaches to the system.
  - Can provide approximately 3,000 range readouts per 6-volt lithium battery.
  - Is capable of detecting multiple target reflections. The operator can apply a minimum range setting and a declination constant setting.
  - Has multiple units of measure for azimuth (i.e., degrees, mils, gons) and range (i.e., feet, yards, meters).

    ***Note:*** Accuracy for the Vector 21-B is +/- 5 meters for distances of 5 to 12,048 meters. Accuracy for azimuth measurements is +/- 10 mils for deviation and +/- 3 mils for inclination.

- *Laser target designator/ranger (LTD/R) pod*. The F/A-18C/D is capable of carrying the AN/AAS-38 LTD/R pod, which is effective during either the day or night and at high altitudes and provides the following functions:
  - Terminal weapons guidance for all laser-guided munitions.
  - Designation of targets for airborne coded laser acquisition/spot trackers.
  - *Night targeting system*. The AH-1W/Z attack helicopter contains the night targeting system, which provides LTD/R capability, as well as FLIR visual capability and video capture. It performs the same functions as the LTD/R pod does for FW platforms.

- *Illumination devices*. Hand-held lasers emit IR light for compatibility with night vision goggles (NVGs). They can either flood IR light within 1,000 meters to enhance general NVG performance or focus a small beam up to 4 kilometers to pinpoint a specific target with an IR light beam for any weapons system employing NVGs. Hand-held lasers are not capable of designating for a laser-guided munition.

## LASER ACQUISITION DEVICES

Laser acquisition devices (e.g., seekers, spot trackers)—

- Are used to acquire reflected laser energy from laser-designated targets.
- Are installed in aircraft for target acquisition or in laser-guided munitions for terminal guidance.
- Allow visual acquisition of a coded laser-designated target.
- Must be set to the same PRF code as the laser designator for the user to see the target being lased. The AH-1W/Z has the capability to use on-board helicopterborne fire and forget missile (HELLFIRE) munitions as an improvised laser spot tracker before firing.

See appendix H for all laser spot tracker-equipped aircraft. There are two common laser acquisition devices:

- *Laser acquisition/spot tracker pod*. The coded laser acquisition/spot tracker can be carried on the F/A-18A/C/D. Once it acquires the laser spot (i.e., target), it passes necessary ballistic information to allow FLIR or radar acquisition of the target and visual display. Desired PRF codes are in-flight selectable. It then employs LGWs or executes visual deliveries of nonlaser ordnance.
- *Angle rate bombing system*. The angle rate bombing system is used on the AV-8B. It consists of a 3-axis gimbaled television/laser spot tracker, which enables a view of the laser spot. The angle rate bombing system provides day or night attack and reattack information for either LGWs or nonguided bombs and allows in-flight selection of PRF codes, though it is affected by smoke or obscurants.

## LASER-GUIDED MUNITIONS

These munitions concentrate on reflected laser energy during the terminal portion of the attack. Such munitions are part of the precision-guided munitions family, which includes Maverick and HELLFIRE missiles and laser-guided bombs.

- *Maverick*. An air-launched, air-to-ground missile that is available in a laser-guided variant and an IR-seeker variant. It can be employed on the AV-8B, A-10, F-15, F-16, and F/A-18 aircraft and is used against field fortifications, SAM sites, and armored vehicles. This missile requires

lock-on before launch and continual designation during flight. Once the Maverick is launched, the aircraft can break away or launch another missile. The PRF code is cockpit selectable.

- *HELLFIRE*. An air-launched, laser-guided, antiarmor missile launched from the AH-lW/Z, AH-64, and OH-58D aircraft. The HELLFIRE can be employed in indirect (i.e, lock-on after launch) or direct (i.e., lock-on before launch) fire methods and launched in four firing modes:
  - *Single*. One missile.
  - *Rapid*. Two or more missiles launched on the same code.
  - *Ripple*. Two or more missiles launched on different codes using multiple laser designators.
  - *Multiple*. Codes and designators used in a combination of rapid and ripple fire. The PRF code is cockpit selectable.
- *Laser-guided bombs*. The MK-82, MK-83, and MK-84 are designations for the 500-lb, 1,000-lb, and 2,000-lb bombs that can be converted to the GBU-12, GBU-16, GBU-10, GBU-22, GBU-23, and GBU-24 laser-guided bombs. These bombs use common laser guidance and control subassemblies with only the aerodynamic surfaces changed to match the particular size of the warhead. They can be employed in a standoff capacity. The PRF codes must be set before aircraft launch.

## LASER ENERGY REFLECTIVITY

Laser energy is reflected in various ways that depend on the nature of the reflecting surface, the angle at which the laser energy strikes the target surface, and the laser beam divergence. This information is important in determining where the laser acquisition, tracking device, or seeker needs to be to acquired and concentrated on the reflected energy spot.

### Laser Spot Size

The laser energy or beam increases in size at a constant rate from its source. This spreading is a function of the designator itself and the distance to the target being designated. This is called beam divergence. For the CLRF, the laser energy spot size can be estimated for any distance by using the following rule of thumb—the spot size is equal to 3 inches plus 8 times the OT distance, presented in thousands of meters.

### Target Surface Reflectivity

Targets contain a combination of mirror-like (e.g., windshields, windows, shiny metal) and low-reflectivity surfaces. Mirror-like surfaces should not generally be designated because the reflective energy does not spread sufficiently to allow the seeker to acquire it. Certain materials are better reflectors of laser energy than others (e.g., brick, dirty metal). Targets with greater laser energy reflectivity increase the probability of a laser seeker picking up the laser spot.

Attack headings for air-delivered munitions should be outside the safety zone, which is an area 10 degrees (i.e., 180 mils) on either side of the laser designator. Laser-guided weapons that are launched within the 20-degree (i.e., 360 mils) safety zone could receive false target indications and acquire the designator. The safest acquisition area for an LGW is more than 10 degrees (i.e., 180 mils) but less than 60 degrees (i.e., 1100 mils) off the laser-target line. This provides

a 50-degree (i.e., 900 mil) cone to either side of the laser-target line for an ideal attack heading (see figure 11-1). Terminal controllers employing laser designators must provide air crews with an attack heading that is within that cone.

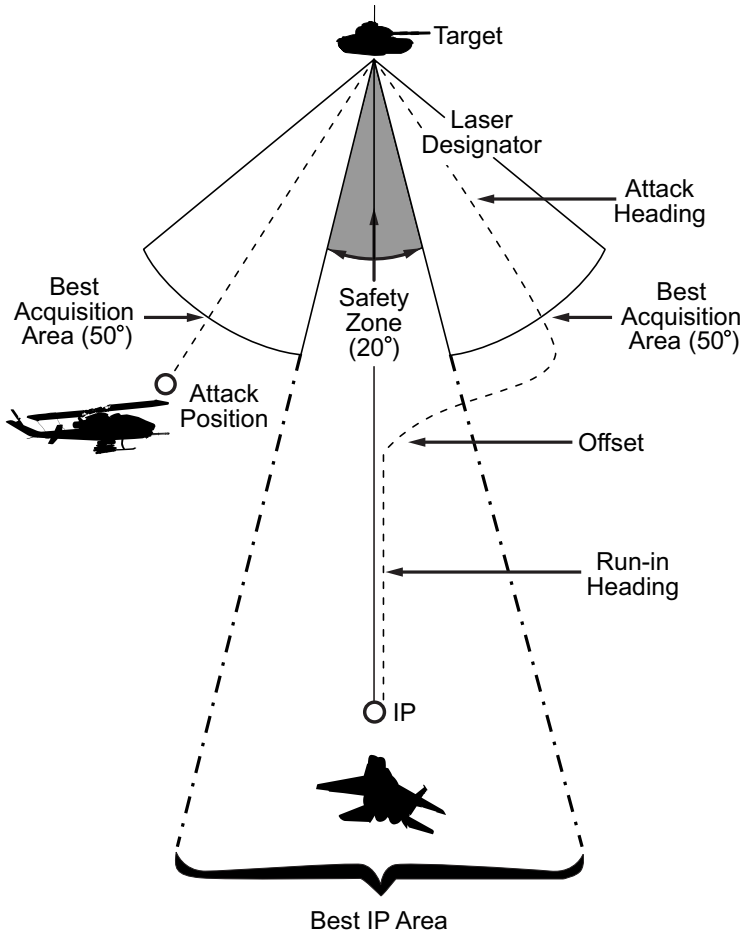



**Figure 11-1. Safety Zone and Optimal Acquisition Area for Delivery of Laser-Guided Weapons.**

The best results are obtained when designated targets reflect the beam upward and toward the incoming seeker or munition. The amount of laser energy that is reflected from a target is difficult to determine and is material dependent (see table 11-1).

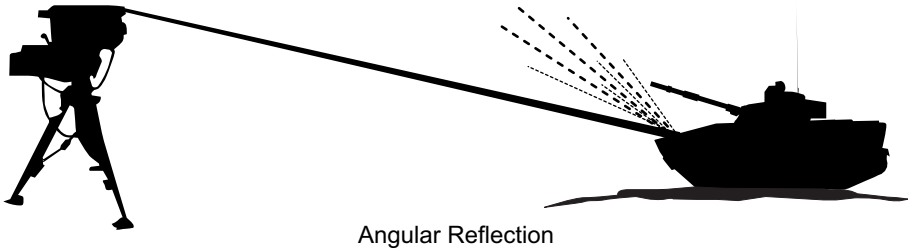
**Table 11-1. Energy Reflection.**

| Material | Percentage of Reflectivity |
|---|---|
| Brick | 55–90 |
| Vegetation | 30–70 |
| Unpolished aluminum | 55 |
| Olive drab metal (dirty) | 2–30 |
| Asphalt | 10–25 |
| Concrete | 10–15 |
| Water | 2 |

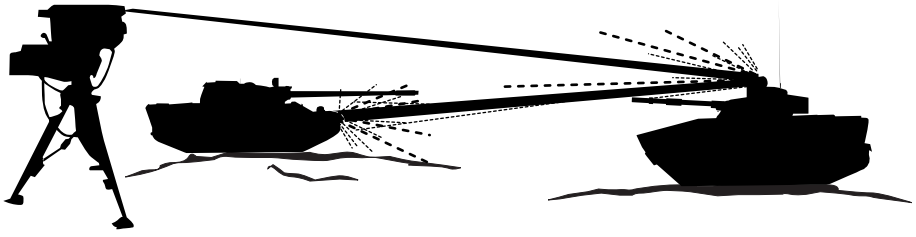
### Energy Reflection on Various Surfaces

A brief description of how the energy is reflected from various types of surfaces follows:

- *Mirror-like reflections*. The laser energy reflects in a narrow path from flat, bare, shiny metal, and glass surfaces as shown in figure 11-2. Any seeker looking for this laser energy must be in this narrow area of reflection to acquire the spot. These surfaces are not suitable for laser designation.



Angular Reflection



Perpendicular Reflection

**Figure 11-2. Mirror-Like Reflections.**

- *Scattered reflections*. Laser energy scatters in a large spherical arc from flat, low-reflectivity surfaces (see figure 11-3). These surfaces are suitable for laser designation.

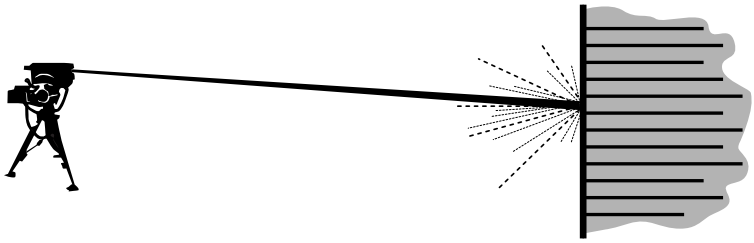


**Figure 11-3. Scattered Reflections.**

- *Spillover*. Laser energy spillover occurs when the laser spot is larger than the target. It is usually caused by beam divergence but may also be caused by a careless designator operator. Reflections from objects near the target may also occur (see figure 11-4). When this happens, the seeker may acquire the wrong spot.



**Figure 11-4. Laser Spillover.**

- *Blocked*. If the seeker is not in the proper position, laser energy reflections from the target can be blocked from the seeker by intervening objects or by the target itself (see figure 11-5).

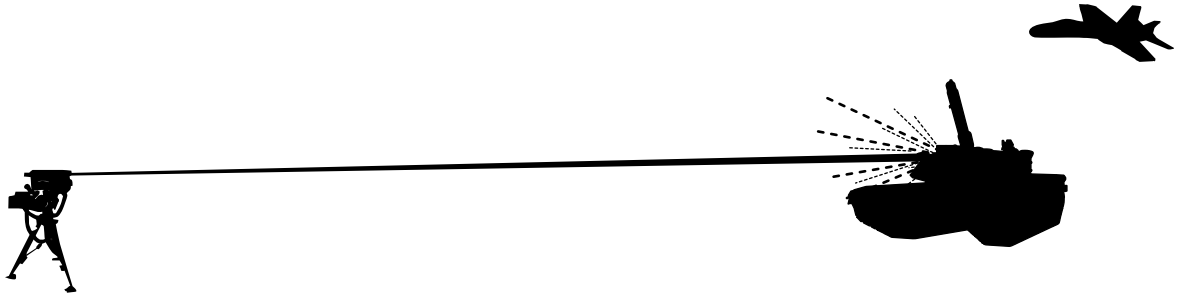


**Figure 11-5. Blocked Reflection.**

- *Absorbed*. Aiming the designator into tunnels and other targets causes laser energy to be absorbed. To avoid this, the operator must aim the designator slightly above a tunnel opening. This will allow a munition to impact at that critical point. For munitions like laser-guided bombs that tend to impact short of the point being designated, this type of designation could guide the bomb into the tunnel opening (see figure 11-6).

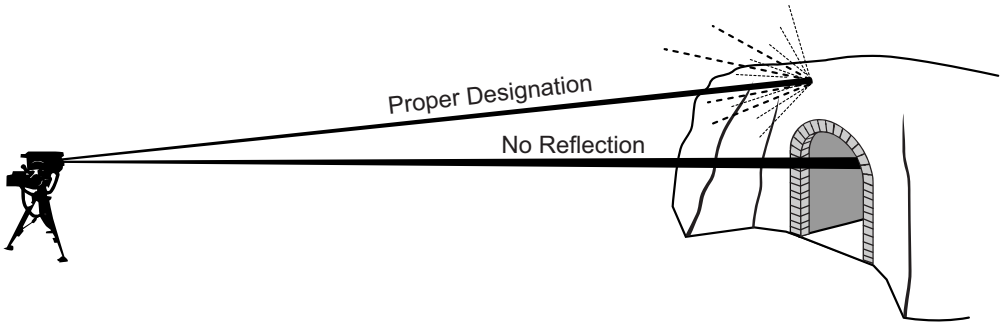



**Figure 11-6. Absorbed Laser Energy on Concave Targets.**

## LASER-GUIDED MUNITIONS PLANNING

### Laser Designator Planning Factors

Based on the commander's guidance, the observer must consider the following factors when employing a laser designator:

- Environmental conditions.
- Designator location relative to the target and delivery system.
- Laser designator aiming points.
- Communications.
- Mobility.

### Mission Execution Employment Factors

In addition to the five basic requirements, the observer must also consider the following key factors when employing laser-guided munitions:

- *Enemy countermeasures*. Judicious use of laser target designators will limit the enemy's countermeasures capability.
- *Battlespace obscuration*. The effects of smoke, dust, and debris can impair the use of laser-guided munitions. The reflective scattering of laser light by smoke particles may present false targets. The operator can use a night sight, alternate positions on higher ground, and alternate designators to reduce smoke effects.
- *Terrain and vegetation*. Irregular terrain and vegetation will affect line of sight.
- *Weather factors*. Types of weather factors are as follows:
  - Extreme temperatures (e.g., below 32 degrees) can affect the laser designator battery life and may require the use of an external power adapter. Placing the battery close to the body under heavy clothing will help to preserve its life.
  - Rain, snow, fog, and low clouds can prevent the effective use of laser-guided munitions. Heavy precipitation can limit the use of laser designators by affecting line of sight.

  - Snow on the ground can produce a negative effect on the accuracy of laser-guided munitions.
  - Fog and low clouds will block the laser-guided munition seeker's field of view, reducing the guidance time and hit probability.
- *Darkness*. Targets are more difficult to locate, range, and designate during periods of poor visibility.
- *Target shape*. Poorly defined targets, such as caves and tunnels, may absorb the laser spots.
- *Seeker and laser designator alignment*. The direction of attack and/or GTL must be within the allowable mission attack angle. Laser-guided or air-launched munitions should attack the target within 60 degrees (i.e., 1,100 mils) to either side of the designator target azimuth. Some munitions may require a smaller angle. The closer the weapon approach angle is to the designator target azimuth, provided it is at least 10 degrees (i.e., 180 mils), the greater the probability of target acquisition and hit.
- *Communications*. Positive communications between the terminal controller and observer and the delivery aircraft and unit are required to coordinate the proper PRF code, seeker or laser designator alignment, and target designation timing.
- *Safety*. The invisible laser beam is intense IR radiation, which can cause serious eye damage and blindness. During peacetime, the use of laser-guided munitions imposes strict safety requirements during training exercises. Operators must adhere to range and unit safety SOPs when employing laser-guided munitions. During combat, the operator must attempt to avoid friendly casualties that may be caused by indiscriminate laser designation. Caution should also be taken when designating reflective surfaces, which can cause dangerous reflected beams. The use of binoculars and similar optical devices during airborne or ground lasing greatly increases the possibility of eye damage. Ground troops located in the target area should use safety goggles when working with aircraft that can laser designate targets. The terminal controllers must be aware of where friendly front lines are located when planning the attack heading for aircraft ordnance delivery.

### Seeker Lock-on to Designator

Laser seekers may occasionally lock on to the designator instead of the target. For example, intervening grass or leaves could reflect sufficient laser energy to cause seeker lock-on. To prevent seeker lock-on to the designator position, the designator should be masked from the seeker's field of view by terrain, vegetation, or a temporary screen, such as blankets or tarps. When the seeker's progress indicates a seeker lock-on to the designator, it may be possible to prevent a mishap by aborting the aircraft's bombing run or by turning off the designator.

### Pulse Repetition Frequency Codes

Laser coding permits the simultaneous use of multiple laser designators and laser-guided seekers or weapons. Laser designators and seekers use a PRF coding system to ensure that a specific seeker and designator combination works in harmony. By setting the same code in both the designator and the seeker, the seeker will track only the target that is designated with that code.

***Code Description***. Dependent on the type of laser equipment, the system uses either a three- or four-digit PRF code. Three-digit settings range from 111 to 788, and four-digit settings range from 1111 to 1788. All three- and four-digit designators or seekers are compatible. When

employing three- and four-digit designators or seekers, the first digit of the four-digit code must always be set to one. The remaining digits of the two systems must match. For example, a four-digit code of 1657 would be compatible with a three-digit code of 657.

***Code Allocation and Assignment***. Laser-guided weapons system codes are controlled and coordinated. At the MAGTF level, different blocks of codes are assigned to artillery, air, and NSFS to prevent interference between supporting arms activities. Each supporting arm then assigns codes to its subordinate units for individual missions and changes codes periodically as required by the situation. Subordinate FSCCs provide positive coordination of the code settings through the various fire support representatives. For individual missions, the munition delivery system (i.e., artillery, ships, and aircraft) employs the codes. For CAS, codes are ultimately assigned to each flight so that no two flights are in the air at the same time with the same code. When an aircraft is on station, the pilot passes the code to the terminal controller. The terminal controller then coordinates with the laser designator operator to ensure that the designator is set to the same code as the aircraft. Individual aircraft may carry LGWs with different preset codes to accommodate multiple aircraft attacks or multiple weapon releases or to allow variation in codes used on consecutive attacks.

***Security***. The PRF codes are handled in the same manner as other classified material. Secure means should be used, if available, when the codes are passed between laser designators and the munition delivery unit or aircraft. However, the absence of compatible security means should not normally dictate the termination of a laser-guided munition attack. In certain situations, codes will be prebriefed.

### Effect on Mission

Laser-guided munitions can be employed against high-priority targets early in the battle before smoke and dust obscure the battlespace. Targets downwind can be attacked first if priorities permit. Use of preplanned aiming points and laser-guided munition footprints can help to overcome effects of obscuration, weather, vegetation, and terrain. Use of a night sight on the designator will help to overcome the effects of darkness and can assist during periods of poor visibility and inclement weather. The adverse effects of the mission execution and employment factors can often be overcome by skillful employment of the designators. Enemy countermeasures can be minimized by aiming the laser designator at an object near the target instead of directly on target (i.e., offset designation).

## METHODS OF EMPLOYMENT

Laser-guided munitions are employed in the ground and airborne modes.

### Ground Mode

Ground laser designators identify targets for artillery, NSFS, and aircraft-delivered munitions. Standard calls for fire are used, but the laser code must be exchanged between the ground designator and the firing unit or aircraft.

### Airborne Mode

Airborne laser designators identify targets for artillery, NSFS, and aircraft-delivered munitions. Airborne designator systems operating in support of ground maneuver forces have the ability to employ all types of laser-guided munitions. Standard calls for fire or requests for air support are used. The code being used must be exchanged.

## EMPLOYMENT CONSIDERATIONS

Operator employment considerations include the designator aiming point, spot tracking techniques, and designator operator positioning.

### Designator Aiming Point Considerations

The range, size, shape, reflectivity characteristics, location, and motion of a target all have an influence on the technique of employing a laser designator. When lasing a target by using a night sight device, the operator must be trained to use the device properly. For example, the operator should know that the IR signature of a target will be at the highest concentration of heat. In the case of a moving vehicle, this heat concentration will be slightly behind the designated lasing point of the target.

Typically, a flat surface is the most favorable surface for designation because it is perpendicular to the direction of the incoming ordnance. If there is not a flat surface, then a curved or irregular surface facing the direction of the incoming ordnance should be a satisfactory aiming point.

### Spot Tracking Techniques

The distance from the laser to the target determines the size of the laser spot. The following techniques should be used to optimize spot tracking and weapon guidance:

- *Target and laser spot size*. If the target is larger in size than the laser spot, a point on the target should be selected to place the spot. The point selected should optimize conditions for spot tracking and weapon guidance. The direction from which the attack will be made, the shape, angular relationship, and reflectivity of the target surface, must be considered. In situations where the laser spot is quite small, the laser must not be aimed into an opening because the opening will absorb the reflected energy.
- *Target masking or obscurity*. If the operator suspects that the target may be partially masked from the view of the incoming seeker, he should aim the laser at a point on the target that will be within the seeker's line of sight. In situations where the target is concealed, it may be necessary to aim the laser spot at an overhead or nearby object. For example, when designating a vehicle under a tree, the laser spot can be positioned in the foliage overhead.
- *Target movement*. In tracking a moving target, the operator may need to designate a point near the target, and wait until the target moves into the designated spot. If the target moves out of sight during lasing, the laser spot may be shifted to another target in the vicinity. If the laser spot tracker or laser-guided ordnance has already locked on, the spot should be moved slowly to the new location. Moving the spot too quickly could interrupt the laser output.

- *Observer survivability*. For observer survivability, designation time should be minimized to reduce the time available for the enemy to detect, locate, and suppress the designator. The operator may lase a spot a designated distance away from the target and walk the spot to the target for the terminal portion of the attack (i.e., offset designation). It minimizes laser on-target time and requires that the operator be advised of the progress of the attack to ensure that the spot is on the target at the proper time. The operator must not move the spot through any location that is masked from view by the attacking aircraft or guided ordnance.
- *Power sources*. Designation time should be minimized to conserve battery life. The life span of recharged batteries is variable and often short. A fresh battery should be installed when preparing to designate targets.

> ***Note:*** Even under vehicular power, it is possible to damage laser components by continuous lasing. The duration of continuous designation should not exceed one minute.

### Designator Operator Positioning Considerations

The laser operator selects a position based on line of sight, cover and concealment, maximum coverage of operations, and communications requirements. Next, the laser operator determines the standoff distance. Standoff distance must be properly used when observing enemy avenues of approach and chokepoints. The vulnerability of the designators must be considered when designating point targets (e.g., tanks, guns). Although standoff may increase survivability of the designator, the operator must be aware that the beam divergence at long standoff ranges could preclude effective point-target designation. The operator should select positions that are near expected locations of high-priority targets while minimizing risks to friendly forces. The sites must be coordinated with the positioning of other antiarmor weapons, such as the TOW [tube-launched, optically tracked, wire-command link guided missile] and Dragon. All antiarmor weapons must be deployed to ensure mutual support and coordination.

## SURVEY CONTROL

The ideal source for all survey information, used to provide observers with accurate grid location and direction, is the supporting artillery battalion sensor section. The self-location procedures are based primarily on using known points or the observer's own directional control. If a known point is a burst or located by map spot, or if direction is obtained by compass, errors exist and will be passed on to the observer's grid and direction. If the elements of survey (i.e., grid location, direction, and elevation) are not available, laser designators and range finders can be used in conjunction with the pocket-sized forward entry device, StrikeLink, or AFATDS. The same procedures can be used during position improvement to improve firing accuracy or extend accuracy into the target area.

### Self-Location

The procedures for self-location use different elements of survey to orient the observer. Self-location can also be employed during position improvement to improve target location accuracy. Once established, these accuracies can be passed to other observers in the area of operations. The different procedures have different requirements and provide different elements of survey.

> ***Note:*** Both the StrikeLink and AFATDS can perform computations.

***Trilateration***. Trilateration requires the distances and vertical angles to 2 known points that are at least 300 mils apart and accurately located. Trilateration provides grid location and direction to the observer. It can be performed with a CLRF. The observer self-locates by determining accurate distances to two known points. The observer can report these distances to the FDC or enter them into the StrikeLink to compute location. The observer always specifies the point on the observer's left (i.e., lase and announce first).

**Example: Self-location by using trilateration**

Observer: *A16 this is A23, perform trilateration, known points 1 and 2.*

FDC: Reads back.

Observer: *Known point 2 on left: distance 3180, vertical angle +10. Known point 1: distance 1230, vertical angle -10.*

FDC: Reads back.

FDC: *Grid 45867 32339, altitude 422. Direction to known point 2:3095 mils.*

Observer: Reads back.

***Triangulation***. Triangulation requires directions to 2 known points that should be at least 300 mils apart and provides a grid location without the altitude. If vertical angle is included in the data, the determined altitude must be verified by at least a map spot. In this case, the observer sends the directions and vertical angles (optional) for two known points to the FDC or enters them into a pocket-sized forward entry device. The FDC determines the observer location and provides an altitude (see figure 11-7).

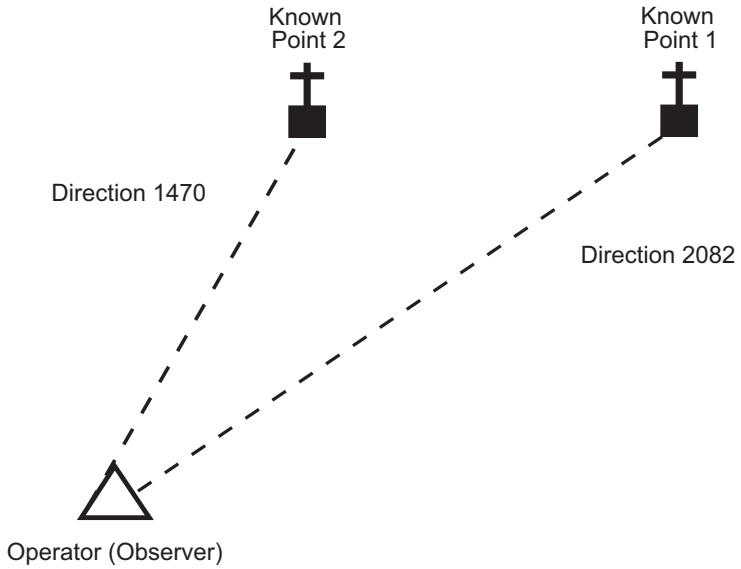



**Figure 11-7. Self-Location by Using Triangulation.**

***Resection***. Resection requires the direction, distance, and vertical angle to one known point. A back azimuth is determined from the polar information to provide a grid location to the observer.

Because the observer is only using one point, there must be accurate directional control and common survey with the FDC for the known point. If not, the errors will be translated into location errors (see figure 11-8).

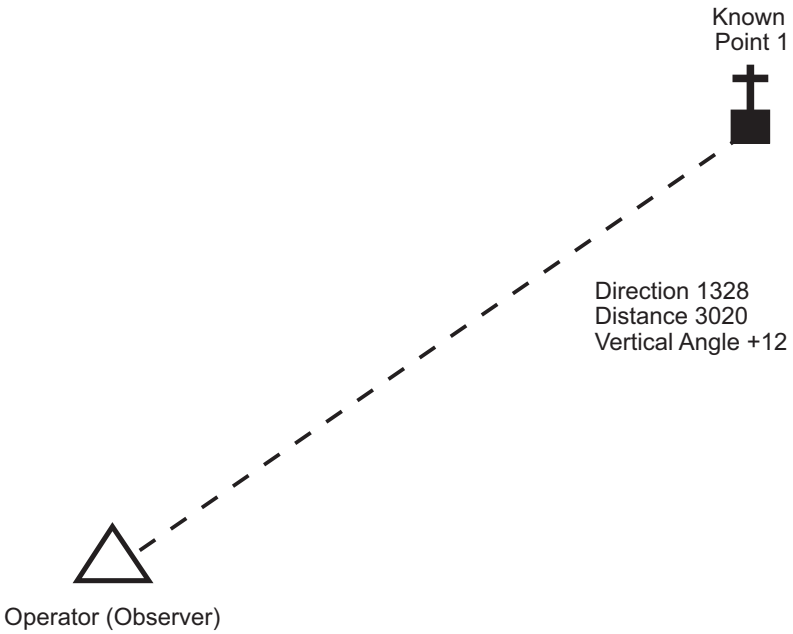



**Figure 11-8. Self-Location by Using Resection.**

***Using One Known Point and One Burst***. If only one known point is available, the second prearranged point may be established by a planned burst of an HE or WP round. The natural dispersion in terms of PER and deflection for the projectile will transfer survey errors to the observer's location. The operator should plan the location of the burst so that it is separated from the known point by at least 300 mils. Graze bursts should be used. By using the laser, the operator ranges the known point and the burst to determine the required direction, distance, or vertical angle for each of the two points and reports these points to the FDC. The FDC computes the laser location and corrected azimuth to the known point and sends the information to the operator. The accuracy of the computed laser location and reference azimuth are affected by the accuracy of the firing data and must include accurate altitude to the burst point. The FDC should use the most accurate data available.

***Using Known Points***. There will be times when an observer will have no pre-established known points and no readily identifiable terrain feature that can be measured from a map. A second observer with an accurately located and oriented laser designator can use it to establish known points for the other observer. To accomplish this, both observers must be able to see a common area well enough to identify and locate objects to serve as known points for self-location. The observed angle from the observer being located to the two points being measured must be greater than 300 mils. Once mutual points have been identified and agreed upon, known points can be as outlined in the example below. See figure 11-9.

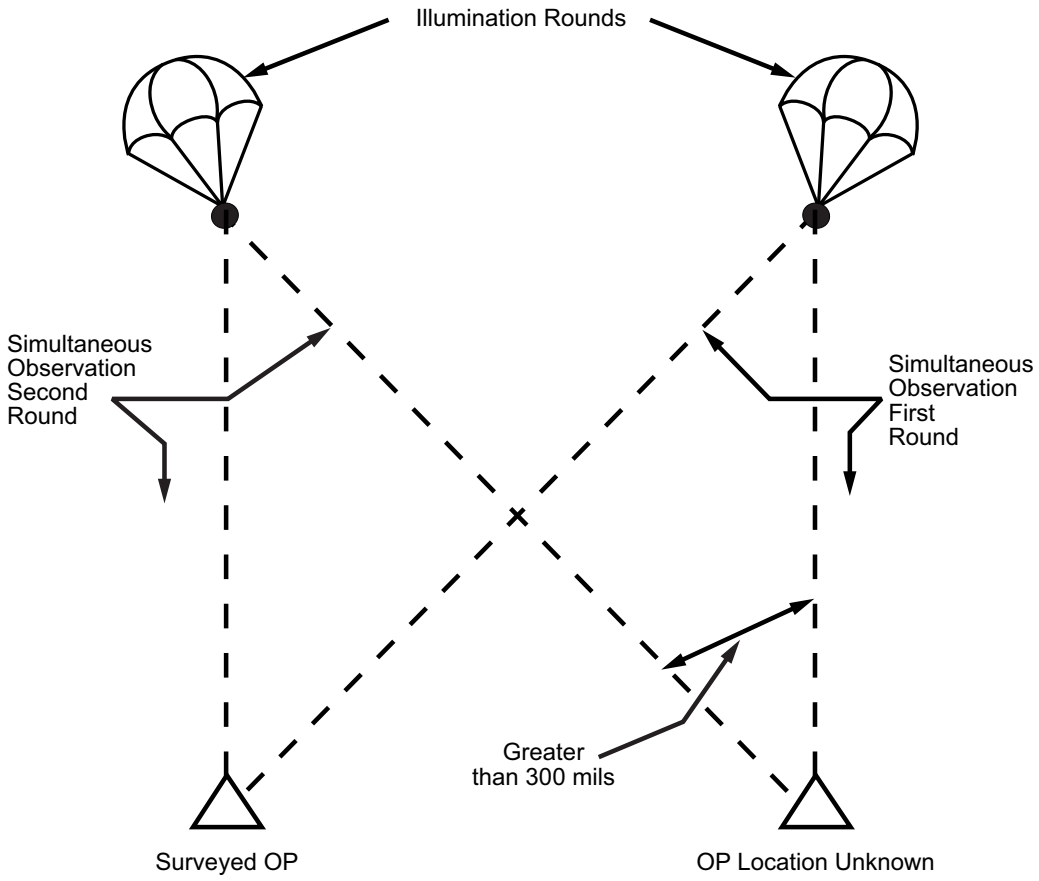



**Figure 11-9. Locating Second Observation Point by Simultaneous Observation.**

### Second Observer Assistance

An observer who has been accurately located and oriented through either survey or self-location can assist other observers with self-location. The second laser operator can establish known points for another operator to use in self-location or can perform a simultaneous observation with the other laser operator on two illumination rounds. To coordinate assistance, the FDC(s) can refer observers requiring self-location to observers with survey control.

### Observer Actions After Being Located

As soon as the observer has obtained an accurate location, it should be recorded on the map. If provided with direction, the azimuth should be adjusted to the reference point. The polar plot should then be determined to several prominent points surrounding the position for future use (see figure 11-10). The StrikeLink or AFATDS can determine the grids to these points for the observer, who can then establish them as known points. The laser can also assist the observer in preparing a visibility diagram by ranging objects along selected azimuths. Defilade areas can then be marked on the map. Once the observer's position is known to the FDC and accurate directional control has been established, the observer can fire for effect on targets from that location. This assumes that the firing unit FDC is firing accurately (see figure 11-10).

**Example: Establishing known points**

**Example 1**

FDC: *A47, this is A16, establish known points for A23, over.*

Observer: *Known point 4: tower at grid 45627 78953, direction 0832, distance 5740, vertical angle minus 9. Known point 5: burned tank at grid 45752 74452, direction 0947, distance 6370, vertical angle minus 11, over.*

With two known points established, the observer can now perform self-location techniques. Any error in the oriented observer's survey will be transferred to the obtaining observer's survey.

**Example 2**

Observer: *A16 this is A47, simultaneous observation with A23, over.*

*1 round, grid 391 516, one round, grid 374 522, over.*

*Illumination by round, at my command, over.*

Second observer: *A47 this is A23, ready to observe, over.*

FDC: *A47 this is A16, ready, over.*

Observer: *A16 this is A47, fire, over.*

As the illumination round descends, the observer coordinates simultaneous lasing on the flare and begins tracking the descending flare. The observer instructs the radio operator to transmit *tracking, tracking, tracking . . . lase*. Once the command lase is given, both observers lase/range the flare's parachute simultaneously, record the data, then repeat the process with the second illumination round. The observers must use their judgment to determine whether they have received an accurate return from the flare's parachute. If one of the observers feels that there is an inaccurate return, the tracking phase should be immediately repeated before any data is sent to the FDC. The controlling observer sends data to the FDC either as polar data or a converted grid. The FDC establishes the data as grid locations. The obtaining observer then sends data to the FDC by using one of the self-location techniques or a digital message system once the grid locations from the controlling observer's data are known.

Observer: *A16 this is A47. Point 1: direction 6377, distance 4120, vertical angle plus 23, over.*

*Point 2: direction 6205, distance 2090, vertical angle plus 45, over.*

Second observer: *A16 this is A23, conduct triangulation, points 1 and 2, over.*

Point 1: *direction 4095. Point 2: direction 4835, over.*

FDC: *A23 this is A16, location 3751 4832, over.*

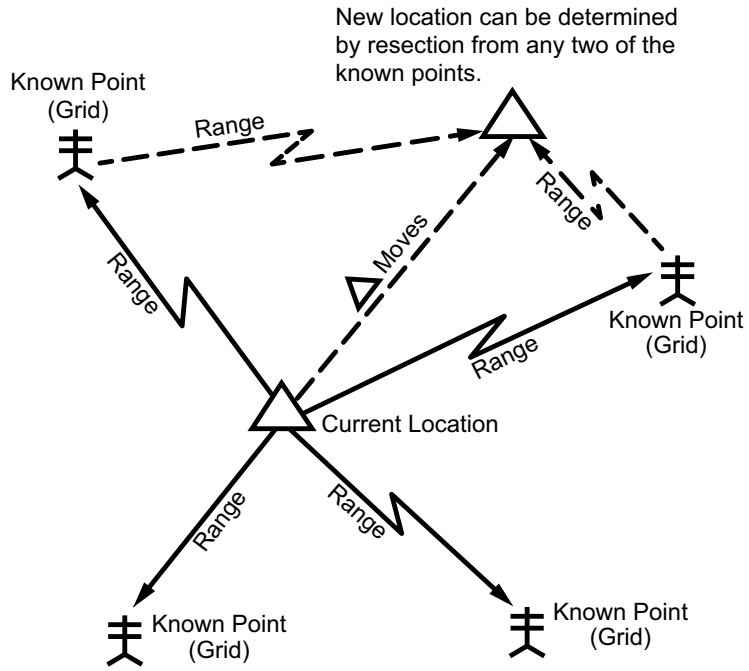



**Figure 11-10. Using a Laser to Determine Known Points and New Location.**

## LASER POLAR MISSIONS

An accurately located and oriented azimuth-determining device and laser range finding capability provide an accurate target location for first-round fire for effect missions. However, some of the requirements for accurate first-round fire for effect may be lacking at the firing unit. If the observer is not sure that first-round fire for effect can be achieved on the target, fire should be adjusted by using laser polar data.

### Fire Direction Center Computed Shift

The following occurs when performing an FDC-computed shift:

Step 1. The operator sends the laser polar plot data of the burst, which is equivalent to a spotting, to the FDC.

Step 2. The FDC computes the shift, which is equivalent to a correction.

Step 3. The observer's data is transmitted as direction, distance, and vertical angle or is converted to grid coordinates. If the burst dissipates before it can be lased, the observer transmits *lost burst* to the FDC.

**Example: Computed shift**

*Burst direction 5872, distance 4350, vertical angle minus 11, fire for effect, over.*

### Observer Computed Shift

If the supporting FDC is not automated, then the observer can compute a subsequent correction or have the FDC process it manually (see table 11-2).

**Example: Calculation of shift by observer**

*H24 this is H58; new target, direction 0220, distance 3680, vertical angle plus 2, over.*

*Battalion assembly area, ICM in effect, over.*

## TARGET SHIFTS

Laser polar missions have the capability to conduct large shifts that are similar to an NSFS fresh target. If a new target is located, or a shift from an auxiliary adjusting point is employed, the observer prevents the FDC from applying the new location as a correction to the previous round by announcing *new target*. If this is not announced, the FDC will apply the difference between the previous burst and new location in the opposite direction.

## COMMON LASER RANGE FINDER EMPLOYMENT

The CLRF is a lightweight, hand-held laser range finder that can determine the range, azimuth, and vertical angle of a target quickly and accurately. The device emits a laser burst and detects its return when the burst is reflected from a distant object. The time lapse between the emission of the beam and its return is converted to meters and displayed in the left side of the eye piece. The internal magnetic compass determines the azimuth and vertical angle to the target and is displayed in the right side of the eye piece. When accurately aimed, the CLRF provides a range that is accurate to within 5 meters of the target, an azimuth that is accurate to within 10 mils, and a vertical angle accurate to within 3 mils. However, clutter in front of or behind the target may cause false readings in the CLRF. To ensure accurate data, the observer should associate the displayed range with a terrain map analysis and the observer's own range estimate to decide whether the reading is accurate. When all of these figures do not correlate, the observer should consider the information addressed in the following subparagraphs.

**Table 11-2. Calculation of Shift by Observer.**

| Procedure | Example |
|---|---|
| Compute the OB distance factor and express it to the nearest 1,000 meters | OB distance 3480<br>OB factor 3 |
| Determine the deviation shift by multiplying the angular deviation by the OB factor | 25 x 3 = 75 (left 80) |
| Determine the range shift: OT range–OB range, and express it to the nearest 10 meters | Distance to target - 3680<br>Distance to burst - 3480<br>Difference 200 |
| Compute a vertical shift if it exceeds 30 meters<br>Determine the vertical angle difference between the burst and the target, multiply by the OB factor, and express it to the nearest 10 meters | Vertical angle to target +2<br>Vertical angle to burst (-) -1<br>Vertical angle difference +3<br>3 x 3 = 9 meters (10 meters) |
| **LEGEND**<br>OB observer-burst<br>Note: The observer's correction would be stated as *left 80, add 200, fire for effect, over*. | |

### Multiple Firings

Three consistent CLRF readings indicate that the observer has aimed in the same place each time.

### Minimum Range Set or Multiple Range Measurements

Although the emitted laser beam is relatively narrow, it is wide enough to reflect from more than one target or object. To mitigate the effects of a cluttered battlefield, the operator can set a minimum range for the CLRF to read or set the CLRF on multiple range readings.

To prevent false readings from an intermediate object between the observer and the target, the CLRF is equipped with a minimum range set. The range set indicates the range within which the CLRF will not register a return. This option eliminates receiving false readings from intermediate objects and enables the operator to lase through chain-link fences, tall grass, or at objects partially obscured by an object (e.g., buildings).

### Declination Constant Set

The CLRF uses an internal magnetic compass to determine its azimuth measurements to a target. This allows the operator to set a declination constant that can be stored so that subsequent readings from the magnetic compass will be displayed in mils grid. Declination constants can be either positive or negative and are set to the nearest mil.

### Target Location

The distance and azimuth provided by the CLRF should always be checked with a quick, but thorough, map analysis. The observer should remember that the CLRF is designed to help refine direction and distance. Therefore, the direction and distance determined by the device should always be correlated with known information before target location is produced.

***Distance Measurement***. The CLRF provides slant range to a target. This means that if the observer is on a significantly higher piece of terrain than the target, the range displayed is for the straight line from the observer to the target, not the distance horizontally along the ground. To compensate for this, the CLRF has additional capabilities to display not only range, but also the vertical difference in height between two objects.

*Horizontal and Height Difference*. The CLRF displays both horizontal distance and the height difference between the observer and the target simultaneously, which allows the observer to compensate for vertical shifts that are 35 meters or greater, if necessary.

*Distance Between Two Objects*. The CLRF also displays the distance between two objects, which allows the observer to measure a 2D [two-dimensional] object. The observer simply lases the start and endpoints of the target or area and the reading displayed is the distance between the two objects. This allows the observer to determine the size of a target and if a different distribution (i.e., sheaf) is necessary to cover the target area properly. This can also be useful in determining trigger distances for moving targets. The observer must be aware that this distance measurement is a straight line distance and does not compensate for curves in a road or other irregularities.

*Horizontal and Vertical Measurement*. The CLRF measures the horizontal and vertical measurement of an object, which allows the observer to measure the dimensions of a 3D object, such as a building or vehicle. The observer lases one corner of the object and moves up diagonally to the opposite corner. The readout displays the height and width of the object.

***Azimuth and Inclination Measurement***. In addition to acting as a laser range finder, the CLRF also has the ability to provide azimuth and inclination measurements, often referred to as direction and vertical angle. The CLRF has a digital compass that works similarly to a magnetic compass. Metal objects and magnetic fields can cause errors in directional readings. Factors influencing azimuth accuracy include minimum safe distances from objects: 55 meters from power lines; 10 meters from tanks or vehicles; 2 meters from crew-served weapons; and 0.5 meters from rifles, knives, watches, and steel helmets. In addition, nonmagnetic batteries should always be used, and the compass should be recalibrated after every battery change to ensure accuracy.

*Azimuth*. Azimuth measurements are accomplished by use of the azimuth button and can be displayed in degrees, mils, and gons. The digital compass may be declinated by inputting the declination constant for that grid zone. This allows the CLRF to display readings in grid north versus magnetic north.

*Azimuth and Inclinations*. Combined azimuth and inclination measurements display both the direction (i.e., grid or magnetic) and the vertical angle to the object being measured. This data is displayed simultaneously in the CLRF display. When both direction and vertical angle are displayed, distance cannot be displayed. If an observer is conducting a laser polar mission, once a distance measurement has been obtained, another separate measurement for direction and vertical angle will need to be taken, or vice versa.

***Defense Advanced Global Positioning System Receiver***. Each CLRF comes with a DAGR. In addition to its intended use as a GPS receiver, this DAGR has +96 Software loaded onto it. This allows it to compute a 10-digit grid and elevation to the target lased by the observer. The DAGR

must be configured to communicate with the CLRF via its configuration menu before operation can begin. Once the CLRF is configured and the DAGR is set up properly, the two are connected by a cable. When the CLRF lases a target (ideally from a tripod or other stable platform) the DAGR automatically computes and displays a 10-digit grid and elevation to that target. Further display screens will also display the laser polar data (i.e., direction, distance, and vertical angle) originally lased by the CLRF. This data can be saved as a planned target in the DAGR. A total of 100 planned targets can be recalled and referenced.

> ***Note:*** When connected together, ensure CLRF declination is set to zero and DAGR set to grid north to have correct declination output readings during operations.

### Adjustment of Fire

Lateral and vertical shifts in the adjustment of fire are computed by using the mil-relation formula. Deviation adjustments are made by using the difference between the azimuths to the burst and target and applying the mil-relation formula, making the correction in the appropriate direction. Range adjustments are made by using the difference in range between the target and the burst, making the correction in the appropriate direction.

# APPENDIX A
# OBSERVATION POST

An OP is a position from which military observations are made or from which fire is directed and adjusted. An OP may be airborne. The selection of an OP is critical to the survivability and the ability of the observer or spotter to effectively call for and adjust fire.

### Observation Post Selection

A good OP must permit observation of the area of operation of the supported unit. The observer must select an OP with other observers' OPs and maneuver OPs in mind so as to prevent and/or minimize gaps or dead spaces. Visibility diagrams should be constructed as time permits. An OP should:

- Prevent identification by aerial observers or in aerial photographs by loose dirt, wire lines, paths and approaches to the position, and communications (e.g., excessive radio traffic, detection of antennas).
- Accommodate the establishment and maintenance of communications.
- Facilitate the adjustment of fire when practical (e.g., angle T).
- Enhance survivability through concealment. Concealment is the only protection available in the early stages of occupation. As time permits, the observer should improve the OP.
- Have routes of entry and exit without arousing the suspicion of the enemy. The edges of woods and villages can be used as entries and exits.
- Make use of elevation provided by crests or trees.
- Avoid landmarks and prominent terrain features because these may be targeted.

When selecting an OP, the observer must consider the characteristics of the forward slope versus those of the reverse slope:

- Forward slope position:
  - Should afford a better view of the front and flanks.
  - Cannot be neutralized by fires impacting on the topographical crest.
  - Should aid in concealment because the hillside provides background.
  - Should not be easily approached during daylight.
  - Should have radio communications, but it may be necessary to remote antennas to the reverse slope to avoid exposure.
  - Does not provide cover from direct fire.
- Reverse slope position:
  - Allows greater freedom of movement.
  - Facilitates installation, maintenance, and concealment of communications equipment.

- Affords protection from direct fire.
- Affords only a limited field of view to the front.
- Causes the OP to be neutralized when enemy fire is adjusted on the topographical crest.

### Observation Post Preparation

The preparation and improvement of the OP must allow sufficient space for the observer, team, and equipment (e.g., the laser designator). If the OP is on the ground—

- A trench is usually the first means of protection, but it may be improved by emplacing a cover of logs and earth.
- It may be fortified with sandbags as time permits.
- It may be concealed by using both the natural cover afforded by the ground and camouflage. The observer must remove the signs of fresh digging. Special precautions must be taken to camouflage the cover and openings.

Figure A-1, figure A-2, and figure A-3 provide illustrations of improved OPs.

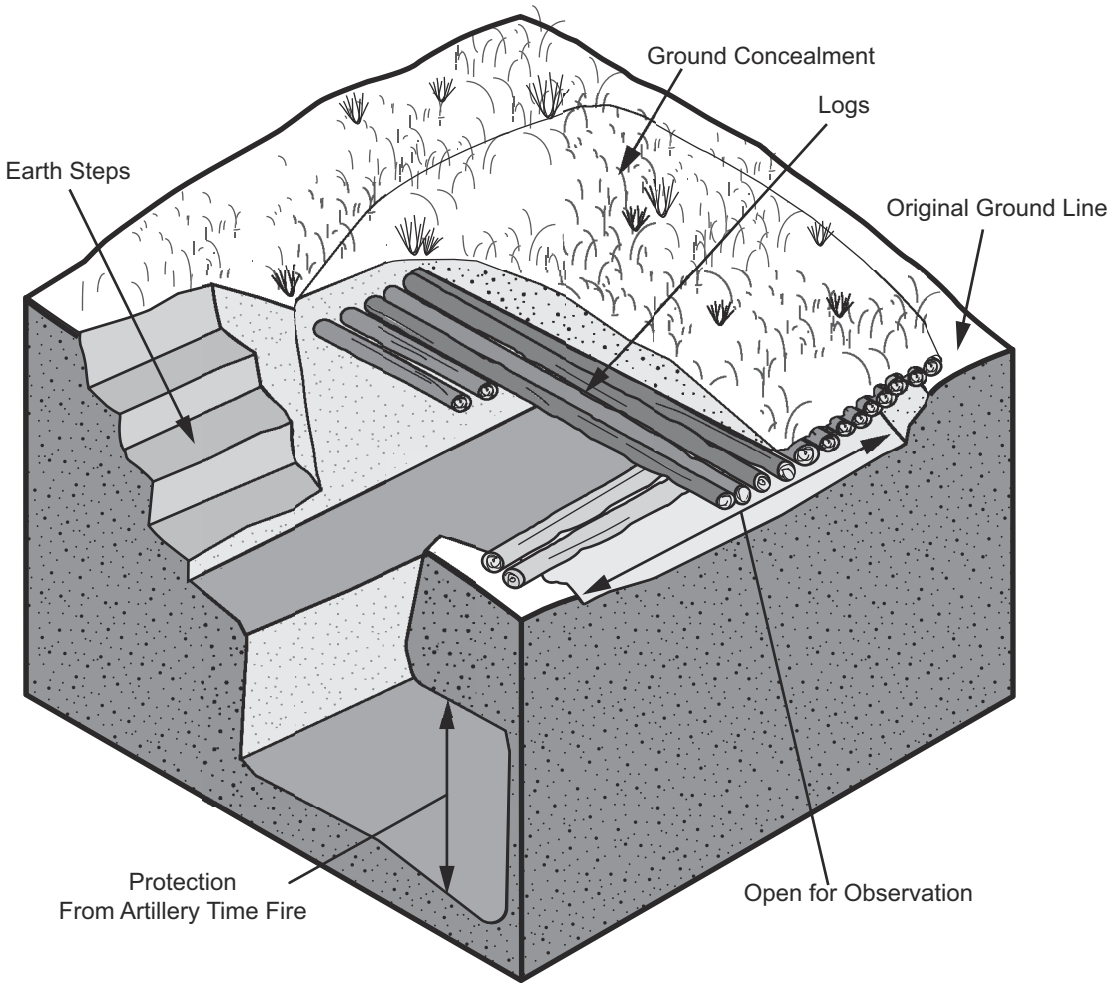



**Figure A-1. Observation Post With Cover.**

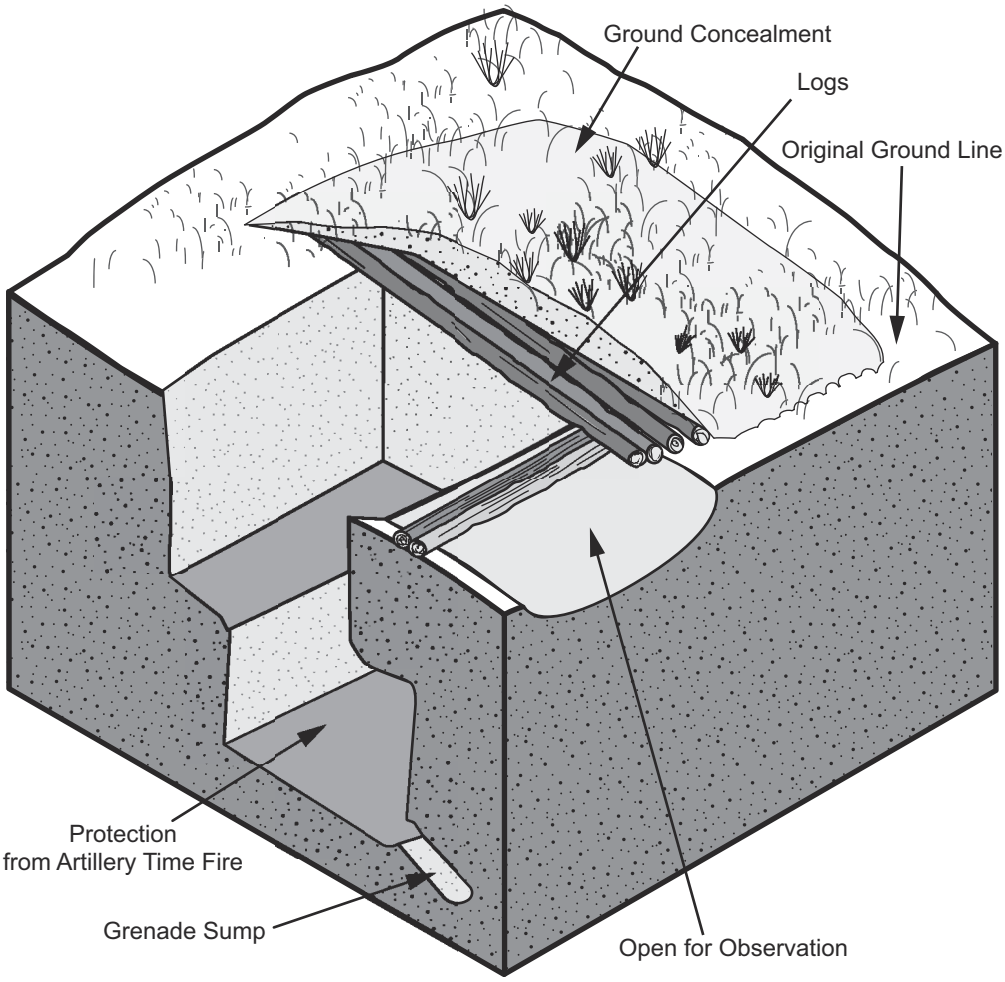



**Figure A-2. Observation Post Using One-Person Fighting Holes.**

### Tactical Occupation of an Observation Post

When conducting a deliberate occupation of an OP, the observer's defensive posture may become permanent and allow the use of many procedures that would normally be omitted during offensive operations. Many of the procedures used are time intensive techniques that are only possible during static operations, such as establishing a deliberate OP. If static operations exist, the observer should focus on security, location, communications, targeting, observation, and position improvement (SLoCTOP).

***Security***. A security patrol covering a 6400-mil area with a 500-meter radius should be established around the surrounding area before occupying the OP. The patrol should consist of one portion of the C-FST that is task-oriented, with the remainder of the team remaining in a holding position to monitor radio nets. The observers must ensure that they do not silhouette themselves during the patrol. They should exercise camouflage, noise, and light discipline during all phases of the OP occupation.

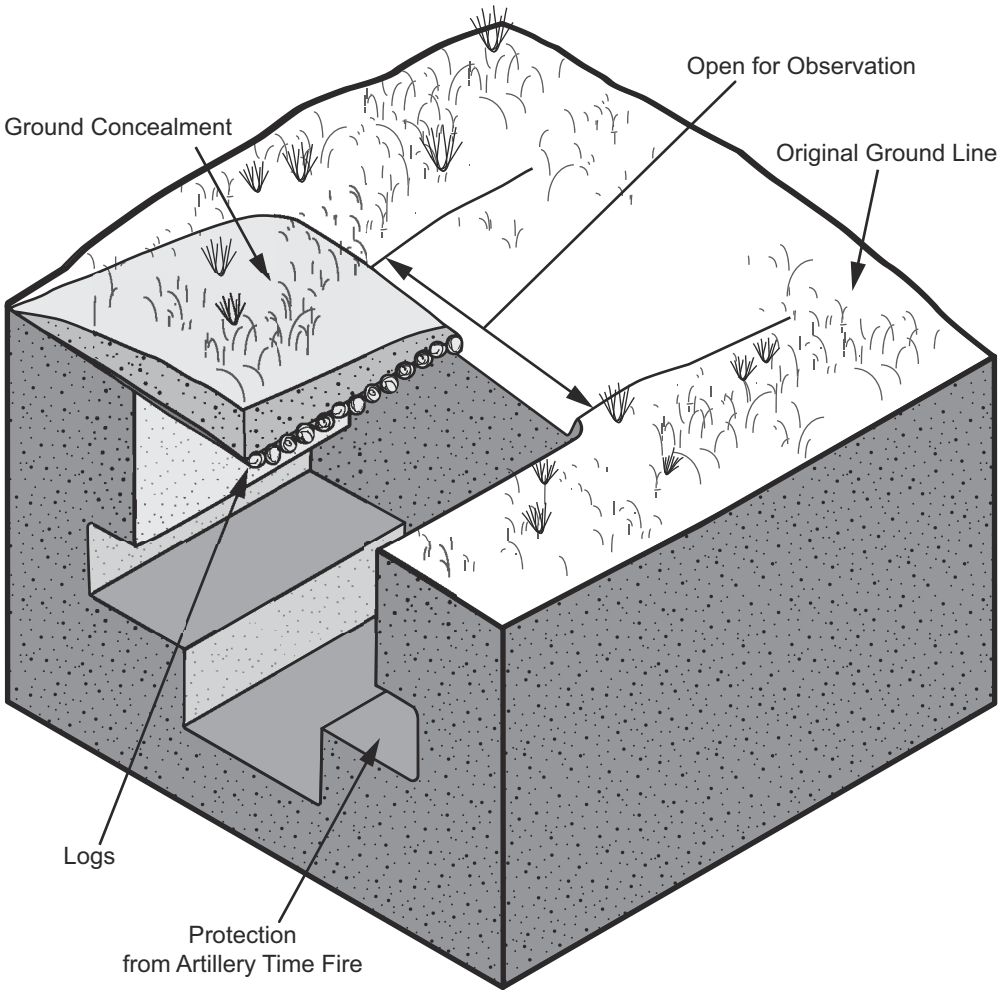



**Figure A-3. Observation Post Using a Two-Person Fighting Hole.**

***Location***. The observer should be finalizing the exact observation site while the security patrol is being conducted. The degree of accuracy for self-location is 100 meters. The position should not be skylined or easily identifiable as an OP (e.g., topographical crest, 2/3 up, on nondescript high ground). The location should offer sufficient observation into the enemy operational area or likely enemy avenues of approach. The observer should prepare an OF fan for use, begin a terrain sketch by using reference points that are easily identifiable, and develop a visibility diagram in accordance with appendix B of this publication. Additionally, the observer should ensure that the current situation map is accurate and contains all current friendly units, known or suspected enemy positions, and graphical control measures.

***Communications***. Communications are the number one priority for the C-FST, as they are the most valuable resource for developing situational awareness during occupation. They must be established with all required stations as early as possible. It is critical for the radio and/or telephone operator to record all information that is transmitted (e.g., other missions, position updates, SALUTE reports) to assist in the smooth transition from a mobile to a static observation posture. If communications cannot be established or if they are distorted, measures must be taken to establish and/or improve the situation (e.g., change location, check batteries, improve antenna).

Because communications are a necessity, the observer should have access to procedures for field-expedient antennas.

> ***Note:*** HHQ at both maneuver and supporting arms agencies must be updated with the most current observer location and other relevant information (e.g., enemy situation).

***Targeting***. The observer should always locate targets by using the most accurate and expedient means available and include these target locations in the terrain sketch. Laser designators should be well concealed. All laser designators and range finders should be operating within safety parameters.

***Observation***. The team members should be proficient in the recognition of friendly and enemy forces. The observer should constantly refine company targets and those assigned by HHQ, identify trigger points and TRPs, review engagement criteria, and ensure that this information is understood by all team members. The observer should ensure that there is a well-implemented plan to sustain 24-hour operations.

***Position Improvement***. The observer should dig-in, including forming a parapet, as time permits. To ensure that the position is sufficiently concealed, it should be viewed from the enemy's point of view. Camouflaging should be continually improved by using items that are organic to the area. Additionally, units should establish SOPs for the conduct of an OP, including a rotation schedule, placement of the latrine, and mess procedures.

Position improvement is continuous. Specific areas for concentration are security, communications, noise and light discipline, camouflage, and weapons and equipment maintenance.

# APPENDIX B
# CONSTRUCTION OF THE VISIBILITY DIAGRAM

The observer constructs the visibility diagram in overlay form and drawn to the map's scale. The completed visibility diagram is formed by the systematic alignment of terrain profiles. A terrain profile is an exaggerated view of a portion of the Earth's surface along a line between two points, such as the line between the OP and point A in figure B-1. The observer can construct a terrain profile from any contour-lined map.

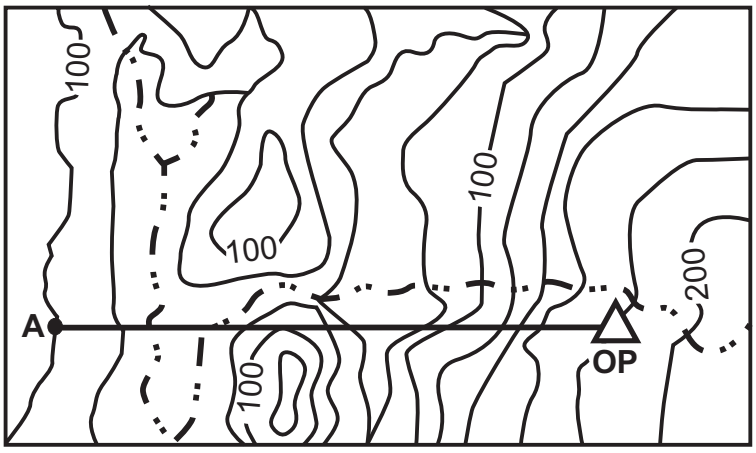



**Figure B-1. Profile (Line OP-A) Constructed on a Contour Map.**

## STEP 1

Draw radial lines from the observer's location:

- Locate and plot own position on the map.
- Construct radial lines from the OP to the limits of the observer's visibility.
  - Each adjacent pair of radial lines should form an angle of no more than 100 mils (see figure B-2).
  - Each radial line from the OP represents a line of vision. The OF fan fulfills this function when placed on the map and oriented.

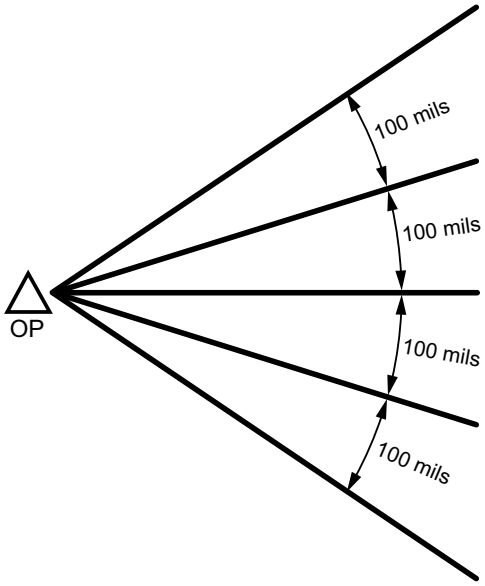



**Figure B-2. Radial Lines of Vision Ranging Out From the Observation Post.**

## STEP 2

Construct the profile. The basic element of the visibility diagram is a terrain profile. Each of the radial lines represents a terrain profile, and each profile must be constructed. The most common way of indicating elevation and relief on a map is by contour lines. A contour line is a line representing an imaginary line on the ground where all points are at the same elevation. Starting at sea level, normally at zero contour, each contour line is the contour interval, and the value of this interval is listed in the marginal data on a map.

Starting at zero elevation, every fifth contour line is drawn so that it is heavier than the other contour lines. The heavier lines are index contours. At some place along each of the index contours, the line is broken and the elevation is listed. The contour lines falling between index contours are called intermediate contours. The elevation of any point is determined by doing the following:

- Determine the contour interval from the map or marginal data.
- Find the numbered contour line nearest to the desired elevation point.
- Determine the direction of slope from the numbered contour line to the desired point.
- Count the number of contour lines that must be crossed to progress from the numbered line to the desired point and noting the direction (i.e., either up or down). The number of lines that are crossed, multiplied by the contour interval, is the distance above or below the starting value.

Along a radial line, determine both the value of the highest and the lowest contour line (see figure B-3) as follows:

- Draw equally spaced horizontal lines on a blank piece of paper so that there will be one line representing each contour value crossed by the profile line from the OP.
- Number each line on the paper by assigning the top line a value equal to one contour interval higher than the highest contour line determined along the radial line.
- Number the remaining lines in a downward sequence, by contour interval, to the bottom line. Assign the bottom line a value of one contour interval lower than the lowest contour line determined.

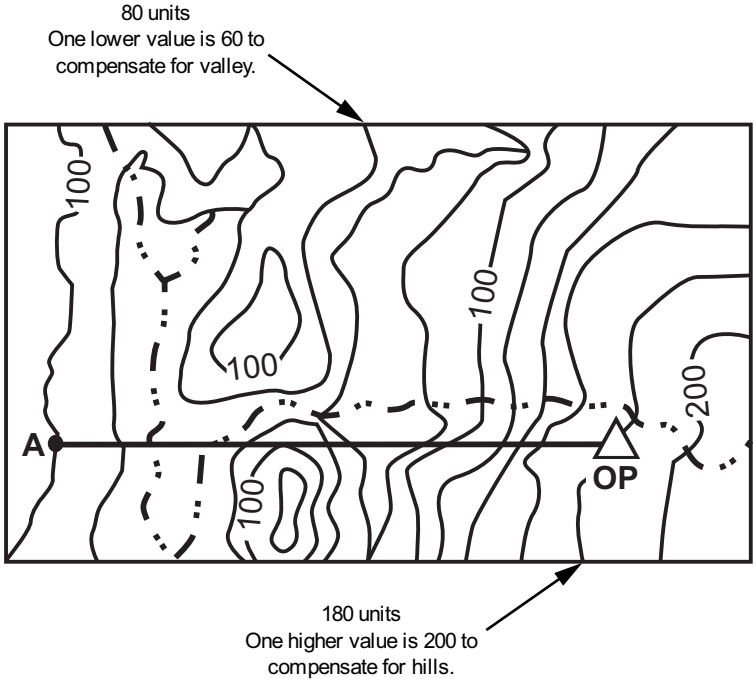



**Figure B-3. Contour Interval.**

- Draw a vertical line from each contour line intersecting the radial line (i.e., profile line). Extend the vertical line to the horizontal line corresponding to the elevation of a contour line.
- Continue this procedure until all contour lines have been connected with their corresponding elevations. The result will appear as a series of perpendicular lines connecting points of a contour line with a horizontal line of a specified elevation.
- Once all vertical lines have been dropped for contour lines, drop the vertical lines from hilltops, ridge tops, streamlines, and valleys (see the broken lines in figure B-4).
- Determine the endpoints of these perpendicular lines by interpolation. If the diagram is being drawn at the OP, make allowances for buildings, new construction, newly grown vegetation, and other changes to the map.
- Connect the endpoints of all perpendicular lines with a smooth, curved line. When the points are connected, the relief of the terrain along the profile line becomes apparent. To determine visibility from the terrain profile, draw straight lines from the OP to the lowest points of

visibility along the entire length of the terrain profile. Those areas that are not visible from the OP are below the straight lines and may be shaded (see figure B-5). Once the areas that are not visible from the OP have been identified, to display them on the profile line, extend perpendicular lines from the left and right limits of the defilade areas as shown in figure B-5. The defilade is shown as a heavily shaded portion of the profile line.

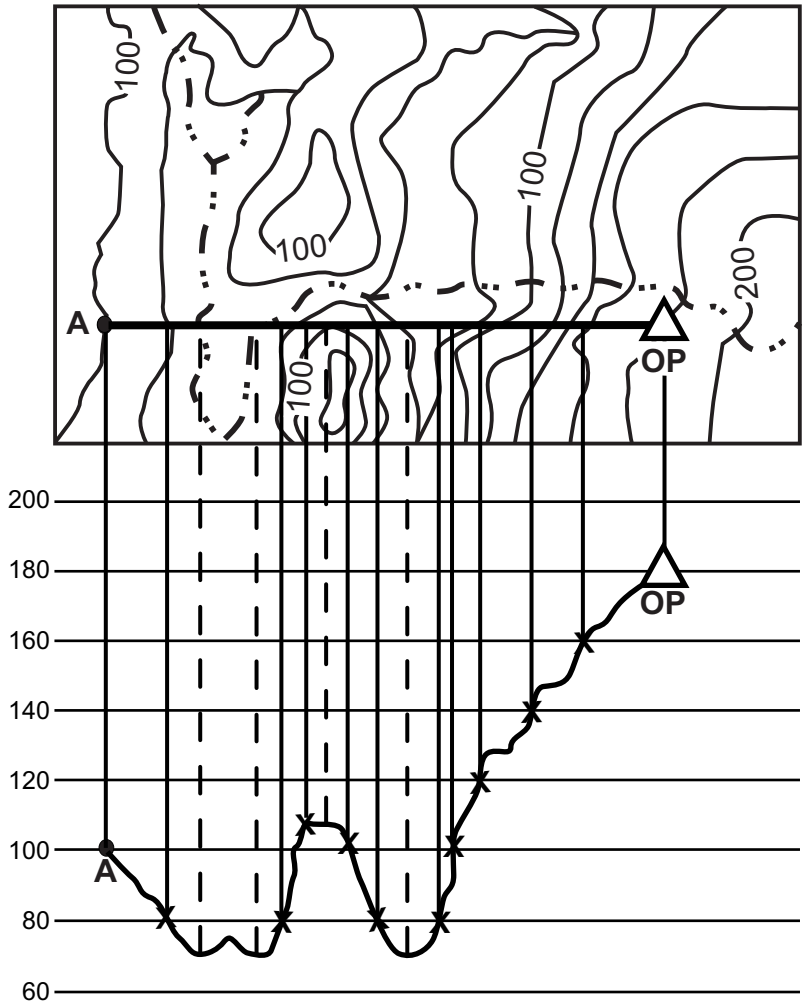



**Figure B-4. Transferring Points from Profile to Profile Line.**

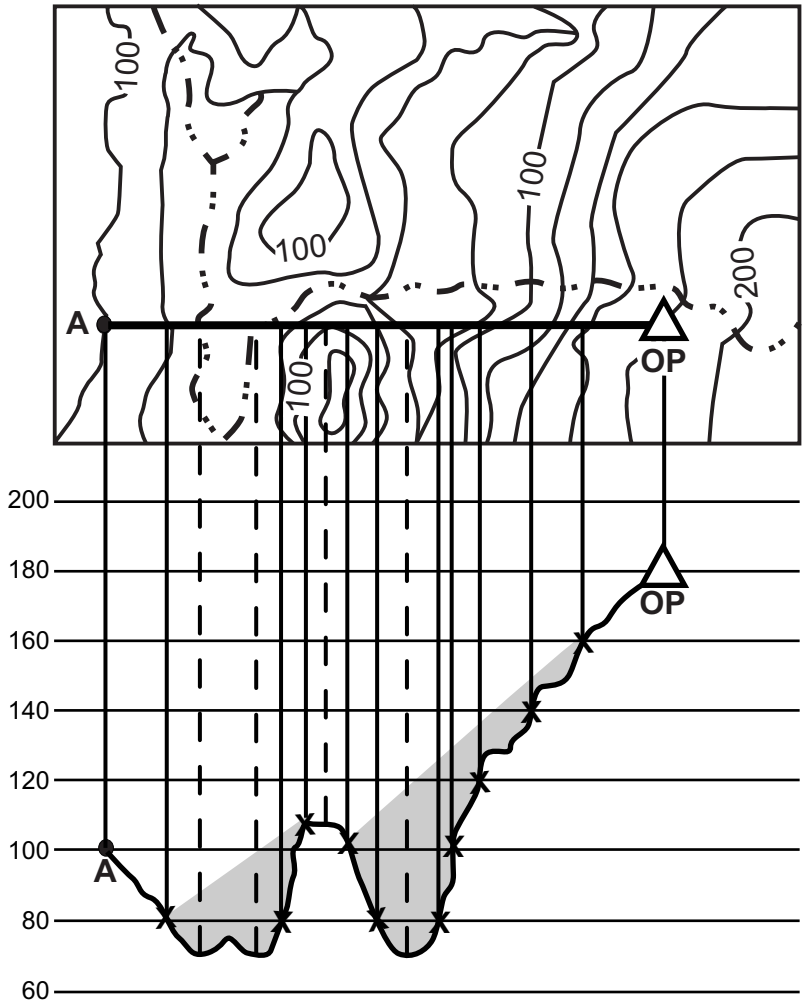



**Figure B-5. Non-Visible Areas Defilade.**

## STEP 3

Complete the visibility diagram. After the non-visible areas have been transferred to the first profile line, repeat the procedures described in step 2 for each profile line within the zone of observation (see figure B-6).

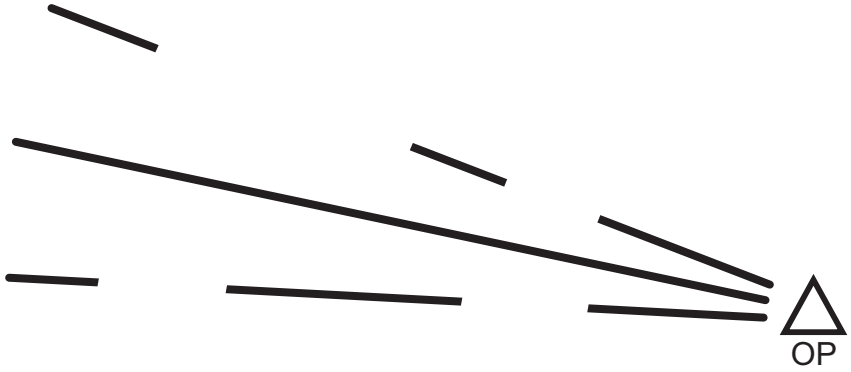



**Figure B-6. Non-visible Areas on Profile Lines.**

As defilade areas along each line of vision are identified and shaded, connect the non-visible portions (see figure B-7).

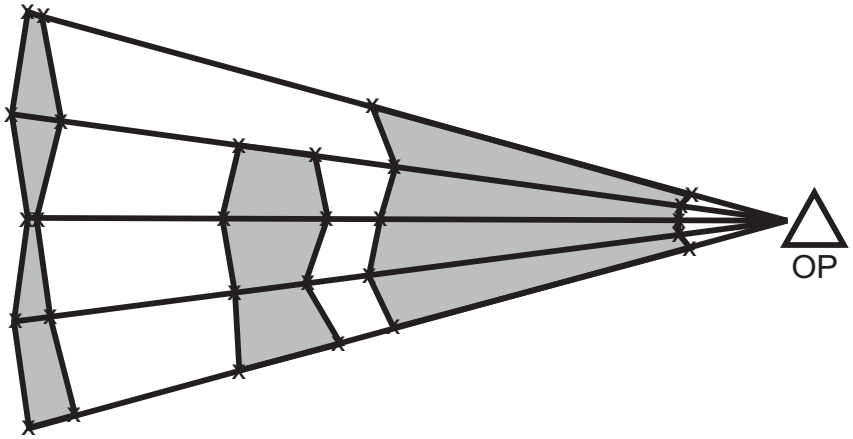



**Figure B-7. Areas of Visibility and Non-visibility.**

After adjacent profile lines have been analyzed and the areas that are not visible have been revealed, the finished product appears as shown in figure B-8. The observer highlights non-visible areas by shading or crosshatching the defilade areas.

Normally, the visibility diagram is completed in overlay form. As a minimum, the marginal data listed in table B-1 should be placed on the overlay as shown in figure B-8.

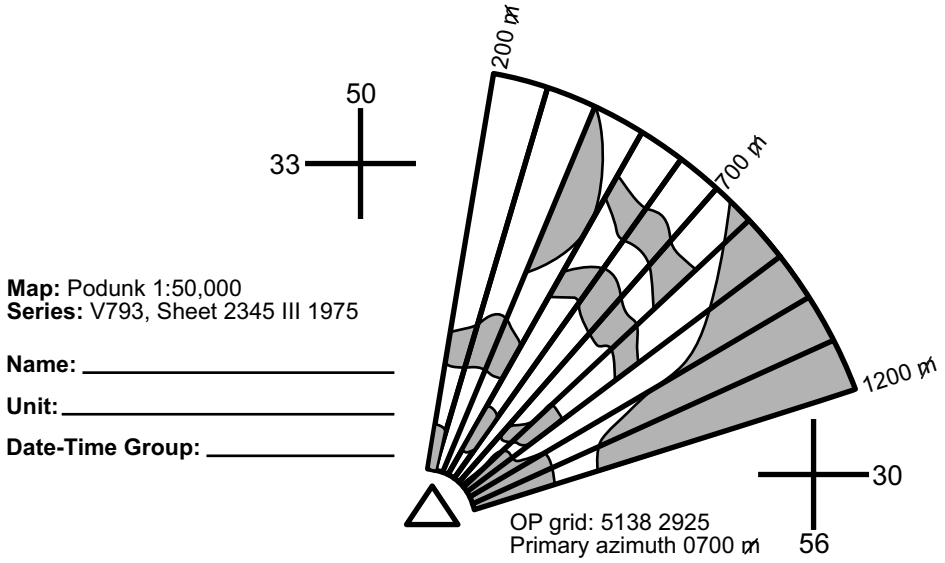



**Figure B-8. Completed Visibility Diagram Overlay With Marginal Data.**

**Table B-1. Marginal Data.**

| Item | Example |
|---|---|
| OP grid | TD 5138 2925 |
| Primary azimuth of observation | 0700 mils |
| Grid register marks | Register marks |
| Map sheet/scale | Podunk, 1:50,000 |
| Map series/date | V793, sheet 2345 III, 1975 |
| Name of observer | 2ndLt Marine |
| Unit | 1/10 |
| Date-time group | 251300 Feb |
| Left and right limits | 200 mils, 1200 mils |

# APPENDIX C
# CRATER ANALYSIS

Whenever and wherever hostile cannon, missile, or mortar shelling is detected, it must be reported without delay to the appropriate intelligence officer. The intelligence officer can then evaluate and act on the information. When counterfire agencies are provided with sufficient information, they can implement immediate operational objectives to ensure the successful attack of hostile weapons. Shelling reports (SHELREPs) form the basis for effective counterfire action. The most reliable, accurate, and informative SHELREPs are visual or electronic observation supplemented by crater analysis and fragment identification. Observers and liaison personnel should be capable of conducting crater analysis.

## Crater Analysis Procedures

Observers can determine the direction of fire of an enemy projectile with reasonable accuracy by analyzing its crater or ricochet furrow. Observers can obtain a weapon's location by plotting the intersection of the back-azimuth rays from two or more widely separated craters caused by projectiles fired from the same weapon. Essentially, crater analysis involves determining the axis of the crater, marking the axis, and measuring the azimuth of the axis to the weapon.

The initial step in crater analysis is to locate a suitable crater for use in determining the direction to the hostile weapon. The crater should have occurred recently and be clearly defined on the ground.

Because the crater is the beginning point for plotting direction to the enemy weapon, observers should determine grid coordinates of the crater as precisely as the time and the method used will allow. Observers must collect shell fragments to identify the type and caliber of the weapon and determine direction to the firing weapon by using one of the methods described in this appendix.

## Artillery Shell Craters

***Fuze Quick Craters***. The detonation of a projectile causes an inner crater. The burst and momentum of the shell carry the effect forward and to the sides, forming an arrow that points to the rear (toward the weapon from which the round was fired). The fuze continues along the line of flight, creating a fuze furrow (groove in the ground). There are two methods of obtaining a direction to a hostile weapon from this type of crater. Observers can obtain the best results by determining a mean or average of several directions from both methods.

*Fuze Tunnel and Center of Crater Method*. In this method, one stake is placed in the center of the crater and another is placed in the furrow at the point where the fuze was blown, forward to the front of the crater (see figure C-1). A direction-measuring instrument is set up in line with the two stakes, and the direction is measured to the hostile weapon. There are five steps of the fuze tunnel and center of crater method:

**Step 1**. Place a stake in the center of the crater.

**Step 2**. Place a second stake in the fuze furrow.

**Step 3**. Set up a direction-measuring instrument (e.g., compass, CLRF) in line with the stakes and away from fragments.

**Step 4**. Orient the instrument.

**Step 5**. Measure the direction to the hostile weapon.

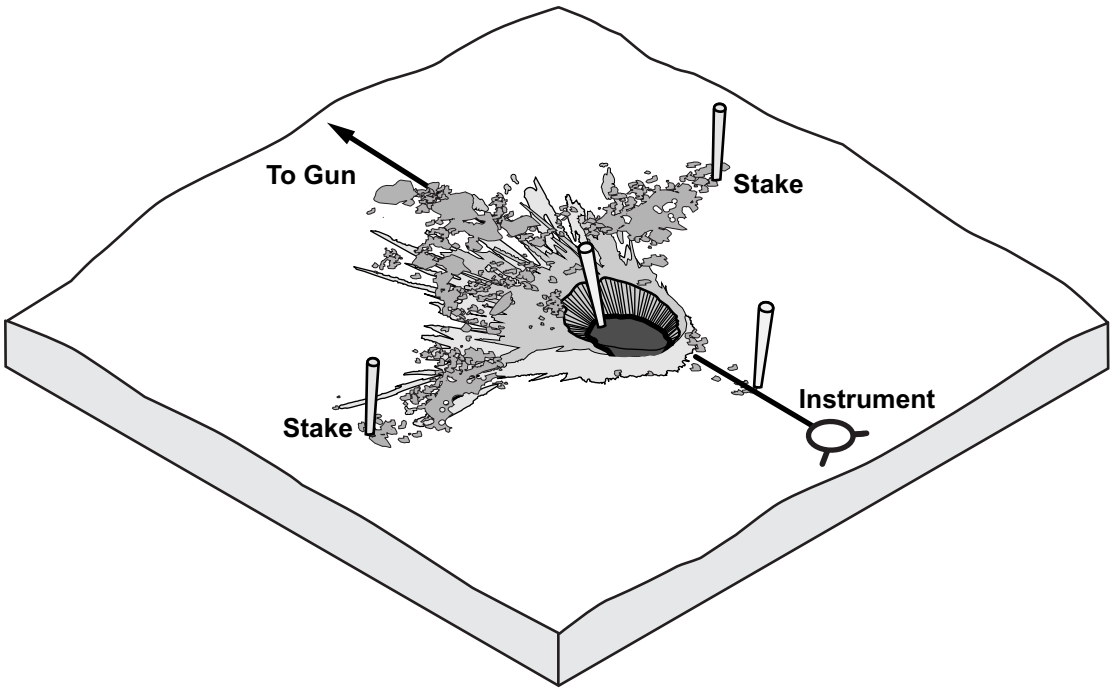



**Figure C-1. Fuze Tunnel and Center of Crater Method.**

A variation of this method is to place a stake where the shell entered the ground instead of in the center of the crater and determine the direction in the same manner. However, this is rarely possible because indications of the point of entry are usually destroyed by the explosion of the shell.

*Side Spray Method*. The side spray method involves bisecting the angle formed by the lines of the side spray by striking arcs (see figure C-2). The seven steps in measuring the direction of a fuze quick crater by the side spray method are as follows:

**Step 1**. Place a stake in the center of the crater.

**Step 2**. Place two stakes, one at the end of each line of side spray, at equal distances from the center stake.

**Step 3**. Hold a length of WD-1 wire to each side spray stake, and strike an arc forward of the fuze furrow.

**Step 4**. Place a stake where these arcs intersect.

**Step 5**. Set up a direction-measuring instrument in line with the stake at the intersection of the arcs and the center stake.

**Step 6**. Orient the instrument.

**Step 7**. Measure the direction to the firing weapon.

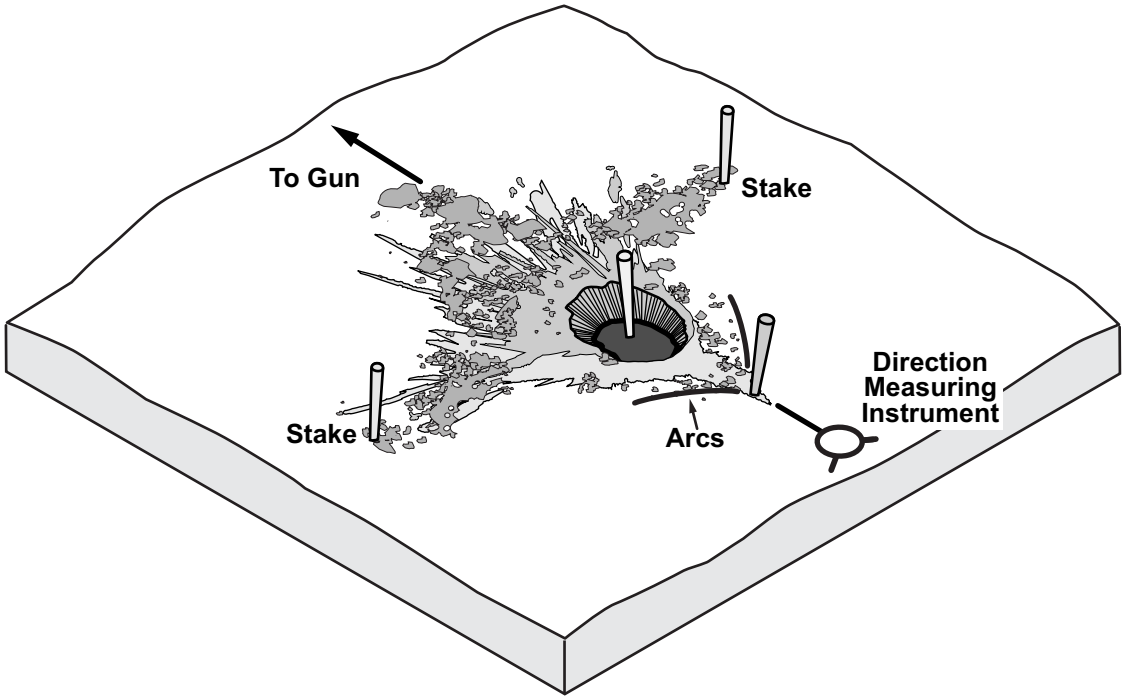



**Figure C-2. Side Spray Method.**

### Fuze Delay Craters

There are two types of fuze delay craters: ricochet and mine action.

*Ricochet*. The projectile enters the ground in a line following the trajectory and continues in a straight line for a few feet, causing a ricochet furrow. The projectile normally deflects upward and at the same time changes direction. The change in direction usually is to the right as a result of the spin or rotation of the projectile. The effect of the air burst can be noted on the ground (see

figure C-3). Directions obtained from ricochet craters are considered to be most reliable. The five steps to determine direction from a ricochet furrow are as follows:

**Step 1**. Clean out the furrow.

**Step 2**. Place stakes at each end of a usable, straight section of the furrow.

**Step 3**. Set up an instrument in line with the stakes and away from the fragments.

**Step 4**. Orient the instrument.

**Step 5**. Measure the direction to the weapon.

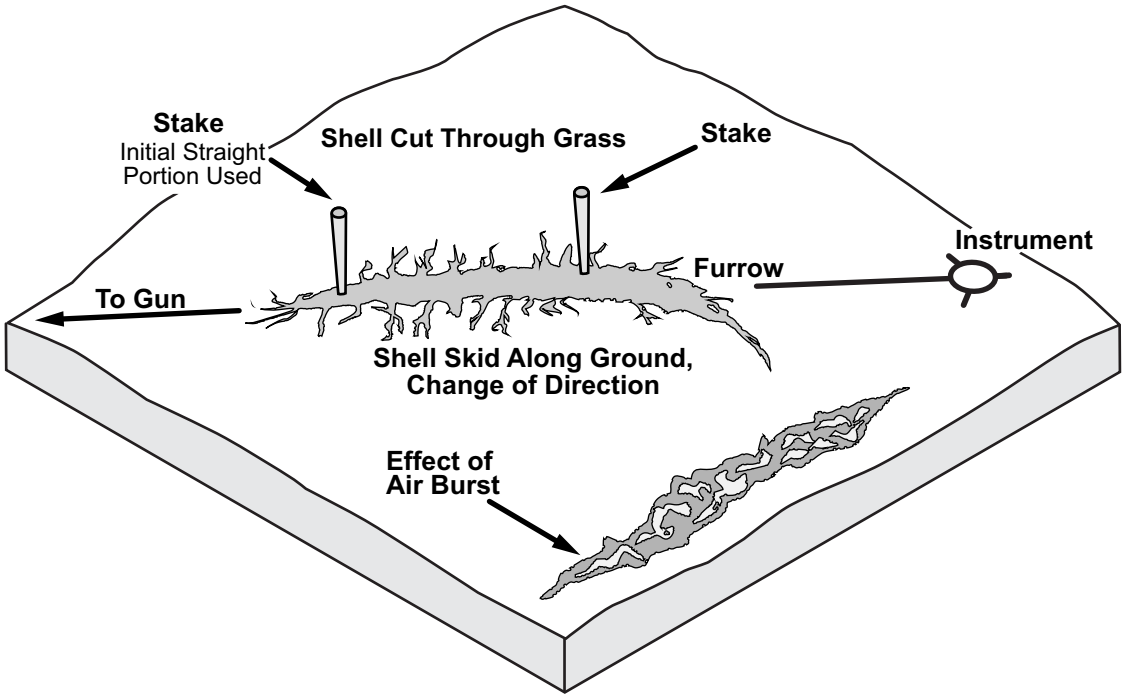



**Figure C-3. Ricochet Furrow Method.**

*Mine Action*. Mine action occurs when a shell bursts beneath the ground. Occasionally, such a burst will leave a furrow that can be analyzed in the same manner as the ricochet furrow. A mine action crater that does not have a furrow cannot be used to determine the direction to the weapon.

### Mortar Shell Craters

In a typical mortar crater, the turf at the forward edge (the direction away from the hostile mortar) is undercut (cut beneath with a portion left overhanging). The rear edge of the crater is rid of vegetation and grooved with splinters (see figure C-4). When fresh, the crater is covered with loose earth that must be carefully removed to disclose the burned inner crater. The ground surrounding the crater is streaked by splinter grooves that radiate from the point of detonation. The ends of the splinter grooves on the rearward side are on an approximately straight line. This line is perpendicular to the line of flight when on level ground or on slopes with contours perpendicular to the plane of fire (see figure C-5). A fuze tunnel is caused by the fuze burying

itself at the bottom of the crater in front of the point of detonation. Three methods may be used to determine direction from a mortar shell crater: main axis, splinter groove, and fuze tunnel.

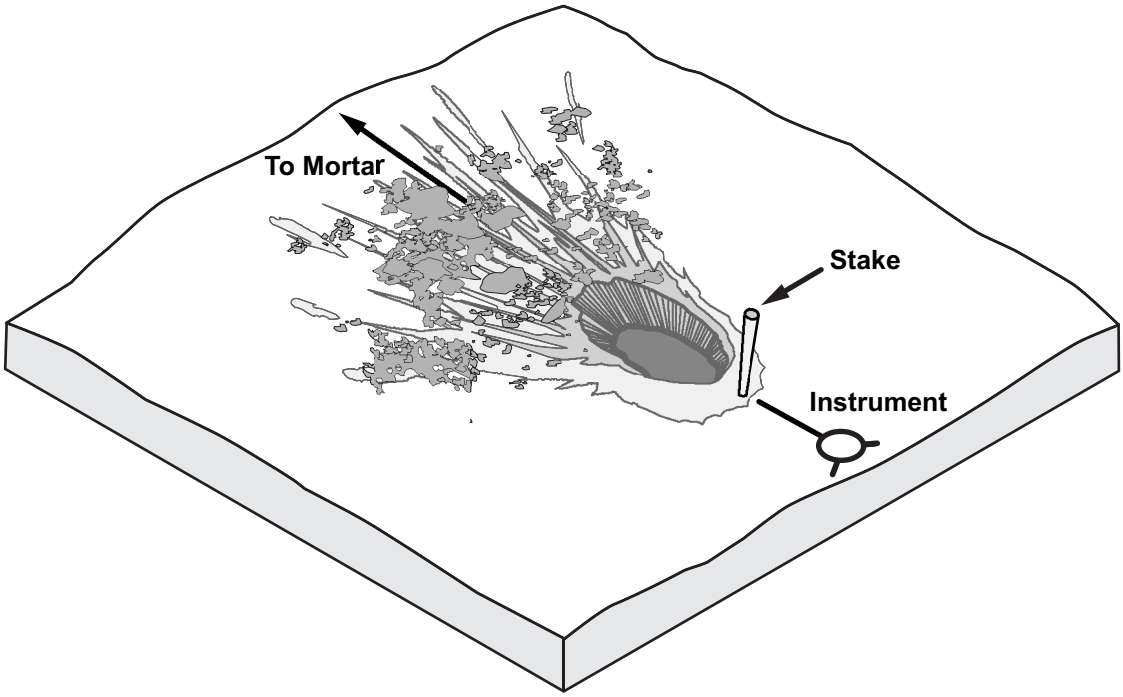



**Figure C-4. Main Axis Method.**

***Main Axis Method***. There are four steps that are taken to determine direction by the main axis method when a definite and regular crater is formed:

**Step 1**. Lay a stake along the main axis of the crater, dividing the crater into symmetrical

halves. The stake points in the direction of the mortar.

**Step 2**. Set up an instrument in line with the stake and away from fragments.

**Step 3**. Orient the instrument.

**Step 4**. Measure the direction to the weapon.

***Splinter Groove Method***. The five steps to determining direction by the splinter groove method are as follows:

**Step 1**. Lay a stake along the ends of the splinter grooves that extend from the crater.

**Step 2**. Lay a second stake perpendicular to the first stake through the axis of the fuze tunnel.

**Step 3**. Set up an instrument in line with the second stake and away from any fragments.

**Step 4**. Orient the instrument.

**Step 5**. Measure the direction to the weapon.

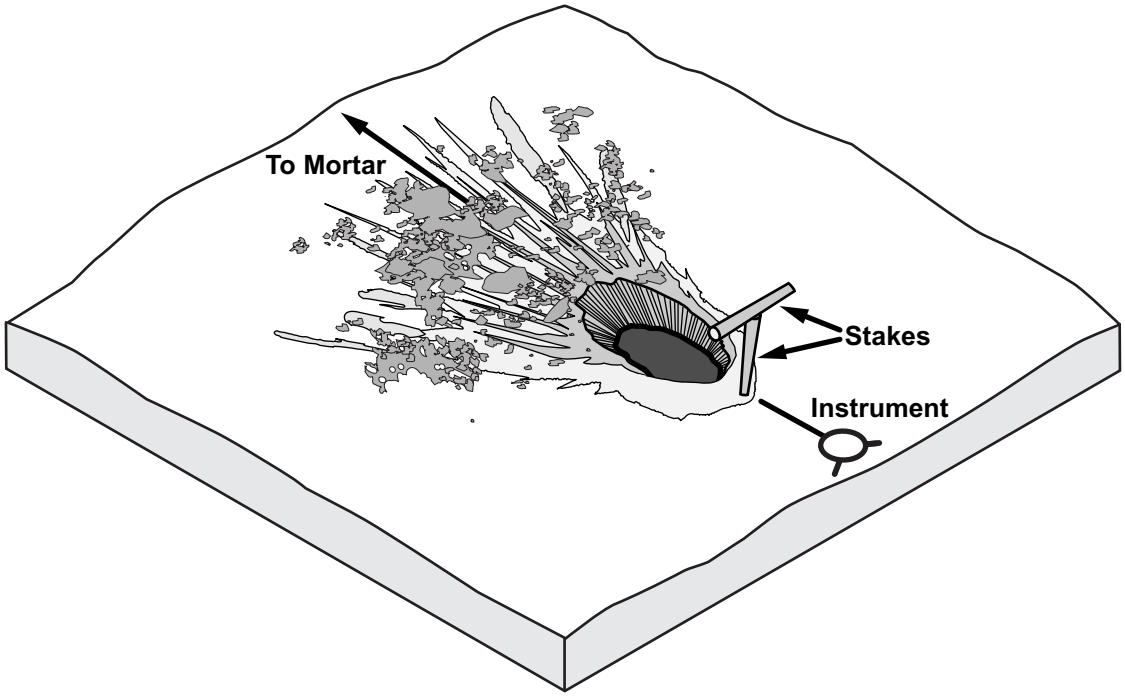



**Figure C-5. Splinter Groove Method.**

*Fuze Tunnel Method*. The four steps that are taken to determine direction by the fuze tunnel method are as follows (see figure C-6):

**Step 1**. Place a stake in the fuze tunnel.

**Step 2**. Set up an instrument in line with the stake and away from any fragments.

**Step 3**. Orient the instrument.

**Step 4**. Measure the direction to the weapon.

### Rocket Craters

A crater resulting from a rocket impacting with a low or medium angle of fall is analyzed in the same manner as an artillery crater resulting from a projectile armed with fuze quick. However, if the rocket impacts with a high angle of fall, the crater is analyzed in the same manner as a crater resulting from a mortar round. The tail fins, rocket motor, body, and other parts of the rocket may be used to determine type and caliber of rocket fired.

### Shell Fragment Analysis

The type and caliber of a hostile weapon can be determined by analysis of shell fragments. Dimensions of the parts, as well as of the complete shell, vary according to the type and caliber of shell (see figure C-7). The fragments must contain one or more feature that can be matched with technical specifications of the shell. Such features are mortar fin assemblies, rotating bands, and fuze wells. Curvature and thickness of large shell fragments can also aid in identification. The observer should ensure that the data on any munitions that are suspected to be in the area are disseminated through intelligence channels. Fragments from hostile shells that cannot be

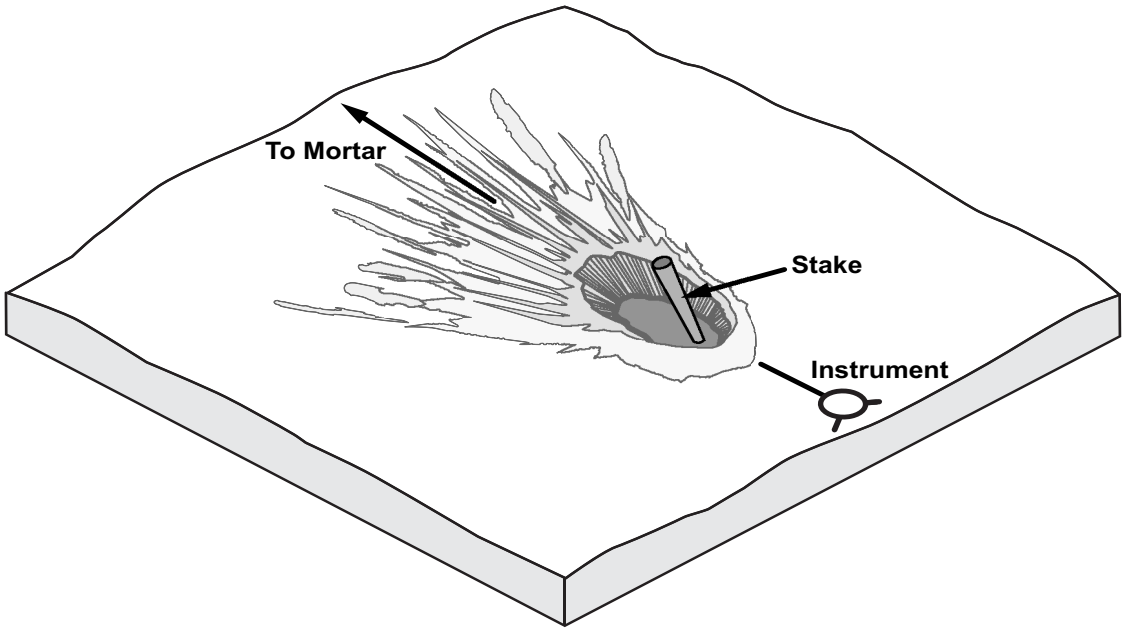



**Figure C-6. Fuze Tunnel Method.**

identified should be tagged and sent to the intelligence officer concerned. To be of maximum value, the tag for the fragment should show the following:

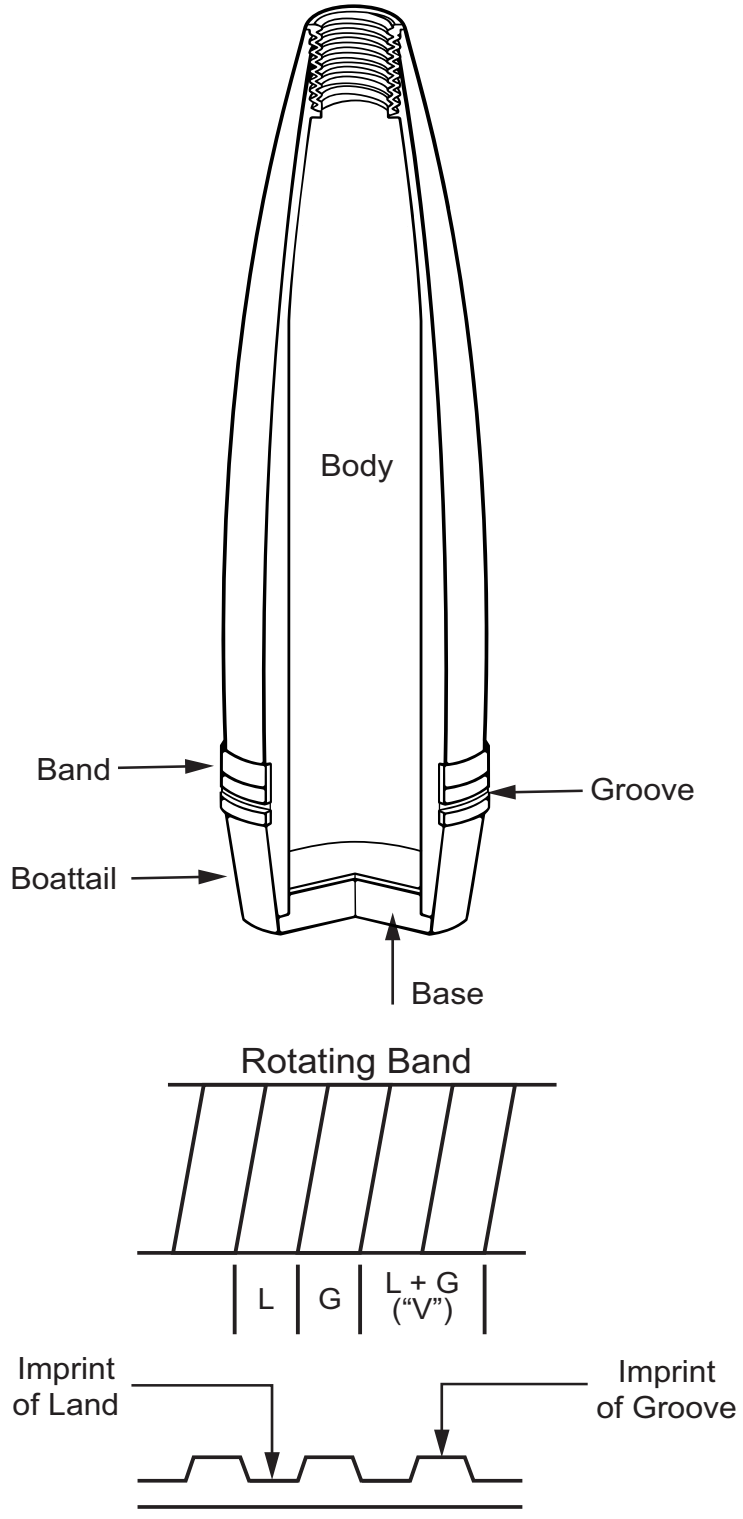
- The date and time that the shell impacted.
- The accurate location of the crater.
- The direction that the shell came from and the method used in determining this direction (e.g., survey of crater, sound, flash).
- The name and organization of the person reporting.
- A reference to a previously submitted SHELREP, if appropriate.

***Duds and Low-Order Bursts***. Logically, a dud would provide the best identification of the caliber of a weapon. However, because a dud may not always be available (or may be considered too dangerous to handle) a low-order burst would provide the next best means of identification. When the explosive filler is incompletely detonated, a low-order burst occurs and large shell fragments result. The observer can use these large pieces to identify thread count, curvature, and wall thickness.

***High-Order Bursts***. A high-order burst will normally form into small, deformed fragments. These fragments are useless for identification purposes unless they include a section of either the rotating band or the rotating band seat. Fragments of either of these sections will positively identify the shell because each shell has its own distinctive rotating markings (see figure C-8).

***Rotating Bands and Band Seats***. The observer may identify a shell by caliber, type, and nation or other place of origin from the following:

- Pattern or rifling imprints.
- Width, number, and size of rotating bands.
- Dimensions and pattern of keying or knurling (i.e., ridges) on the band seat.
- Dimensions and pattern of keying and knurling impressed on the rotating bands.




**LEGEND**

**G** groove
**L** land

**Figure C-7. Typical Shell Showing Critical Measurements.**

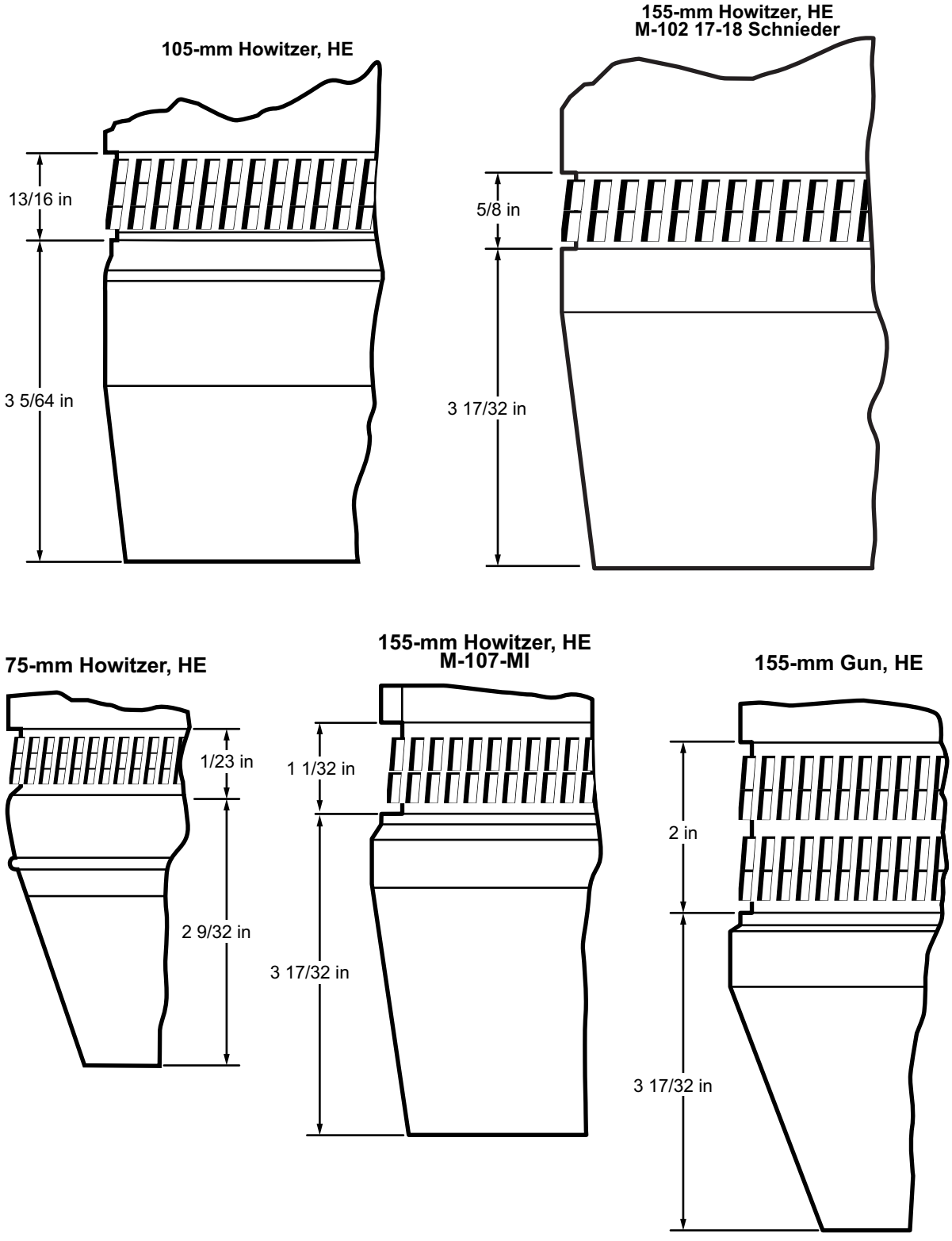



**Figure C-8. Shell Fragment Identification, US Ammunition.**

***Tail Fins***. The observer may identify a mortar from the mortar shell fragments and tail fins. The tail fins are the best indication of type and caliber (see figure C-9). A mortar that is not fin stabilized may be identified from pieces of the projectile that are imprinted with rifling. Tail fins are often found in the fuze hole of the crater.

> ***Note:*** With the exception of rotating bands and band seats on the tail fins, different types of shells may be identical in one dimension, such as wall thickness, but seldom will be alike in two or more dimensions. Therefore, it is possible to make positive identification from two or more dimensions.

***Fuzes***. Because the same type of fuze may be used with several types of projectiles, it is impossible to establish the type and caliber of a weapon by examination of the fuze.

***Other Common Artillery and Mortar Rounds***. Some other common artillery and mortar rounds are shown in figure C-9, figure C-10, figure C-11, figure C-12, and figure C-13.

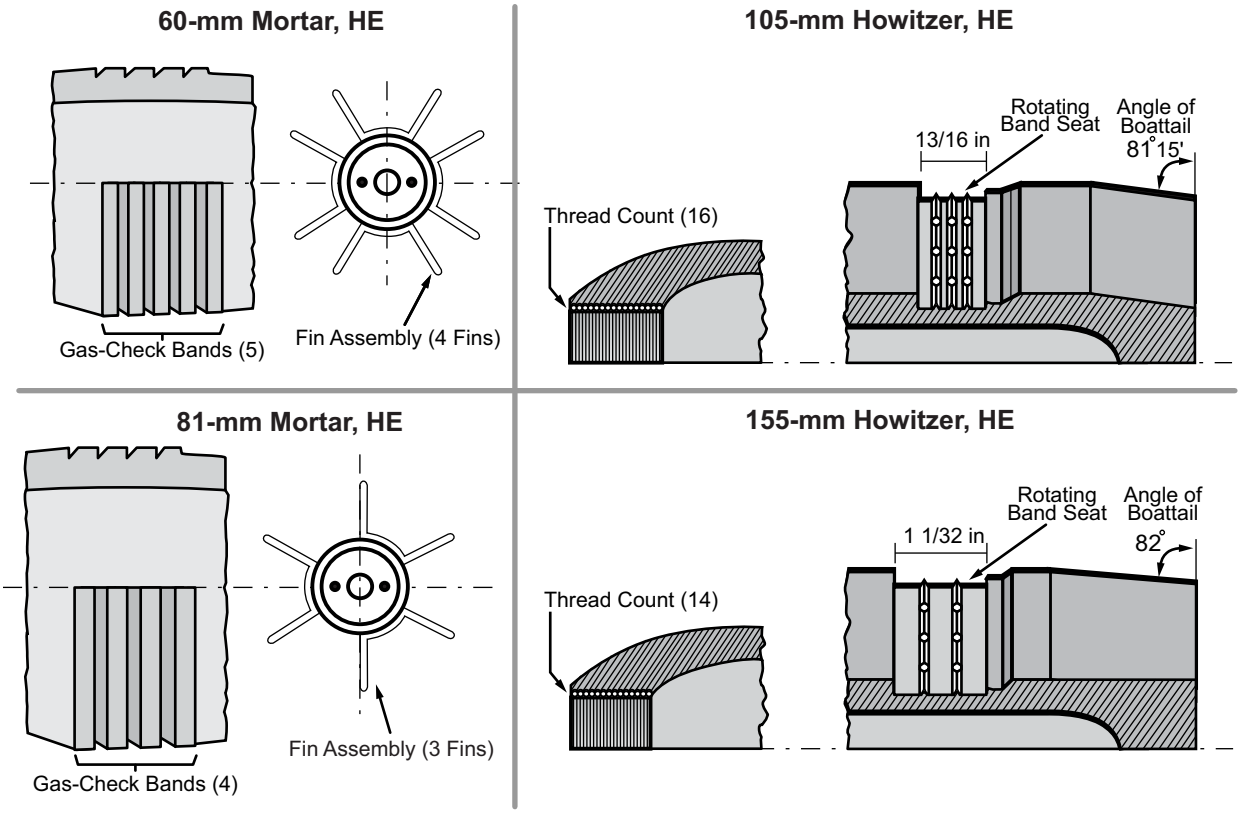



**Figure C-9. Shell Fragment and Tail Fin Identification, US Ammunition.**

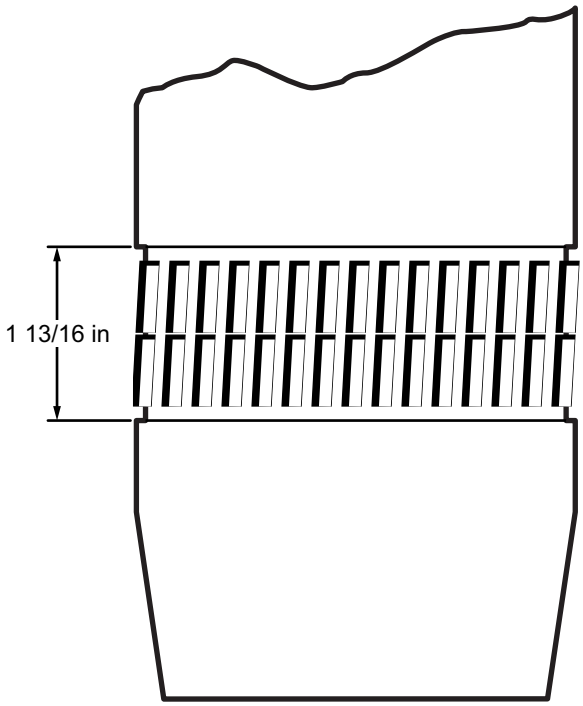



**Figure C-10. 122-mm Gun Projectile.**

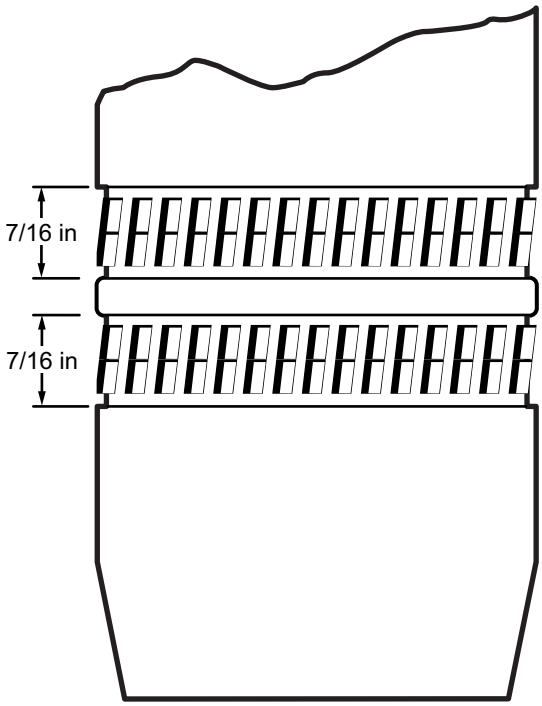



**Figure C-11. 85-mm Projectile.**

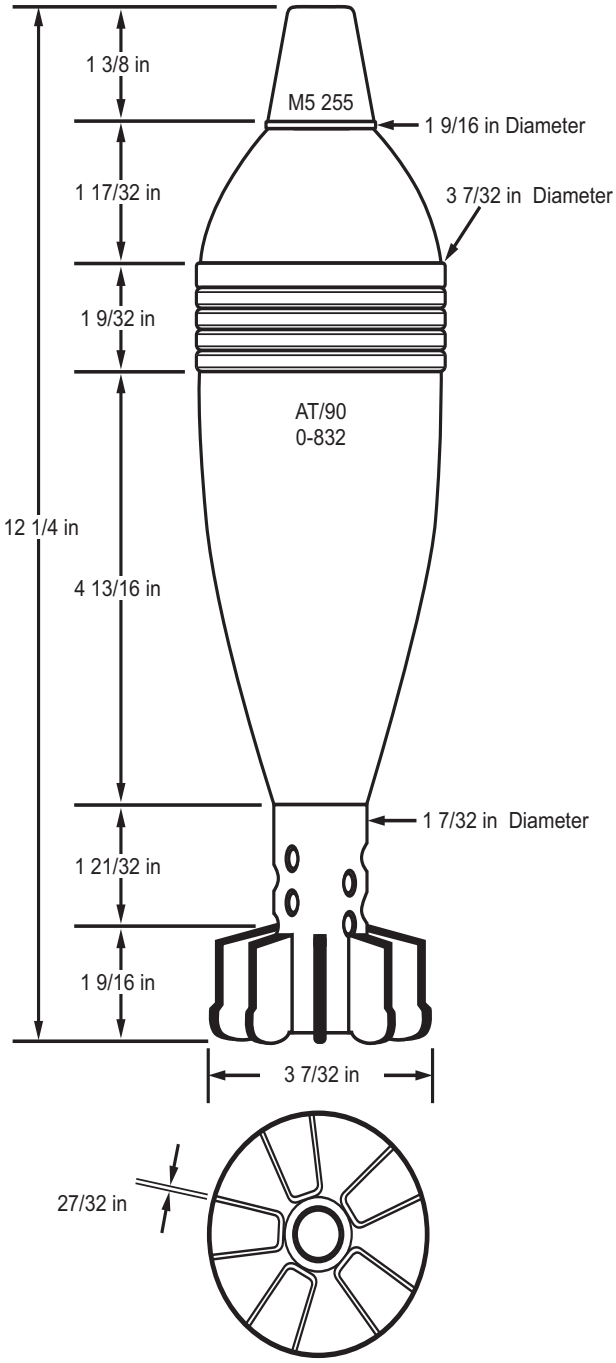



**Figure C-12. 82-mm Mortar Round, 5 Fins.**

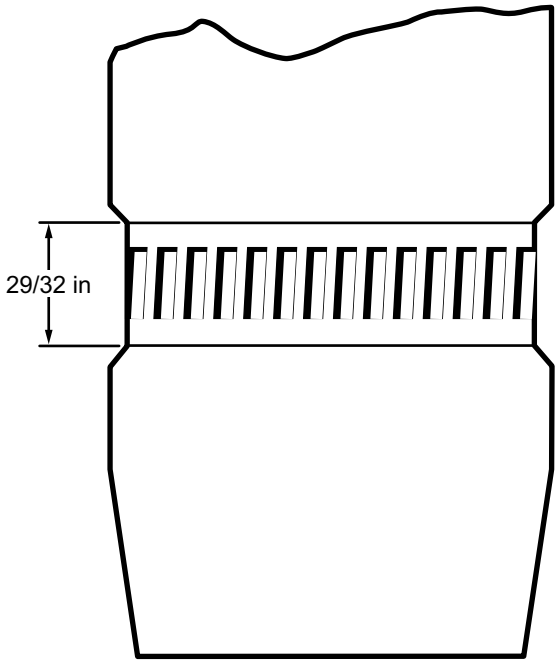



**Figure C-13. 152-mm Projectile.**

### Determination of Caliber by Fragment Geometric Analysis

The geometric method of determining projectile caliber is based on the problem of circumscribing a circle about a triangle. For accurate results, the following considerations apply:

- The fragment selected for use should be the largest available. It should include an arc of the projectile circumference, ranging in size from a minimum of 1/2 inch (37mm) for a small-caliber weapon to a minimum of 2 inches for a large-caliber weapon.

- The fragment must be from that portion of the projectile located between the rotating band and the *bourrelet*. In the case of a nonboat tail (square base) projectile, the fragment may be from any portion located between the *bourrelet* and the base.
- The fragment should not be distorted. However, if the fragment is only slightly distorted, the results will be fairly accurate and will give a close approximation of the caliber.
- The approximate caliber of a suitable fragment that meets the above conditions can be determined by using the following procedure (see figure C-14):
- Select two points, such as A and B as illustrated in the "I" portion of figure C-14, and place them as far apart as possible on the circumference of the projectile fragment.
- Measure the chord (straight line segment) distance between points A and B with dividers, or any other suitable instrument, and plot this measurement on paper (I and II, figure C-14).
- Select a third point C, on the arc fixed by A and B, and measure the distance from point A to point C. Using this distance as the radius, strike an arc at point A on the paper (II, figure C-14).
- Measure the distance on the fragment from point B to point C. Using this distance as the radius, strike an arc at point B on the paper. Mark the intersection of the two arcs. This is the plot of point C.
- Draw a triangle using points A, B, and C as the vertices. Erect perpendicular bisectors to the sides of the triangle (IV, figure C-14). To construct a perpendicular bisector of a line, set off a radius greater than one-half the length of the line. Using this radius, strike arcs (one on each side of the line) from each end of the line, and draw a line connecting the two points of intersection of the arcs. This line is the perpendicular bisector (III, figure C-14).
- Measure the distance from the point of intersection of the perpendicular bisectors to one of the vertexes of the triangle, and multiply this distance by two. The result is the diameter of the projectile that produced the fragment.

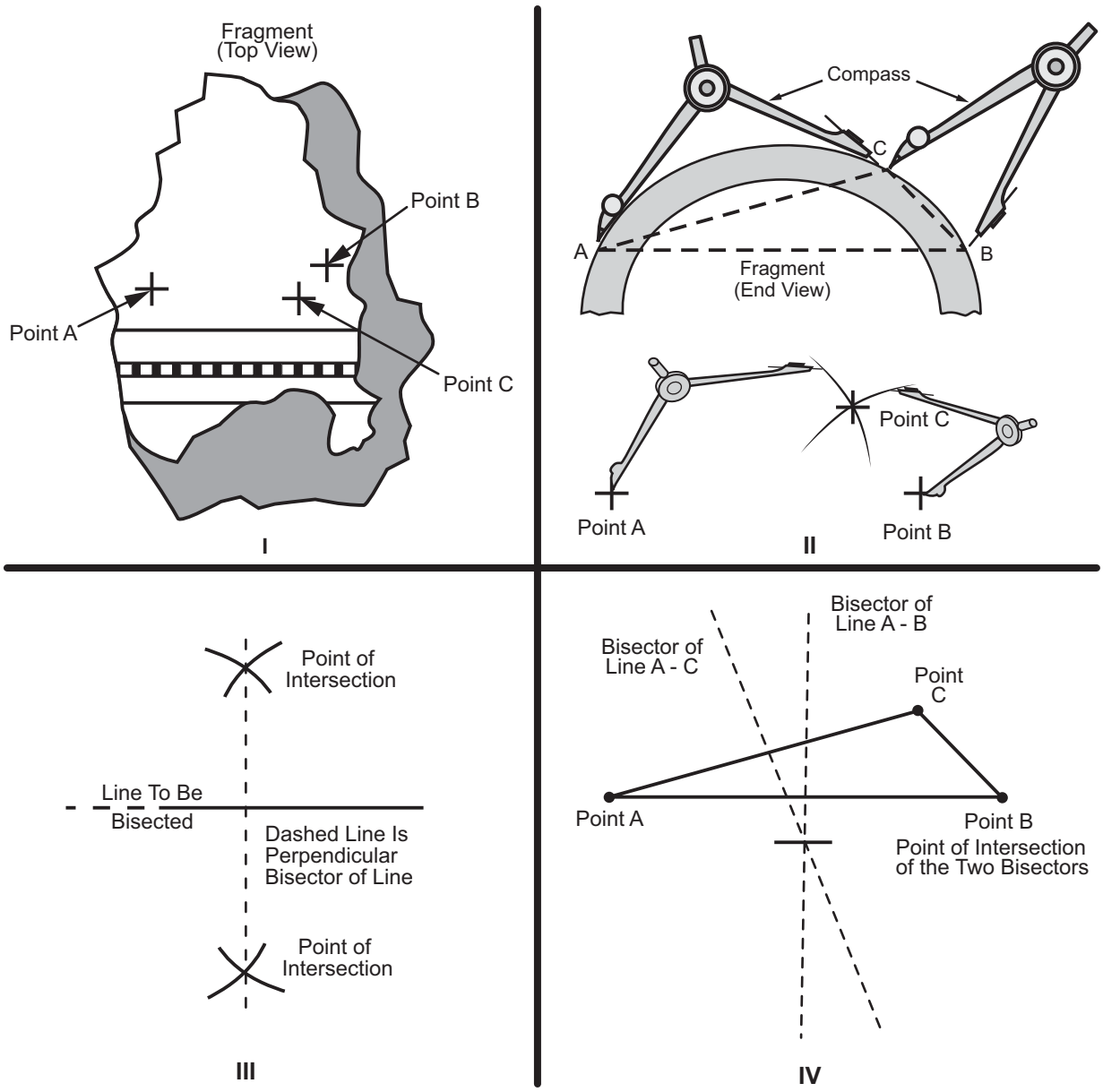



**Figure C-14. Determination of Projectile Caliber by Geometric Analysis of a Fragment.**

### Shelling Reports

A SHELREP is any report of enemy shelling containing information on caliber, direction, time, density, and area shelled. The information obtained from a crater should be forwarded by the most rapid means available to the appropriate personnel. The information is transmitted by using the standard SHELREP, which corresponds to lines a through k of DA [Department of the Army] Form 2185-R, *Artillery Counterfire Information*. The information, no matter how incomplete, should be forwarded. Fragmentary or incomplete information is often of value in supplementing or confirming existing information.

Items a, b, and k—unit of origin, position of the observer, and friendly damage incurred—are encoded for security reasons. The current call sign or code name for the unit is in item a, and codes used to transmit the information are included in items b and k. Item b is not applicable when this form is used for crater analysis.

Because three elements—direction, dimensions, and curvature—must be measured for crater analysis, the following equipment is required:

- Measuring instrument (e.g., a compass).
- Dividers and a ruler.
- Curvature template, which is used to measure the curvature of the fragment and so determine the caliber of the shell (see table C-1). The template can be constructed of heavy cardboard, acetate, wood, or other appropriate material.
- Ammunition data sheets on commonly encountered munitions.

**Table C-1. Artillery Counterfire Information Form Example.**

| **Artillery Counterfire Information (Field Manual 6-121)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Received By** | **From M/D/YY** | | **Time** | | | **Number** | | | | |
| Section I — BOMREP, SHELREP, MORTREP. Cross out any items that are not applicable | | | | | | | | | | |
| **Unit of origin:** *Current call sign, address, group, or code name* | **Position of observer:** *Encode if headquarters or important OP* *Column F gives information on location* | **Direction:** *Measured clockwise from grid north in degrees or mils (state which one) of flash, sound, or groove of shell (state which and omit for aircraft)* | **Time from:** | **Time to:** | **Area bombed, shelled, of mortared:** *Grid reference in CLEAR or direction to impact in degrees or mils; distance in meters* | **Number and nature of guns:** *Mortar, rocket launcher, aircraft, or other methods of delivery* | **Nature of fire:** *Registration bombardment, harassing* | **Number and type of caliber:** *State whether measured or assumed-of shells, rockets, missiles, or bombs* | **Time of flash to bang:** *Omit for aircraft* | **Damage:** *Encode if required* |
| **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** |
| FO 61 | NA | 4810 mils Groove. | 05 45 | 05 47 | TD 3932 8402 | 4 ARTY | Harassing | 4 HE 122 | NA | NA |
| **LEGEND** ARTY-artillery BOMREP- bombing report MORTREP-mortar report | | | | | | | | | | |

# APPENDIX D
# TARGET ANALYSIS AND MUNITIONS EFFECTS

To ensure that the firing unit employs effective munitions, the observer must provide an accurate target analysis.

### Observer Responsibilities

As the eyes of indirect-fire supporting arms, artillery observers, mortar FOs, and NSFS spotters must properly describe the target to the firing unit. In addition, the observers must recommend (i.e., fire request) and NSFS spotters must decide (i.e., fire order) on the best method of attack based on the size, type, and posture of the target.

### Target Analysis

A target must be analyzed to determine its weak points. This determination is based upon where the target is most vulnerable, which fires will best exploit the target's weaknesses, and the degree of damage desired (see table D-1 and table D-2). When analyzing a target, the observer should consider what effects are sought based upon suppression, neutralization, and destruction.

***Suppression***. Suppression of a target limits the ability of enemy personnel to perform their mission. This type of fire is used against likely, suspected, or inaccurately located enemy units where time is essential. Suppression can be delivered by small delivery units. Various munitions can be used to cause suppressive results, such as HE or smoke. The effect of suppressive fires lasts only as long as the duration of fires and does not damage the target.

**Table D-1. Target Characteristics and Considerations.**

| Target Characteristics | Considerations |
|---|---|
| Composition | Indicates achievable destructive or incendiary effects |
| Size and shape | May require special sheaf, multiple aim points |
| Vulnerability | Affects weapon selection |
| Mobility | May affect weapon/ammunition selection because of required response time |
| Resiliency | May affect decision to engage |
| Location | May affect weapon selection because of proximity to friendly forces Accuracy will affect volume of fire to achieve desired effects |

**Table D-2. Environmental Characteristics and Considerations.**

| Environmental Characteristics | Considerations |
|---|---|
| Weather | Restricts/prohibits use of some weapons/munitions. For example, clouds and fog may affect the use of lasers and some aircraft/ordnance |
| | Wind affects attacking targets with smoke, ICM, FASCAM, or illumination projectiles |
| Terrain | Rugged terrain reduces vulnerability of targets and increases volume of fire for desired effects |
| | Overhead vegetation reduces effectiveness of some munitions and requires delay fuze action |
| | Orientation of terrain features in the target area may require repositioning of firing units or high-angle fires |
| Urbanized areas | Reserve ICM and HE/VT for firing at personnel on rooftops and targets in the open |
| | Employ high-angle fires for targets in defilade |
| | Use HE/Q or CP for creating rubble and against covered targets |
| | Note that HE/delay is not effective for mortar or brick penetration (use HE/Q or CP) |
| | Are conducive to illumination and incendiary munitions |
| | Allow use of FASCAM to close routes |
| Mountainous areas | Require high-angle fires to attack defilade targets |
| | Increase lethality of HE in hard, rocky surfaces |
| | Reduce effectiveness of WP, ICM, and FASCAM in deep snow and wooded areas |
| | Make unobserved fires less accurate in changing atmospheric conditions |
| | Enhance air bursts on reverse slopes |
| | Allow use of FASCAM to compartmentalize or close routes |
| | Are conducive to rock slides |
| | Offer opportunity for CAS to attack targets on reverse slopes and steep slopes |
| Jungle areas | Reduce effects of most munitions because of vegetation |
| | Restrict employment of bomblet submunitions (e.g., ICM, cluster bomb units) because of overhead cover |
| | Promote fires in proximity to friendly forces |
| Desert areas | Reduce effectiveness of unobserved fires due to target dispersion |
| | Increase use of smoke for screening; however, atmospheric conditions reduce duration of smoke screens |
| Arctic areas | Slow rates of fire |
| | Cause ICM, FASCAM, and HE/Q to be less effective because of deep snow and mud |
| | Allow the best results for air bursts |
| | Reduce smoke effectiveness |
| | Cause resupply of ammunition expenditure to be controlled because of difficulty of resupply |

***Neutralization***. Neutralization of a target knocks the target out of the battle temporarily. Personnel casualties or weapons system damage of 10 percent or more are considered necessary to neutralize a unit. A damaged weapons system will have significantly degraded performance until repairs are made. Examples of a neutralized target include a firepower kill, such as a destroyed main sight or gun, or a mobility kill from a damaged engine or tread. The unit or target can become effective again when the casualties are replaced and the damage is repaired. The assets required to neutralize a target vary according to the type and size of the target, the weapon, and/or the ammunition used.

***Destruction***. Destruction requires a target to be completely reconstituted or replaced. It is defined differently for units and individual weapons systems. Casualties or system damages of 30 percent are considered to render a unit destroyed. Destruction of an individual weapons system occurs when it suffers both a firepower and mobility kill, a crew kill, or a catastrophic kill. With precision destruction missions, direct hits are used to destroy hard materiel targets.

### Ammunition and its Effects

Ammunition and its effects for indirect-fire weapons should consider both projectiles and fuzes.

#### *Projectiles*

*High Explosives*. The HE projectile is a hollow shell filled with TNT [trinitrotoluene] or Composition B. When detonated by a PD, delay, VT, or mechanical time fuze, the bursts will cause fragmentation and blast over a wide area. It is most often used by the observer in adjustment. Shell HE is effective against personnel, vehicles, and material and is fired by mortars, artillery, and NSFS. The HE/VT, effective against stationary armored vehicles, is delivered from artillery and NSFS.

*White Phosphorous*. The WP shell is a bursting, chemical-type projectile. Its hollow shell bursts on impact by an internal charge that expels burning WP over a limited area. The WP shell is—

- Used for marking, screening, obscuring, and incendiary effects.
- Used against vehicles; petroleum, oils, and lubricants and ammunition storage areas; and enemy observers.
- Fired with an impact fuze. However, it may be fired with a fuze timed to obtain an air burst. It cannot be fired with a fuze VT. The WP shell can be fired by mortars, artillery, and NSFS.

*Illumination*. This is a base-ejection projectile. A canister containing burning illuminant is ignited and expelled in a small parachute. This projectile is used for either battlespace illumination or marking. Illumination can be fired by mortars, artillery, or NSFS.

*Infrared Illumination*. This is a base-ejection projectile. A canister containing a burning illuminant is ignited and expelled in a small parachute. This projectile is used for either battlespace illumination or marking. Infrared illumination can be fired by mortars, artillery, and aircraft. A night vision device must be used to see the battlespace when using this projectile.

*Felt-Wedge Smoke*. The M825 improved smoke round—

- Is a base-ejection projectile that uses felt wedges impregnated with WP to create uniform dispersion of smoke over an area. The M825 provides 5 to 10 minutes of smoke over a large area. Unburned wedges can cause a hazard to friendly forces; therefore, caution must be exercised when operating in these areas.
- Is delivered by a 155-mm artillery weapon.

*Family of Scatterable Mines*. The FASCAM artillery shells are used to deliver ADAM or RAAMS against an enemy force and are delivered by a 155-mm artillery weapon.

*Improved Conventional Munitions*. The ICM shell is a base-ejection projectile that consists of a mechanical time fuze and a body assembly containing grenades. When the fuze functions, the grenades are dispersed over a large area. The current type of ICM in use is the DPICM, which is produced in two artillery munitions—M483A1, called ICM, and M864, called base-burn ICM. The DPICM is very effective against exposed troops, vehicles, and armored vehicles. The ICM projectiles can be fired by artillery and rocket systems.

*High Capacity*. The high-capacity projectile is a fragmenting round that can also produce penetration effects. The high-capacity projectile is fired by the 5-inch naval gun. The projectile may have multiple fuzes, including a nose fuze. The fuzes are—

- A nose plug.
- A PD or mechanical time fuze.
- An auxiliary detonating fuze, which is an intermediate detonating device to magnify the explosion of the nose fuze.
- A base detonating fuze with a delayed arming action.

*Excalibur*. The Excalibur round is a coordinate-seeking projectile that uses a GPS signal to guide itself onto the target. It is considered a precision-guided munition and is much more accurate than the standard HE round. It can only be fired from the M777 howitzer.

### *Fuzes*

*Fuze Quick*. Fuze quick is a PD fuze that functions on impact. It is fired from all indirect-fire weapons (e.g., artillery, mortars, NSFS) with the HE projectile or WP projectile. Fuze quick loses its effect if troops are in trenches, on uneven ground, or on earthworks. It is used against personnel who are either standing or prone on the ground, armored vehicles, and light material.

*Fuze Delay*. A fuze delay is a 0.05-second delay that can be set on the quick fuze to allow either ricochet fire or penetration. The observer should use fuze delay for penetration if firing into dense woods, against light earthworks, or non-masonry buildings. Fuze delay—

- Is not effective against concrete or brick.
- Can be used in conjunction with a ricochet. A ricochet causes a low air burst when there is a small angle of impact on a hard surface. Ricochets are particularly common when firing high charges in artillery or when firing NSFS.

*Mechanical Time*. The mechanical time fuze functions in the air at a given time along the trajectory. It requires adjustment to achieve the proper 20-meter HOB when used with HE or WP. Therefore, another shell and/or fuze combination should be considered if time is critical and air bursts are desired. Time fuzes—

- Should never be used for high-angle missions.
- Are used with HE and WP against troops in the open, in trenches, or in fighting holes; vehicles; and materiel.
- Can be fired by all artillery weapons and NSFS.
- Are used for payload munitions, such as illumination, smoke, M825 smoke, and ICM projectiles.

*Proximity Variable Time*. Proximity VT fuzes are radio activated for detonation at a 7-meter HOB. Various proximity fuzes exist in the NSFS inventory. A VT fuze provides a more effective air burst than fuze time and does not have to be adjusted. A proximity VT fuze—

- Is an excellent fuze to fire with shell HE for fire for effect missions, unobserved fires, or high-angle fires.
- Should be used in missions conducted by an aerial observer when an air burst is desired.
- Is used against all targets that can be attacked with fuze time.
- Can be fired with HE projectiles by all artillery weapons, mortars, and the 5-inch naval gun.

*Controlled Variable Time*. Controlled VT fuzes have an adjustable arming feature that prevents the fuze from arming until the set time has elapsed; therefore, it provides more safety when firing over friendly troops. The CVT fuze is available for NSFS HE projectiles. It is the preferred proximity fuze for NSFS. The CVT fuze has a 7-meter HOB.

*Other Variable Time*. Other versions of the VT fuze exist in the NSFS inventory (e.g., VT-RF [variable time-radio frequency], VT-IR [variable time-infrared]).

*Concrete Piercing*. Concrete piercing (CP) fuzes are used with artillery and NSFS HE projectiles for attack of concrete structures, earth, and log-reinforced emplacements. The two types of CP fuzes are non-delay and delay. Non-delay fuzes are used primarily for spotting or for clearing rubble and shattering concrete. Delay fuzes are used to destroy a concrete target. Table D-3 provides a guide for selecting weapons to attack various targets.

**Table D-3. Guide for the Attack of Targets.**

| Target | Weapon/Ordnance | |
|---|---|---|
| Personnel in the open | Mortar | HE/Q or VT |
| | Artillery | HE/Q, VT, or time; DPICM |
| | NSFS | HE/Q, time, or VT |
| | Air | GP bombs, fuel air explosive, cluster, firebombs, guns |
| Personnel in fighting holes | Mortar | HE/VT |
| | Artillery | HE/VT or time |
| | NSFS | HE/VT or time |
| | Air | fuel air explosive, GP bombs, cluster |
| Personnel under light cover | Mortar | HE-delay |
| | Artillery | HE-delay or HE/Q/VT mix |
| | NSFS | HE-delay |
| | Air | GP bombs, rockets, guns, cluster |
| Personnel under heavy cover (concrete bunkers) | Artillery | HE-CP, HE/Q |
| | NSFS | armor piercing or HE-delay |
| | Air | GP bombs, guided weapons |
| Armored vehicles | Mortar | HE/Q or VT |
| | Artillery | HE/Q, VT, or time; DPICM; Excalibur |
| | NSFS | HE/Q or delay |
| | Air | guided weapons, GP bombs, rockets, guns, cluster |
| Field artillery | Artillery | DPICM, HE/VT, WP, FASCAM |
| | NSFS | HE/Q or VT, WP |
| | Air | cluster, guided weapons, GP bombs |
| AAA: automatic | Mortar | HE/VT, WP |
| | Artillery | DPICM, HE/VT, WP, smoke |
| | NSFS | HE/Q or VT, WP |
| | Air | cluster, guided weapons, GP bombs, firebombs, guns |
| AAA: self-propelled | Mortar | HE/Q or VT |
| | Artillery | HE/Q, VT, or time; DPICM; Excalibur |
| | NSFS | HE/Q or delay |
| | Air | guided weapons, GP bombs, rockets, guns, cluster |
| Missile launchers | Mortar | HE/VT |
| | Artillery | DPICM, HE/VT |
| | NSFS | HE/Q or VT |
| | Air | missiles, guided and cluster weapons, GP bombs, firebombs |

**Table D-3. Guide for the Attack of Targets. (Continued)**

| Target | Weapon/Ordnance | |
|---|---|---|
| Radar installations | Mortar | HE/Q or VT |
| | Artillery | DPICM, HE/Q or VT |
| | NSFS | HE/Q or VT |
| | Air | missiles, guided/cluster weapons, GP bombs, fuel air explosive, guns, rockets |
| Field fortifications | Mortar | HE-delay, WP |
| | Artillery | HE-CP or delay, DPICM, WP |
| | NSFS | HE-CP or delay, HE/Q, WP |
| | Air | GP bombs, guided bombs, rockets |
| Supply depots/dumps | Mortar | HE/VT, WP |
| | Artillery | HE/VT or time, DPICM, WP |
| | NSFS | HE/VT or time, WP |
| | Air | cluster, firebombs, GP bombs, guided bombs, rockets |
| Roads | Mortar | HE-delay |
| | Artillery | HE-delay or CP, FASCAM |
| | NSFS | HE-delay or CP |
| | Air | GP bombs |
| Trucks | Mortar | HE/Q or VT, WP |
| | Artillery | HE/Q or VT, DPICM, WP |
| | NSFS | HE/Q or VT, WP |
| | Air | guided missiles and cluster weapons, GP bombs, guns, rockets |
| Buildings | Mortar | HE-delay, HE/Q or VT, WP |
| | Artillery | HE-CP or delay, HE/Q, WP |
| | NSFS | HE-CP or delay, HE/Q, WP |
| | Air | guided bombs and missiles, GP bombs |
| **LEGEND:** | | |
| GP general purpose | | |

# APPENDIX E
# TIMING THE DELIVERY OF FIRE SUPPORT

An important aspect when requesting and coordinating fire support is the ability to time the delivery of fires. Techniques such as synchronization, elapsed time, and event timing are used in Marine Corps operations.

> ***Note:*** Other techniques and terminology for timing the delivery of fire support (e.g., the running clock) should be avoided because they are difficult to establish and often create confusion.

### Synchronization

Synchronization is a technique that places all units on a common time. The two types of synchronization are AN/PSN-11 precise lightweight global positioning system receiver (PLGR) or DAGR and synchronized clock.

***AN/PSN-II PLGR or DAGR***. The preferable device for synchronizing is the AN/PSN-11 PLGR or DAGR, because it is the easiest and most accurate electronic device available to establish common time. The PLGR or DAGR must be able to track at least one satellite. An unencrypted PLGR or DAGR, encrypted PLGR or DAGR, and time cube will all display the exact same time, expressed in seconds.

***Synchronized Clock***. The synchronized clock uses a specific hour/minute based on either the local or universal (i.e., ZULU) time zone, as dictated by the OPORD or unit SOP. The synchronized clock—

- Requires all units to be placed on an established time and requires periodic time checks.
- Streamlines the coordination of timing once it has been established.

The synchronized clock is established by the senior command element or headquarters and is disseminated to all units. Dissemination can be accomplished electronically from unit to unit by voice time checks or acquired as needed from the Naval Observatory. The following example provides voice transmissions for establishing a synchronized clock.

**Example: Voice transmissions**

Sender: *T7Y* (unit or collective call sign) *this is V8P, stand by for time check in 2 minutes, time will be 1505, over.*

Receiver: *V8P this is T7Y, roger, out*. If collective call sign, each unit responds.

Sender: *T7Y this is V8P, stand by for time check . . . 5-4-3-2-1-hack, time is 1505, over.*

Receiver: *V8P, this is T7Y, time 1505, out.*

> ***Note:*** Specify the time zone if it is different from the unit SOP or OPORD. For example, *time 1505 SIERRA.*

*Local Time*. A local time zone (e.g., ROMEO time zone) may be used to establish the synchronized clock. The use of the local time zone on the synchronized clock may cause confusion if the unit or supporting forces are operating over more than one time zone.

*Universal Time*. Universal time is based on the ZULU time zone. Use of universal time facilitates timing of actions across time zones and is the preferred basis for establishing a synchronized clock. If required, units and agencies can independently access the Naval Observatory, which provides an automated, continuous broadcast of time. The units and agencies can acquire universal time from the Naval Observatory on HF radio frequencies of 5.000, 10.000, 15.000, 20.000, or 25.000 MHz. Universal time is particularly advantageous when operations involve joint forces and/or aircraft operating from remotely located airfields.

> ***Note:*** Universal time is determined from observations of the stars, radio sources, and also from ranging observations of the moon and artificial Earth satellites. The scale determined directly from such observations is designated universal time observed (UTO); it is slightly dependent on the place of observation. When UTO is corrected for the shift in longitude of the observing station caused by polar motion, the time scale UT1 is obtained. When an accuracy better than one second is not required, universal time can be used to mean coordinated universal time.

### Elapsed Time

The delivery of fires may be timed by specifying a number of minutes and/or seconds that are required to elapse from a stated countdown reference or "hack." Elapsed time is most desirable when timing the delivery of fires in an immediate or time-critical situation, when a synchronized clock has not been established or its accuracy is doubtful. Elapsed time is difficult to disseminate when several units or agencies are involved (e.g., during a coordinated attack of a target by aircraft, artillery, or NSFS).

Elapsed time is expressed in relation to the transmission of hack. When starting an elapsed time, hack is transmitted by specifying the number of minutes and seconds to elapse before ordnance will impact the target. The hack is used in transmitting the TTT for immediate or on-call CAS.

**Example: Hack**

*Eight* (minutes understood) *plus zero, zero* (seconds understood) . . . *hack.*

The term hack is used for all supporting arms and replaces the term mark for use in initiating or establishing time.

### Event Timing

The timing of fires may be in relation to a specific event (e.g, H-hour, H-5, L-hour, L-3). However, precautions should be taken to ensure that all agencies that are involved in the event are aware of the correct H- or L-hour.

# APPENDIX F
# AIR BREVITY CODES

**Air Brevity Codes**

| Code | Definition | Type of Communication |
|---|---|---|
| ABORT | Cease action/attack/event/mission | |
| ANGELS | Height of FRIENDLY aircraft in thousands of feet from MSL | |
| ATTACK COMPLETE | Mandatory call from the attack aircraft to the JTAC and/or FAC during type 3 CAS terminal control indicating completion of ordnance release<br>See also CLEARED TO ENGAGE | A/S |
| BINGO | Fuel state needed for recovery* | |
| BLIND | No visual contact with FRIENDLY aircraft/ground position<br>Opposite of VISUAL | A/A, S/A, A/S |
| BUSTER | Fly at maximum continuous speed (military power) | |
| (target/object) CAPTURED | Specified surface target or object has been acquired and is being tracked with an on-board sensor * | A/S |
| CHATTERMARK | Begin using briefed radio procedures to counter communications jamming | |
| CLEARED HOT | 1. Type 1 and 2 CAS terminal control clearance to release ordnance on this pass<br>2. Training range operations: the range control officer or range safety officer authorizes ordnance release | A/S |
| CLEARED TO ENGAGE | 1. Type 3 CAS terminal attack control clearance. Attack aircraft or flight may initiate attacks within the parameters imposed by the JTAC **<br>2. Clearance to fire on designated GROUP/target ** | A/S<br>A/A, A/S |
| CONTACT | 1. Sensor information at the stated position<br>2. Acknowledges sighting of a specified reference point (either visually or via sensor)<br>3. Individual radar return within a GROUP or ARM | A/S<br>A/A |
| CONTINUE | Continue present maneuver, does not imply a change in clearance to engage or expend ordnance | |
| CONTINUE DRY | Continue present maneuver, ordnance release not authorized<br>Used to provide approval to aircraft to continue the pass without expending ordnance during Type 1, 2, or 3 control (JTAC must use “Type 3, CONTINUE DRY” for dry Type 3 control)<br>Note: Simulated weapons deliveries may be performed. | A/S |

## Air Brevity Codes

| Code | Definition | Type of Communication |
|---|---|---|
| CYCLOPS | Any unmanned aircraft | |
| DASH (#) | Aircraft position within a flight<br>Use if specific call sign is unknown | |
| DEADEYE | Laser designator system inoperative | |
| HOLD FIRE | An emergency fire control order to stop firing on a designated target, to include destruction of any missiles in flight * | |
| HOSTILE | A contact identified as enemy upon which clearance to fire is authorized in accordance with theater rules of engagement*<br>WARNING: This use of HOSTILE is as a brevity term for air-to-air and maritime air engagements and should not be confused with the same term in tactical data link identification and rules of engagement. | A/A, AIR-MAR |
| JOKER | Fuel state above BINGO at which separation or BUGOUT or event termination should begin | |
| LASER ON | Start/acknowledge laser designation | A/S, S/S |
| LASING | The speaker is firing the laser | A/S, S/S |
| MAGNUM (system/location) | Launch of FRIENDLY anti-radiation missile | A/S, E/W |
| NEGATIVE LASER | Laser energy has not been acquired | A/S |
| NO JOY | Aircrew does not have visual contact with the TARGET/BANDIT<br>Opposite of TALLY | A/A, A/S, S/A |
| OFFSET (direction) | Maneuver in a specified direction with reference to the target | |
| PIG(S) | FRIENDLY glide weapon(s) (e.g., joint stand-off weapon [JSOW]) | A/S |
| PLAYTIME | Amount of time aircraft can remain on station, given in hours plus minutes (e.g., ONE PLUS THIRTY equals 1 hour and 30 minutes) | |
| (freq) POGO (freq) | Switch to communication channel number preceding POGO<br>If unable to establish communications, switch to channel number following POGO<br>If no channel number follows POGO, return to this channel | |
| PULSE | Illuminate/illuminating a position with flashing IR energy | |
| PUSHING | 1. Departing designated point<br>2. (GROUP/descriptions) GROUP has turned cold and will continue to be monitored | A/A<br>A/A |
| RIFLE | FRIENDLY A/S missile launch * | A/S |
| ROPE | Circling an IR pointer around an aircraft to help the aircraft identify the FRIENDLY ground position<br>CAUTION: This technique may damage night vision devices. | A/S |
| SAUNTER | Fly at best endurance | |

## Air Brevity Codes

| Code | Definition | Type of Communication |
|---|---|---|
| SHIFT (direction/track number) | Shift laser/IR/radar/ device energy/aim point *<br>Note: Can be used to shift from the offset position onto the target. Also used during multi-aircraft attack to shift laser energy or target assignments. | A/S, AIR-MAR |
| SMOKE | Smoke marker used to mark a position | A/S |
| SNAKE | Oscillate an IR pointer in a figure eight about a target * | A/S |
| SPARKLE | 1. Mark/marking target by IR pointer<br>2. Platform is capable to IR point | A/S, S/S |
| SPLASH(ED) | 1. Target destroyed *<br>2. Weapons impact<br>3. Informative call to observer or spotter 5 seconds prior to estimated time of impact * | A/A, S/A<br>A/S<br>S/S, S/A |
| SPOT | 1. Acquisition of laser designation<br>2. Platform is laser spot tracker [LST] capable | A/S |
| STARE<br>(with laser code and reference point) | Cue the laser spot search/tracker function on the specified laser code in relation to the specified reference point<br>Reference point may include the following: steer point, geographic reference (GEOREF), bearing and range, or data link point** | |
| STEADY | Stop oscillation of IR pointer | A/S |
| SUNSHINE | Illuminating target with artificial illumination | A/S |
| TALLY | Sighting of a target, non-friendly aircraft, or enemy position<br>Opposite of NO JOY | A/A, A/S |
| TERMINATE | In training, cease local engagement without affecting the overall exercise | A/A |
| VISUAL | Sighting of a FRIENDLY aircraft or ground position<br>Opposite of BLIND | A/A, A/S |
| WINCHESTER | No ordnance remaining | |

**KEY:**

* Meaning may differ from North Atlantic Treaty Organization brevity word

** Not a North Atlantic Treaty Organization brevity word

**LEGEND:**

A/A applies to air-to-air operations/communications

AIR MAR- applies to maritime air operations/communications

A/S applies to air-to-surface operations/communications

S/A applies to surface-to-air operations/communications

S/S applies to surface-to-surface operations/communications

# APPENDIX G
# JOINT TACTICAL AIR STRIKE REQUEST SAMPLE

| JOINT TACTICAL AIR STRIKE REQUEST | See Joint Pub 3-09.3 for preparation instructions. |
|---|---|

SECTION I - MISSION REQUEST

DATE

| 1. UNIT CALLED | THIS IS | REQUEST NUMBER | SENT / TIME / BY |
|---|---|---|---|
| | | | |

2. PREPLANNED: [A] PRECEDENCE _____ [B] PRIORITY _____
IMMEDIATE: [C] PRIORITY _____

RECEIVED / TIME / BY

3. TARGET IS/NUMBER OF
[A] PERS IN OPEN _____ [B] PERS DUG IN _____ [C] WPNS/MG/RR/AT _____ [D] MORTARS, ARTY _____
[E] AAA ADA _____ [F] RKTS MISSILE _____ [G] ARMOR _____ [H] VEHICLES _____
[I] BLDGS _____ [J] BRIDGES _____ [K] PILLBOX, BUNKERS _____ [L] SUPPLIES, EQUIP _____
[M] CENTER (CP, COM) _____ [N] AREA _____ [O] ROUTE _____ [P] MOVING N E S W _____
[Q] REMARKS _____

4. TARGET LOCATION IS
[A] _____ (COORDINATES) [B] _____ (COORDINATES) [C] _____ (COORDINATES) [D] _____ (COORDINATES)
[E] TGT ELEV _____ [F] SHEET NO. _____ [G] SERIES _____ [H] CHART NO. _____

CHECKED / BY

5. TARGET TIME/DATE
[A] ASAP _____ [B] NLT _____ [C] AT _____ [D] TO _____

6. DESIRED ORD/RESULTS [A] ORDNANCE _____
[B] DESTROY _____ [C] NEUTRALIZE _____ [D] HARASS/INTERDICT _____

7. FINAL CONTROL
[A] FAC/RABFAC _____ [B] CALL SIGN _____ [C] FREQ _____
[D] CONT PT _____

8. REMARKS
1. IP _____
2. HDNG _____ MAG OFFSET: L/R
3. DISTANCE _____
4. TGT ELEVATION _____ FEET MSL
5. TGT DESCRIPTION _____
6. TGT LOCATION _____
7. MARK TYPE _____ CODE _____
8. FRIENDLIES _____

9. EGRESS _____

THE FOLLOWING MAY BE INCLUDED IN THE "REMARKS", IF REQUIRED:
BCN-TGT _____ MAG BCN GRID ____/____
BCN-TGT _____ METERS TGT GRID ____/____
BCN ELEVATION _____ FEET MSL

SECTION II - COORDINATION

| 9. NSFS | 10. ARTY | 11. AIO/G-2/G-3 |
|---|---|---|
| | | |

| 12. REQUEST<br>☐ APPROVED<br>☐ DISAPPROVED | 13. BY | 14. REASON FOR DISAPPROVAL |
|---|---|---|
| | | |

| 15. RESTRICTIVE FIRE/AIR PLAN<br>[A] IS NOT IN EFFECT [B] NUMBER | 16. IS IN EFFECT<br>[A] (FROM TIME) _____ [B] (TO TIME) _____ |
|---|---|

| 17. LOCATION<br>[A] _____ (FROM COORDINATES) [B] _____ (TO COORDINATES) | 18. WIDTH (METERS) | 19. ALTITUDE/VERTEX<br>[A] _____ (MAXIMUM/VERTEX) [B] _____ (MINIMUM) |
|---|---|---|
| | | |

SECTION III - MISSION DATA

| 20. MISSION NUMBER | 21. CALL SIGN | 22. NO. AND TYPE AIRCRAFT | 23. ORDNANCE |
|---|---|---|---|
| | | | |
| 24. EST/ACT TAKEOFF | 25. EST TOT | 26. CONT PT (COORDS) | 27. INITIAL CONTACT |
| | | | |
| 28. FAC/FAC(A)/TAC(A) CALL SIGN/ FREQ | 29. AIRSPACE COORDINATION AREA | 30. TGT DESCRIPTION | *31. TGT COORD/ELEV |
| | | | |

32. BATTLE DAMAGE ASSESSMENT (BDA) REPORT (USMTF INFLTREP)

LINE 1/CALL SIGN _____ LINE 4/LOCATION _____
LINE 2/MSN NUMBER _____ LINE 5/TOT _____
LINE 3/REQ NUMBER _____ LINE 6/RESULTS _____
REMARKS _____

*TRANSMIT AS APPROPRIATE

DD FORM 1972, APR 2003 PREVIOUS EDITION MAY BE USED.

# APPENDIX H
# WEAPONS REFERENCE DATA

**Table H-1. Characteristics of US Mortars, Artillery, and Rockets.**

| Caliber | 60 mm | 81 mm | 120 mm[1] | 105 mm[1] | 155 mm | 155 mm | 155 mm[1] | 227 mm[1] | 607 mm[1] |
|---|---|---|---|---|---|---|---|---|---|
| Model | M224 | M252 | M120/ 121 | M119A1 | M777 | M198 | M109A5/ A6 | MLRS HIMARS | ATACMS |
| Maximum range (m) | 3500[2] | 5,600[3] | 7200[1] | 11,500 | 18,300 22,000[4] | 18,300 22,000[4] | 18,200 21,700[4] | 32,000 45,000[5] 65,000+[8,9] | 165,000[10] 300,000[6] 145,000[11] 270,000[12] |
| Ammunition | HE, WP, ILLUM | HE, WP, RP, ILLUM, IR ILLUM | HE, WP, ILLUM | HE, HC, WP, ILLUM, APICM | HE, HC, WP, ILLUM, APICM, DPICM, M825 smoke, FASCAM Excalibur | HE, HC, WP, ILLUM, APICM, DPICM, M825 smoke, FASCAM | HE, HC, WP, ILLUM, APICM, DPICM, M825 smoke, FASCAM | DPICM, UNITARY (HE)[9] | APAM BAT[11] UNITARY (HE)[12] |
| Maximum rate of fire (rounds/ min) | 30.00 | 30.00 | 16.00 | 10.00 | 4.00 | 4.00 | 4.00 | 6/70 seconds | 2/20 seconds |
| Sustained rate of fire (rounds/ min) | 20.00 | 15.00 | 4.00 | 3.00 | 2.00 | 2.00 | 1.00 | N/A | N/A |
| Range of RAP (m) | N/A | N/A | N/A | 19,500 | 30,100 | 30,100 | 30,000 | N/A | N/A |
| Range of DPICM (m) | N/A | N/A | N/A | 14,100 | 18,000 20,200 | 18,000 28,200[7] | 17,900 28,100[7] | N/A | N/A |
| Minimum range (m) | 70.00 | 80.00 | 2.00 | N/A | N/A | N/A | N/A | 8,000 13,000[5] 15,000[8,9] | 25,000[10] 70,000[6] 35,000[11] 70,000[12] |
| Fuzes | PD, MTSQ, MOF | PD, MTSQ, MOF | PD, MTSQ, MOF | PD, VT, MT, MTSQ, CP, delay | PD, VT, MT, MTSQ, delay | PD, VT, MT, MTSQ, delay | PD, VT, MT, MTSQ, delay | PD[9], ET, VT[9] | ET |
| Illumination time (seconds) | 40.00 | 60.00 | 60.00 | 75.00 | 120.00 | 120.00 | 120.00 | N/A | N/A |

**Table H-1. Characteristics of US Mortars, Artillery, and Rockets. (Continued)**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HE burst width (1 round) | 30.00 | 35.00 | 75.00 | 35.00 | 50.00 | 50.00 | 50.00 | CLASSIFIED[9] | N/A |
| FPF | 90<br>3 tubes | 280<br>8 tubes | 310<br>4 tubes | 210<br>6 guns | 300<br>6 guns | 300<br>6 guns | 300 6 guns<br>150 3 guns | N/A | N/A |

**NOTES:**
1. Marine Corps units do not possess these weapons systems. However, Marine Corps units may operate with Army units equipped with these weapons.
2. With M720 ammunition.
3. With M821 ammunition.
4. With M795 HE, M825 smoke ammunition.
5. M26A2 extended-range DPICM.
6. Block 1A ATACMS.
7. BBDPICM M864.
8. M-30 guided DPICM.
9. M-31 guided unitary.
10. Block 1 ATACMS.
11. Block 2 ATACMS.
12. ATACMS quick reaction unitary.

**LEGEND:**

| | |
|---|---|
| APAM | antipersonnel |
| ATACMS | Army tactical missile system |
| BAT | brilliant antiarmor technology |
| ET | electronic time |
| ILLUM | illumination |
| MLRS | multiple launch rocket system |
| MOF | multioption fuze |
| MT | mechanical time |
| MTSQ | mechanical time, super quick |
| RAP | rocket assisted projectile |

For more information about the capabilities and limitations of weapons platforms and munitions, see MCRP 3-16.6.

**Table H-2. US Aircraft Capabilities Guide.**

| Type of Aircraft | Communications Package | Navigation | Guns | Conventional Ordnance | | Laser Equipment | |
|---|---|---|---|---|---|---|---|
| | | | | External | Maximum Load | Tracker | Designator |
| AV-8B | 2 UHF | TACAN<br>INS<br>Radar[2] | 25 mm<br>300 rounds | All | 8,000 lb | No | No |
| AH-1W[3] | 2 UHF[1]<br>2 VHF-AM[1]<br>2 VHF-FM[1] | TACAN<br>ADF<br>FM homer<br>Radar beacon | 20 mm<br>750 rounds<br>or<br>20-mm pod | 2.75" rockets<br>5" rockets<br>TOW missile<br>HELLFIRE<br>Sidearm | 2,500 lb | No | Yes |
| F/A-18A/C[4] | 2 UHF[1]<br>2 VHF-AM[1]<br>2 VHF-FM[1] | TACAN<br>ADF<br>INS<br>Radar<br>FLIR | 20 mm<br>580 rounds | All | 13,700 lb | Yes<br>(pod) | Yes |
| F/A-18D[4] | 2 UHF[1]<br>2 VHF-AM[1]<br>2 VHF-FM[1] | TACAN<br>ADF<br>INS<br>Radar<br>FLIR | 20 mm<br>515 rounds | All | 13,500 lb | Yes<br>(pod) | Yes |
| A-10 | UHF<br>VHF-AM<br>VHF-FM | TACAN<br>INS | 30 mm<br>1100<br>rounds | All | 16,000 lb | Yes<br>(pod) | No |

**Table H-2. US Aircraft Capabilities Guide. (Continued)**

| Type of Aircraft | Communications Package | Navigation | Guns | Conventional Ordnance | | Laser Equipment | |
|---|---|---|---|---|---|---|---|
| | | | | External | Maximum Load | Tracker | Designator |
| AH-64 | UHF<br>VHF-AM<br>VHF-FM | TACAN<br>ADF<br>Doppler | 30 mm<br>1200 rounds | 70-mm rocket<br>HELLFIRE | 3,000 lb | Yes | Yes |
| F-16[4] | UHF[1]<br>VHF-AM[1]<br>VHF-FM[1] | TACAN<br>ADF<br>INS<br>Radar<br>ILS | 20 mm<br>515 rounds | All | 12,000 lb | No | Yes |
| F-15E[4] | UHF | TACAN<br>ADF<br>INS<br>Radar<br>ILS | 20 mm<br>512 rounds | All | 13,220 lb | No | Yes[3] |

**NOTES:**

[1] Can only monitor two frequencies at a time.

[2] AV-8B Plus is equipped with radar but has no laser spot tracker.

[3] The AH-1W Night Tactics System aircraft is GPS capable, and its FLIR is grid-/range-designation capable.

[4] Some aircraft are GPS

**LEGEND:**

ADF automatic direction finder
AM amplitude modulation
ILS instrument landing system
INS inertial navigation system
TACAN tactical air navigation
TOW tube-launched, optically tracked, wire-guided capable.
* See MCRP 3-31.6

**Table H-3. World Artillery, Mortars, and Rocket Launchers.**

| Manufacturer/ Weapon | Basic Range (m) | Base Burn/ RAP Range (m) | Rate of Fire | | Countries/ Organizations Possessing | Remarks |
|---|---|---|---|---|---|---|
| | | | Maximum | Sustained | | |
| **Austria** | | | | | | |
| GHN-45, 155-mm towed | 30,300 | 39,600 | 7 per min | 2 per min | Iran, Iraq, Thailand | None |
| **Brazil** | | | | | | |
| ASTROS II, MRL | — | 30,000<br>60,000 | 32 per min<br>4 per min | Reload<br>Reload | Saudi Arabia, Iran, Qatar | None |
| **China** | | | | | | |
| WS-1, 320-mm MRL | — | 80,000 | 4 per min | Reload | None | None |
| Type 83, 273-mm MRL | — | 40,000 | 4 per min | Reload | None | None |
| Type 71, 180-mm MRL | — | 20,000 | 10 per min | Reload | None | None |
| WA 021, 155-mm towed | 30,000 | 39,000 | 5 per min | 2 per min | None | None |

**Table H-3. World Artillery, Mortars, and Rocket Launchers. (Continued)**

| Manufacturer/ Weapon | Basic Range (m) | Base Burn/ RAP Range (m) | Rate of Fire | | Countries/ Organizations Possessing | Remarks |
|---|---|---|---|---|---|---|
| | | | Maximum | Sustained | | |
| Type 83, 152-mm towed | 30,400 | 38,000 | 4 per min | 2 per min | Iraq | None |
| Type 82/85, 130-mm MRL | — | 15,000 | 60 per 5 min | Reload | Thailand | None |
| Type 59-1, 130-mm towed | 27,500 | 38,000 | 10 per min | 10 per min | Iran, Iraq, North Korea, Oman, Egypt, Lebanon | None |
| **France** | | | | | | |
| GCT, 155-mm SP | 23,000 | 29,000 | 6 per min | 2 per min | Iraq, Kuwait, Saudi Arabia | None |
| GCT, 155-mm towed | 24,000 | 32,000 | 3 per 18 sec | 6 per min | Cyprus | None |
| MkF3, 155-mm SP | 20,000 | 25,000 | 3 per min | 1 per min | Iraq, Kuwait, UAE | None |
| **Germany** | | | | | | |
| PzH 2000, 155-mm SP | 30,000 | 40,000 | 3 per 10 sec | 9 per min | None | None |
| **Iran** | | | | | | |
| N10, 450-mm MRL | | 150,000 | 1 per min | 2 per hr | None | None |
| **Iraq** | | | | | | |
| ARABEL 100, 400-mm MRL | | 100,000 | 4 per min | Reload | None | None |
| ARABEL 50, 262-mm MRL | | 50,000 | 12 per min | Reload | Former Yugoslavia, Bosnian-Serb Army, Croatia | None |
| **Israel** | | | | | | |
| 845, 155-mm towed | 24,000 | 39,000 | 5 per min | 2 per min | None | None |
| M71, 155-mm towed | 23,500 | 30,000 | 5 per min | 2 per min | Singapore, Thailand, South Africa | None |
| **Italy** | | | | | | |
| Palmaria, 155-mm SP | 24,700 | 30,000 | 3 per 20 sec | 4 per min | Libya, Nigeria | None |
| **North Korea** | | | | | | |
| M1985, 240-mm MRL | | 43,000 | 12 per min | Reload | Iran | CHEM |
| M1978, 170-mm SP | 40,000 | | INA | INA | Iran, Iraq | None |

**Table H-3. World Artillery, Mortars, and Rocket Launchers. (Continued)**

| Manufacturer/ Weapon | Basic Range (m) | Base Burn/ RAP Range (m) | Rate of Fire | | Countries/ Organizations Possessing | Remarks |
|---|---|---|---|---|---|---|
| | | | Maximum | Sustained | | |
| M46, 130-mm SP | 27,500 | | 6 per min | 1.1 per min | None | None |
| BM 11, 122-mm MRL | | 20,500 | 30 per min | Reload | PLO, Syria, Iran, Iraq, Uganda | None |
| M1981, 122-mm SP | 23,900 | | INA | INA | None | None |
| M1992, 120-mm SP mortar | 8,700 | | INA | INA | None | None |
| **Russia/CIS** | | | | | | |
| FROG-7, MRL | | 70,000 | 1 per min | 1 per hr | Former Warsaw Pact, Iraq, Afghanistan, Algeria, Cuba, Egypt, North Korea, Libya, Syria, Yemen | NUKE, CHEM |
| SMERCH, 300-mm MRL | | 70,000 | 12 per min | Reload | Kuwait, UAE | None |
| 2S4, 240-mm SP mortar | 9,600 | 18,000 | 1 per min | 40 per hr | Iraq, Czech Republic | NUKE, LGM |
| M240, 240-mm towed mortar | 9,700 | 18,000 | 1 per min | 38 per hr | IRA, Iraq, North Korea, Egypt, Oman, Lebanon | NUKE, LGM |
| BM 27, 220-mm MRL | | 35,000 | 16 per min | Reload | Afghanistan, Syria | CHEM, mines |
| 2S7, 203-mm SP | 37,500 | 47,000 | 2 per min | 2 per min | Czech Republic, Slovakia, Poland | None |
| 2S3, 180-mm towed | 30,400 | 43,800 | 1 per min | 1 per 2 min | India, Iraq, Egypt, Syria | None |
| 2S3, 152-mm SP | 20,600 | 24,000 | 4 per min | 1 per min | Hungary, Iraq, Libya, Syria | None |
| 2S19, 152-mm SP | 24,700 | 30,000 | 8 per min | 8 per min | None | LGM |
| 2S5, 152-mm SP | 28,400 | 37,000 | 5 per min | 5 per min | None | None |
| 2A36, 152-mm towed | 28,400 | 37,000 | 5 per min | 1 per min | Finland | None |
| D-20, 152-mm towed | 17,230 | 30,000 | 5 per min | 1 per min | Algeria, China, Cuba, Egypt, Vietnam, Former Yugoslavia | None |

**Table H-3. World Artillery, Mortars, and Rocket Launchers. (Continued)**

| Manufacturer/ Weapon | Basic Range (m) | Base Burn/ RAP Range (m) | Rate of Fire | | Countries/ Organizations Possessing | Remarks |
|---|---|---|---|---|---|---|
| | | | Maximum | Sustained | | |
| BM 14, 122-mm MRL | | 9,800 | 16 per min | Reload | Algeria, China, Afghanistan, Cambodia, Egypt, Syria, North Korea, Vietnam | CHEM |
| BM 21, 140-mm MRL | | 20,400 | 40 per min | Reload | China, Egypt, India, Iran, Iraq, North Korea, others | CHEM, mines |
| 2S1, 122-mm SP | 15,300 | 22,000 | 8 per min | 1.1 per min | None | None |
| D-30, 122-mm towed | 15,300 | 22,000 | 8 per min | 1.1 per min | China | None |
| 2S9, 120-mm SP mortar | 8,900 | 13,000 | 6 per min | 6 per min | Afghanistan | LGM |
| 2S23, 120-mm SP mortar | 8,900 | 12,900 | 10 per min | 10 per min | None | LGM |
| 2B9, 82-mm SP towed mortar | 4,300 | | 120 per min | | Hungary | None |
| **South Africa** | | | | | | |
| G-6, 155-mm SP | 30,800 | 39,600 | 3 per 21 sec | 4 per min | UAE, Oman | None |
| G-5, 155-mm towed | 30,200 | 39,000 | 3 per min | 3 per min | None | None |
| **United Kingdom** | | | | | | |
| FH 70, 155-mm towed | 24,700 | 31,500 | 3 per 13 sec | 2 per min | Germany, Italy, Japan, Saudi Arabia | None |
| **Former Yugoslavia** | | | | | | |
| M-77, 128-mm MRL | | 20,600 | 32 per min | Reload | Iraq, Bosnia, Bosnian Serb Army, Croatia, Montenegro, Serbia | None |

**NOTE:** A complete listing of all world artillery systems and their characteristics is available in the classified National Ground Intelligence Center series *Field Artillery Worldwide*. Reference Defense Science and Technology (DST) 1130S-115-94, *Cannon and Mortars*; DST 1130S-94 Vol. 2, Sup. 1; and NGIC 1143-200D-95, *Multiple Rocket Launcher Systems*.

**LEGEND:**

| | | | |
|---|---|---|---|
| CHEM | chemical munitions capable | MRL | multiple rocket launcher |
| CIS | Commonwealth of Independent States | NUKE | nuclear munitions capable |
| INA | information not available | PLO | Palestine Liberation Organization |
| IRA | Irish Republican Army | SP | self-propelled |
| LGM | laser-guided munitions capable | UAE | United Arab Emirates |

# GLOSSARY

## Section I. Acronyms and Abbreviations

AAA ..... antiaircraft artillery
ACA ..... airspace coordination area
ACE ..... aviation combat element
ACM ..... airspace coordinating measure
ADA ..... air defense artillery
ADAM ..... area denial artillery munition
AFATDS ..... Advanced Field Artillery Tactical Data System
APICM ..... antipersonnel improved conventional munition
ASAP ..... as soon as possible
ATO ..... air tasking order

BBDPICM ..... base burn dual-purpose improved conventional munitions
BDA ..... battle damage assessment
BP ..... battle position

CAS ..... close air support
C-FST ..... company fire support team
CLRF ..... common laser range finder
COF ..... conduct of fire
CP ..... concrete piercing
CVT ..... controlled variable time (fuze)

DAGR ..... Defense Advanced Global Positioning System Receiver
DASC ..... direct air support center
DPICM ..... dual-purpose improved conventional munitions

FAC ..... forward air controller
FAC(A) ..... forward air controller (airborne)
FASCAM ..... family of scatterable mines
FDC ..... fire direction center
FDO ..... fire direction officer
FFCC ..... force fires coordination center
FLIR ..... forward-looking infrared
FM ..... frequency modulation
FO ..... forward observer
FOM ..... figure of merit
FPF ..... final protective fire
FSCC ..... fire support coordination center
FSO ..... fire support officer

ft ..... foot/feet
FW ..... fixed-wing

GPS ..... Global Positioning System
GTL ..... gun-target line
GURF ..... guns up ready to fire (report)

HA ..... holding area
HB ..... high burst
HC ..... hexachloroethane
HE ..... high explosive
HELLFIRE ..... helicopterborne fire and forget missile
HE/Q ..... high explosive /fuze quick
HF ..... high frequency
HHQ ..... higher headquarters
HOB ..... height of burst
hr ..... hour

ICM ..... improved conventional munitions
in ..... inch
IP ..... initial point
IR ..... infrared

JFO ..... joint fires observer
JP ..... joint publication
JTAC ..... joint terminal attack controller
JTAR ..... joint tactical air strike request

km ..... kilometer

LGW ..... laser-guided weapon
LTD/R ..... laser target designator/ranger

m ..... meter
m/mil ..... milliradian
MAGTF ..... Marine air-ground task force
MCRP ..... Marine Corps reference publication
MCTP ..... Marine Corps tactical publication
MGRS ..... military grid reference system
MHz ..... megahertz
min ..... minute
mm ..... millimeter(s)
MOS ..... military occupational specialty
mph ..... miles per hour
MPI ..... mean point of impact (artillery)
mps ..... meters per second
MSL ..... mean sea level

MTL ..... maneuver-target line
MTO ..... message-to-observer
mW ..... megawatt

NGLO ..... naval gunfire liaison officer
NLT ..... not later than
nm ..... nautical mile
NSFS ..... naval surface fire support
NVG ..... night vision goggle

OAS ..... offensive air support
OB ..... observer-burst
OF ..... observed fire
OP ..... observation post
OPORD ..... operation order
OT ..... observer-target
OTL ..... observer-target line
oz ..... ounce

PD ..... point detonating
PER ..... probable error in range
PLGR ..... precise lightweight global positioning system receiver
POSREP ..... position report
PRF ..... pulse repetition frequency

RAAMS ..... remote antiarmor mine system
RALS ..... right, add, left, subtract
RP ..... red phosphorus
RW ..... rotary-wing

SACC ..... supporting arms coordination center
SALUTE ..... size, activity, location, unit, time, and equipment
SAM ..... surface-to-air missile
SEAD ..... suppression of enemy air defenses
sec ..... second
SHELREP ..... shelling report
SLoCTOP ..... security, location, communications, targeting, observation, and position improvement
SOP ..... standing operating procedure

TAC(A) ..... tactical air coordinator (airborne)
TACC ..... tactical air control center (Navy)
TACP ..... tactical air control party
TOF ..... time of flight
TOT ..... time on target
TRP ..... target reference point
TTT ..... time to target

UHF ..... ultrahigh frequency
US ..... United States
UTM.....universal transverse mercator
UTO ..... universal time observed

VHF ..... very high frequency
VT ..... variable time (fuze)

WP ..... white phosphorous

## Section II. Definitions

**add**—In artillery and naval fire support, a correction used by an observer/spotter to indicate that an increase in range along a spotting line is desired. (MCRP 1-10.2)

**adjust fire**—In artillery and naval fire support: 1. A method of control transmitted in the call for fire by the observer or spotter to indicate that he will control the adjustment. 2. An order or request to initiate an adjustment of fire. See also call for fire. (As contained in this glossary, this term and definition are applicable to this publication only.)

**adjustment of fire** (NATO)—Process used in artillery and naval gunfire to obtain correct bearing, range, and height of burst (if time fuzes are used) when engaging a target by observed fire. (Army) — Pertains to mortar fire also. (See also call for fire.) See FM 6-20. (As contained in this glossary, this term and definition are applicable to this publication only.)

**air**—In artillery and naval gunfire support, a spotting, or an observation, by a spotter or an observer to indicate that a burst or group of bursts occurred before impact. (As contained in this glossary, this term and definition are applicable to this publication only.)

**airburst**—An explosion of a bomb or projectile above the surface as distinguished from an explosion on contact with the surface or after penetration. (As contained in this glossary, this term and definition are applicable to this publication only.)

**altitude**—The vertical distance of a level, a point or an object considered as a point, measured from mean sea level. See also **drop altitude; elevation; minimum safe**. (DOD Dictionary)

**battle damage assessment**—The estimate of damage composed of physical and functional damage assessment, as well as target system assessment, resulting from the application of lethal or nonlethal military force. Also called **BDA**. See also **combat assessment**. (DOD Dictionary)

**battle damage assessment**—(See DOD Dictionary for core definition. Marine Corps amplification follows.) The timely and accurate estimate of the damage resulting from the application of military force. Battle damage assessment estimates physical damage to a particular target, functional damage to that target, and the capability of the entire target system to continue its operations. (MCRP 1-10.2)

**bracketing**—(DOD, NATO) A method of adjusting fire in which a bracket is established by obtaining an over and a short along the spotting line, and then successively splitting the bracket in half until a target hit or desired bracket is obtained. See FM 6-30. (As contained in this glossary, this term and definition are applicable to this publication only.)

**close air support**—Air action by fixed-wing and rotary-wing aircraft against hostile targets that are in close proximity to friendly forces and that require detailed integration of each air mission with the fire and movement of those forces. Also called **CAS**. See also **air interdiction**; **immediate mission request; preplanned mission request**. (DOD Dictionary)

**correction**—Any change in firing data to bring the mean point of impact or burst closer to the target. A communications procedure word to indicate that an error in data has been announced and the corrected data will follow. (As contained in this glossary, this term and definition are applicable to this publication only.)

**danger close**—In close air support, artillery, mortar, and naval gunfire support fires, it is the term included in the method of engagement segment of a call for fire which indicates that friendly forces are within close proximity of the target. The close proximity distance is determined by the weapon and munition fired. See also **final protective fire**. (DOD Dictionary)

**designate**—A command given to lase a target for a laser-guided weapon. (As contained in this glossary, this term and definition are applicable to this publication only.)

**direct air support center**—The principal air control agency of the Marine air command and control system responsible for the direction and control of air operations directly supporting the ground combat element. Also called **DASC**. (DOD Dictionary)

**direct fire**—Fire delivered on a target using the target itself as a point of aim for either the weapon or the director. (DOD Dictionary)

**down** (NATO)—In artillery and naval gunfire support: 1. A term used in a call for fire to indicate that the target is at a lower altitude than the reference point used in identifying the target. 2. A correction used by an observer/spotter to indicate that a decrease in height of burst is desired. (Army) — Includes mortars and direct fire. See FMs 6-20, 7-90, 7-91, 17-12, and 23-1. (As contained in this glossary, this term and definition are applicable to this publication only.)

**drop**—In artillery and naval gunfire support, a correction used by an observer/spotter to indicate that a decrease in range along a spotting line is desired. (AAP-6) Denotes a shift correction, a decrease in the observer-target distance. (As contained in this glossary, this term and definition are applicable to this publication only.)

**final protective line**—A line of fire selected where an enemy assault is to be checked by interlocking fire from all available weapons. A final protective line may be parallel with, or oblique to, the front of the position. Also called **FPL**. (As contained in this glossary, this term and definition are applicable to this publication only.)

**fire direction center**—That element of a command post, consisting of gunnery and communications personnel and equipment, by means of which the commander exercises fire direction and/or fire control. Also called **FDC**. (DOD Dictionary)

**fire for effect**—(DOD) That volume of fires delivered on a target to achieve the desired effect. (NATO) 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. Also called **FFE**. See also **call for fire; destroy; final protective fire; fire mission; neutralize; suppression**. (As contained in this glossary, this term and definition are applicable to this publication only.)

**fire support area**—An appropriate maneuver area assigned to fire support ships by the naval force commander from which they deliver gunfire support to an amphibious operation. (DOD Dictionary)

**fire support station**—An exact location at sea within a fire support area from which a fire support ship delivers fire. (DOD Dictionary)

**fuze**—A device which initiates an explosive train. (As contained in this glossary, this term and definition are applicable to this publication only.)

**fuze** (**specify**)—In artillery and naval gunfire support, a command or request to indicate the type of fuze action desired; i.e., delay, quick, time, proximity. (As contained in this glossary, this term and definition are applicable to this publication only.)

**gon**—A measurement of plane angles, corresponding to 1/400 of a full circle, thus dividing a right angle in 100. The unit is also known as the grad, grade or gradian. One gon is equal to 9/10 of a degree or $\pi/200$ of a radian. (As contained in this glossary, this term and definition are applicable to this publication only.)

**graze**—In artillery and naval gunfire support, a spotting, or an observation, by a spotter or an observer to indicate that all bursts occurred on impact. (As contained in this glossary, this term and definition are applicable to this publication only.)

**gun-target line**—An imaginary straight line from gun to target. Also called **GTL**. (DOD Dictionary)

**high-angle fire**—Fire delivered at angles of elevation greater than the elevation that corresponds to the maximum range of the gun and ammunition concerned; fire, the range of which decreases as the angle of elevation is increased. (Army) Fire delivered to clear an obstacle (such as a hill) that low-angle fire cannot, or fire delivered to attack targets on the reverse side of an obstacle (such as a hill) that cannot be attacked with low-angle or direct fire. (As contained in this glossary, this term and definition are applicable to this publication only.)

**immediate smoke**—A mission fired, normally by a platoon, to immediately screen or obscure the enemy and/or friendly positions or movement. (As contained in this glossary, this term and definition are applicable to this publication only.)

**immediate suppression**—A fire for effect-type mission, fired normally by battery standing operating procedures, in which a platoon fires to force the enemy to take cover. (As contained in this glossary, this term and definition are applicable to this publication only.)

**indirect fire**—Fire delivered on a target that is not itself used as a point of aim for the weapons or the director. See also **direct laying**. (As contained in this glossary, this term and definition are applicable to this publication only.)

**lateral spread**—A technique used to place the mean point of impact of two or more units 100 meters apart on a line perpendicular to the gun-target line. (As contained in this glossary, this term and definition are applicable to this publication only.)

**line**—In artillery and naval gunfire support, a spotting, or an observation, used by a spotter or an observer to indicate that a burst(s) occurred along the observer target line. (As contained in this glossary, this term and definition are applicable to this publication only.)

**list of targets**—A tabulation of confirmed or suspect targets maintained by any echelon for informational and fire support planning purposes. (As contained in this glossary, this term and definition are applicable to this publication only.)

**low-angle fire**—Fire delivered at angles of elevation below the elevation that corresponds to the maximum range of the gun and ammunition concerned. (As contained in this glossary, this term and definition are applicable to this publication only.)

**maximum ordinate**—In artillery and naval gunfire support, the height of the highest point in the trajectory of a projectile above the horizontal plane passing through its origin. Also called **vertex height**. (DOD Dictionary)

**mean point of impact**—The point whose coordinates are the arithmetic means of the coordinates of the separate points of impact/burst of a finite number of projectiles fired or released at the same aiming point under a given set of conditions. (As contained in this glossary, this term and definition are applicable to this publication only.)

**naval surface fire support**— Fire provided by Navy surface gun and missile systems in support of a unit or units. Also called NSFS. (DOD Dictionary)

**observation post**—A position from which military observations are made, or fire directed and adjusted, and which possesses appropriate communications; may be airborne. Also called **OP**. (As contained in this glossary, this term and definition are applicable to this publication only.)

**observed fire fan**—A device used to refine an observer's estimation of distance in the target area. (Field Manual 6-30)

**observer-target factor**—The distance from the observer to the target in meters, expressed to the nearest thousand then divided by one thousand. (for example, the observer-target factor for 6,300 meters is 6). (As contained in this glossary, this term and definition are applicable to this publication only.)

**observer-target line**—An imaginary straight line from the observer/spotter to and through the target. (As contained in this glossary, this term and definition are applicable to this publication only.)

**point target**—A target of such small dimension that it requires the accurate placement of ordnance in order to neutralize or destroy it. It is generally a target that is less than 200 meters in

length and width. (As contained in this glossary, this term and definition are applicable to this publication only.)

**projectile**—An object projected by an applied exterior force and continuing in motion by virtue of its own inertia, as a bullet, shell, or grenade. Also applied to rockets and to guided missiles. (As contained in this glossary, this term and definition are applicable to this publication only.)

**range spread**—The technique used to place the mean point of impact of two or more units 100 meters apart on the gun-target line. (As contained in this glossary, this term and definition are applicable to this publication only.)

**reduced charge**—1. The smaller of the two propelling charges available for naval guns. 2. Charge employing a reduced amount of propellant to fire a gun at short ranges as compared to a normal charge. (DOD Dictionary)

**reference line**—A convenient and readily identifiable line used by the observer or spotter as the line to which spots will be related. (As contained in this glossary, this term and definition are applicable to this publication only.)

**reference point**—A prominent, easily identified terrain feature to which an observer knows the direction. (Field Manual 6-30)

**refinement**—A final correction sent to the fire direction center to move the center of impact to the adjusted point; always given for any mission. (Field Manual 6-30)

**registration fire**—Fire delivered to obtain accurate data for subsequent effective engagement of targets. (As contained in this glossary, this term and definition are applicable to this publication only.)

**round**—One shot fired by a weapon. (As contained in this glossary, this term and definition are applicable to this publication only.)

**rounds complete**—(NATO) In artillery and naval fire support, the procedural term used to indicate that the number of rounds ordered at "fire for effect" have been fired. [Note: the Army definition also applies to mortar fire.] (As contained in this glossary, this term and definition are applicable to this publication only.)

**salvo**—1. In naval gunfire support, a method of fire in which a number of weapons are fired at the same target simultaneously. 2. In close air support or air interdiction operations, a method of delivery in which the release mechanisms are operated to release or fire all ordnance of a specific type simultaneously. (DOD Dictionary)

**sheaf**—In artillery, mortar and naval gunfire support, planned planes (lines) of fire that produce a desired pattern of bursts with rounds fired in two or more weapons. (As contained in this glossary, this term and definition are applicable to this publication only.)

**shell (specify)**—A command or request indicating the type of projectile to be used. (As contained in this glossary, this term and definition are applicable to this publication only.)

**shelling report**—Any report of enemy shelling containing information on caliber, direction, time, density and area shelled. (As contained in this glossary, this term and definition are applicable to this publication only.)

**ship adjust**—In naval gunfire, a method of control in which the ship can see the target and adjust the fire. (As contained in this glossary, this term and definition are applicable to this publication only.)

**shot**—A report that indicates that a gun or guns have been fired. (As contained in this glossary, this term and definition are applicable to this publication only.)

**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. (As contained in this glossary, this term and definition are applicable to this publication only.)

**spotting**—A process of determining by visual or electronic observation, deviations of artillery or naval gunfire from the target in relation to a spotting line for the purpose of supplying necessary information for the adjustment or analysis of fire. (As contained in this glossary, this term and definition are applicable to this publication only.)

**spotting line**—Any straight line to which the fall of shot of projectiles is related or fire is adjusted by an observer or a spotter. (DOD Dictionary)

**spreading fire**—A notification by the spotter or the naval gunfire ship, depending on who is controlling the fire, to indicate that fire is about to be distributed over an area. (As contained in this glossary, this term and definition are applicable to this publication only.)

**summit**—The highest altitude above mean sea level that a projectile reaches in its flight from the gun to the target; the algebraic sum of the maximum ordinate and the altitude of the gun. (DOD Dictionary)

**supporting arms**—Weapons and weapons systems of all types employed to support forces by indirect or direct fire. (DOD Dictionary)

**suppression of enemy air defenses**—Activity that neutralizes, destroys, or temporarily degrades surface-based enemy air defenses by destructive and/or disruptive means. Also called **SEAD**. (DOD Dictionary)

**sustained rate of fire**—Actual rate of fire that a weapon can continue to deliver for an indefinite length of time without seriously overheating. (DOD Dictionary)

**target number**—The reference number given to a target. (As contained in this glossary, this term and definition are applicable to this publication only.)

**time of flight**—In artillery, mortar, and naval gunfire support, the time in seconds from the instant a weapon is fired, launched, or released from the delivery vehicle or weapons system to the instant it strikes or detonates. (MCRP 3-12A)

**time on target**—The actual time at which munitions impact the target. (DOD Dictionary) The local time, expressed in minutes after the hour, when the forward air controller desires ordnance impact on target. Also called **TOT**. (MCRP 1-10.2)

**trajectory**—The path of a projectile, missile, or bomb in flight. (As contained in this glossary, this term and definition are applicable to this publication only.)

**Universal Time**— A measure of time that conforms, within a close approximation, to the mean diurnal rotation of the Earth and serves as the basis of civil timekeeping. Also called ZULU time. (Formerly called Greenwich Mean Time.) (DOD Dictionary)

**up**—(NATO) In artillery and naval fire support: a. A term used in a call for fire to indicate that the target is higher in altitude than the point which has been used as a reference point for the target location. b. A correction used by an observer or a spotter in time fire to indicate that an increase in height of burst is desired. [Note: the Army definition also applies to mortar fire.] (Army) Indirect fire, a term used to move the point of aim higher than the previous point of aim, usually expressed in mils. (As contained in this glossary, this term and definition are applicable to this publication only.)

# REFERENCES

## Joint Issuances

Joint Publications (JPs)

3-09 Joint Fire Support

3-09.3 Close Air Support

Miscellaneous

DOD Dictionary of Military and Associated Terms

Joint Munitions Effectiveness Manual

## Army Publications

Technical Manual (TM)

11-5820-1172-13&P *Operator and Maintenance Manual Defense Advanced GPS Receiver (DAGR) Satellite Signals Naviagtion Set*

Miscellaneous

Graphic Training Aid 06-07-003, *Observed Fire Fan*

National Ground Intelligence Center series *Field Artillery Worldwide*. Defense Science and Technology (DST) 1130S-115-94, *Cannon and Mortars* DST 1130S-94 Vol. 2, Sup. 1; and NGIC 1143-200D-95, *Multiple Rocket Launcher Systems*

## Marine Corps Publications

Marine Corps Reference Publications (MCRPs)

1-10.2 Marine Corps Supplement to the Department of Defense Dictionary of Military and Associated Terms

3-31.6 Multi-Service Tactics, Techniques, and Procedures for the Joint Application of Firepower (JFIRE)

3-20F.7 Marine Air Traffic Control Detachment Handbook

Marine Corps Tactical Publication (MCTP)

3-10F Fire Support Coordination in the Ground Combat Element

A non-cost copy of this document is available at:

https://www.marines.mil/News/Publications/MCPEL/

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