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## APPENDIX D

### CRATER ANALYSIS

**Crater analysis is an important step toward defeating the enemy's countermortar effort. By conducting a simple analysis of the craters produced by enemy fire and by reporting the results, the mortar leader can provide valuable information about the enemy. Crater analysis is the responsibility of all mortar leaders. It is especially important during low-intensity conflict.**

#### D-1. EQUIPMENT

Most of the equipment needed to conduct crater analysis is available in the mortar platoon or section. A key piece, the curvature template, must be constructed.

a. A *declinated aiming circle (or M2 compass)*, *stakes*, and *twine or communications wire* are used to obtain the direction from the crater to the weapon that fired the projectile.

b. A curvature template is used to measure the curvature of a fragment to determine the caliber of the shell (Figure D-1). The template can be constructed of heavy cardboard, acetate, wood, or other appropriate material.

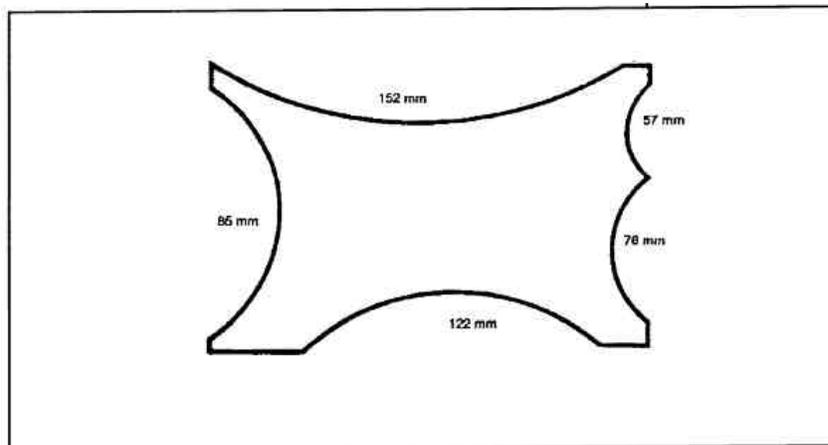


Figure D-1. Curvature template.

## **D-2. VALUE OF ANALYSIS**

By studying shelling reports based on crater analysis, artillery experts at division artillery can--

- a. Confirm the existence of suspected enemy locations.
- b. Confirm the type of enemy artillery and obtain an approximate direction to it.
- c. Detect the presence of new types of enemy weapons, new calibers, or new ammunition manufacturing methods.

## **D-3. INSPECTION OF SHELLED AREAS**

Shelled areas should be inspected as soon after the shelling. Craters that are exposed to the elements or are abused by personnel deteriorate quickly and lose their value as a source of information.

## **D-4. CRATER LOCATION**

Craters must be located accurately for plotting on charts, maps, or aerial photographs. Deliberate survey is not essential; hasty survey techniques or map spotting usually suffices. Grid locations provided by GPS receivers are sufficiently accurate. Direction can be determined by using an aiming circle or a compass.

## **D-5. DETERMINATION OF DIRECTION**

A clear pattern produced on the ground by the detonating shell indicates the direction from which the shell came.

- a. In determining direction, the mortar leader considers the following:
  - The effects of stones, vegetation, stumps, and roots in the path of the projectile.
  - Variations in density and type of soil.
  - The slope of the terrain at the point of impact.

From any group, use only the most clearly defined and typical craters.

- b. The direction from which a round was fired is often indicated by the marks made as it passes through trees, snow, or walls. Leaders must not overlook the possible deflection of the shell upon impact with these objects.
- c. Often, when an artillery round with a delay fuze is fired at low angle, it bounces or ricochets from the surface of the earth. In doing so, it creates a groove, called a *ricochet furrow*. Leaders must determine if the shell was deflected before or while making the furrow.

## **D-6. CRATER ANALYSIS PROCEDURES**

The actual crater created by enemy fire is an excellent source of information to the artillery counterfire planners. The mortar platoon leader should conduct immediate crater analysis and report the results.

- a. The first step in crater analysis is to locate a usable crater for determining the direction to the hostile weapon. The crater should be clearly defined on the ground and reasonably fresh. Since the crater is the beginning point for plotting the direction to the enemy weapon, the mortar platoon leader determines the grid coordinates of the crater as an eight-digit grid or as precisely as time and method used allow. He determines the direction to the firing weapon by one of the methods described in the following paragraphs. He can collect shell fragments for identifying the type and caliber of the weapon.
- b. The projectile direction of flight is determined with reasonable accuracy from its crater or ricochet furrow. By accurately locating the crater and determining the direction of flight, the mortar leader can obtain the azimuth that will pass through or near the enemy position. He can determine the direction to an enemy battery from only one crater or ricochet furrow. However, plotting the intersection of the azimuths from at least three widely separated groups of craters is more accurate.
- c. Differences in angle of fall, projectile burst patterns, directions of flight, and time fuze settings can help to distinguish between enemy batteries.

### **NOTES:**

1. Refer to FM 3-100 for guidance on friendly troop safety from the effects of craters contaminated with chemical agents.
2. Refer to STANAG 2002 in FM 3-100 for guidance in marking craters containing chemical, biological, or radiological contamination.
3. Refer to TC 6-50, The Field Artillery Cannon Battery, Appendix K for detailed explanations of the procedures used to measure the direction from a crater towards the enemy firing position.

## **D-7. LOW-ANGLE FUZE QUICK CRATERS (ARTILLERY)**

The detonation of a low-angle artillery 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.

## **D-8. LOW-ANGLE FUZE DELAY CRATERS (ARTILLERY)**

There are two types of fuze delay craters: ricochet furrow and mine action.

a. **Ricochet Furrow.** The projectile enters the ground and continues in a straight line for a few feet, causing a ricochet furrow. The projectile normally deflects upward; at the same time, it changes direction, usually to the right as the result of the spin of the projectile. The effect of the airburst can be noted on the ground. Directions obtained from ricochet craters are considered to be the most reliable.

b. **Mine Action.** A mine action crater occurs when a shell bursts beneath the ground. Occasionally, such a burst leaves a furrow that can be analyzed the same as the ricochet furrow. A mine action crater that does not have a furrow cannot be used to determine the direction to the weapon.

#### **D-9. MORTAR SHELL CRATERS (HIGH ANGLE)**

In typical mortar crater, the turf at the forward edge (the direction away from the hostile mortar) is undercut. The rear edge of the crater is shorn of vegetation and grooved by splinters. When fresh, the crater is covered with loose earth, which must be carefully removed to disclose the firm, burnt 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 approximate straight line. This line is perpendicular to the line of flight if the crater is on level ground or on a slope with contours perpendicular to the plane of fire. A fuze tunnel is caused by the fuze burying itself at the bottom of the inner crater in front of the point of detonation.

#### **D-10. ROCKET CRATERS**

A crater resulting from a rocket impacting with a low or medium angle of fall is analyzed the same as a crater resulting from an artillery projectile armed with fuze quick. However, if the rocket impacts with a high angle of fall, the crater is analyzed the same 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 the caliber and type of rocket fired.

#### **D-11. SHELL FRAGMENT ANALYSIS**

An expert can identify a shell as to caliber, type, and nation of origin from shell fragments found in the shell crater.

#### **D-12. SHELLING REPORTS**

The division artillery is responsible for counterfire. Therefore, BOMREPs, SHELREPs, and MORTREPs should be forwarded quickly through fire support channels.

a. Regardless of how little information has been obtained, leaders must not hesitate to forward these reports. Fragmentary or incomplete information (a radio or telephone

report) is often valuable in supplementing or confirming existing information. This radio or telephone report may be followed by a written report.

b. Any usable fragments obtained from crater analysis should be tagged (shoe tag) and sent to the battalion S2. As a minimum, the tag must indicate the following:

- The location of the crater.
- The direction to the hostile weapon.
- The date-time group of the shelling.