MCRP 3-15.2A
FM 23-90

Mortars

U.S. Marine Corps

PCN 144 000100 00

PREFACE

This publication prescribes guidance for leaders and crewmen of mortar squads and platoons. It is concerned with the problems of mortar crew training. It presents practical solutions to assist in the timely delivery of accurate mortar fires but does not discuss all possible situations. Local requirements may dictate minor variations from the methods and techniques described herein. However, principles should not be violated by modification of techniques and methods.

The scope of this publication includes mortar crew training at squad and section levels. The 60-mm mortar, M224; 81-mm mortar, M29A1; 81-mm mortar, M252; 4.2-inch (107-mm) mortar, M30; and 120-mm mortar, M120, are discussed herein to include nomenclature, sighting, equipment, characteristics, capabilities, ammunition, and maintenance.

Note: For clarity and simplicity, the artwork in this manual does not show soldiers in BDUs. The words and required art detail cannot be seen due to the camouflage on BDUs.

The provisions of this publication are the subject of international agreements:

QSTAG 900	Characteristics of a Multirole Mortar Fuze (Edition One)
STANAG 2321	NATO Code of Colors for the Identification of Ammunition (Except Ammunition of a Caliber Below 22 millimeters)

The proponent of this manual is HQ TRADOC. Submit changes for improving this publication on DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forward it to US Army Infantry School, ATTN: ATSH-INB-O, Fort Benning, GA 31905-5594.

Unless otherwise stated, whenever the masculine gender is used, both men and women are included.

FM 23-90
TECHNICAL ORDER 11W2-5-13-21
1 MARCH 2000

By Order of the Secretary of the Army:

ERIC K. SHINSEKI
General, United States Army
Chief of Staff

Official:

JOEL B. HUDSON
Administrative Assistant to the
Secretary of the Army
0000505

DISTRIBUTION: *Active Army, Army National Guard, and U.S. Army Reserve*: To be distributed in accordance with the initial distribution number 110209, requirements for FM 23-90.

*FM 23-90/TO 11W2-5-13-21

FIELD MANUAL
NO. 23-90
TECHNICAL ORDER
NO. 11W2-5-13-21

HEADQUARTERS
DEPARTMENT OF THE ARMY
AND THE AIR FORCE
WASHINGTON, DC, 1 March 2000

FM 23-90
MCRP 3-15.2A

MORTARS

Table of Contents

PREFACE

CHAPTER 1 INTRODUCTION

Section I General Doctrine
- 1-1. Effective Mortar Fire
- 1-2. Mortar Positions

Section II Indirect Fire Team
- 1-3. Applications
- 1-4. Team Mission

Section III Safety Procedures
- 1-5. Duties of the Safety Officer and Supervisory Personnel
- 1-6. Ammunition Care and Handling
- 1-7. Field Storage of Ammunition

CHAPTER 2 SIGHTING AND FIRE CONTROL EQUIPMENT

Section I Compass, M2
- 2-1. Characteristics
- 2-2. Description
- 2-3. Use

Section II Aiming Circles, M2 and M2A2

2-4. Characteristics
2-5. Description
2-6. Use
2-7. Accessory Equipment
2-8. Setup and Leveling of Aiming Circle
2-9. Declination Constant
2-10. Orienting of the Instrument on Grid North to Measure Grid Azimuth to Objects
2-11. Measurement of Horizontal Angle Between Two Points
2-12. Orienting of the 0-3200 Line on a Given Grid Azimuth
2-13. Orienting of the 0-3200 Line on a Given Magnetic Azimuth
2-14. Verifying the Lay of the Platoon
2-15. Orienting by Orienting Angle
2-16. Disassembly of Aiming Circle
2-17. Care and Maintenance

Section III Sightunits
2-18. Sightunit, M53-Series
2-19. Operation of M53 Sightunit
2-20. Care and Maintenance of M53 Sightunit
2-21. Sightunit, M64-Series
2-22. Sightunit, M67

Section IV Boresights
2-23. Boresight, M45-Series
2-24. Boresight, M115
2-25. Principles of Operation
2-26. Installation
2-27. Sight Calibration
2-28. Boresight Method of Calibration
2-29. Calibration for Deflection Using the M2 Aiming Circle

Section V Other Equipment
2-30. Instrument Light, M53E1
2-31. Aiming Posts, M14 and M1A2
2-32. Aiming Post Lights, M58 and M59

Section VI Laying the Section
2-33. Reciprocal Laying

2-34. Reciprocal Laying on a Grid Azimuth
2-35. Reciprocal Laying on a Magnetic Azimuth
2-36. Reciprocal Laying Using the Orienting Angle
2-37. Reciprocal Laying Using the Mortar Sights
2-38. Reciprocal Laying Using the M2 Compass
2-39. Placing Out Aiming Posts
2-40. Alternate Method of Placing Out Aiming Posts
2-41. Correction for Displacement of Sight
Section VII Loading and Firing
2-42. Firing the Mortar
2-43. Target Engagement
2-44. Execution of Fire Commands
2-45. Arm-and-Hand Signals
2-46. Subsequent Fire Commands
2-47. Repeating and Correcting of Fire Commands
2-48. Reporting of Errors in Firing
2-49. Night Firing
CHAPTER 3 60-mm MORTAR, M224
Section I Squad and Section Organization and Duties
3-1. Organization
3-2. Duties
Section II Components
3-3. Tabulated Data
3-4. Cannon Assembly, M225
3-5. Baseplate, M7
3-6. Baseplate, M8
3-7. Bipod Assembly, M170
Section III Operation
3-8. Premount Checks
3-9. Mounting of the Mortar
3-10. Safety Checks Before Firing
3-11. Small Deflection and Elevation Changes
3-12. Large Deflection and Elevation Changes
3-13. Referring of the Sight and Realignment of Aiming Posts
3-14. Malfunctions

3-15. Removal of a Misfire
3-16. Dismounting and Carrying of the Mortar
Section IV Ammunition
3-17. Classification
3-18. Color Codes
3-19. Preparation of Ammunition
3-20. Types of Fuzes
3-21. Standard B Ammunition
3-22. Care and Handling
CHAPTER 4 81-mm MORTAR, M252
Section I Squad and Section Organization and Duties
4-1. Organization
4-2. Duties
Section II Components
4-3. Tabulated Data
4-4. Cannon Assembly, M253
4-5. Mount, M177
4-6. Baseplate, M3A1
Section III Operation
4-7. Premount Checks
4-8. Mounting of the Mortar
4-9. Safety Checks Before Firing
4-10. Small Deflection and Elevation Changes
4-11. Large Deflection and Elevation Changes
4-12. Referring of the Sight and Realignment of Aiming Posts Using M64 Sight
4-13. Malfunctions
4-14. Removal of a Misfire
4-15. Dismounting of the Mortar
Section IV Ammunition
4-16. Classification
4-17. Function
4-18. High-Explosive Ammunition
4-19. Red/White Phosphorus Ammunition
4-20. Illuminating Ammunition

4-21. Types of Fuzes
4-22. Characteristics of Proximity Fuzes
4-23. Fuze Wrench and Fuze Setter
4-24. Preparation of Ammunition
4-25. Care and Handling

CHAPTER 5 81-mm MORTAR, M29A1

Section I Squad and Section Organization and Duties
5-1. Organization
5-2. Duties

Section II Components
5-3. Tabulated Data
5-4. Cannon Assembly, M29A1
5-5. Bipod Assembly, M23A1
5-6. Baseplate, M3

Section III Operation
5-7. Premount Checks
5-8. Mounting of the Mortar
5-9. Safety Checks Before Firing
5-10. Small Deflection and Elevation Changes
5-11. Large Deflection and Elevation Changes
5-12. Referring of the Sight and Realignment of Aiming Posts Using M53 Sight
5-13. Malfunctions
5-14. Removal of a Misfire
5-15. Dismounting of the Mortar

Section IV Ammunition
5-16. Function
5-17. High-Explosive Ammunition
5-18. White Phosphorus Ammunition
5-19. White Phosphorus Ammunition
5-20. Types of Fuzes
5-21. Characteristics of Proximity Fuzes
5-22. Fuze Wrench and Fuze Setter
5-23. Preparation of Ammunition
5-24. Care and Handling

CHAPTER 6 4.2-INCH MORTAR, M30

Section I Squad and Section Organization and Duties

6-1. Organization

6-2. Duties

6-3. Section Drill and Section Leader Duties

Section II Components

6-4. Tabulated Data

6-5. Mortar Cannon, M30

6-6. Mortar Mount, M24A1

Section III Operation of Ground-Mounted Mortar

6-7. Mounting of the Mortar

6-8. Safety Checks Before Firing

6-9. Small Deflection Change

6-10. Large Deflection and Elevation Changes

6-11. Loading and Firing of M329A2 Round

6-12. Malfunctions

6-13. Removal of a Misfire

6-14. Dismounting of the Mortar

Section IV Mortar Carriers, M106, M106A1, and M106A2

6-15. Description

6-16. Tabulated Data

Section V Operation of Carrier-Mounted Mortar

6-17. Mortar and Vehicular Mount

6-18. Maintenance

6-19. Placement of Mortar Into Firing Position on Carrier

6-20. Laying for Deflection and Elevation

6-21. Removal of a Misfire (Carrier-Mounted)

6-22. Mounting of Mortar on Carrier From Ground-Mounted Position

6-23. Dismounting of Mortar From Carrier

6-24. Preparation for a March Order From Ground-Mounted Position

6-25. Safety Checks

6-26. Measurement of Minimum and Maximum Elevations

6-27. Squad Formations

6-28. Dismounted Mortar Squad

6-29. Reciprocally Laying the Mortar Carrier Section

Section VI Ammunition

6-30. Classification

6-31. Types of Fuzes

6-32. Preparation of Ammunition

6-33. Care and Handling

CHAPTER 7 120-mm MORTAR, M120

Section I Squad and Section Organization and Duties

7-1. Organization

7-2. Duties

Section II Components

7-3. Tabulated Data for the 120-mm Mortar, M120

7-4. Barrel Assembly, M298

7-5. Bipod Assembly, M191 (Carrier-/Ground-Mounted)

7-6. Bipod Assembly, M190 (Ground-Mounted)

7-7. Baseplate, M9

Section III Operations

7-8. Placing a Ground-Mounted 120-mm Mortar Into Action

7-9. Performing Safety Checks on a Ground-Mounted 120-mm Mortar

7-10. Performing Small Deflection and Elevation Changes on a Ground-Mounted 120-mm Mortar

7-11. Performing Large Deflection and Elevation Changes on a Ground-Mounted 120-mm Mortar

7-12. Malfunctions on a Ground-Mounted 120-mm Mortar

7-13. Performing Misfire Procedures on a Ground-Mounted 120-mm Mortar During Combat

7-14. Loading and Firing the Ground-Mounted 120-mm Mortar

7-15. Taking the 120-mm Mortar Out of Action

Section IV Mortar Carrier, M1064A3

7-16. Description

7-17. Tabulated Data for the M1064A3 Carrier

Section V Operation of a Carrier-Mounted 120-mm Mortar

7-18. Mortar and Vehicular Mount

7-19. Maintenance

7-20. Placing Carrier-Mounted 120-mm Mortar Into Action

7-21. Lay for Deflection and Elevation on a Carrier-Mounted 120-mm Mortar
7-22. Performing Misfire Procedures on a Carrier-Mounted 120-mm Mortar During Combat
7-23. Mounting of the Mortar From a Carrier to a Ground-Mounted Position
7-24. Taking the Mortar Out of Action (Ground-Mounted to M1064A3 Carrier-Mounted)
7-25. Performing Safety Checks on a Carrier-Mounted 120-mm Mortar
7-26. Reciprocally Laying the Mortar Carrier Section
Section VI Ammunition
7-27. Classification
7-28. Authorized Cartridges
7-29. Preparation for Firing
7-30. Loading and Firing
7-31. Unfired Cartridges
7-32. Care and Handling of Cartridges
7-33. Fuzes
7-34. Setting Fuzes
7-35. Resetting Fuzes
CHAPTER 8 FIRE WITHOUT A FIRE DIRECTION CENTER
Section I Fire Procedures
8-1. Advantages and Disadvantages
8-2. Firing Data
8-3. Observer Corrections
8-4. Initial Fire Commands
8-5. Fire Commands
8-6. Fire Control
8-7. Movement to Alternate and Supplementary Positions
8-8. Squad Conduct of Fire
8-9. Reference Line
8-10. Fire Adjustment
8-11. Squad Use of Illumination and Smoke
8-12. Attack of Wide Targets
8-13. Attack of Deep Targets

Section II Direct-Lay Method
8-14. Step 1: Initial Firing Data
8-15. Step 2: Referring the Sight
8-16. Step 3: Bracketing the Target
8-17. Step 4: Fire for Effect
Section III Direct-Alignment Method
8-18. Mortar Dismounted
8-19. Mortar Mounted
8-20. Natural Object Method
Section IV Adjustment of Range
8-21. Range Spottings
8-22. Miscellaneous Spottings
8-23. Bracketing Method
8-24. Creeping Method of Adjustment
8-25. Normal Fire Commands
8-26. Modified Fire Commands
8-27. Fire Control
8-28. Establishment of a Reference Line and Shifting From That Line
8-29. Ladder Method of Adjustment
CHAPTER 9 GUNNER'S EXAMINATION
Section I Preparatory Instruction
9-1. Methods of Instruction
9-2. Prior Training
9-3. Preparatory Exercises
9-4. Examining Board
9-5. Location and Date
9-6. Eligible Personnel
9-7. Qualification Scores
9-8. General Rules
Section II Gunner's Examination With Ground-Mounted Mortar
9-9. Subjects and Credits
9-10. Equipment
9-11. Organization
9-12. Procedure
9-13. Mounting of the Mortar

9-14. Small Deflection Change
9-15. Referring of the Sight and Realignment of Aiming Posts
9-16. Large Deflection and Elevation Changes
9-17. Reciprocal Laying
Section III Gunner's Examination With the Track-Mounted Mortar
9-18. Subjects and Credits
9-19. Equipment
9-20. Organization
9-21. Procedure
9-22. Placement of Mortar Into a Firing Position From Traveling Position
9-23. Small Deflection Change
9-24. Referring of the Sight and Realignment of Aiming Posts
9-25. Large Deflection and Elevation Changes
9-26. Reciprocal Laying
9-27. Support Squad
APPENDIX A TRAINING DEVICES
APPENDIX B MORTAR TRAINING STRATEGY
GLOSSARY
REFERENCES
AUTHENTICATION

DISTRIBUTION RESTRICTION: Approved for public release, distribution is unlimited.

*****This publication supersedes FM 55-1, 30 November 1984.

CHAPTER 1

INTRODUCTION

The mission of the mortar platoon is to provide close and immediate indirect fire support for the maneuver battalions and companies.

Section I. GENERAL DOCTRINE

Doctrine demands the timely and accurate delivery of indirect fire to meet the needs of supported units. All members of the indirect fire team must be trained to quickly execute an effective fire mission.

1-1. EFFECTIVE MORTAR FIRE

For mortar fire to be effective, it must be dense enough and must hit the target at the *right* time with the *right* projectile and fuze. Good observation is necessary for effective mortar fire. Limited observation results in a greater expenditure of ammunition and less effective fire. Some type of observation is desirable for every target to ensure that fire is placed on the target. Observation of close battle areas is usually visual. When targets are hidden by terrain features or when great distance or limited visibility is involved, observation can be by radar or sound. When observation is possible, corrections can be made to place mortar fire on the target by adjustment procedures; however, lack of observation must not preclude firing on targets that can be located by other means.

a. Mortar fire must be delivered by the most accurate means that time and the tactical situation permit. When possible, survey data are used to accurately locate the mortar position and target. Under some conditions, only a rapid estimate of the location of weapons and targets may be possible. To achieve the most effective massed fires, a survey using accurate maps should be made of each mortar position, registration points, and targets.

b. The immediate objective is to deliver a large volume of accurate and timely fire to inflict as many casualties as possible on the enemy. The number of casualties inflicted in a target area can usually be increased by surprise fire. If surprise massed fires cannot be achieved, the time required to bring effective fires on the target should be kept to a minimum. The greatest demoralizing effect on the enemy can be achieved by delivery of a maximum number of effective rounds from all the mortars in the shortest possible time.

c. Mortar units must be prepared to accomplish multiple fire missions. They can provide an immediate, heavy volume of accurate fire for sustained periods. Mortars are suppressive indirect fire (high-angle-of-fire) weapons. They can be

employed to neutralize or destroy area or point targets, screen large areas with smoke, and to provide illumination or coordinated HE/illumination.

d. In the armor and mechanized infantry battalions, mortars are normally fired from mortar carriers; however, they maintain their capability to be ground-mounted. Firing from the carrier permits rapid displacement and quick reaction.

1-2. MORTAR POSITIONS

Mortars should be employed in defilade to protect them from enemy direct fire and observation, and to take the greatest advantage of their indirect fire role. Although the use of defilade precludes sighting the weapons directly at the target (direct lay), it is necessary for survivability. Because mortars are indirect fire weapons, special procedures ensure that the weapon and ammunition settings used will cause the projectile to burst on or above the target. A coordinated effort by the indirect fire team ensures the timely and accurate engagement of targets.

Section II. INDIRECT FIRE TEAM

Indirect fire procedure is a team effort (Figure 1-1). Since the mortar is normally fired from defilade (where the crew cannot see the target), the indirect fire team gathers and applies the required data. The team consists of an FO, an FDC, and the gun squad.

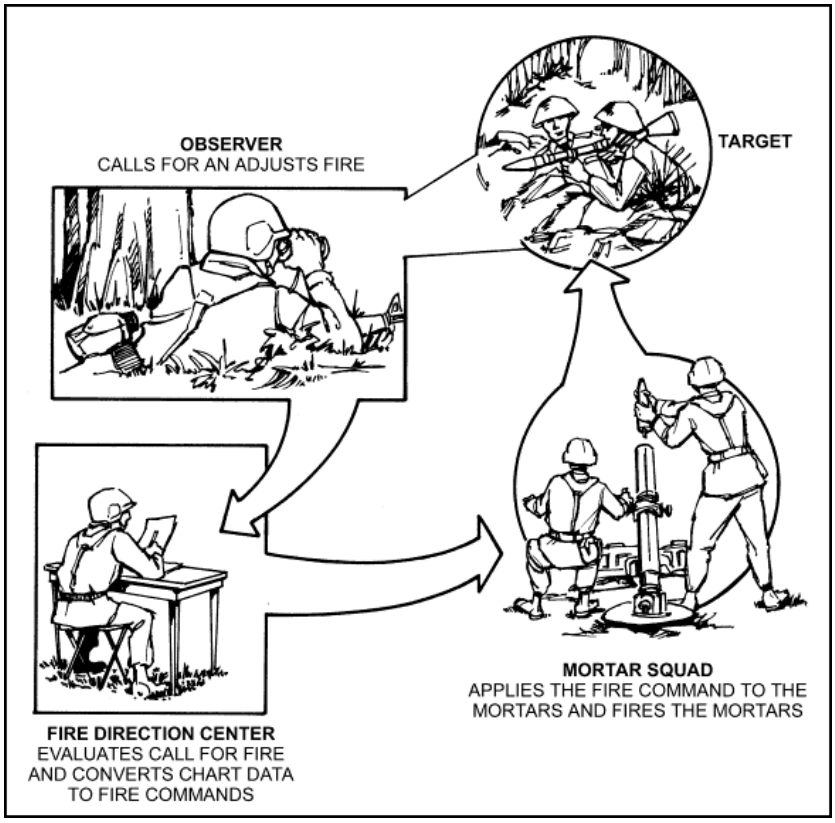


Figure 1-1. Indirect fire team.

1-3. APPLICATIONS

To successfully accomplish missions from a defilade position, certain steps must be followed in applying essential information and engaging targets.

- Locate targets and mortar positions.
- Determine chart data (direction, range, and vertical interval from mortars to targets).
- Convert chart data to firing data.
- Apply firing data to the mortar and ammunition.

1-4. TEAM MISSION

The team mission is to provide accurate and timely response to the unit it supports. Effective communication is vital to the successful coordination of the efforts of the indirect fire team.

a. The forward observer (FO), as part of the fire support team (FIST), is normally provided by a direct support (DS) artillery battalion. One 4-man FO team supports each mechanized infantry company. The light infantry company is supported by a 10-man company-level FO team. The team is composed of a lieutenant, staff sergeant, radio-telephone operator, driver with a HMMWV at company headquarters, and six FOs (one 2-man team for each infantry platoon in the company). The FO's job is to find and report the location of targets, and to request and adjust fire.

b. The fire direction center (FDC) has two computer personnel who control the mortar firing. They convert the data in a call for fire from the FO into firing data that can be applied to the mortars and ammunition.

c. A mortar squad consists of three to five mortarmen, depending on the system. The squad lays the mortar and prepares the ammunition, using the data from the FDC fire command. When those data have been applied, the squad fires the mortar--it must also be able to fire without an FDC.

Section III. SAFETY PROCEDURES

Although safety is a command responsibility, each member of the mortar fire team must know safety procedures and enforce them. Misfire procedures discussed in this field manual are based on peacetime operations. (See ARTEP 7-90-Drill for combat operations.)

1-5. DUTIES OF THE SAFETY OFFICER AND SUPERVISORY PERSONNEL

Safety officers must help commanders meet the responsibility of enforcing safety procedures. The safety officer has two principal duties: first, to ensure that the section is properly laid so that when rounds are fired, they land in the impact area; second, to ensure that all safety precautions are observed at the firing point.

a. **Duties Before Departing for Range**. The safety officer must read and understand the following:

- AR 385-63.
- Post range and terrain regulations.
- The terrain request of the firing area to know safety limits and coordinates of firing positions.
- Appropriate field and technical manuals pertaining to weapons and ammunition to be fired.

b. **Duties of Supervisory Personnel**. Supervisory personnel must know the immediate action to be taken for firing accidents. The following is a list of *minimum* actions that must be taken if an accident occurs.

(1) Administer first aid to injured personnel, then call for medical assistance.

(2) If the ammunition or equipment presents further danger, move all personnel and equipment out of the area.

(3) Do not change any settings on or modify the position of the mortar until an investigation has been completed.

(4) Record the ammunition lot number involved in the accident or malfunction and report it to the battalion ammunition officer. If a certain lot number is suspected, its use should be suspended by the platoon leader.

c. **Mortar Range Safety Checklist**. A mortar range safety checklist can be written for local use. The following is a suggested checklist, which can also include three columns on the right titled "Yes," "No," and "Remarks."

(1) *Items to check before firing.*

(a) Is a range log or journal maintained by the officer in charge?

(b) Is radio or telephone communication maintained with--

- Range control?
- Unit S3?
- Firing crews?
- Forward observers?
- Road or barrier guards?

(c) Are the required emergency personnel and equipment present on the range?

- Properly briefed and qualified medical personnel.
- A wheeled or tracked ambulance.
- Fire-fighting equipment.

(d) Are the following range controls and warning devices available, readily visible, and in use during the firing exercise?

- Barrier/road guards briefed and in position.
- Road barriers in position.
- Red range flag in position.

- Blinking red lights for night firing.
- Signs warning trespassers to beware of explosive hazards and not to remove duds or ammunition components from ranges.
- Noise hazard warning signs.

(e) Are current copies of the following documents available and complied with?

- AR 385-63.
- Technical and field manuals pertinent to the mortar in use.
- Appropriate firing tables.
- Installation range regulations.

(f) Are the following personal safety devices and equipment available and in use?

- Helmets.
- Protective earplugs.
- Protective earmuffs.

(g) Is the ammunition the correct caliber, type, and quantity required for the day's firing? Are the rounds, fuzes, and charges--

- Stored in a location to minimize possible ignition or detonation?
- Covered to protect them from moisture and direct sunlight?
- Stacked on dunnage to keep them clear of the ground?
- Strictly accounted for by lot number?
- Exposed only immediately before firing?
- Stored separately from ammunition and protected from ignition?

(h) Has the range safety officer verified the following?

- The mortar safety card applies to the unit and exercise.
- The firing position is correct and applies to the safety card, and the base mortar is within 100 meters of the surveyed firing point.
- Boresighting and aiming circle declination are correct.
- The plotting board or MBC is correct.
- The FO has been briefed on the firing exercise and knows the limits of the safety fan.
- The lay of each mortar is correct.
- The safety stakes (if used) are placed along the right and left limits.

- Each safety NCO and gunner has been informed in writing of the following:
  - Right and left limits (deflection).
  - Maximum elevation and charge.
  - Minimum elevation and charge.
  - Minimum time setting for fuzes.
- All personnel at the firing position have been briefed on safety misfire procedures.
- If the safety card specified overhead fire, firing is IAW AR 385-63.
- The mortars are safe to fire by checking--
  - Mask and overhead clearance.
  - Weapons and ammunition.
  - Properly seated sights on weapons.
  - Carefully positioned lights on the sights and aiming stakes for night firing.
- The OIC is informed that the range is cleared to fire and that range control has placed it in a "wet" status.

(2) *Items to check during firing.*

(a) Are the unit personnel adhering to the safety regulations?

(b) Is each charge, elevation, and deflection setting checked before firing?

(c) Does the safety NCO declare the mortar safe to fire before the squad leader announces, "Hang it, fire"?

(d) Do all gun settings remain at last data announced until a subsequent fire command is issued by the FDC?

(e) Are ammunition lots kept separate to avoid the firing of mixed lots?

(3) *Items to check after firing.*

(a) Have the gunners and safety NCO verified that no loose propellants are mixed with the empty containers?

(b) Has the safety NCO disposed of the unused propellants?

(c) Has the unused ammunition been inventoried and repacked properly?

(d) Have the proper entries been made in the equipment logbook (DA Form 2408-4).

(e) Has the OIC or safety officer notified range control of range status and other required information?

(f) Has a thorough range police been conducted?

d. **Safety Card**. The safety officer should receive a copy of the safety card from the OIC before allowing fire to begin. He constructs a safety diagram based on the information on the safety card. A safety card should be prepared and approved for each firing position and type of ammunition used. The form of the card depends upon local regulations (training list, overlay, range bulletin). Even without a prescribed format, it should contain the following:

- Unit firing or problem number.
- Type of weapon and fire.
- Authorized projectile, fuze, and charge zone.
- Grid of the platoon center.
- Azimuth of left and right limits.
- Minimum and maximum ranges and elevations.
- Any special instructions to allow for varying limits on special ammunition or situations.

e. **Safety Diagram**. The safety officer, on receipt of the safety card, constructs a safety diagram. The safety diagram is a graphic portrayal of the data on the safety card, which need not be drawn to scale but must accurately list the sight settings that delineate the impact area. The diagram serves as a convenient means of checking the commands announced to the gun crews against those commands that represent the safety limits.

(1) The diagram shows the right and left limits, expressed in deflections corresponding to those limits; the maximum and minimum elevations; and the minimum fuze settings (when applicable) for each charge to be fired. The diagram also shows the minimum and maximum range lines, the left and right azimuth limits, the deflections corresponding to the azimuth limits, and the direction on which the guns are laid. The safety diagram must show only necessary information.

(2) To accurately complete a safety diagram, the safety officer must use the information supplied by range control or, in the example in Figure 1-2, the safety card.

1. Enter the known data, supplied from the safety card, on the safety diagram.
2. Determine the azimuth center sector.

3. Determine mounting azimuth.
4. Determine mils left and right deviations of mounting azimuth.
5. Determine referred deflection.
6. Determine deflections to left and right limits.
7. Determine minimum and maximum charges and elevations.
8. If illumination is to be used, determine from the appropriate firing tables the minimum and maximum charges and ranges to burst and impact for the canister. The minimum range is used to determine the minimum charge and range to burst. The maximum range is used to determine the maximum charge and range to impact.

EXAMPLE

1. Place all data supplied by the safety card on the safety diagram at this time.
2. Add the right and left limits and divide by 2 to compute the azimuth center sector.

RIGHT LIMIT	0920
LEFT LIMIT	+ 0500
TOTAL	= 1420

TOTAL = 1420 divided by 2 = 0710

3. The answer 0710 is the azimuth center sector to use.
4. Determine mounting azimuth. For all mortars (M16 plotting board), round off to nearest 50 mils; for example, 0710 = 0700.
5. Determine referred deflection. It can be any number, but 2800 is normally used.
6. Determine referred deflection for left and right limits.
   a. Determine the number of mils from the mounting azimuth to the left limit.

MOUNTING AZIMUTH	0700
LEFT LIMIT	- 0500
MILS TO LEFT LIMIT	= 0200

   b. Using the LARS rule for referred deflection, calculate the left limit deflection.

CENTER OF SECTOR	
REFERRED DEFLECTION	2800
MILS TO LEFT LIMIT	+ 0200
LEFT LIMIT DEFLECTION	= 3000

   c. Determine the number of mils from the mounting azimuth to the right

limit.

RIGHT LIMIT	0920
MOUNTING AZIMUTH	- 0700
MILS TO RIGHT LIMIT	= 0220

d. Using the LARS rule for referred deflection, calculate the right limit deflection.

CENTER OF SECTOR	
REFERRED DEFLECTION	2800
MILS TO RIGHT LIMIT	- 0220
RIGHT LIMIT DEFLECTION	= 2580

7. Determine minimum and maximum charges and elevations by using the firing tables for the mortar being fired.

Note: When determining deflections for 4.2-inch mortars, add the minimum drift for the minimum range to the left limit deflection and maximum drift for the maximum range to the right limit deflection. This is the responsibility of the section sergeant.

Figure 1-2. Example of how to complete a safety diagram (continued).

1-6. AMMUNITION CARE AND HANDLING

A complete round of mortar ammunition contains all the components needed to get the round out of the tube and to burst it at the desired place and time. The key to proper ammunition functioning is protection. Rounds prepared but not fired should be placed back in their containers, fin end first. Safety is always a matter of concern for all section personnel, and it requires special attention where ammunition is concerned. Supervision is critical, because improper care and handling can cause serious accidents as well as inaccurate fire. Following are some of the principles of proper ammunition handling.

- Never tumble, drag, throw, or drop individual cartridges or boxes of cartridges.
- Do not allow smoking, open flames, or other fire hazards around ammunition storage areas.
- Inspect each cartridge before it is loaded for firing. Dirty ammunition can damage the weapon or affect the accuracy of the round.
- Keep the ammunition dry and cool.
- Never make unauthorized alterations or mix components of one lot with another.

Note: For care and handling of specific mortar rounds, see corresponding chapter in this manual.

a. **Projectiles/Cartridges**. Each projectile must be inspected to ensure that there is no leakage of the contents, and that the projectile is correctly assembled. The HE 4.2-inch mortar projectiles are issued without a fuze. Each is issued with a removable supplementary charge so that it can be used with an impact, mechanical, or VT (proximity) fuze.

b. **Burning of Unused Propelling Charges**. Mortar increments and propelling charges are highly flammable, and they must be handled with extreme care to preclude exposure to heat, flame, or any spark-producing source. This includes exposure to the hot residue from burning increments or propelling charges that float downward after a cartridge leaves the barrel. Like other types of ammunition, increments and propelling charges must be kept cool and dry. Storing these items inside the ammunition boxes until needed is an effective way to prevent premature combustion.

(1) Unused charges must not be saved but should be removed to a storage area until they can be burned or otherwise disposed of.

(2) Burning increments create a large flash and a lot of smoke. In a tactical environment, the platoon leader must ensure that burning increments do not compromise camouflage and concealment. The burning of increments in a dummy position, if established, can aid in the deception effort. The safety officer, in a range environment, supervises the disposal of unused propellant increments.

c. **Fuzes**. Never fire a round with a fuze that is not authorized for that round. Specific fuzes available for each weapon system are discussed in this manual.

(1) Fuzes are sensitive to shock and must be handled with care. Before fuzing a round, inspect the threads of the fuze and fuze well for cleanliness and crossed threads. The fuze should be screwed into the fuze well slowly until resistance is met and then firmly seated with a sharp twist of the M25 or M18 fuze wrench, as appropriate.

WARNING

Premature detonation may occur if a fuze is not properly seated.

(2) To prevent accidental functioning of the point-detonating elements of fuzes of the M524 series, the fuzes must not be dropped, rolled, or struck

under any circumstances. Any mechanical-time fuze that is set and modified must be reset to SAFE, and the safety wires (if applicable) must be replaced before the fuze is repacked in the original carton.

(3) All primers must be inspected before use for signs of corrosion. If a seal has been broken, it is likely that the primer has been affected by moisture and should be turned in.

d. **Segregation of Ammunition Lots**. Different lots of propellant burn at different rates and give slightly different effects in the target area. Therefore, the registration corrections derived from one lot do not always apply to another. Ammunition MUST be segregated by lot and weight zone (square weight [4.2-inch mortar only]). In the field storage area, on vehicles or in a dump, ammunition lots should be roped off with communications wire or twine and conspicuously marked with a cardboard sign or other marker.

1-7. FIELD STORAGE OF AMMUNITION

Most ammunition components can be stored at temperatures as low as -80 degrees F for not longer than three days and as high as 160 degrees F for not longer than four hours.

a. The greatest hazards to ammunition in the storage area are weather, enemy fire, NBC contamination, improper handling, and accidental fires. Regardless of the method of storage, those hazards must be considered. Some general considerations that apply to storage are as follows:

(1) Stack ammunition by type, lot number, and weight zone (Figure 1-3).

Note: WP ammunition must be stacked fuze-end up.

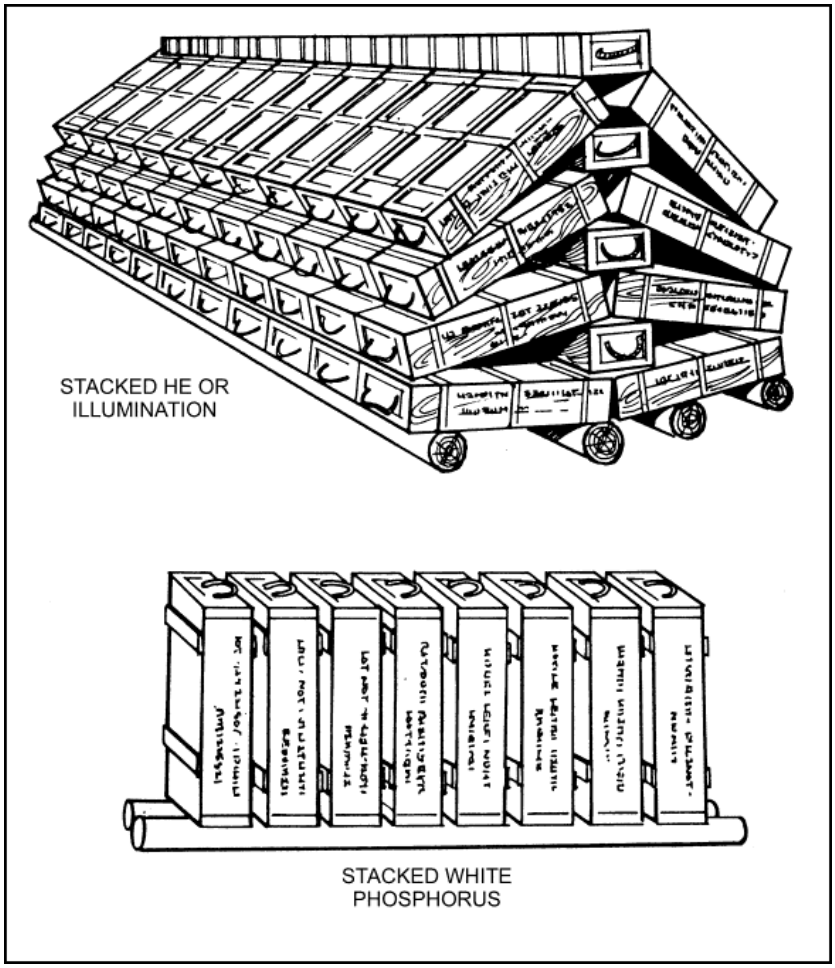


Figure 1-3. Stacked ammunition.

(2) If ammunition is being stored on the ground, use good strong dunnage at least 6 inches under each stack.

(3) Keep the ammunition dry and out of direct sunlight by storing it in a vehicle or covering it with a tarpaulin. Be sure adequate ventilation is provided around ammunition and between covering material and ammunition.

(4) Protect ammunition as much as possible from enemy indirect fires. If sandbags are used for protection, keep the walls at least 6 inches from the stacks and the roof at least 18 inches from the stacks to ensure proper ventilation.

b. An increase in malfunctions can occur with some proximity fuzes if fired when the temperature is below 0 degrees F or above 120 degrees F. Powder temperature affects the muzzle velocity of a projectile and is of frequent concern to the FDC.

CHAPTER 2

SIGHTING AND FIRE CONTROL EQUIPMENT

Proper employment of sighting and fire control equipment ensures effective fire against the enemy. This chapter describes this equipment and its applications.

Section I. COMPASS, M2

The compass (Figures 2-1 through 2-3) is used to measure azimuths or angles of site. It measures magnetic azimuths or grid azimuths, when the instrument has been declinated for the locality.

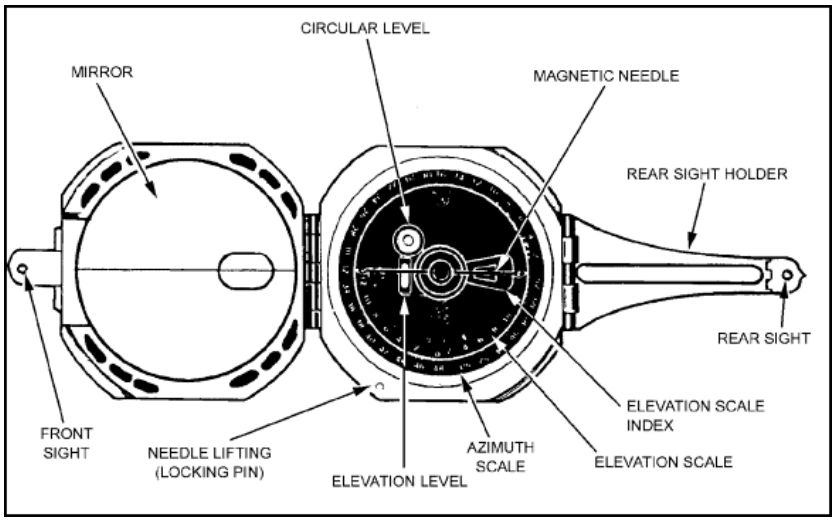


Figure 2-1. Compass, M2, (top view).

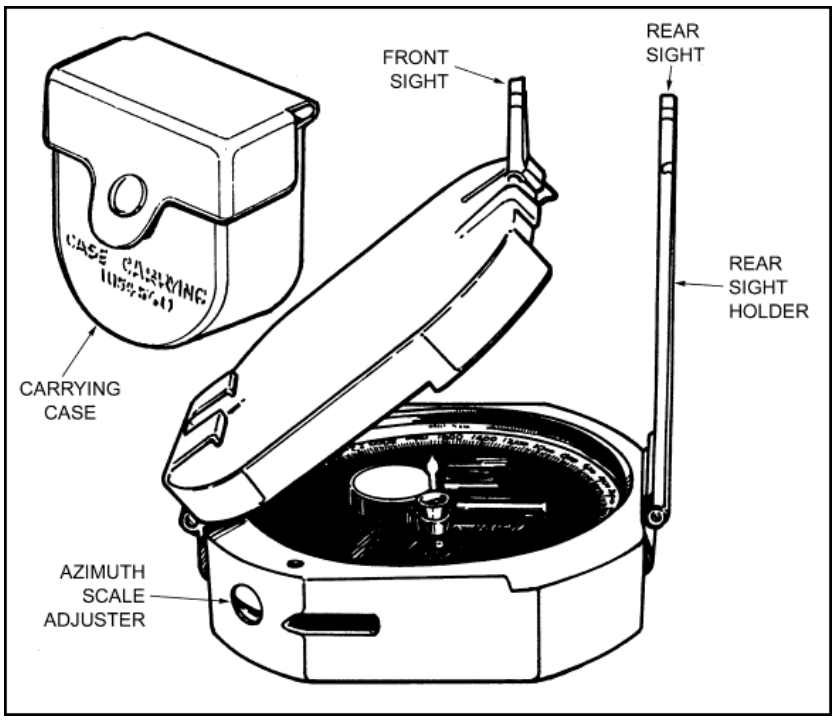


Figure 2-2. Compass, M2 (side view).

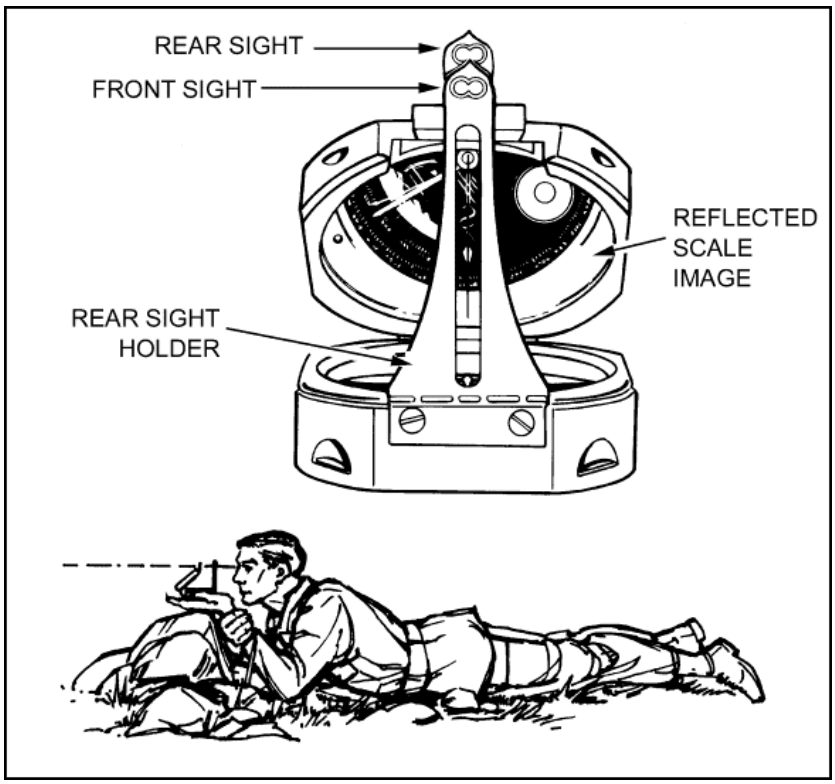


Figure 2-3. Compass, M2 (user's view).

Note: For detailed information, see TM 9-1290-333-15.

2-1. CHARACTERISTICS

The main characteristics of the M2 compass are:

Angle-of-site scale	1200-0-1200 mils
Azimuth Scale	0 to 6400 mils
Dimensions Closed	2 3/4 inches by 1 1/8 inches
Weight	8 ounces

2-2. DESCRIPTION

The principal parts of the compass are described herein.

a. **Compass Body Assembly**. This assembly consists of a circular glass window that covers the instrument, and keeps dust and moisture from its interior, protecting the compass needle and angle-of-site mechanism. A hinge assembly holds the compass cover in the position in which it is placed. A hole in the cover coincides with a small oval window in the mirror on the inside of the cover. A sighting line is etched across the face of the mirror.

b. **Angle-of-Site Mechanism**. The angle-of-site mechanism is attached to the bottom of the compass body. It consists of an actuating (leveling) lever located on the back of the compass, a leveling assembly with a tubular elevation level, and a circular level. The instrument is leveled with the circular level to read azimuths and with the elevation level to read angle of site. The elevation (angle-of-site) scale and the four points of the compass, represented by three letters and a star, are engraved on the inside bottom of the compass body. The elevation scale is graduated in two directions; in each direction it is graduated from 0 to 1200 mils in 20-mil increments and numbered every 200 mils.

c. **Magnetic Needle and Lifting Mechanism**. The magnetic needle assembly consists of a magnetized needle and a jewel housing that serves as a pivot. The north-seeking end of the needle is white. (The newer compasses have the north and south ends of the needle marked "N" and "S" in raised, white lettering.) On some compasses a thin piece of copper wire is wrapped around the needle for counterbalance. A lifting pin projects above the top rim of the compass body. The lower end of the pin engages the needle-lifting lever. When the cover is closed, the magnetic needle is automatically lifted from its pivot and held firmly against the window of the compass.

d. **Azimuth Scale and Adjuster**. The azimuth scale is a circular dial geared to the azimuth scale adjuster. This permits rotation of the azimuth scale about 900 mils in either direction. The azimuth index provides a means of orienting the azimuth scale at 0 or the declination constant of the locality. The azimuth scale is graduated from 0 to 6400 in 20-mil increments and numbered at 200-mil intervals.

e. **Front and Rear Sight**. The front sight is hinged to the compass cover. It can be folded across the compass body, and the cover is closed. The rear sight is made in two parts--a rear sight and holder. When the compass is not being used, the rear sight and holder are folded across the compass body and the cover is closed.

2-3. USE

The compass should be held as steadily as possible to obtain accurate readings. The use of a sitting or prone position, a rest for the hand or elbows, or a solid nonmetallic support

helps eliminate unintentional movement of the instrument. When being used to measure azimuths, the compass must not be near metallic objects.

a. To measure a magnetic azimuth--

(1) Zero the azimuth scale by turning the scale adjuster.

(2) Place the cover at an angle of about 45 degrees to the face of the compass so that the scale reflection is viewed in the mirror.

(3) Adjust the front and rear sights to the desired position. Sight the compass by any of these methods:

(a) Fold the rear sight holder out parallel with the rear sight of the compass face perpendicular to its holder. Sight through the window in the cover. If the object sighted is at a lower elevation than the compass, raise the rear sight holder as needed. The compass is correctly sighted when it is level and the black centerline of the window, rear sight, and object are aligned.

(b) Raise the front and rear sights perpendicular to the face of the compass (Figure 2-2 and Figure 2-3). Sight over the tips of the rear and front sights. The compass is correctly sighted when it is level and the tips of the sights and object are aligned.

(4) Hold the compass in both hands, at eye level, with the arms braced against the body and the rear sight near the eyes. For precise measurements, rest the compass on a nonmetallic stake or object.

(5) Level the instrument by viewing the circular level in the mirror and moving the compass until the bubble is centered. Sight on the object, look in the mirror, and read the azimuth indicated by the black (south) end of the magnetic needle.

b. To measure a grid azimuth--

(1) Index the known declination constant on the azimuth scale by turning the azimuth scale adjuster. Be sure to loosen the locking screw on the bottom of the compass. (The new lightweight [plastic] M2 compass has no locking screw.)

(2) Measure the azimuth as described above. The azimuth measured is a grid azimuth.

c. To measure an angle of site or vertical angle from the horizontal--

(1) Hold the compass with the left side down (cover to the left) and fold the rear sight holder out parallel to the face of the compass, with the rear sight perpendicular to the holder. Position the cover so that, when looking through the rear sight and the aperture in the cover, the elevation vial is reflected in the mirror.

(2) Sight on the point to be measured.

(3) Center the bubble in the elevation level vial (reflected in the mirror) with the level lever.

(4) Read the angle on the elevation scale opposite the index mark. The section of the scale graduated counterclockwise from 0 to 1200 mils measures plus angles of site. The section of the scale graduated clockwise from 0 to 1200 mils measures minus angles of site.

Section II. AIMING CIRCLES, M2 AND M2A2

The aiming circle is used to obtain angular values. It is a low-power telescope that is mounted on a composite body and contains a magnetic compass, adjusting mechanisms, and leveling screws for establishing a horizontal plane. The instrument is supported by a baseplate for mounting on a tripod. Angular measurements in azimuth are indicated on graduated scales and associated micrometers.

2-4. CHARACTERISTICS

The main characteristics of the aiming circles are described herein.

	M2	M2A2
Weight (w/o equipment)	9 pounds	9 pounds
Weight (w/equipment less batteries)	21 pounds	21 pounds
Azimuth rotation	6400 mils	6400 mils
Elevation (maximum)	800 mils	1100 mils
Depression (maximum)	400 mils	400 mils
Magnification	4 power	4 power
Field of view	10 degrees	10 degrees

2-5. DESCRIPTION

The M2 and M2A2 aiming circles consist of an elbow telescope mounted on orienting and elevating mechanisms, which are contained within a main housing. The main housing, in turn, is supported by adjusting screws through the baseplate.

2-6. USE

The M2 or M2A2 aiming circle (Figure 2-4) is used for the precise measurement of the azimuth and elevation angles of a ground or aerial target with the respect to a preselected baseline as required for the orientation of indirect fire weapons. It can also be used for general topographical surveying.

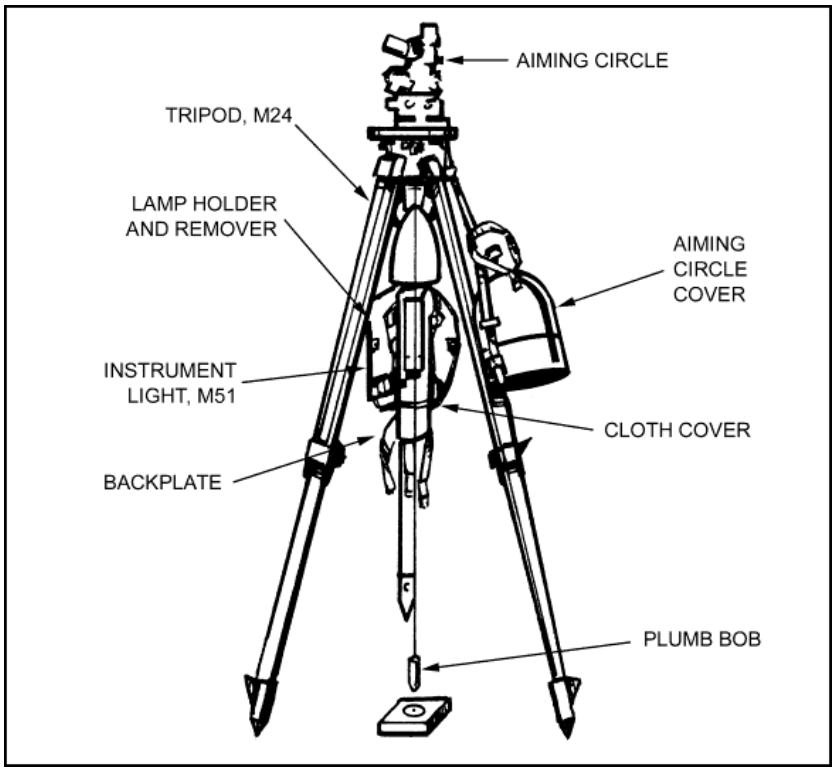


Figure 2-4. Aiming circles, M2 and M2A2, and accessory equipment.

Note: For detailed information, see TM 9-1290-262-15.

a. The orienting and elevating mechanisms permit unlimited azimuth orienting movement (360 degrees [6400 mils] and limited elevation and depression [M2, 1200 mils; M2A2, 1500 mils]). Azimuth orienting rotation is controlled by two orienting knobs (Figure 2-5). Azimuth measurement is controlled by the micrometer knob. Elevation and depression movement are controlled by the elevation micrometer knob. The azimuth micrometer worm can be disengaged to

provide rapid azimuth measurement of movement by exerting pressure on the azimuth micrometer knob against the pressure of an internal spring-loaded plunger. Releasing the pressure on the azimuth micrometer knob allows the mechanism to reengage. A similar throw-out mechanism permits the azimuth orienting worm to also be disengaged to provide rapid azimuth orienting movement.

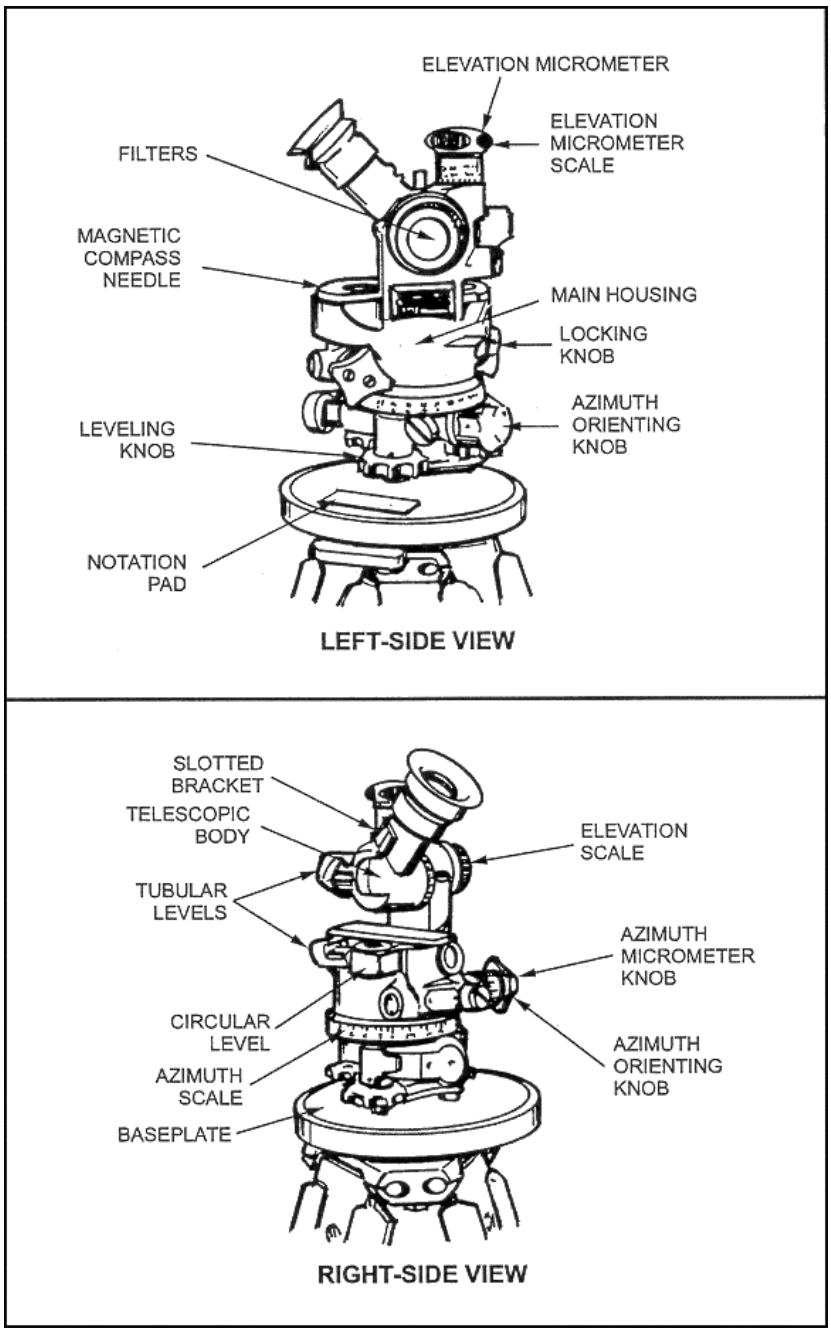

ELEVATION MICROMETER
ELEVATION MICROMETER SCALE
FILTERS
MAGNETIC COMPASS NEEDLE
MAIN HOUSING
LOCKING KNOB
AZIMUTH ORIENTING KNOB
LEVELING KNOB
NOTATION PAD
LEFT-SIDE VIEW
SLOTTED BRACKET
TELESCOPIC BODY
ELEVATION SCALE
TUBULAR LEVELS
AZIMUTH MICROMETER KNOB
CIRCULAR LEVEL
AZIMUTH SCALE
AZIMUTH ORIENTING KNOB
BASEPLATE
RIGHT-SIDE VIEW

Figure 2-5. Aiming circle, M2

b. The telescope of the aiming circle is a four-power, fixed-focus, elbow-type instrument. The reticle of the telescope contains cross lines graduated to give azimuth and elevation angular readings from 0 to 85 mils in 5-mil increments. Thus, the FO can read small angular values directly from the reticle without referring to the azimuth and elevation micrometer scales. An externally stowed filter is provided for protection against the rays of the sun. A slotted bracket provides the means of securing the lamp bracket on one lead wire of the M51 instrument light so that illumination of the reticle during night operation can be accomplished. The reflector can be illuminated and used in conjunction with the sightunits on the mortars during night operations to backlight the vertical centerline of the aiming circle.

c. Three levels are contained within the telescope body and main housing of the aiming circle. One tubular level, held between two bosses on the telescope body, is used to establish a true horizontal line-of-sight. The two bosses supporting this level are machined to form an open sight for approximate alignment of the telescope and target, and for quick or emergency sighting. One circular level and one tubular level are held within bosses on the main housing. The circular level is used for rough leveling of the aiming circle, and the tubular level is used for fine leveling adjustments. The three leveling screws on the baseplate are used to level the instrument and each is controlled by a leveling screw knob.

d. A magnetic compass needle is located in a recess in the top of the housing. A magnifier and rectangular reticle located at one end of the recess enable the FO to observe the end of the compass needle and to align the line of sight of the telescope with the needle. The compass needle can be locked in position by actuating the locking lever on the side of the housing.

e. Azimuth scales and elevation scales are employed to measure accurate azimuth or elevation angles. The scales provide coarse readings and the micrometer provides fine reading. The two readings added together give the angle. Graduation intervals and numeral scales are graduated into relatively large round number intervals for convenience in reading. The scale intervals are in graduations of 100 mils.

(1) The azimuth scale is graduated from 0 to 6400 mils (zero equals 6400). The upper series forms the main azimuth scale, colored black and numbered at 200-mil intervals. The lower series, colored red, is numbered from 0 to 3200 mils (the large zero in the main scale equals 3200). The red scale should only be used when verifying the lay of the aiming circle with another aiming circle.

(2) The azimuth micrometer scale is graduated at 1-mil intervals and numbered from 0 to 100 at ten 10-mil intervals.

(3) The elevation scale is graduated and numbered on both sides of 0. Minus (red) readings represent depression and plus (black) readings represent elevations at 100-mil intervals from minus 400 to 800 mils.

(4) The elevation micrometer scale is graduated at 1-mil intervals from 0 to 99 mils--large zero is designated 0 and 100. Red numerals represent depression and black numerals represent elevation.

f. A notation strip is provided on the baseplate. This strip is a raised and machined surface on which scale readings, settings, or other data can be recorded for reference.

2-7. ACCESSORY EQUIPMENT

The accessory equipment for the M2 aiming circle includes the aiming circle cover, M24 tripod, and the accessory kit which includes the M51 instrument light, backplate, cloth cover, plumb bob, and a lamp holder and remover. This equipment is mounted on the M24 tripod when the instrument is set up for use.

a. The *aiming circle cover* is a metal cover that protects and houses the aiming circle when not in use. It attaches to the baseplate of the aiming circle and can be carried by means of its strap. When the aiming circle is in use, the cover is placed on the tripod head cover.

b. The *M24 tripod* comprises three telescoping wooden legs hinged to a metal head, which contains a captive screw for attaching the aiming circle. When not in use, the tripod cover should be fitted on the head to protect the head and captive screw from damage, and the legs are held retracted by a strap. Attachments are provided so that the aiming circle cover and cloth cover with attached accessory equipment can be mounted on its legs when the aiming circle is set up for use. A hook is also provided from which the plumb bob can be suspended by means of its attaching thread when in use.

c. The *M51 instrument light* is a lighting device for use with the M2 aiming circle during night operations and for certain test and adjustment procedures. The light is flashlight battery-powered and contains two attaching lead wires. A lamp bracket attached to one lead wire can be inserted into the slotted bracket of the aiming circle telescope for illumination of the telescope reticle. A hand light, attached to the other lead wire, can be used for general-purpose illumination (scales, level vials, reflector, compass needle, and so forth). Rotation of the rheostat knob turns the two lamps on and off and increases or decreases the intensity of illumination.

d. The *backplate* provides the necessary clips and attachments for securing and protecting the instrument light and lamp bracket, hand light, and lead wires of the light. The plate with the attached instrument light is stored within the cloth cover.

e. The *cloth cover* is used to store the backplate and attached M51 instrument light. It is also used to store the plumb bob and a lamp holder and remover. When the aiming circle is set up for use, the cloth cover with attached equipment is mounted on one of the legs of the M24 tripod. When not in use, attached snap fasteners keep the cover in a closed position.

f. The *plumb bob* is used to aid in orienting the aiming circle over a certain grid point. It composes a pointed weight attached to a nylon thread that can be suspended from the hook under the tripod head when in use. The effective length of the thread can be adjusted by means of the slide. When not in use, the plumb bob is stored within the cloth cover.

g. A *lamp holder* and *remover* are used to hold spare incandescent lamps for the M51 instrument light. They also facilitate the removal and replacement of unserviceable lamps in the light.

2-8. SETUP AND LEVELING OF AIMING CIRCLE

The aiming circle must always be level during operation.

a. Unstrap the tripod legs, loosen the leg clamp thumbscrews, extend the legs so that the tripod is about chest high, and tighten the leg clamp thumbscrews. Spread the legs about 18 inches apart, adjust the legs so the tripod head is about level, and plant the feet firmly in the ground.

b. Remove the tripod head cover. Open the baseplate cover of the aiming circle head. Keeping the baseplate cover pointed toward you, thread the tripod guide screw assembly into the aiming circle until it is firmly seated. The base of the aiming circle should not protrude over the machine surface of the tripod head. Pull out and down on the strap latch assembly. Remove the cover and hang it on the tripod head cover.

c. If the instrument is to be set up over an orienting point, attach the plumb bob to the hook. Adjust the tripod legs and aiming circle head until it is over the point.

d. Loosen the leveling screws to expose sufficient threads (3/8 to 1/2 inch) on the three screws to permit the instrument to be leveled. Number the leveling screws clockwise, 1, 2, and 3 (Figure 2-6). Now place the tubular level vial over the notation pad. Grasp leveling screw number 1 between the thumb and forefinger of the right hand, and grasp leveling screw number 2 between the thumb and forefinger of the left hand. Turn the screws so that the thumbs move toward or away from each other. Using these two leveling screws, center the bubble. The bubble moves in the same direction as the left thumb.

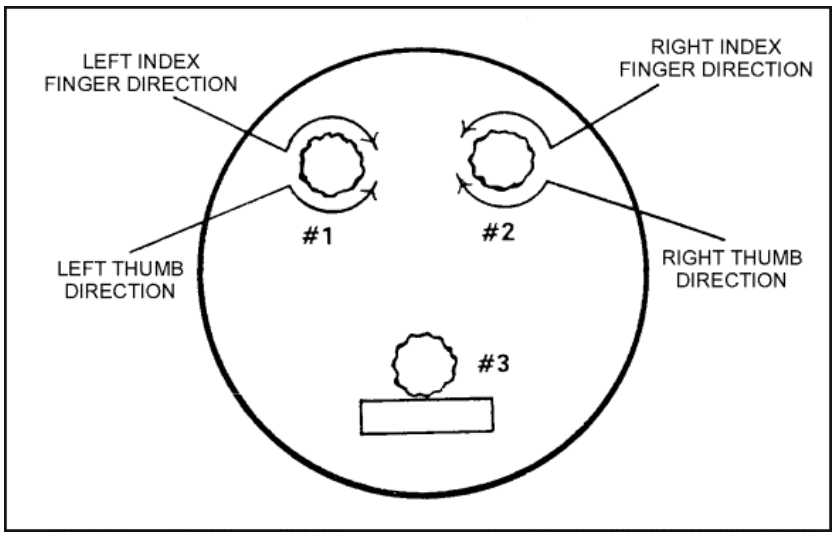


Figure 2-6. Leveling screws.

e. Rotate the aiming circle head until the magnifier is over the notation pad. Level the tubular level by turning only level screw number 3. The bubble should now remain level in any direction that the aiming circle is rotated. A variation of one graduation from the center of the vial is acceptable. If the bubble does not remain level, repeat this procedure.

Note: If the spring plate is bent, the aiming circle cannot be leveled and must be turned in to the DS maintenance unit.

f. The aiming circle should be set up at the distance indicated from the following objects:

OBJECT	DISTANCE (METERS)
High-tension power lines	150
Electronic equipment	150
Railroad tracks	75
Tanks and trucks	75
Vehicles	50
Barbed wire	30
Mortars or telegraph wire	25
Helmets, and so forth	10

2-9. DECLINATION CONSTANT

Since the magnetic needle of an aiming circle does not point to the grid north determined from a map, it is necessary to correct for this difference by using the declination constant. The declination constant of an instrument is the clockwise angle between grid north and magnetic north; that is, the grid azimuth of magnetic north. This constant differs slightly for different instruments and must be recorded on each instrument. The constant also varies for the same instrument in different localities. To determine the declination constant, proceed as follows:

a. **Declination Station**. Declination stations are established by corps artillery, division artillery, and artillery battalion survey teams to determine the declination constants of instruments and to correct for local attractions, annual variations, and instrument errors. When a unit moves from one locality to another, a station should be established where all instruments are declinated. If the declination constants for all instruments of a unit are determined at the same station, grid azimuths measured with each instrument will agree with the map grid, and all instruments will agree with each other. The point chosen for the declination station must have a view of at least two distant, well-defined points with a known grid azimuth. Two additional points are desirable, one in each quadrant, as a check.

b. **Procedure for Declinating Aiming Circle at a Declination Station**. Where a declination station is available, the procedure for declinating the aiming circle is as follows:

STEP 1. Set up and fine-level the aiming circle directly over the declination station marker using the plumb bob.

STEP 2. Place the grid azimuth of the first azimuth marker on the scales using the recording motion. Place the vertical cross line of the telescope on the azimuth marker using the nonrecording (orienting) motion. The aiming circle is now oriented on grid north.

STEP 3. With the recording motion, rotate the instrument to zero. Release the magnetic needle and look through the magnifier. Center the north-seeking needle using the recording motion, then relock the magnetic needle.

STEP 4. Notice the new azimuth on the scale, which is the declination constant--record it.

STEP 5. Recheck the aiming circle level and repeat steps 2 through 4 using the remaining azimuth markers until three readings have been taken. If there is only one marker, repeat the entire procedure twice using the same marker.

STEP 6. Find the average declination constant using these three readings.

EXAMPLE 1

1st point reading = 6399 mils
2d point reading = 6398 mils
3d point reading = 6398 mils

Total = 19195 mils

19195 ÷ 3 = 6398.3 (rounded off to the nearest whole number) = 6398 mils (average declination constant)

EXAMPLE 2

1st point reading = 0030 mils
2d point reading = 0031 mils
3d point reading = 0029 mils

Total = 0090 mils

0090 ÷ 3 = 0030 mils (average declination constant)

STEP 7. Record the average declination constant in pencil on the notation (strip) pad of the aiming circle as its declination constant. All readings should be within 2 mils of each other; if not, repeat steps 2 through 4. Ensure the aiming circle is directly over the station marker to obtain the 2-mil tolerance. If the desired 2-mil accuracy is not gained after two tries, the aiming circle is defective and should be turned in for repair.

c. **Use of the Grid-Magnetic Angle**. If an aiming circle is used in a new area without a declination station, a declination constant can be determined by using the grid-magnetic (GM) angle from a map. When the GM angle (converted to mils) is westerly, it is subtracted from 6400 mils. The remainder is the declination constant. When the GM angle is easterly, the angle (in mils) is the declination constant.

d. **Redeclination of an Aiming Circle**. An aiming circle is redeclinated when moved over 25 miles (40 kilometers) from the last declination station. It is also redeclinated upon initial issue, when returned from repair (if 30 days since last declinated), or if severely jolted.

e. **Procedure for Declinating an Aiming Circle When a Declination Station is Not Available**. This procedure is the least desirable and should be used only

when no other means are available. It does not compensate for the error that could be inherent in the aiming circle.

(1) Determine the GM angle from the map of the area in which the aiming circle is to be used. This GM angle is used as indicated below.

(2) In 1, Figure 2-7, the difference between grid north and magnetic north is 200 mils (westerly). This total is then subtracted from 6400 mils. The declination constant that can be used is 6200 mils.

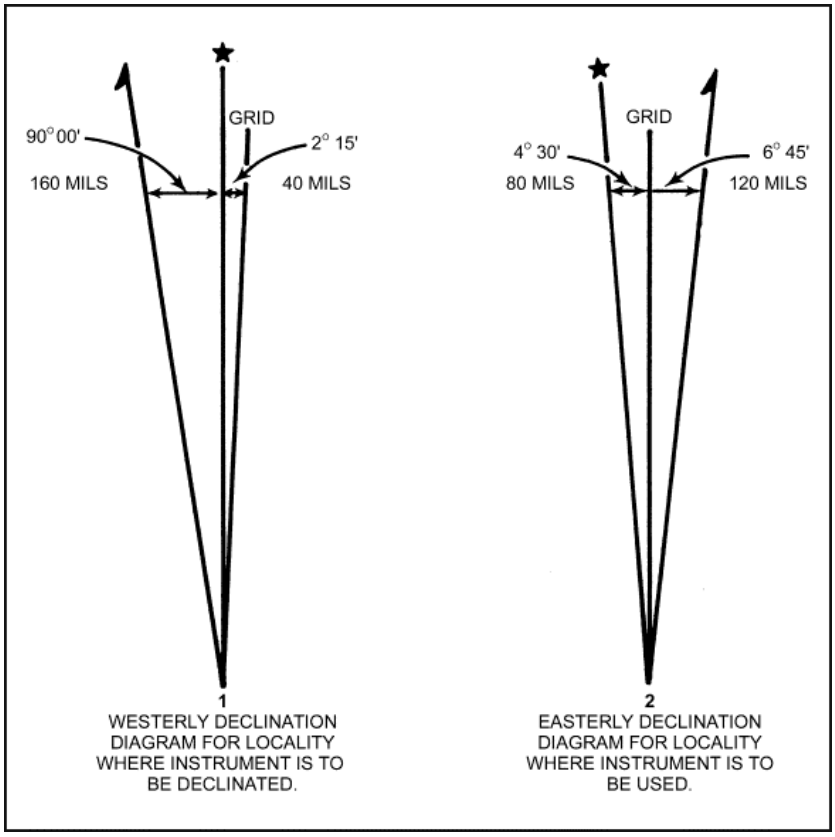


Figure 2-7. Marginal data from a map.

(3) In 2, Figure 2-7, the difference between grid north and magnetic north in a clockwise direction is 120 mils. This can be used as the declination constant.

f. **When to Declinate the Aiming Circle**. Certain rules prescribe how often and under what circumstances the aiming circle should be declinated to determine and keep the declination constant current. These rules are as follows:

(1) The aiming circle should be declinated when it is moved 25 miles or more from the area in which it was last declinated. A move of a few miles can change the relationship of grid north and magnetic north as measured by the instrument. In some locations, a move of less than 25 miles could require declination of the aiming circle.

(2) The aiming circle must be declinated after an electrical storm or after receiving a severe shock, such as a drop from the bed of a truck to the ground. The magnetic needle is a delicately balanced mechanism, and any shock can cause a significant change in the declination constant.

(3) The aiming circle should be declinated every 30 days to guard against changes that may have occurred due to unreported accidents to the instrument. If a radical change is observed, the instrument should be declinated again within a few days to determine if the observed change was due to a magnetic storm or is a real change in the characteristics of the instrument.

(4) The aiming circle should be declinated when it is initially received and when it is returned from support maintenance repair. Variations in the declination constant due to the time of day are not significant enough to warrant declinating again.

2-10. ORIENTING OF THE INSTRUMENT ON GRID NORTH TO MEASURE GRID AZIMUTH TO OBJECTS

The procedure to orient the aiming circle on grid north to measure grid azimuth to objects is as follows:

a. Level the instrument.

b. Set the azimuth micrometer and the azimuth scale on the declination constant of the instrument.

c. Release the magnetic needle.

d. With the orienting knob, align the south end of the needle accurately with the center etched line by using the magnetic needle magnifier.

e. Lock the magnetic needle and close the orienting knob covers.

f. Using the throw-out mechanism (azimuth knob), turn the telescope until the vertical line of the reticle is about on the object.

g. By rotating the azimuth knob, bring the vertical line exactly on the object.

h. Read the azimuth to the object on the azimuth and micrometer scales.

2-11. MEASUREMENT OF HORIZONTAL ANGLE BETWEEN TWO POINTS

To measure the horizontal angle between two points, at least two measurements should be made.

a. Set the azimuth micrometer and the azimuth scale at zero.

b. Rotate the instrument using the orienting knob throw-out mechanism until the vertical line of the telescope is about on the left edge of the left-hand object.

c. Lay the vertical line exactly on the right edge of the left-hand object by rotating the orienting knob.

d. Using the throw-out mechanism (azimuth knob), turn the telescope clockwise until the vertical line is about on the left edge of the right-hand object.

e. Lay the vertical line exactly on the left edge of the right-hand object by turning the azimuth knob.

f. Read the horizontal angle on the scales and record the value to the nearest 0.5 mil. This completes the first repetition.

g. Rotate the aiming circle, using the lower motion, until the vertical cross line is again on the rear station.

Note: The value obtained from the first repetition is still on the scales.

h. Rotate the aiming circle body, using the upper motion, until the vertical cross line is again on the forward station.

i. Read and record the accumulated value of the two measurements of the angle to the nearest 0.5 mil. This completes the second repetition.

j. Divide the second reading by 2 to obtain the mean angle to the nearest 0.1 mil. This mean angle must be within 0.5 mil of the first reading; if it is not, the measurement is void and the angle is measured again.

2-12. ORIENTING OF THE 0-3200 LINE ON A GIVEN GRID AZIMUTH

The procedure for orienting the 0-3200 line of the aiming circle on a given grid azimuth is illustrated below. In this example, the mounting azimuth is 5550 mils and the aiming circle is assumed to have a declination constant of 6380 mils.

a. Set up and level the aiming circle.

b. Subtract the announced mounting azimuth from the declination constant of the aiming circle (adding 6400 to the declination constant of the aiming circle if the mounting azimuth is larger). In this case, subtract the mounting azimuth 5550 from the declination constant 6380.

Solution:

Declination constant	6380 mils
Announced mounting azimuth	- 5550 mils
Remainder	830 mils

c. Set the remainder on the azimuth and micrometer scales of the aiming circle. In this case, the remainder is 830 mils (recording motion).

d. Release the compass needle. Look through the window in the cover housing and rotate the instrument until the needle floats freely using the orienting knob throw-out mechanism. For fine adjustments, use orienting knobs until the magnetic needle is exactly centered on the etched marks on the magnifier. Relock the compass needle to orient the 0-3200 line of the aiming circle on the mounting azimuth; in this case, grid azimuth of 5550 mils (Figure 2-8).

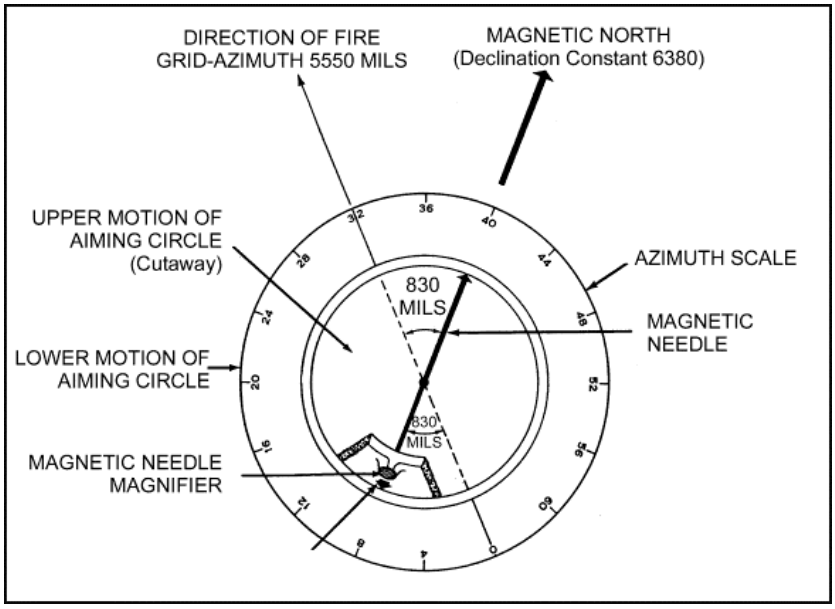


Figure 2-8. Aiming circle oriented in desired direction of fire.

e. Once the aiming circle is oriented, do not disturb the lower motion of the aiming circle.

2-13. ORIENTING OF THE 0-3200 LINE ON A GIVEN MAGNETIC AZIMUTH

The procedure for orienting the 0-3200 line of the aiming circle on a given magnetic azimuth is as follows:

a. Subtract the announced magnetic azimuth from 6400.

b. Set the remainder on the azimuth and micrometer scales of the aiming circle.

c. Release the compass needle and rotate the orienting knob until the magnetic needle is exactly centered in the magnetic needle magnifier. Lock the compass needle.

d. The 0-3200 line of the aiming circle is now oriented on a given magnetic azimuth.

2-14. VERIFYING THE LAY OF THE PLATOON

After the platoon is laid, the platoon leader verifies the lay by using another M2 aiming circle, which is referred to as the safety circle.

a. The platoon leader or designated safety officer sets up and orients an M2 aiming circle by using the method that was used with the lay circle (Figure 2-9). The aiming circle must be located where it can be seen by all mortars and should not be closer than 10 meters to the lay circle.

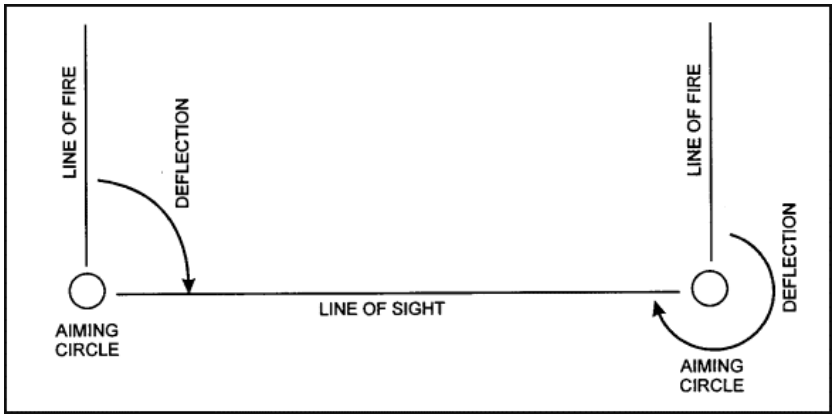


Figure 2-9. Method used to orient an M2 aiming circle.

b. After picking up a line of sight on the lay circle, the safety circle operator commands, LAY CIRCLE REFER, AIMING POINT THIS INSTRUMENT. The lay circle operator sights his instrument onto the safety circle by use of the recording motion.

c. When the aiming circle is used to orient another aiming circle for direction, the reading between the two circles will be 3200 mils apart, because both circles measure horizontal clockwise angles from the line of fire. To prevent confusion, remember that if you see red, read red. One half of the aiming circle azimuth scale has a second red scale that goes in the opposite direction of the black scale.

d. There should be no more than 10 mils difference between the circles.

e. If the lay circle and the safety circle deflection are within the 10-mil tolerance, the instrument operator on the safety circle places the deflection reading by the lay circle on the upper motion of the safety circle. With the lower motion, the instrument sights back on the lay circle. This serves to align the 0-3200 line of the safety circle parallel to the 0-3200 line of the lay circle.

f. The instrument operator on the safety circle commands, PLATOON, REFER AIMING POINT THIS INSTRUMENT. All gunners refer and announce the deflection to the safety circle. If the deflection referred by the mortar is within 10 mils, the operator on the safety circle announces that the mortar is safe. Once the mortars are safe, the operator announces, "The platoon is safe."

g. The platoon leader walks the gun line and visually checks the guns to ensure they are parallel. An M2 compass should also be used to ensure the guns are on the azimuth of fire.

2-15. ORIENTING BY ORIENTING ANGLE

Orienting by orienting angle eliminates magnetic errors that result from the use of the magnetic needle of the aiming circle.

a. An orienting angle is the horizontal clockwise angle from the mounting azimuth to the orienting line, the vertex being at the orienting station. It is a line of known direction established on the ground near the firing section which serves as a basis for laying for direction. This line is established by a survey team.

b. The instrument operator sets the aiming circle over the orienting station and levels it. He places the orienting angle on the azimuth scale. He then sights on the far end of the orienting line, using the lower motion. The magnetic needle is not used to orient the aiming circle. This eliminates any magnetic error that may exist in the instrument. The orienting knob cover is closed.

c. The 0-3200 line of the aiming circle is now oriented parallel to the mounting azimuth. Example azimuth of orienting line is 3200 mils. The azimuth on which the section leader wishes to lay the section is 1600 mils. The orienting angle is 1600 mils (Figure 2-10).

Azimuth of orienting line	3200 mils
Minus mounting azimuth	1600 mils
Orienting angle	- 1600 mils

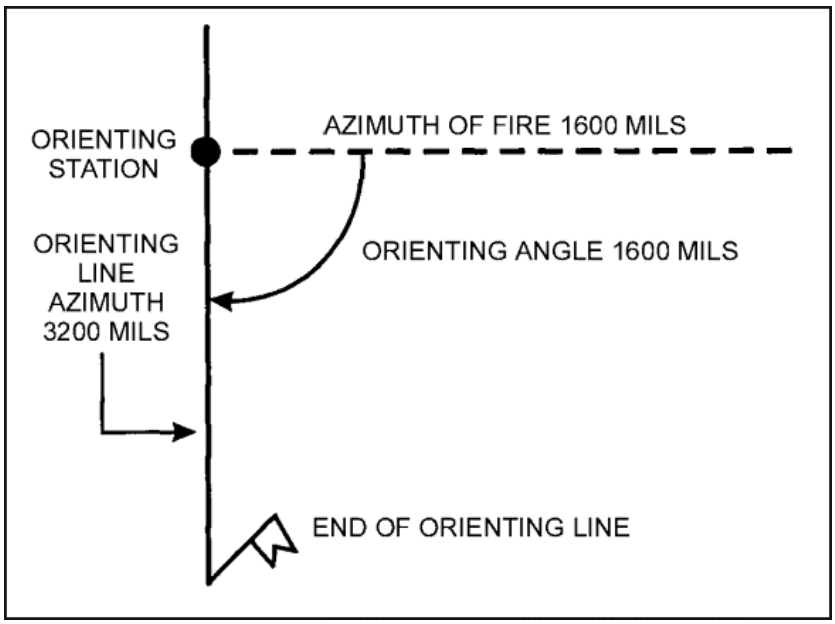


Figure 2-10. Orienting by orienting angle.

The aiming circle is set up over the orienting station by use of the plumb bob. The upper motion is used to set off 1600 mils on the aiming circle. The section leader sights on the end of the orienting line using the lower motion. The 0-3200 line of the aiming circle is now oriented.

2-16. DISASSEMBLY OF AIMING CIRCLE

Instructions for disassembling the aiming circle are located inside the circle cover.

2-17. CARE AND MAINTENANCE

The aiming circle cannot withstand rough handling or abuse. Proper care prolongs its life and ensures better results for the user. Inaccuracies or malfunctions result from mistreatment. The following precautions must be observed:

a. Since stops are provided on instruments to limit the travel of the moving parts, do not attempt to force the rotation of any knob beyond its stop limit.

b. Keep the instrument as clean and dry as possible. If the aiming circle is wet, dry it carefully.

c. When not in use, keep the equipment covered and protected from dust and moisture.

d. Do not point the telescope directly at the sun unless a filter is used; the heat of the focused rays can damage optical elements.

e. Keep all exposed surfaces clean and dry to prevent corrosion and etching of the optical elements.

f. To prevent excessive wear of threads and other damage to the instrument, do not tighten leveling, adjusting, and clamping screws beyond a snug contact.

Note: Only maintenance personnel are authorized to lubricate the aiming circle.

Section III. SIGHTUNITS

The M53-series and M64-series sightunits are the standard sighting devices used with the mortars. The sightunits are used to lay the mortar for elevation and deflection.

2-18. SIGHTUNIT, M53-SERIES

The sightunit, M53-series, consists of an M128 telescope mount and an M109 elbow telescope fastened together in one unit for operation (Figure 2-11). The elbow telescope provides magnification and a line of sight from which the weapon is aimed. The telescope mount secures the telescope in the correct position with respect to weapon azimuth and elevation axis).

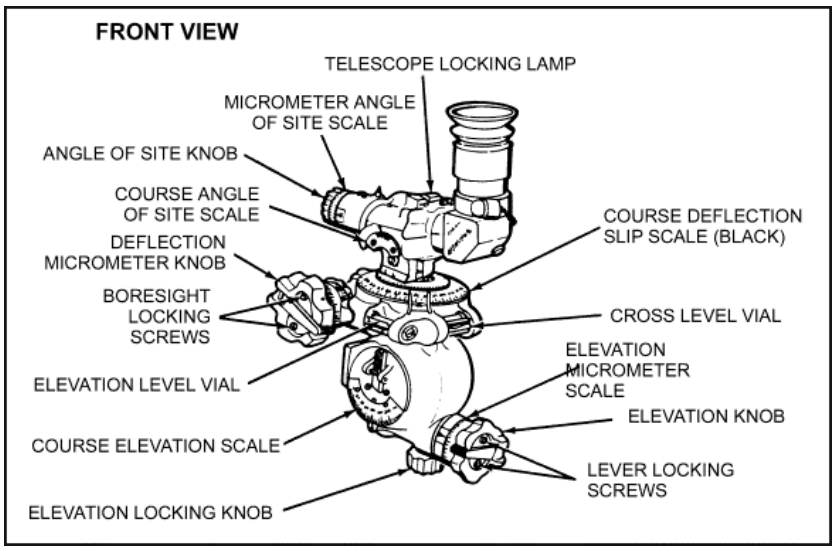


Figure 2-11. Sightunit, M53.

a. **Elbow Telescope, M109**. The elbow telescope (Figure 2-12) is a lightweight, 4-power, fixed-focus instrument with a 10-degree field of view that provides the optical line of sight for aiming the weapon in azimuth and elevation planes.

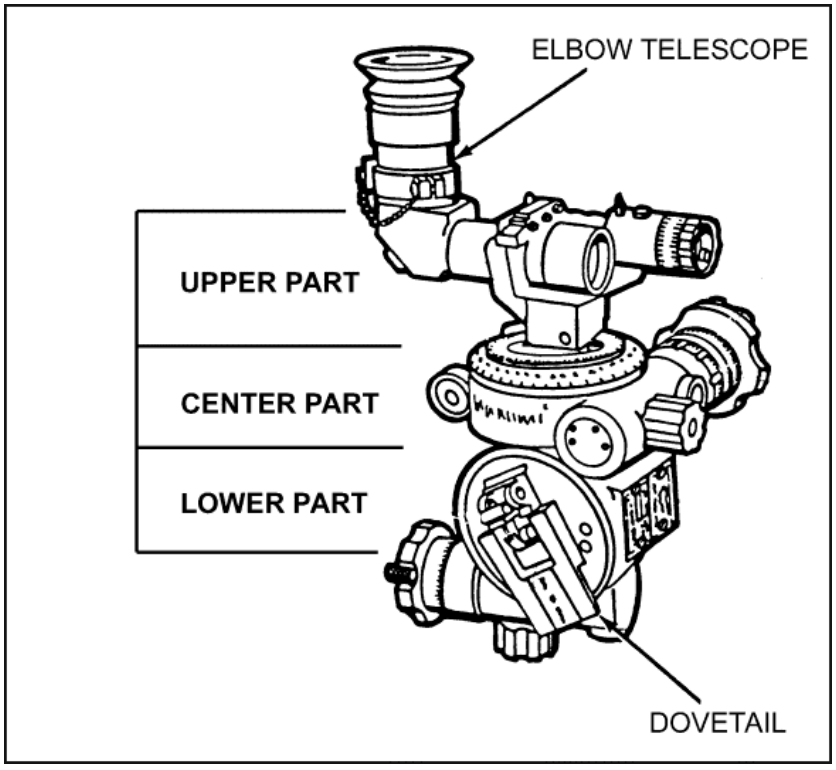


Figure 2-12. Sightunit with elbow telescope, M109.

(1) The telescope incorporates a cross- or lined-mil scale reticle that can be illuminated for night operations. The reticle pattern consists of two center lines at right angles to each other. Both center lines are graduated every 5 mils from 5 to 85 and are numbered every 10 mils in all four quadrants on both center lines.

(2) The telescope can be used in three positions: with the eyepiece to the left, right, or up. The eyepiece provides maximum comfort to the user. A telescope locking clamp permits the elbow telescope to be moved to any of the three positions and locked in these positions by the locking clamp. Indexes on the telescope and support indicate the horizontal and vertical positions of the center lines on the reticle when boresighted and the plumbed positions of the center lines. If the indexes are not lined up, the image is tilted.

(3) An angle-of-site mechanism, controlled by an angle-of-site knob, moves the telescope in a vertical plane.

b. **Telescope Mount, M128**. The telescope mount consists of three main parts: lower, center, and upper. The lower part contains a locking lever hatch, elevation micrometer knob with scales, and elevation locking knob. The center part contains a bushing for vertical axis, deflection micrometer knob and deflection locking knob, stationary and slip scales, and a pair of level vials. The upper part consists of a common horizontal axis. The telescope support is fitted with an open sight, light projection unit, and angle-of-sight knob with scales.

(1) *Lower part*. A dovetail located on the right side of the mount fits into the sight socket on the sight mount assembly to secure the sightunit to the weapon.

(a) A dual-purpose locking device in the lower section of the mount locks the dovetail of the sightunit into the sight socket of the sight mount assembly. The locking device is also used to unlock the connection between the dovetail parts for disassembly.

(b) A semicircular, course elevation scale on the left side has 18 graduations, each graduation representing 100 mils. The graduations are numbered every 200 mils, from minus 2 through 0 to 16. Negative (red) readings are for depression; positive (black) readings are for elevation settings. A reference index is inscribed on the lower part of the casting. The scale settings can be adjusted by loosening the two attaching screws, slipping the scale, and tightening the screws.

(c) The elevation knob elevates or depresses the line of sight and is fitted with a crank handle for large changes. Secured to the elevation knob is an adjustable micrometer scale consisting of positive and negative readings, numbered in black for elevation and red for depression. The scale has 100 graduations, each representing 1 mil, and is numbered every 10 mils from 0 to 90. A reference index is inscribed on the main casting. To release the scale for slipping, two screws at the front of the elevation knob must be loosened. A device controlled by a locking knob prevents the elevation knob from rotating during firing.

(2) *Center part*. The fixed deflection scale is a nonslip scale of 64 red graduations, with each 400 mils numbered in red from 0 to 60. The scale rotates with the upper part of the telescope mount when the deflection knob is turned.

(a) The deflection knob is fitted with a crank for large changes. The index for the scale is on a stationary bracket which is bolted to the main casting. The deflection micrometer scale consists of 100 red graduations numbered from 0 to 90 in increments of 10 mils. This scale is fastened to the deflection knob. To slip the micrometer scale, two screws at the front of the deflection knob must be loosened. The scale is pushed toward the sightunit and rotated to the desired setting.

(b) The coarse deflection slip scale is a large circular scale retained in place by friction and located adjacent to the fixed deflection scale. The slip scale has 64 black graduations numbered every 200 mils. The index for the scale is engraved on the main casting. The coarse deflection setting can be changed by depressing the scale and turning.

(c) The adjustable micrometer deflection slip scale, also located on the deflection knob, has 100 black graduations numbered from 0 to 90 in increments of 10 mils. The scale is retained in place by friction. The scale is fitted with an index attached to the main housing.

(d) Two level vials, located 90 degrees apart on the main housing, are used for leveling the sightunit. Both vials have rotating metal covers to protect them from damage.

(3) *Upper part*. The telescope support is equipped with an open sight, clamping mechanism, and mechanism for adjusting the angle-of-sight reading change.

2-19. OPERATION OF M53 SIGHTUNIT

Operation of the M53 sightunit is described herein.

a. **Attaching the Sightunit**. Insert the dovetail of the telescope mount into the sight socket. Press the locking lever inward, seat the mount firmly, and release the locking lever.

Note: Until the baseplate is firmly seated, remove the sight from the mortar before firing each round.

b. **Placing Sightunit Into Operation**. Place the sightunit into operation as follows:

(1) *Setting for deflection.*

(a) To place a deflection setting on the sight, turn the deflection knob. This turns the elbow telescope, the coarse deflection scales, and the deflection micrometer scales. Before attempting to place a deflection setting on the sightunit, ensure that the deflection locking knob is released. After placing a setting on the sight, lock the locking knob to lock the data onto the sight and to ensure that the scale does not slip during firing.

(b) When setting the deflection, it is necessary to use the red fixed coarse scale and the red fixed micrometer scale to obtain the desired setting. Set the first two digits of the deflection on the coarse scale and the last two on the micrometer scale.

Note: The black coarse scale and the black micrometer scale are slip scales.

(c) Setting a deflection on the deflection scale does not change the direction in which the barrel is pointing (the lay of the mortar). It only moves the vertical line off (to the left or right) the aiming line. The deflection placed on the sight is the deflection announced in the fire command. Place a deflection on the sight before elevation.

(2) *Setting the elevation.*

(a) To set for elevation, turn the elevation knob. This operates both the elevation micrometer and coarse elevation scales. Both scales must be set properly to obtain the desired elevation. For example, to place elevation 1065 mils on the M53 sightunit, turn the elevation knob until the fixed index opposite the moving coarse elevation scale is between the black 1000- and 1100-mil graduations on the scale (the graduations are numbered every 200 mils, from minus 2 through 0 to 16), and the 65-mil mark on the elevation micrometer is opposite the fixed index. When making elevation settings, remember that the black numbers are for elevation and the red numbers are for depression.

(b) Setting an elevation on the elevation scale does not change the elevation of the mortar barrel. The elevation to be placed on the sight is announced in the fire command.

(c) Before setting elevations on the sight, unlock the elevation locking knob. Once the elevation is placed on the sight, lock the elevation locking knob. This ensures the data placed on the sight do not accidentally change.

c. **Replacing the sightunit in the carrying case**. Before returning the sightunit to the carrying case, close the covers on the level vials and set an elevation of 800 mils and deflection of 3800 mils on the scales. Place the elbow telescope in the left horizontal position. All crank handles should be folded into the inoperative position. The M53 instrument light is stored in the same case with the rheostat knob down.

2-20. CARE AND MAINTENANCE OF M53 SIGHTUNIT

Although the M53-series sightunits are rugged, if abused or handled roughly, the unit could be inaccurate or malfunction.

a. Avoid striking or otherwise damaging any part of the sight. Be particularly careful not to burr or dent the dovetail bracket. Avoid bumping the micrometer knobs, telescope adapter, and level vials. Except when using the sight, keep the metal vial covers closed.

b. Keep the sight in the carrying case when not in use. Keep it as dry as possible, and do not place it in the carrying case while it is damp.

c. When the sight fails to function correctly, return it to the DS maintenance unit for repair. Members of the mortar crew are **not** authorized to disassemble the sight.

d. Keep the optical parts of the telescope clean and dry. Remove dust from the lens with a clean camel's-hair brush. Use only lens cleaning tissue to wipe these parts. Do not use ordinary polishing liquids, pastes, or abrasives on optical parts. Use only authorized lens cleaning compound for removing grease or oil from the lens.

e. Occasionally oil only the sight locking devices by using a small quantity of light preservative lubricating oil. To prevent accumulation of dust and grit, wipe off excess lubricant that seeps from moving parts. Ensure that no oil gets on the deflection and elevation scales. (Oil removes the paint from the deflection scale.) No maintenance is authorized.

2-21. SIGHTUNIT, M64-SERIES

The sightunit (Figure 2-13) is the device on which the gunner sets deflection and elevation to hit targets by using the elevation level vial and the cross-level vial. After the sight has been set for deflection and elevation, the mortar is elevated or depressed until the elevation bubble on the sight is level. The mortar is then traversed until a proper sight picture is seen (using the aiming posts as the aiming point) and cross-level bubble is level. The mortar is laid for deflection and elevation when all bubbles are level. After the ammunition has been prepared, it is ready to be fired.

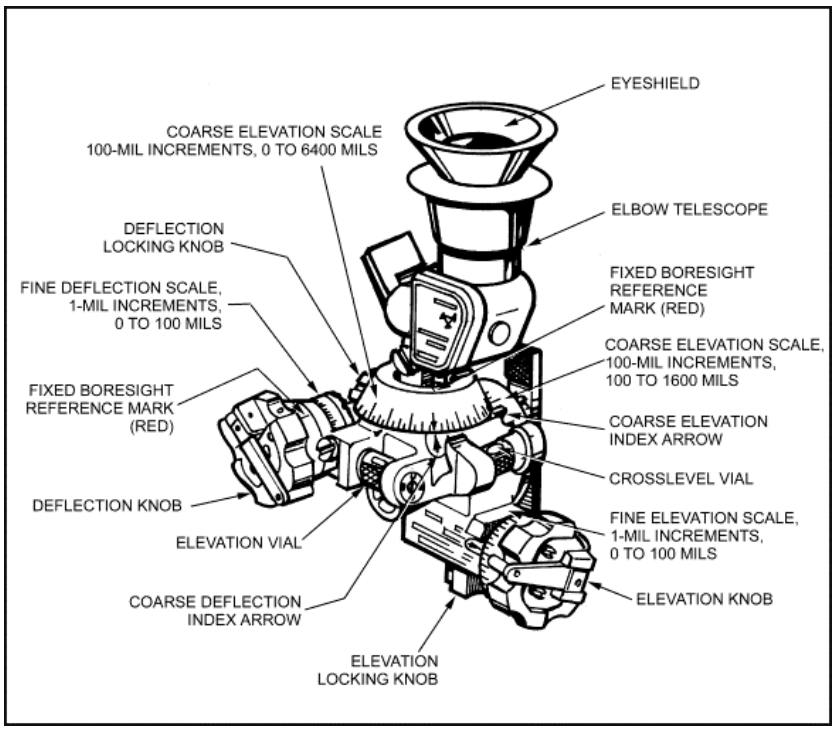


Figure 2-13. Sightunit, M64-series.

a. **Major Components**. The two major components are the elbow telescope and sight mount. The elbow telescope has an illuminated cross line. The sight mount has a dovetail, locking knobs, control knobs, scales, cranks, and locking latch.

(1) *Dovetail*. The dovetail is compatible with standard US mortars. When the dovetail is properly seated in the dovetail slot, the locking latch clicks. The locking latch is pushed toward the barrel to release the sight from the dovetail slot for removal.

(2) *Locking knobs*. The red locking knobs lock the deflection and elevation mechanisms of the sight during firing.

(3) *Micrometer knobs*. The elevation and deflection micrometer knobs are large for easy handling. Each knob has a crank for large deflection and elevation changes.

(4) *Scales*. All scales can be adjusted to any position. Micrometer scales are white. The elevation micrometer scale and fixed boresight references (red lines) above the coarse deflection scale and adjacent to the micrometer deflection scale are slipped by loosening slot-headed screws. Coarse deflection scales and micrometer deflection scales are slipped by depressing and rotating. The coarse elevation scale is factory set and should not be adjusted at crew level. (If the index does not align with the coarse elevation scale within ±20 mils when boresighting at 800 mils, DS-level maintenance should be notified.) The screws that maintain the coarse elevation scale are held in place with locking compound. If the screws are loosened and then tightened without reapplying the locking compound, the coarse elevation scale can shift during firing.

b. **Illumination**. Instrument lights are not needed when using the sightunit at night. Nine parts of the sight are illuminated by tritium gas.

- Telescope.
- Coarse elevation scale.
- Coarse elevation index arrow.
- Elevation vial.
- Fine elevation scale.
- Coarse deflection index arrow.
- Cross-leveling vial.
- Fine deflection scale.
- Coarse deflection scale.

c. **Tabulated Data**. The tabulated data of the M64-series sightunit are as follows:

Weight: 2.5 pounds (2.2 kilograms).
Field of view: 17 degrees (302 mils).
Magnification: 1.5 unity power.
Length: 4 3/8 inches (11 centimeters).
Width: 4 3/4 inches (12 centimeters).
Height: 7 3/8 inches (19 centimeters).
Light source: Self-contained, radioactive tritium gas (H3).

CAUTION
When not in use, store the sightunit in its carrying case.

d. **Safety Precautions**. The radioactive material used in the sightunit for illumination during night operations is tritium gas (H^3), which is sealed in glass tubes. The gas is not hazardous when intact. If there is no illumination, the RPO or NBC officer should be notified.

WARNING

Do not try to repair or replace the radioactive material. If skin contact is made with tritium, wash the area immediately with nonabrasive soap and water.

(1) *Identification.* Radioactive self-luminous sources are identified by means of warning labels (Figure 2-14), which should not be defaced or removed. If necessary, they must be replaced immediately.

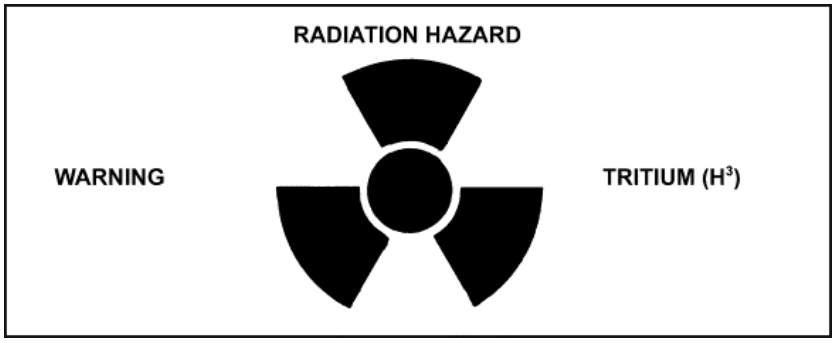


Figure 2-14. Warning label for tritium gas (H^3).

(2) *Storage and shipping.* All radioactively illuminated instruments or modules that are defective must be evacuated to a depot maintenance activity. Defective items must be placed in a plastic bag and packed in the shipping container from which the replacement was taken. Spare equipment must be stored in the shipping container as received until installed on the weapon. Such items should be stored in an outdoor shed or unoccupied building.

Note: For information on first aid, see FM 21-11.

2-22. SIGHTUNIT, M67

The M67 sightunit (Figure 2-15) is used to lay the M120/M121 mortar for deflection and elevation. Lighting for night operations using the sightunit is provided by radioactive tritium gas contained in phosphor-coated glass vials. The sightunit is lightweight and portable. It is attached to the bipod mount by means of a dovetail. Coarse elevation and deflection scales and fine elevation and deflection scales are used in conjunction with elevation and deflection knob assemblies to sight the mortar system.

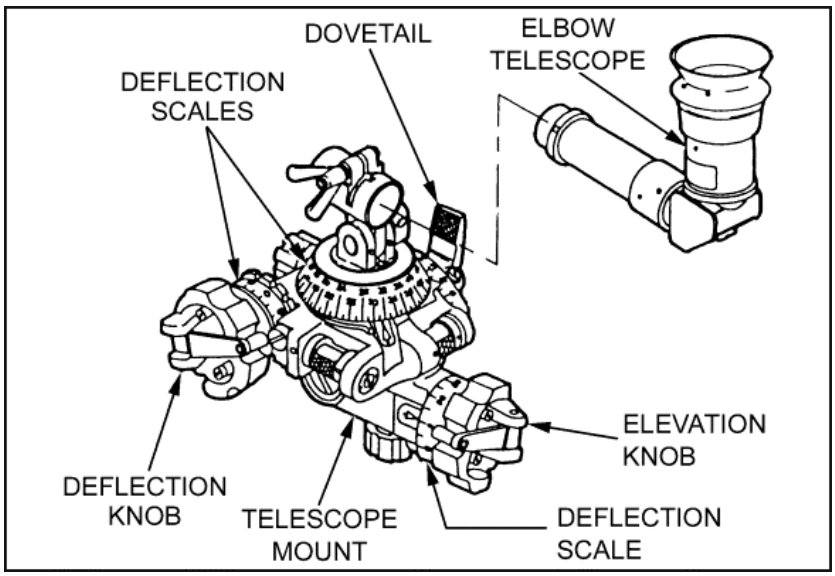


Figure 2-15. M67 sightunit.

a. **Major Components.** The M67 sightunit consists of two major components: the elbow telescope and the telescope mount.

(1) *Elbow telescope.* The elbow telescope is 4.0-power, hermetically sealed with a tritium illuminated crosshair reticle.

(2) *Telescope mount.* The telescope mount, provided with tritium back-lighted level vials, indexes, and translucent plastic scales, is used to orient the elbow telescope in azimuth and elevation.

CAUTION
When not in use, store the sightunit in its carrying case.

b. **Equipment Data.** The equipment data for the M67 sightunit are as follows:

Field of view	10 degrees
Magnification	4.0 X nominal 3.5 effective

Dimensions	4 3/8 x 5 3/8 x 8 1/2 inches (11.1 x 13.7 x 21.6 centimeters)
Illumination	Self-illuminated 6 to 8 years service life
Weight	2.9 pounds (1.3 kilograms)
Radioactive material	5.79 curies of tritium

c. **Safety Precautions.** The radioactive material used in the sightunit for illumination during night operations is tritium gas (H^3), which is sealed in glass tubes. The gas is not hazardous as long as the glass tubes are intact. If there is no illumination, the RPO or NBC officer should be notified. Radioactive self-luminous sources are identified by means of warning labels (Figure 2-14), which should not be defaced or removed. These warning labels should be replaced as necessary.

WARNING

Do not try to repair or replace the radioactive material. If skin contact is made with tritium, wash the area immediately with nonabrasive soap and water.

Section IV. BORESIGHTS

Boresights are adjusted by the manufacturer and should not require readjustment as a result of normal field handling.

2-23. BORESIGHT, M45-SERIES

The boresight, M45-series, detects deflection and elevation errors in the sight.

a. **Components**. The boresight, M45, (Figure 2-16) consists of an elbow telescope, telescope clamp, body, two strap assemblies, and clamp assembly.

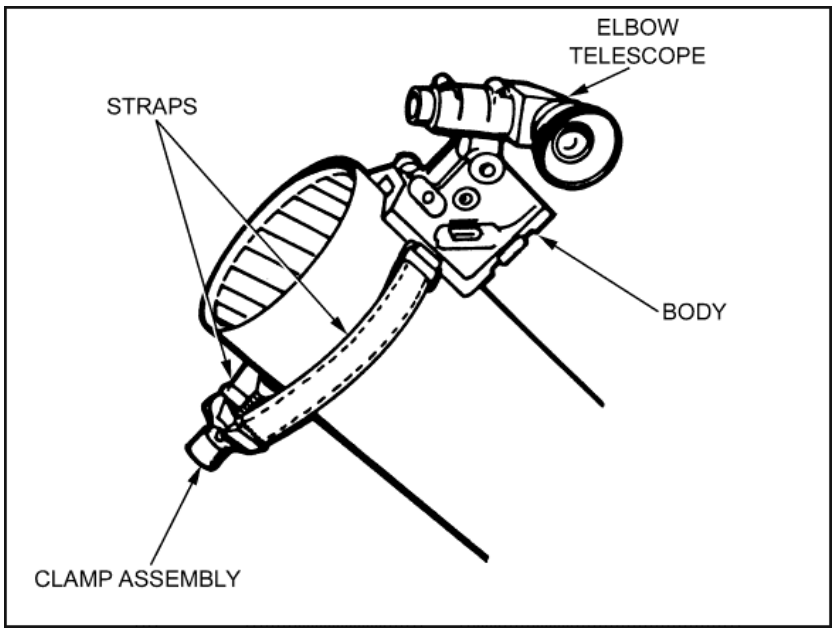


Figure 2-16. Boresight, M45.

(1) The elbow telescope establishes a definite line of sight.

(2) The telescope clamp maintains that line of sight in the plane established by the centerline of the V-slides.

(3) The body incorporates two perpendicular V-slides. It contains level vials (preset at 800 mils elevation) that are used to determine the angle of elevation of 800 mils and whether the V-slides are in perpendicular positions. It also provides the hardware to which the straps are attached.

(4) Two strap assemblies are supplied with each boresight and marked for cutting in the field to the size required for any mortar.

(5) The clamp assembly applies tension to the strap assemblies to secure the boresight against the mortar barrel.

b. **Tabulated Data**. The tabulated data of the M45-series boresight are as follows:

Weight: 2.5 pounds

Field of View: 12 degrees
Magnification: 3 power

2-24. BORESIGHT, M115

The boresight, M115, (Figure 2-17) detects deflection and elevation errors in the sight. The boresight has three plungers that keep it in place when mounted in the muzzle of the barrel. The telescope has the same field of view and magnification as the M64-series sightunit. The elevation bubble levels only at 0800 mils.

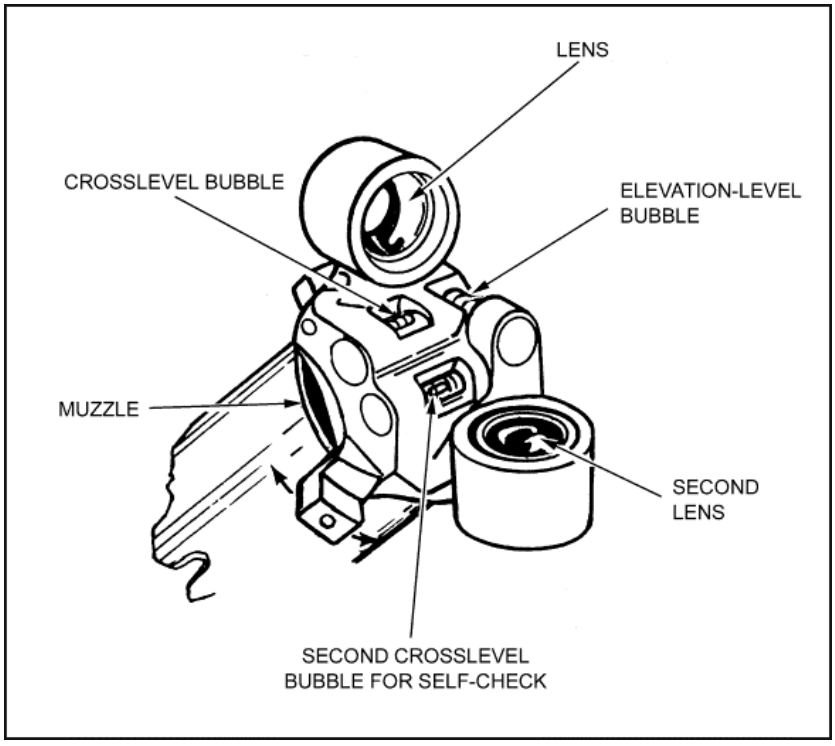


Figure 2-17. Boresight, M115.

a. **Second Cross-level Bubble**. A second cross-level bubble is used as a self-check of the M115. After leveling and cross-leveling, the M115 can be rotated 180 degrees in the muzzle until the second cross-level bubble is centered. The

image of the boresight target should not vary in deflection. A large deviation indicates misalignment between the cross-level bubble and lenses.

b. **Components**. The components of the M115 boresight are the body, telescope, and leveling bubbles (one for cross-leveling and one for elevation).

c. **Tabulated Data.** The tabulated data of the M115 boresight are as follows:

Weight:	5 ounces
Field of view:	17 degrees
Magnification:	1.5 power

2-25. PRINCIPLES OF OPERATION

The boresight is constructed so that the telescope line of sight lies in the plane established by the center lines of the V-slides. When properly secured to a mortar barrel, the centerline of the contacting V-slide is parallel to the centerline of the barrel. Further, the cross-level vial, when centered, indicates that the center lines of both slides, the elbow telescope, and the barrel lie in the same vertical plane. Therefore, the line of sight of the telescope coincides with the axis of the barrel, regardless of which V-slide of the boresight is contacting the barrel. The elevation vial is constructed with a fixed elevation of 800 mils.

2-26. INSTALLATION

Installation procedures for the M45 boresight are described herein.

a. Remove the boresight, clamp assembly, and straps from the carrying case. Grasp the boresight by the body to prevent damaging the telescope.

b. Place the ring over the hook and attach the strap snap to the eye provided on the strap shaft.

c. If necessary, release the catches and reset the straps to the proper length.

d. Remove any burrs or projecting imperfections from the seating area of the mortar barrel to ensure proper seating of the boresight. Attach the boresight to the barrel below and touching the upper stop band on the M252 mortar. However, attach the boresight about 1 inch from the muzzle of the barrel on all other mortars.

Note: For further information, see TM 9-1240-278-12.

2-27. SIGHT CALIBRATION

Always calibrate the mortar sight to the mortar on which it is to be mounted. This procedure is necessary since the sight socket that receives the sightunit is a machined part and varies in accuracy with each mortar. There is no set rule for frequency of calibration. The sight should be calibrated each time the mortar is mounted in a new location, since the movement might disturb the setting of the elevation and deflection scales. Time available and accuracy dictate the frequency of calibration.

2-28. BORESIGHT METHOD OF CALIBRATION

Once the mortar has been mounted, place the M53-, M64-, or M67-series sightunit into position in the sight socket. Using the M53- (fixed deflection [red] scale), the M64-, or the M67-series sightunit, place a deflection of 3200 mils and an elevation of 0800 mils on the scales. For the M252 mortar, place a deflection of 0 mils on the sight. Align the vertical cross line of the sight on an aiming point (at least 200 meters distant) by shifting the bridge assembly or bipod. If necessary use the traversing mechanism; however, keep the mortar within two turns of center of traverse (four turns of center of traverse for the 120-mm mortar). Make a visual check of the mortar for cant; if cant exists, remove this cant and re-lay, if necessary.

Note: For a detailed discussion of the boresight method of calibration, see applicable TM.

a. **Elevation Setting**.

(1) Install the boresight on the mortar barrel. Center the cross-level vial by rotating the boresight slightly around the outside diameter of the mortar barrel. Slight movements are made by loosening the clamp screw and lightly tapping the boresight body. When the bubble centers, tighten the clamp screw.

(2) Elevate or depress the mortar barrel until the boresight elevation level vial is centered. The mortar is now set at 800 mils (45 degrees) elevation.

(3) Using the elevation micrometer knob, elevate or lower the sightunit until the elevation level bubble is centered. If necessary, cross-level the sightunit.

(4) Recheck all level bubbles.

(5) The reading on the coarse elevation scale of the sightunit should be 800 mils and the reading on the elevation micrometer scale should be 0. If adjustment is necessary, proceed as indicated below.

(a) Loosen the two screws that secure the coarse elevation scale and slip the scale (for the M53-series sightunit only) until the 800-

mil mark on the scale coincides with the reference mark on the housing. Tighten the two screws to secure the scales.

Note: Do not adjust the M64-series sightunit coarse elevation scale. If it does not line up with the 0800-mil mark, turn it in to DS maintenance.

(b) Loosen the two screws on the elevation micrometer knob and slip the elevation micrometer scale until the 0 mark on the micrometer scale coincides with the reference mark on the housing. Tighten the two screws to secure the micrometer scale.

(6) Recheck all level bubbles.

b. **Deflection Setting**.

(1) Check again to ensure that the sight setting reads 3200 on the fixed deflection (red) scale and elevation 800 mils. Set zero deflection for the M252 mortar.

(2) Traverse the mortar no more than two turns of center of traverse (four turns for the 120-mm mortar) and align the vertical cross line of the boresight on the original aiming point. Adjust the boresight to keep the cross-level bubble centered since the mortar could cant during traversing. (If the mortar is initially mounted on the aiming point, it decreases the amount of traverse needed to align the cross line on the aiming point.) Also, the elevation level bubble may need to be leveled.

(3) After the boresight is aligned on the aiming point, level the sight by centering the cross-level bubble. Rotate the deflection micrometer knob until the sight is aligned on the aiming point. The coarse deflection scale should read 3200 mils and the micrometer scales should read 0. If adjustment is necessary, loosen the two screws on the deflection micrometer knob and slip the micrometer deflection scale until the arrow on the index is aligned with the zero mark on the micrometer scale.

(4) To ensure proper alignment, remove and place the boresight in position underneath the barrel as shown in Figure 2-18. Center the boresight cross-level bubble and check the vertical cross line to see if it is still on the aiming point. If cant exists, the vertical cross line of the boresight is not on the aiming point. This indicates that the true axis of the bore lies halfway between the aiming point and where the boresight is now pointing.

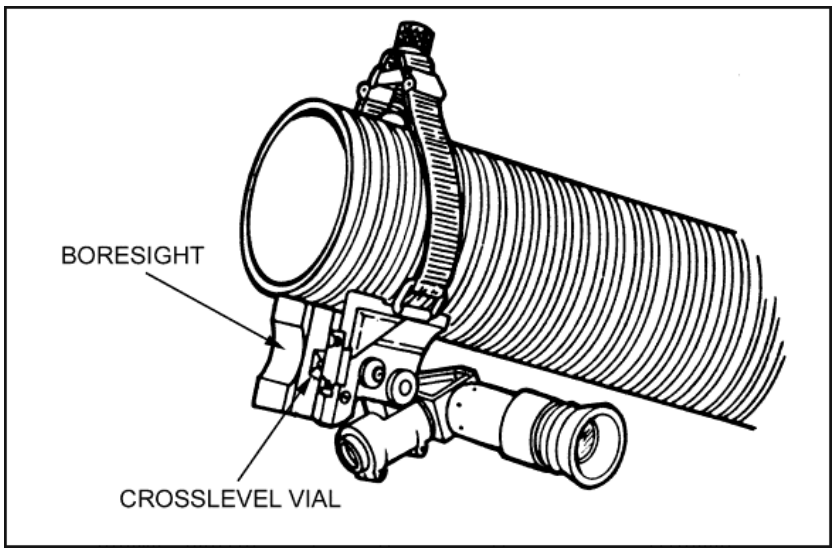


Figure 2-18. Checking for proper alignment with the boresight device.

(5) To correct this error, look through the boresight, traverse the mortar onto the aiming point. If bubbles are level, use the deflection micrometer knob and place the vertical cross line of the sight back onto the aiming point. With the sight in this position, index one-half of the mil variation between the sight and boresight. Slip zero on the micrometer scale to the index mark--for example, the mil variation is 10 mils and one-half of this value is 5 mils. Loosen the two screws on the deflection micrometer and index zero.

(6) Check all level bubbles, sightunit, and boresight.

(7) With a deflection on the micrometer scale of half the value of the original mil variation, both the sightunit and boresight are on the aiming point. If an error exists, repeat the procedure outlined above.

(8) Using the M64-series sightunit, adjust the deflection scale and micrometer scale of the sightunit to zero. To do this, loosen the deflection knob screws and slip the scale to zero. Adjust the deflection micrometer scale to zero by pushing in on the micrometer knob retaining button and slipping the scale to zero.

(9) Check again all level bubbles, and the lay of the sightunit and the boresight on the aiming point.

Note: The M53-series sightunit should be received from the manufacturer with the red deflection scale calibrated on 3200. If it is not, turn the sightunit in to DS maintenance for calibration.

c. **Removal**.

(1) Loosen the clamp screw, releasing the boresight from the barrel.

(2) Swing the elbow telescope until it is about parallel with the elevation level bubble.

(3) Release the clamp assembly and straps by removing the ring from the hook and strap shaft.

(4) Stow the clamp assembly and straps in the corner compartment. Put the boresight in the center compartment of the carrying case.

2-29. CALIBRATION FOR DEFLECTION USING THE M2 AIMING CIRCLE

Two methods can be used to calibrate the sight for deflection using the M2 aiming circle: the angle method (Figure 2-19) and the distant aiming point method (Figure 2-20).

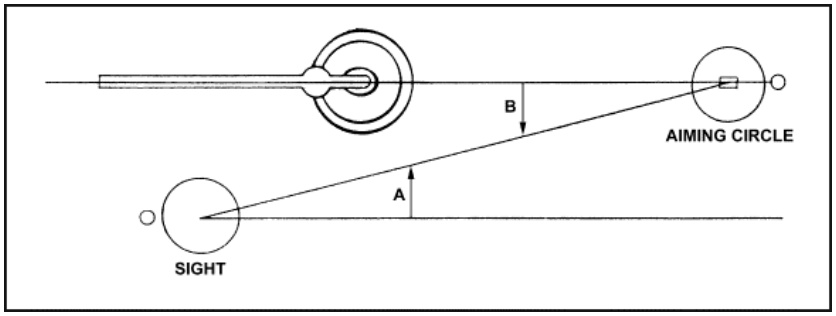


Figure 2-19. Calibration for deflection using the angle method.

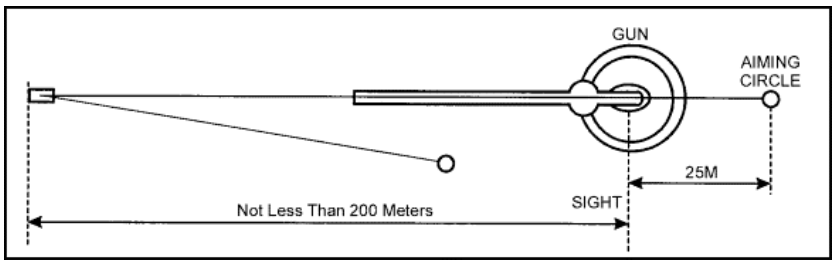


Figure 2-20. Calibration for deflection using the distant aiming point method.

a. **Calibration for Deflection Using the Angle Method.**

(1) Set up the aiming circle 25 meters to the rear of the mounted mortar. (The mortar is mounted at 800 mils elevation.)

(2) With the aiming circle fine leveled, index 0 on the azimuth scale and azimuth micrometer scale. Using the orienting motion (nonrecording motion) align the vertical line of the reticle of the telescope so that it bisects the baseplate.

(3) Traverse and cross-level the mortar until the center axis of the barrel from the baseplate to the muzzle is aligned with the vertical line of the aiming circle telescope reticle.

(4) Turn the deflection knob of the sight until the vertical line is centered on the lens of the aiming circle and read angle A, opposite the fixed index.

(5) Turn the azimuth micrometer knob of the aiming circle until the vertical line of the telescope is laid on the center of the sight lens and read angle B, opposite the azimuth scale index. If the sight is in calibration, angles A and B will be equal. If they are not equal the sight is adjusted by loosening the two screws in the face of the deflection knob of the sight and slipping the micrometer deflection scale until the scale is indexed at the same reading as angle B of the aiming circle.

b. **Calibration for Deflection Using the Aiming Point Method.**

(1) Set up the aiming circle and fine level. Align the vertical line of the telescope on a distant aiming point (a sharp, distinct object not less than 200 meters in distance).

(2) Move the mortar baseplate until the baseplate is bisected by the vertical line of the telescope of the aiming circle. Mount the mortar at an elevation of 800 mils. Traverse and cross-level the mortar until the axis of

the barrel from the baseplate to the muzzle is bisected by the vertical line of the aiming circle (the mortar should be mounted about 25 meters from the aiming circle).

Note: Indexing the aiming circle at 0 is not necessary; only the vertical line is used to align the mortar with the distant aiming point.

(3) The aiming circle operator moves to the mortar and lays the vertical line of the sight on the same distant aiming point. If the sight is calibrated, the deflection scales of the sight are slipped to a reading of 3200.

Section V. OTHER EQUIPMENT

Other equipment required to operate and employ mortars are discussed in this section.

2-30. INSTRUMENT LIGHT, M53E1

The instrument light (Figure 2-21) illuminates the reticle of the M109 elbow telescope and scales of the M128 telescope mount during night operations. This instrument light is the standard night light used with the 4.2-inch and 120-mm mortars.

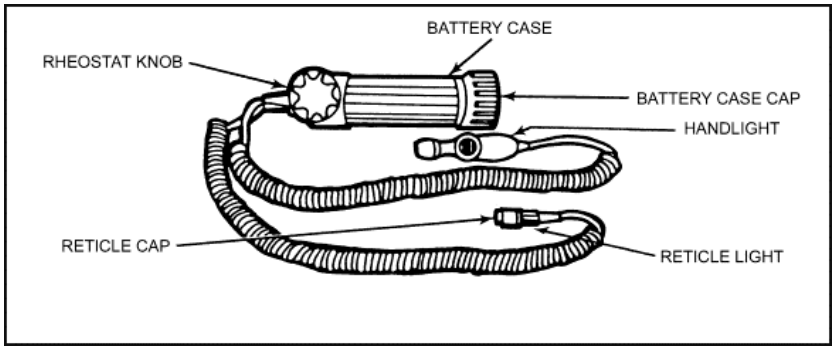


Figure 2-21. Instrument light, M53E1.

a. The light consists of mainly two flashlight batteries, battery case, rheostat knob, and two separate light assemblies attached to a pair of flexible lead wires that extend from one end of the battery case. Because the wires are coiled, the leads can be extended from a normal length of 2 feet to about 6 feet.

b. One light assembly consists of a bracket assembly that can be screwed into the lamp bracket holder for lighting the elbow telescope reticle. This light is turned on/off by the rheostat knob. The knob is also used to increase or decrease the

intensity of the illumination. The second light assembly is a hand light that can be directed upon the telescope mount scales or the level vials as required. The on/off switch for this light is located on the hand light.

c. To place the instrument light into operation (Figure 2-22), the cap is pressed inward at the end of the battery case and turned counterclockwise until free. Two BA-30 batteries are inserted terminal ends first. The cap is installed by turning clockwise until finger tight. Install the battery case of the light in the carrying case with the rheostat knob accessible. The carrying case is positioned so the lead wires reach the sightunit. The dust cover is removed from the lamp bracket holder of the M109 elbow telescope, and the protective cap is removed from the end of the light assembly lead. The end of the light assembly is threaded into the socket on the elbow telescope for illuminating the telescope reticle. The hand light is retained in the case until required for use. DO NOT ATTEMPT TO USE THE M53 LIGHT ON THE LIGHT PROJECTOR OF THE M53 SIGHT.

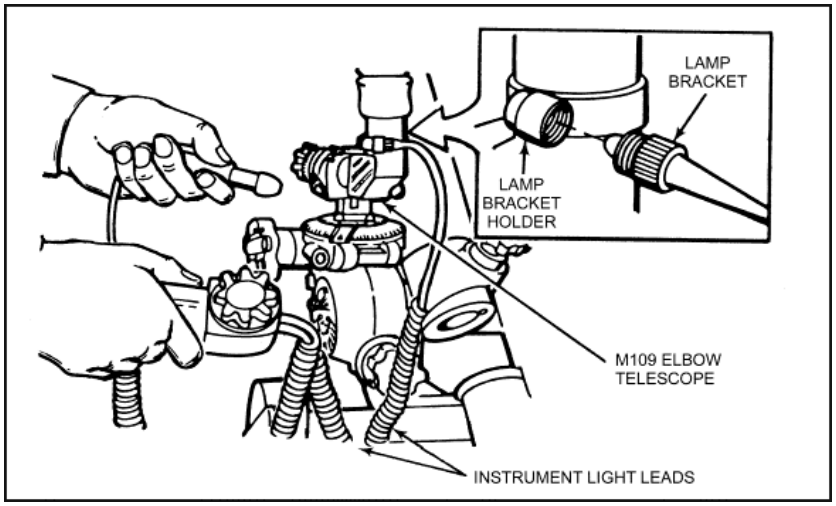


Figure 2-22. Installation of instrument light.

d. The M166 carrying case is a lightweight, sturdy case with an isofoam bed that provides storage for the M53 sightunit and the M53 instrument light (Figure 2-23).

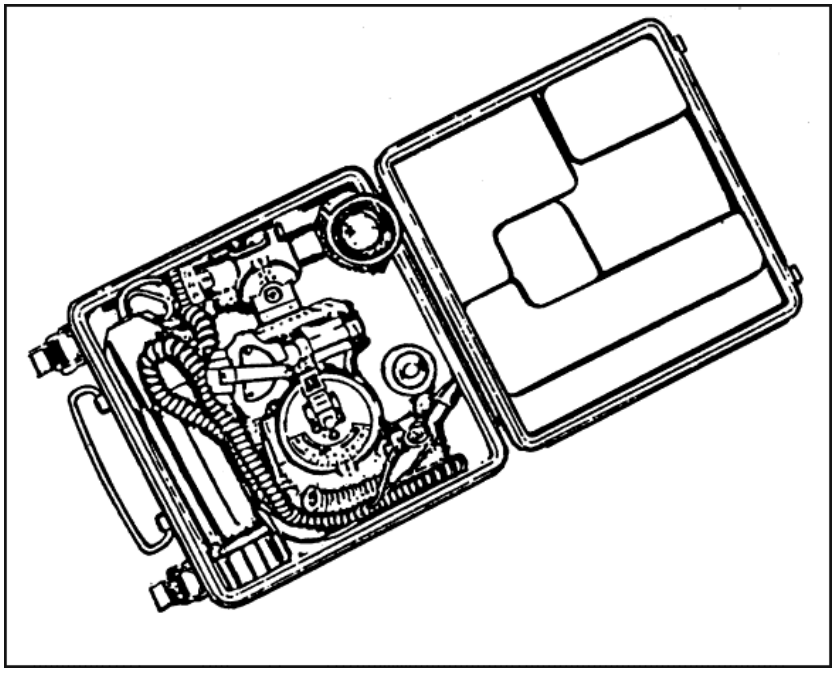


Figure 2-23. Carrying case, M166.

2-31. AIMING POSTS, M14 and M1A2

The M14 aiming posts (Figure 2-24) are used to establish an aiming point (reference line) when laying the mortar for deflection. They are made of aluminum tubing and have a pointed tip on one end. Aiming posts have red and white stripes so they can be easily seen through the sight. The M14 aiming post comes in a set of eight segments, plus a weighted stake for every 16 segments to be used as a driver in hard soil. The stake has a point on each end and, after emplacement, it can be mounted with an aiming post. The segments can be stacked from tip to tail, and they are carried in a specially designed case with a compartment for each segment. Four M1A2 aiming posts are provided with the mortar. They may be stacked end to end (two at most).

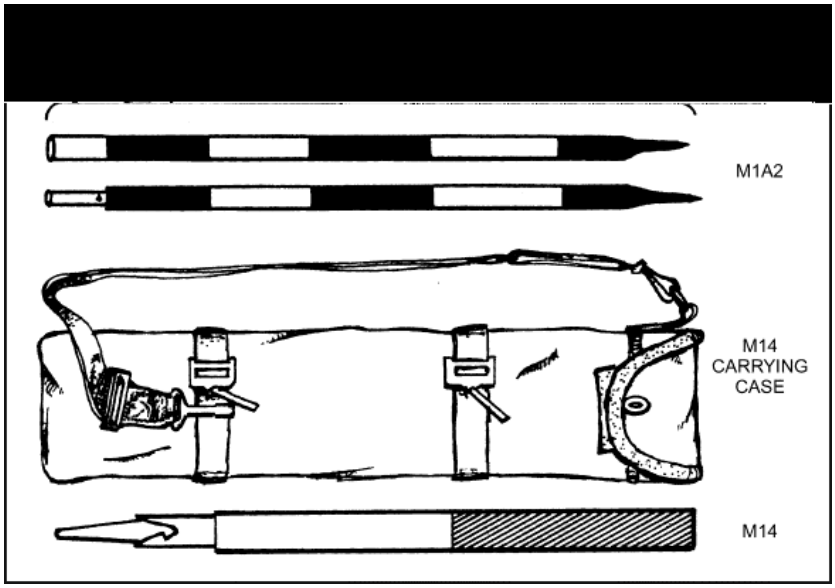


Figure 2-24. Aiming posts, M14 and M1A2.

2-32. AIMING POST LIGHTS, M58 and M59

Aiming post lights (Figure 2-25) are attached to the aiming posts so they can be seen at night through the sight. The near post must have a different color light than that of the far post. Aiming post lights come in sets of three--two green (M58) and one orange (M59). An extra third light is issued for the alternate aiming post. Each light has a clamp, tightened with a wing nut, for attachment to the aiming post. The light does not have a cover for protection when not in use and does not need batteries.

Figure 9-4. Diagram of equipment layout and position of personnel for the gunner's examination (81-mm mortar, M252).

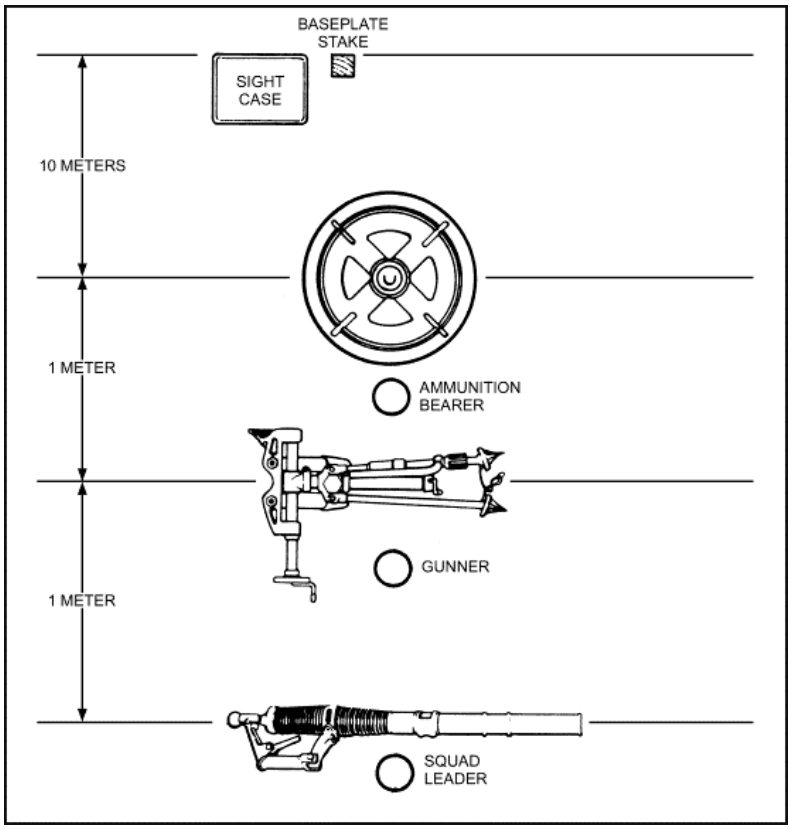


Figure 9-5. Diagram of equipment layout and position of personnel for the gunner's examination (60-mm mortar).

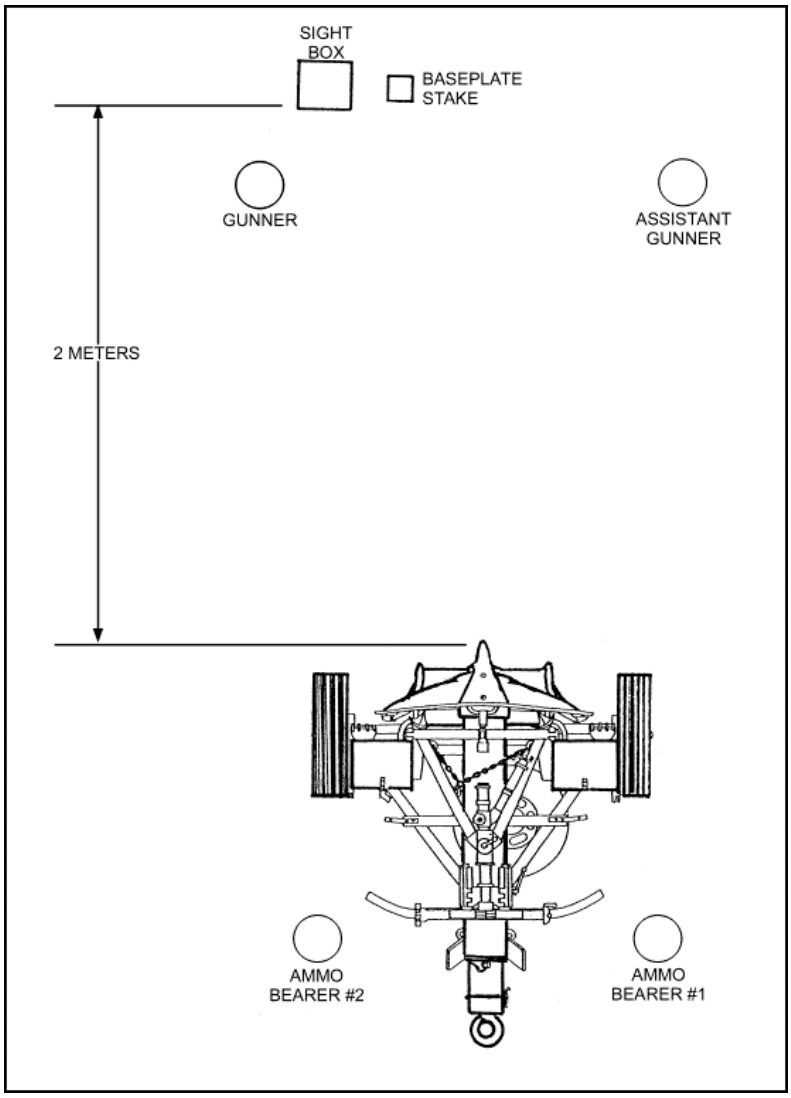


Figure 9-6. Diagram of equipment layout and position of personnel for the gunner's examination (120-mm mortar).

(2) *(All mortars)* The mortar sight is seated in its case with 3800 mils (3200 mils for the M64 sights) set on the deflection scale and 0800 mils set on the elevation scale, and the sightbox is closed and latched.

(3) *(4.2-inch only)* The two sandbags or ammunition boxes are placed under the spade to prevent the baseplate assembly from tilting. They are in position at the start of the examination.

(4) *(4.2-inch only)* The standard assembly is in low range at its lowest elevation, with the traversing assembly side traversed all the way to the right with the crank closed.

(5) *(4.2-inch only)* The mortar locking pin is fully inserted and locked.

(6) *(All mortars except 4.2-inch)* The candidate should examine the equipment before mounting.

(7) *(120-mm only)* Traverse extension is locked and centered.

c. **Procedure.** The candidate is given two trials; his credit score is the total of these two trial scores.

(1) The candidate and his assistants take their positions. The candidate is instructed to mount the mortar at 3200 mils deflection and 900 mils elevation for the 4.2-inch mortar, or 3200 mils deflection and 1100 mils elevation for all other mortars.

Note: When using the M53 series sightunit, the red deflection scale is used for all laying procedures.

(2) The evaluator points to the exact spot where the mortar is to be mounted. He indicates the initial direction of fire by pointing in that direction and gives the command ACTION, at which time the candidate begins mounting the mortar. After mounting the mortar, he should have 3200 mils deflection and 900 mils elevation on the sight for the 4.2-inch mortar or 1100 mils elevation and 3200 mils deflection for all other mortars.

(3) The assistants may manipulate the sight mount knob and elevation crank. They may center the connection for the mortar locking pin assembly, but they MUST NOT manipulate the sight for deflection or elevation settings.

(4) When the test is completed, the candidate announces, "Up." Time is charged against him from the command ACTION to the announcement "Up."

d. **Scoring.** Scoring procedures are as follows:

(1) The candidate receives no credit when the--

- Time exceeds 1 minute, 40 seconds (4.2 inch only); time exceeds 1 minute and 15 seconds (120-mm only); time exceeds 90 seconds (all other mortars).
- Sight is not set correctly for deflection and elevation.
- Cross-level and elevation bubbles are not centered.
- Mortar locking pin, or the clevis lock pin is not fully locked.
- Connection for the mortar locking pin assembly (buffer carrier, 60-mm mortar) or the traversing slide assembly is off center more than two turns.
- Assistant manipulates the sight for a deflection or elevation setting.
- The baseplate is not positioned correctly in relation to the baseplate stake.
- The selector switch on the barrel is not on D for drop-fire (60-mm mortar only).
- The collar assembly is not positioned on the lower saddle (60-mm mortar only).
- Firing pin recess is not facing upwards on the barrel (81-mm mortar, M252 only).
- Traverse is more than four turns (120-mm only).
- Barrel clamp is not locked (120-mm only).
- Cross-level lock is not tight (120-mm only).
- Leg-locking handwheel is not wrist-tight (81-mm mortar, M252 only).
- The coarse cross-level nut is not wrist-tight (60-mm and 81-mm, M29A1, mortars only).
- The collar locking knob is not secured (hand-tight) to the barrel (60-mm and 81-mm, M252, mortars only).
- The bipod legs are not fully extended and the spread cable or chain is not taut (60-mm; 81-mm, M29A1; and 120-mm mortars only).

(2) When the mortar is correctly mounted within the prescribed limits, credit is given as follows:

TIME (seconds)	**POINT CREDIT FOR EACH TRIAL**

120-mm	4.2-inch Mortar	All Other Mortars	
51 or less	50 or less	65 or less	10
52 to 57	51 to 60	66 to 70	9
58 to 63	61 to 70	71 to 75	8
64 to 69	71 to 80	76 to 80	7
70 to 75	81 to 90	81 to 85	6
	91 to 100	86 to 90	5
76 or over	101 or over	91 or over	0

9-14. SMALL DEFLECTION CHANGE

The candidate is tested at station No. 2 on his ability to perform the gunner's duties when he is given commands that require a change in deflection.

a. **Equipment.** Prescribed in Table 9-1.

b. **Conditions.** A mortar is mounted with the sight installed. The sight is laid on two aiming posts (placed out 50 to 100 meters from the mortar) on a referred deflection of 2800 mils and 900 mils elevation for the 4.2-inch mortar, and 2800 mils deflection and 1100 mils elevation for all other mortars. The mortar is center of traverse, and the vertical line of sight is on the left edge of both aiming posts.

(1) The candidate is allowed to check the deflection set on the sight before each trial.

(2) He is allowed to start each trial with his hand on the deflection knob. (The assistant may start with his hand on the sight mount knob [4.2-inch only]).

(3) The change in deflection does not involve movement of the bridge assembly but causes the candidate to traverse the mortar at least 50 mils and not more than 75 mils (4.2-inch) and at least 20 mils and not more than 60 mils (all mortars except 4.2-inch).

(4) Traversing extension is locked and centered (120-mm).

c. **Procedure.** The candidate is given two trials; his credit score is the total of these two trials.

(1) The candidate is given one assistant. A different command is given for each trial. The evaluator records the time and checks the candidate's work after each command has been executed.

(2) The evaluator announces an initial command requiring a change in deflection of 50 to 75 mils for the 4.2-inch mortar. All other mortars require a change in deflection of 20 to 60 mils and an elevation change of 35 to 90 mils. The candidate may proceed with the exercise as soon as the deflection element is announced. The evaluator announces the command in normal sequence and cadence.

(3) No manipulation by the assistant is allowed except for cross-leveling on the 4.2-inch mortar.

(4) Time is charged against the candidate from the announcement of the last digit of the elevation element until the candidate announces, "Up."

d. **Scoring.** Scoring procedures are as follows:

(1) The candidate receives no credit when the--

- Time exceeds 20 seconds (4.2-inch); time exceeds 76 seconds (120-mm); time exceeds 35 seconds (all other mortars).
- Sight is not set correctly for deflection or elevation.
- Elevation bubble is not centered.
- Cross-level bubble is not centered.
- Assistant manipulates the mortar or sight for elevation or deflection.
- Vertical cross line of the sight is more than 2 mils off the correct sight picture.

(2) When the mortar is laid correctly within the prescribed limits, credit is given as follows:

TIME (seconds)			**POINT CREDIT FOR EACH TRIAL**
120-mm	**4.2-inch Mortar**	**All Other Mortars**	
20 or less	8 or less	20 or less	10
21 to 23	9 to 11	21 to 23	9

24 to 26	12 to 14	24 to 26	8
27 to 31	15 to 17	27 to 31	7
32 to 35	18 to 20	32 to 35	6
36 or over	21 or over	36 or over	0

9-15. REFERRING OF THE SIGHT AND REALIGNMENT OF AIMING POSTS

The candidate is tested at station No. 3 on his ability to perform the gunner's duties in referring the sight and realigning the aiming posts.

a. **Equipment.** Prescribed in Table 9-1.

b. **Conditions.** The mortar is mounted with the appropriate or proper sight installed. The sight is laid on two aiming posts (placed out 50 and 100 meters from the mortar) on a referred deflection of 2800 mils and 900 mils elevation for the 4.2-inch mortar, and 2800 mils deflection and 1100 mils elevation for all other mortars.

(1) The mortar is within two turns of center of traverse (four turns for the 120-mm). The candidate receives an administrative command with a deflection of 2860 or 2740 mils. The mortar is then re-laid on the aiming posts using the traversing crank.

(2) The candidate checks the conditions before each trial and is allowed to start the test with his hand on the deflection knob of the sight.

(3) The change in deflection in the command must be less than 25 mils but greater than 5 mils. The elevation remains constant at 900 or 1100 mils.

(4) The candidate is allowed two assistants--one to place out aiming posts and one to move the bridge or bipod (mount) and to cross-level. The assistants do not manipulate the sight or mortar for elevation or deflection.

(5) Traverse extension will not be used. It will remain locked in the center position.

c. **Procedure.** The candidate is given two trials; his credit score is the total of these two trials.

(1) A different command is given for each trial. The evaluator records the time and checks the candidate's work after each command has been executed.

(2) When the candidate is ready, he is given a command--for example, REFER, DEFLECTION TWO EIGHT EIGHT ZERO (2880), REALIGN AIMING POSTS.

(3) The candidate repeats each element of the command, sets the sight with the data given in the command, and directs one assistant in realigning the aiming posts. Then he centers his traversing assembly and, with the help of the assistant gunner, moves the bridge or bipod (mount) assembly and re-lays on his aiming posts. After he lays the mortar on the realigned posts, he announces, "Up."

Note: This procedure ensures that, after a registration mission (using a parallel sheaf), the mortars have matching deflections.

(4) Time is taken from the announcement of refer and align aiming post to the candidate's announcement of "Up."

(5) The candidate's assistant may not leave the mortar position until he hears the word POSTS in the command REALIGN AIMING POSTS.

d. **Scoring.** Scoring procedures are as follows:

(1) No credit is given when the--

- Time exceeds 1 minute, 40 seconds (4.2-inch only); time exceeds (120-mm only); time exceeds 1 minute, 15 seconds (all other mortars).
- Traversing crank is turned before the aiming posts are realigned.
- Sight is not set correctly for deflection or elevation.
- Mortar is not cross-leveled or correctly laid for elevation.
- Vertical line of the sight is more than 2 mils off the correct sight picture.
- Traversing assembly slide is more than two turns (four turns for the 120-mm) to the left or right of the center position.
- Assistant manipulates the sight or mortar for elevation or deflection.

(2) When the mortar is found to be correctly laid within the prescribed limits, credit is given as follows:

TIME (seconds)	**POINT CREDIT FOR EACH TRIAL**

120-mm	4.2-inch Mortar	All Other Mortars	
60 or less	70 or less	60 or less	10
61 to 65	71 to 80	61 to 65	9
66 to 70	81 to 90	66 to 70	8
71 to 75	91 to 100	71 to 75	7
76 or over	101 or over	76 or over	0

9-16. LARGE DEFLECTION AND ELEVATION CHANGES

The candidate is tested at station No. 4 on his ability to perform the gunner's duties when he is given commands requiring a large change in deflection and elevation.

a. **Equipment.** Prescribed in Table 9-1.

b. **Conditions.** A mortar is mounted with the sight installed. The sight is laid on two aiming posts placed out 50 to 100 meters from the mortar on a referred deflection of 2800 mils (1100 mils elevation for the 120-mm). For the first trial, using the 4.2-inch mortar, 900 mils elevation (low range) is used; for the second trial, 1065 mils elevation (high range) is used (for all mortars but the 4.2-inch, the elevation change will be greater than 100 mils but less than 200 mils). The mortar is within two turns of center of traverse (four turns for the 120-mm).

(1) The candidate is allowed to check the deflection and elevation setting before each trial. He is allowed to start each trial with his hand on the deflection knob.

(2) The change in deflection involves movement of the bridge or bipod assembly and causes the candidate to shift the barrel not less than 200 mils and not more than 300 mils. The change in elevation causes him to elevate or depress the barrel from low range to high range, or vice versa.

(3) Traverse extension is locked and centered (for the 120-mm).

c. **Procedure.** The candidate is given two trials; his credit score is the total of these two trials.

(1) The candidate is given two assistants--one assistant may visually align the mortar while the other shifts the bridge and standard assemblies. The assistants neither manipulate the sight nor lay the mortar for deflection. A

different command is given for each trial. The evaluator records the time and checks the candidate's mortar after each command has been executed.

(2) The evaluator announces a command that requires a change in deflection and elevation, involving movement of the bridge assembly and a change in the elevation range--for example: NUMBER ONE, HE QUICK, ONE ROUND, DEFLECTION THREE ZERO FOUR FIVE (3045), CHARGE TWO FOUR (24), ELEVATION ONE ZERO SIX FIVE (1065).

(3) The candidate repeats each element of the command. As soon as the deflection element is given, he places the data on the sight and re-lays on the aiming point with a compensated sight picture. As soon as the mortar is laid, he announces, "Up." The assistants must remain in their normal positions until the deflection element is given.

(4) Time is taken from the announcement of the last digit of the elevation element of the fire command until the candidate announces, "Up."

d. **Scoring.** Scoring procedures are as follows:

(1) The candidate receives no credit when the--

- Time exceeds 1 minute and 15 seconds (60-mm mortar); time exceeds 55 seconds (120-mm); time exceeds 60 seconds (all other mortars).
- Sight is not set correctly for deflection or elevation.
- Mortar is not correctly laid for elevation.
- Mortar is not cross-leveled.
- Vertical line is more than 2 mils off the compensated or aligned sight picture.
- Traversing assembly slide is more than two turns (four turns for the 120-mm) to the left or right of the center position.
- Assistants make unauthorized movements or manipulations.
- Collar assembly is not positioned on the correct saddle for the announced elevation (60-mm).
- Traverse extension is not locked and centered (for the 120-mm).

(2) When the mortar is laid correctly within the prescribed limits, credit is given as follows:

TIME (seconds)	**POINT CREDIT FOR EACH TRIAL**

120-mm	4.2-inch Mortar	All Other Mortars	
35 or less	40 or less	35 or less	10
36 to 40	41 to 47	36 to 40	9
41 to 45	48 to 54	41 to 45	8
46 to 50	55 to 61	46 to 50	7
51 to 55	62 to 68	51 to 55	6
	70 to 75	56 to 60	5
56 or over	76 or over	61 or over	0

9-17. RECIPROCAL LAYING

The candidate is tested at station No. 5 on his ability to perform the gunner's duties in laying a mortar for direction.

a. **Equipment.** Prescribed in Table 9-1.

b. **Station Setup.** The evaluator sets up the aiming circle about 25 meters to the left front of the station. He levels the instrument and orients the aiming circle so that the 0-3200 line is in the general direction the mortar is mounted. A direction stake is placed out about 25 meters in front of the mortar position.

c. **Conditions.** The candidate is given one assistant to shift the bridge or bipod assembly. The assistant does not manipulate the sight or mortar in laying for elevation or deflection. The conditions of the test are as follows:

(1) The 4.2-inch mortar is mounted for the candidate at 900 mils elevation, 3200 mils deflection. All other mortars are mounted at 3200 mils deflection and 1100 mils elevation. The mortar is laid on a direction stake on the initial mounting azimuth with the traversing mechanism centered.

(2) The mounting azimuth on which the candidate is ordered to lay the mortar is not less than 150 mils or more than 200 mils away from the initial mounting azimuth.

(3) The evaluator sets up the aiming circle about 25 meters to the left front of the mortar, with the instrument leveled and the 0-3200 line already on the mounting azimuth on which the mortar is to be laid.

(4) The candidate is allowed to start the test with his hand on the deflection knob. The assistants must remain in their normal positions until the evaluator gives the first deflection element.

(5) Traverse extension is locked and centered (for the 120-mm).

d. **Procedure.** The candidate is given two trials; his credit score is the total of these two trial scores.

(1) The evaluator operates the aiming circle during this test. He lays the vertical line on the mortar sight and commands AIMING POINT THIS INSTRUMENT.

(2) The candidate refers his sight to the aiming point and replies AIMING POINT IDENTIFIED.

(3) The evaluator then announces the deflection--for example, "Number one, deflection two three one five (2315)."

(4) The candidate repeats the announced deflection, sets it on his sight, and lays the mortar on the center of the aiming circle lens. He then announces, "Number one ready for recheck." The evaluator announces the new deflection immediately so that there is no delay.

(5) The operation is completed when the candidate announces, "Number one, zero (or one) mil(s), mortar laid."

(6) Time is taken from the last digit of elevation first announced by the evaluator until the candidate announces, "Number one, zero (or one) mil(s), mortar laid."

e. **Scoring.** Scoring procedures are as follows:

(1) The candidate receives no credit when the--

- Time exceeds 1 minute, 55 seconds.
- Sight is not set correctly for deflection or elevation.
- Elevation bubble is not centered.
- Cross-level bubble is not centered.
- Vertical line of the sight is not centered on the aiming circle lens.
- The mortar sight and the aiming circle deflection difference exceeds 1 mil.
- Assistant performs unauthorized manipulations or movements.
- Traversing mechanism is more than two turns (four turns for the 120-mm) from center of traverse. Traverse extension is not locked in the center position.

(2) When the mortar is laid correctly within the prescribed limits, credit is given as follows:

TIME (seconds)	POINT CREDIT FOR EACH TRIAL
55 or less	10
56 to 67	9
68 to 79	8
80 to 91	7
92 to 103	6
104 to 115	5
116 or over	0

Section III. GUNNER'S EXAMINATION WITH THE TRACK-MOUNTED MORTAR

This examination tests the gunner's ability to perform basic mortar gunnery tasks with the track-mounted mortar system.

9-18. SUBJECTS AND CREDITS

The examination consists of the following tests with maximum credit scores as shown.

Placing the mortar into a firing position from the traveling position	20 points
Small deflection change	20 points
Referring the sight and realigning the aiming posts	20 points
Large deflection and elevation changes	20 points
Reciprocally laying	20 points

9-19. EQUIPMENT

The minimum equipment needed for the five stations includes five mortars, five M106-series carriers, five sights, one aiming circle, eight aiming posts, and five stopwatches.

9-20. ORGANIZATION

The organization prescribed in Table 9-2 is recommended for the conduct of the gunner's examination. Variations are authorized, depending on local conditions and the number of men being tested.

STATION	PHASE	EQUIPMENT	
		FOR CANDIDATE	FOR EXAMINING OFFICER
1	Placement of the mortar into firing position from the traveling position.	1 mortar carrier 1 mortar 1 sight	1 stopwatch
2	Small deflection change.	1 mortar carrier 1 mortar 1 sight 2 aiming posts	1 stopwatch
3	Referring of the sight and realignment of the aiming posts.	1 mortar carrier 1 mortar 1 sight 2 aiming posts	1 stopwatch
4	Large deflection and elevation changes.	1 mortar carrier 1 mortar 1 sight 2 aiming posts	1 stopwatch
5	Reciprocal laying.	1 mortar carrier 1 mortar 1 sight 2 aiming posts	1 stopwatch 1 aiming circle

Table 9-2. Organization for conducting gunner's examination (carrier-mounted).

9-21. PROCEDURE

The candidate carries his scorecard from station to station. The evaluator at each station fills in the time, trial scores, and credit score, and initials the appropriate spaces.

9-22. PLACEMENT OF MORTAR INTO A FIRING POSITION FROM TRAVELING POSITION

The candidate is tested at station No. 1 on his ability to perform quickly and accurately the gunner's duties in placing the mortar into the firing position from the traveling position.

a. **Equipment.** Prescribed in Table 9-2.

b. **Conditions.** The mortar is secured in the traveling position by the mortar tie-down strap.

(1) The sight is in its case, and the case is in its stowage position.

(2) The candidate selects an assistant gunner.

(3) The blast attenuator device is removed and stored properly for the 120-mm mortar system.

(4) The mortar hatch covers are closed and locked (the ramp may be in the up or down position).

(5) The gunner and assistant gunner are seated in their traveling positions.

(6) The evaluator ensures that the candidate understands the requirement of the test and instructs him to report I AM READY before each trial.

c. **Procedure.** The candidate is given two trials; his credit score for the test is the total of these two trials.

Note: The traverse extension (120-mm) is not used during the gunner's examination. It remains locked in the center position.

(1) The evaluator positions himself inside or outside the carrier where he can best observe the action of the candidate. The evaluator's position should not interfere with the action of the candidate.

(2)The trial is complete when the candidate announces, "Up."

d. **Scoring.** Scoring procedures are as follows:

(1) The candidate receives no credit when the--

- Time exceeds 1 minute, 30 seconds (4.2-inch only); time exceeds 1 minute, 15 seconds (120-mm only).
- Sight is not set at 3200 mils deflection and 900 mils elevation for the 4.2-inch only; sight is not set at 3200 mils deflection and 1100 mils elevation for the 120-mm only.

- Elevation and cross-level bubbles are not centered (within outer red marks).
- Turntable and traversing assembly slide are not centered. (For the 120-mm, the traverse extension must also be centered and locked.)
- Mortar standard assembly support is not in the firing position (raised) (4.2-inch only).
- The traversing lock handle is not locked.
- The detent pins are not in the innermost detent (4.2-inch only).
- The standard base trunnions are not correctly seated and aligned in the standard support trunnion bearing (4.2-inch only).
- The elevation locking cam is not locked (4.2-inch only).
- The recoil stop clamp is not in position and the wing nut is not taut (4.2-inch only).
- The white line on the barrel is not aligned with the white line on the buffer housing assembly (120-mm only).
- The mortar locking pin is not fully seated and locked (4.2-inch only).
- The mortar carrier rear hatch covers are not securely latched.
- The safety mechanism is not set on FIRE (F showing) (120-mm only).
- The cross-level locking knob is not hand tight (120-mm only).
- The buffer housing assembly is not positioned against the lower collar stop (120-mm only).
- The blast attenuator device knob is not hand tight (120-mm only).
- The assistant manipulates the sight and or mortar for elevation and or deflection (120-mm only).

(2) When the mortar is found to be in the correct firing position within the prescribed limits, credit is given as follows:

TIME (seconds)		**POINT CREDIT FOR EACH TRIAL**
120-mm	**4.2-inch Mortar**	
50 or less	65 or less	10
51 to 57	66 to 70	9
58 to 63	71 to 75	8
64 to 69	76 to 80	7

70 to 75	81 to 85	6
	86 to 90	5
76 or over	91 and over	0

9-23. SMALL DEFLECTION CHANGE

The candidate is tested at station No. 2 on his ability to perform the gunner's duties when he is given commands that require a change in deflection.

a. **Equipment.** Prescribed in Table 9-2.

b. **Conditions.** The mortar is prepared for action with sight installed.

(1) The sight is laid on two aiming posts (placed out 50 to 100 meters from the mortar) on a referred deflection of 2800 and 900 mils elevation (for the 120-mm, referred deflection of 2800 and 1100 mils elevation). The turntable is centered, and the traversing mechanism is within two turns of center of traverse. For the 120-mm, the turntable is centered, the traversing mechanism is within four turns of center of traverse, and the traverse extension is centered and locked. The vertical line of the sight is on the left edge of both aiming posts.

(2) The change in deflection causes the candidate to traverse the mortar at least 50 but not more than 75 mils. For the 120-mm, traverse the mortar 20 to 60 for deflection and 30 to 90 for elevation.

(3) The candidate selects an assistant gunner (4.2-inch only).

(4) The candidate is allowed to begin the test with his hand on the deflection knob.

c. **Procedure.** The candidate is given two trials; his credit score for the test is the total of these two trials.

(1) The evaluator announces an initial command requiring a change in deflection.

(2) The candidate repeats each element of the command, sets the sight with the data given, and traverses and cross-levels the mortar until he obtains the correct sight picture.

(3) Time is charged against the candidate from the announcement of the last digit of the elevation element until the candidate's announcement of "Up."

(4) For the 120-mm, deflection of 20 to 60 mils and elevation 30 to 90 mils.

(5) For the 120-mm, traverse extension will not be used.

d. **Scoring.** Scoring procedures are as follows:

(1) The candidate receives no credit when--

- The time exceeds 20 seconds (35 seconds for the 120-mm).
- The deflection is not indexed correctly (deflection and elevation are not set correctly for the 120-mm).
- The elevation and cross-level bubbles are not centered within the outer lines.
- The vertical cross line of the sight is not within 2 mils of the left edge of the aiming post.
- The traverse extension is centered and locked in position (120-mm only).

(2) When the mortar is laid correctly within the prescribed limits, credit is given as follows:

TIME (seconds)		**POINT CREDIT FOR EACH TRIAL**
120-mm	**4.2-inch Mortar**	
20 or less	10 or less	10
21 to 23	11 and 12	9
24 to 26	13 and 14	8
27 to 31	15 and 16	7
32 to 35	17 and 18	6
	19 and 20	5

36 or over	21 or over	0

9-24. REFERRING OF THE SIGHT AND REALIGNMENT OF AIMING POSTS

The candidate is tested at Station No. 3 on his ability to perform the gunner's duties in referring the sight and realigning the aiming posts.

a. **Equipment.** Prescribed in Table 9-2.

b. **Conditions.** The sight is laid on two aiming posts (placed out 50 and 100 meters from the mortar) on a referred deflection of 2800 mils and 900 mils elevation for the 4.2-inch mortar (1100 mils elevation for the 120-mm). The ramp is down with ammunition bearer in or outside the vehicle.

(1) The mortar is within two turns of center of traverse (four turns for the 120-mm). The candidate receives an administrative command with a deflection of 2860 or 2740 mils. The mortar is then re-laid on the aiming posts using the traversing crank.

(2) The candidate checks the conditions before each trial. He is allowed to start the test with his hand on the deflection knob of the sight.

(3) The change in deflection in the command must be less than 25 mils but greater than 5 mils. The elevation remains constant at 900 mils (1100 mils for the 120-mm).

(4) The candidate selects two assistants--one assistant realigns the aiming posts and the other assists in moving the turntable and cross-leveling. The assistants do not manipulate the sight or mortar for elevation or deflection.

(5) The traversing extension will not be used. It will remain locked in the center position.

c. **Procedure.** The candidate is given two trials; his credit score is the total of these two trials.

(1) A different command is given for each trial. The evaluator records the time and checks the candidate's work after each command has been executed.

(2) When the candidate is ready, he is given a command--for example, REFER, DEFLECTION TWO EIGHT EIGHT ZERO (2880), REALIGN AIMING POSTS.

(3) The candidate repeats each element of the command, sets the sight with the data given in the command, and directs one assistant in realigning the aiming posts. Upon completion of these actions, the candidate centers the traversing assembly and, with the help of the other assistant, moves the turntable and re-lays on the aiming posts. After he lays the mortar on the realigned aiming posts, he announces, "Up."

(4) Time is taken from the announcement of REFER, DEFLECTION TWO EIGHT EIGHT ZERO (2880), REALIGN AIMING POSTS until the candidate announces, "Up."

(5) The candidate's assistants are not permitted to leave the carrier until the command REALIGN AIMING POSTS is given.

d. **Scoring.** Scoring procedures are as follows:

(1) The candidate receives no credit when the--

- Time exceeds 1 minute, 40 seconds for the 4.2-inch; time exceeds 1 minute, 15 seconds for the 120-mm.
- Traversing assembly slide is turned before the aiming posts are realigned.
- Traverse extension and turntable are not locked in the center position (120-mm).
- Sight is set incorrectly for deflection or elevation.
- Elevation and deflection bubbles are not centered.
- Sight picture is not correct.
- Traversing assembly slide is more than two turns (four turns for the 120-mm) to the left or right of the center position.
- Assistant manipulates the sight or mortar for elevation or deflection.

(2) When the mortar is laid correctly within the prescribed limits, credit is given as follows:

TIME (seconds)		**POINT CREDIT FOR EACH TRIAL**
120-mm	**4.2-inch Mortar**	
60 or less	75 or less	10
61 to 65	76 to 80	9

66 to 70	81 to 85	8
71 to 75	86 to 90	7
76 to 80	91 to 95	6
	96 to 100	5
81 or over	21 or over	0

Note: If for any reason either of the aiming posts fall before the candidate announces, "Up," the trial will be terminated and re-administered.

9-25. LARGE DEFLECTION AND ELEVATION CHANGES

The candidate is tested at station No. 4 on his ability to perform the gunner's duties when he is given commands requiring a large change in deflection and elevation.

a. **Equipment.** Prescribed in Table 9-2.

b. **Conditions.** The evaluator selects a deflection change that is at least 200 but not more than 300 mils off the referred deflection of 2800 mils and 1100 mils elevation.

(1) The change in deflection involves movement of the turntable. The change in elevation causes the candidate to elevate or depress the barrel from low range to high range, or vice versa. The change in elevation is not less than 100 mils and not more than 200 mils for the 120-mm mortar.

(2) The candidate selects two assistants.

(3) Traversing extension and turntable are locked the center position.

(4) The candidate is allowed to check the deflection and elevation settings before each trial.

(5) The candidate is allowed to begin the test with his hand on the deflection knob.

c. **Procedure.** The candidate is given three trials. If he chooses to use the first (practice) as record, he must use the second as record. If he chooses to use the first trial as practice, he must use the second and third trials as record. He selects two assistants--one assistant may visually align the mortar, while the other elevates or depresses the standard assembly and assists in moving the turntable. The assistant does not manipulate the sight or lay the mortar for deflection.

(1) The evaluator announces a command that requires a change in deflection involving movement of the turntable and an elevation change involving movement of the elevating mechanism cam.

(2) The candidate is allowed to start the test with his hand on the deflection knob. He repeats each element of the fire command and sets the sight with the data given in the command.

(3) As soon as the deflection element is announced, he can immediately place the data on the sight. The assistants must remain in their normal positions until the elevation element is given.

(4) The evaluator times the candidate from the announcement of the last digit of the elevation command to the candidate's announcement of "Up."

(5) A different deflection and elevation are given in the second trial.

d. **Scoring.** Scoring procedures are as follows:

(1) The candidate receives no credit when the--

- Time exceeds 60 seconds (55 seconds for the 120-mm).
- Sight is not indexed correctly for deflection or elevation.
- Elevation and cross-level bubbles are not centered.
- Vertical line of the sight is more than 2 mils off the correct compensated sight picture.
- Traversing mechanism is more than two turns (four turns for the 120-mm) off center of traverse.
- Turntable is not in the locked position.
- Assistants make any unauthorized manipulation of the mortar or sightunit for elevation or deflection.
- Traversing extension is not locked in the center position.

(2) When the mortar is laid correctly within the prescribed limits, credit is given as follows:

TIME (seconds)		**POINT CREDIT FOR EACH TRIAL**
120-mm	**4.2-inch Mortar**	
45 or less	35 or less	10

46 to 50	36 to 40	9
51 to 55	41 to 45	8
56 to 60	46 to 50	7
61 to 65	51 to 55	6
	56 to 60	5
66 or over	61 or over	0

9-26. RECIPROCAL LAYING

The candidate is tested at station No. 5 on his ability to quickly and accurately perform the gunner's duties in reciprocally laying the mortar.

a. **Equipment.** Prescribed in Table 9-2.

b. **Conditions.** The mortar is prepared for action and laid on an initial azimuth by the evaluator and his assistants.

(1) The sight is set at 3200 mils deflection and 900 mils elevation.

(2) The evaluator sets up the aiming circle about 75 meters from the carrier where it is visible to the gunner.

(3) The evaluator orients the aiming circle on an azimuth of not less than 150 mils or not more than 200 mils away from the initial azimuth.

(4) The candidate is allowed to begin the test with his hand on the deflection knob with the carrier engine running.

(5) A relay man is positioned halfway between the aiming circle and carrier to relay commands.

(6) The traversing mechanism is centered and the traversing extension is locked in the center position.

c. **Procedure.** The candidate is given three trials. If he chooses to use the first (practice) as record, then he must use the second as record. If he chooses to use the first trial as practice, then he must use the second and third trials as record.

(1) The evaluator operates the aiming circle during the test.

(2) Once the candidate identifies the aiming point, the evaluator announces the deflection.

(3) Time is started from the last digit of the first deflection announced by the evaluator.

(4) When the candidate announces, "Ready for recheck," the evaluator immediately announces the new deflection.

(5) The trial is complete when the gunner announces, "Zero mils (or one mil), mortar laid."

d. **Scoring.** Scoring procedures are as follows:

(1) The candidate receives no credit when the--

- Time exceeds 2 minutes, 15 seconds for the 4.2-inch; time exceeds 1 minute, 33 seconds for the 120-mm.
- Difference between the deflection setting on the sight and the last deflection reading from the aiming circle is more than 1 mil.
- Elevation and cross-level bubbles are not centered.
- Vertical reticle line of the sight is not centered on the lens of the aiming circle.
- Traversing extension is not locked in the center position.
- The mortar sight and the aiming circle are not sighted on each other with a difference of more than 1 mil between deflection readings.
- Turntable is not centered and locked.

(2) When the mortar is laid correctly, credit is given as follows:

TIME (seconds)		**POINT CREDIT FOR EACH TRIAL**
120-mm	**4.2-inch Mortar**	
55 or less	60 or less	10
56 to 67	61 to 75	9
68 to 79	76 to 90	8
80 to 90	91 to 105	7

91 to 95	106 to 120	6
	121 to 135	5
96 or over	136 or over	0

9-27. SUPPORT SQUAD

Support squads are located in cavalry units, task units, and light infantry units. The gunner's examination for the support squad is the same as that used by the mortar section, except for the reciprocal laying, and refer and realign stations. The tests below are substituted respectively for the reciprocal laying and for the refer and realign stations. The entire refer and realign station is eliminated, and the procedures for direct lay are used.

a. **Reciprocal Laying.** In this test (4.2-inch mortar only) the compass is substituted for the aiming circle.

(1) *Conditions.* The mortar is prepared for action and laid on an initial azimuth by the evaluator and his assistants.

(a) The turntable is centered with the sight set at 3200 mils deflection and 900 mils elevation.

(b) The evaluator places the M2 compass on a stake about 75 meters from the mortar carrier and measures the azimuth to the mortar sight. He then selects a mounting azimuth from the azimuth measured to the mortar sight.

(c) The candidate selects an assistant gunner and driver.

(d) The evaluator ensures that the candidate understands the requirements of the test and instructs him to report I AM READY before each trial.

(2) *Procedure.* The candidate is given two trials; his credit score for the test is the total of these two trials.

(a) The evaluator operates the compass during the test.

(b) When the candidate identifies the aiming point, the evaluator announces the deflection.

(c) When the gunner is laid back on the aiming point, he announces, "Up," and the evaluator commands REFER,

DEFLECTION TWO EIGHT ZERO ZERO (2800), PLACE OUT AIMING POSTS.

(d) The ammunition bearer moves out as soon as the initial deflection has been announced by the evaluator and places out the aiming posts as directed by the gunner.

(e) The trial is complete when the gunner announces, "Up," after the aiming posts are in position.

(3) *Scoring*. The scoring procedures are as follows:

(a) The candidate receives no credit when the--

- Time exceeds 2 minutes, 15 seconds.
- Deflection placed on the sight is incorrect.
- Elevation and cross-level bubbles of the sight are not centered.
- Turntable is not centered.
- Aiming posts are not properly aligned.

(b) When the mortar is laid correctly, credit is given as follows:

TIME (seconds)	**POINT CREDIT FOR EACH TRIAL**
70 or less	10
71 to 81	9
82 to 92	8
93 to 103	7
104 to 114	6
115 to 125	5
126 or over	0

b. **Reciprocal Laying (Light Infantry Mortars).** In this test, the sight-to-sight method is used to reciprocal lay the mortar.

(1) *Conditions.* The mortar is prepared for action on an azimuth by the evaluator and his assistants.

(a) The sight is set at 3200 mils deflection and 1100 mils elevation.

(b) The evaluator sets up the base mortar about 35 meters from the test mortars where it is visible to the gunner.

(c) The evaluator orients the base mortar on an azimuth of not less than 150 mils or more than 200 mils away from the initial azimuth.

(d) The candidate selects an assistant gunner (optional for the 60-mm mortar).

(e) The candidate is allowed to begin the test with his hand on the deflection micrometer knob.

(f) The evaluator ensures that the candidate understands the requirements of the test, and he instructs him to report I AM READY before each trial.

(2) *Procedure*. The candidate is given two trials; his credit score is the total of these two trials.

(a) The evaluator positions himself at the base mortar and commands AIMING POINT THIS INSTRUMENT.

(b) The gunner refers his sight to the aiming point and replies, "Aiming point identified."

(c) The evaluator reads the deflection from the sight of the base mortar. He determines the back azimuth of that deflection by adding/subtracting 3200 mils and announces the deflection--for example, the deflection on the base mortar is 1200 mils. The evaluator adds 3200 mils to this deflection (1200 + 3200 = 4400 mils) and announces, "Number one, deflection four four zero zero (4400)."

(d) The candidate repeats the announced deflection, sets it on the sight, and, with the help of his assistant gunner, lays the mortar on the center of the base mortar sight lens. He then announces, "Number one ready for recheck." The evaluator announces the new deflection as soon as possible so that there is no delay.

(e) The operation is completed when the candidate announces, "Number one, zero (or one) mil(s), mortar laid."

(3) *Scoring*. The scoring procedures are as follows:

(a) The candidate receives no credit when the--

- Time exceeds 1 minute, 55 seconds.
- Deflection placed on the sight is incorrect.
- Elevation and cross-level bubbles of the sight are not centered.
- Mortar is not within two turns of center of traverse (four turns for the 120-mm).
- The sight and the base mortar sight are not sighted on each other with a difference of not more than 1 mil between deflection readings.

(b) When the mortar is laid correctly, credit is given as follows:

TIME (seconds)	**POINT CREDIT FOR EACH TRIAL**
55 or less	10
56 to 67	9
68 to 79	8
80 to 91	7
92 to 103	6
104 to 115	5
116 or over	0

APPENDIX A

TRAINING DEVICES

The most efficient and direct method of teaching conduct of fire is by firing combat ammunition under field conditions. However, ammunition training allowances and range limitations often restrict such training to subcaliber firing on reduced or miniature ranges.

Section I. THE 60-mm SUBCALIBER ASSEMBLY

The 60-mm subcaliber assembly is a training device for use with the 4.2-inch mortar system.

A-1. DESCRIPTION

The subcaliber assembly consists of a 60-mm barrel modified for inserting into a 4.2-inch barrel. The M2 60-mm barrel is the only barrel authorized for use. The components of the assembly are an insert, filler block, and filler block retriever.

a. The insert (Figure A-1) consists of a 60-mm mortar barrel, which is fitted with two aluminum rings that allow it to fit snugly into the 4.2-inch barrel. The aluminum rings also prevent the rifling in the barrel from being scored (Figure A-2).

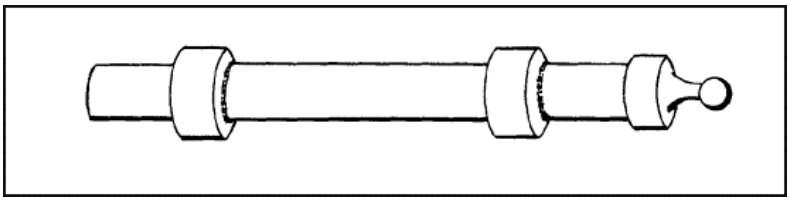


Figure A-1. The 60-mm mortar insert.

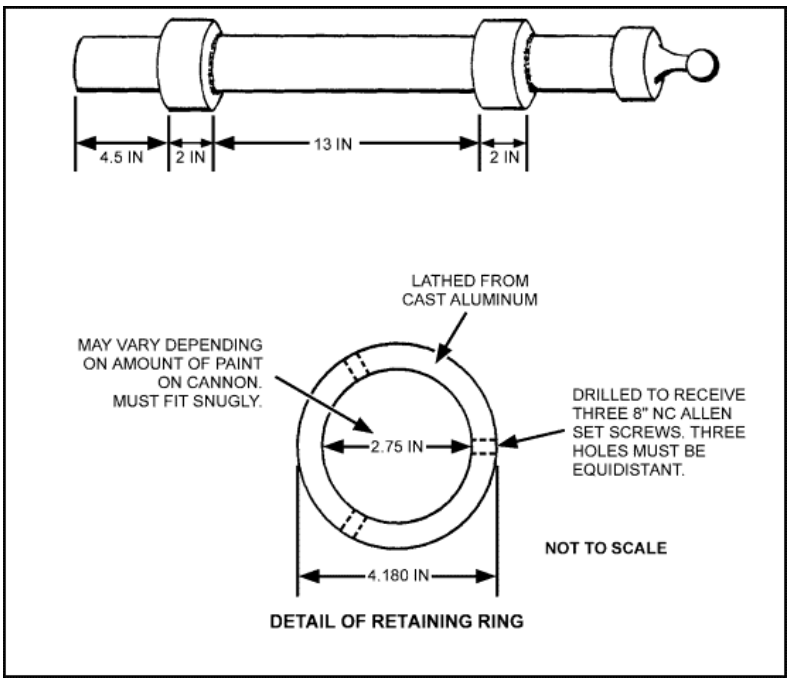


Figure A-2. Aluminum rings.

b. The filler block (Figure A-3) consists of a round steel pipe fitted with an aluminum shock cap on either end, which fit snugly into the barrel without scoring it. Either aluminum cap receives the spherical projection of the 60-mm barrel and distributes the recoil shock. The center of each cap is threaded to receive the filler block retriever. The shock caps fit over the striker pin of the 4.2-inch barrel, allowing all the shock to be exerted on the base end of the barrel rather than on the striker pin (Figure A-4).

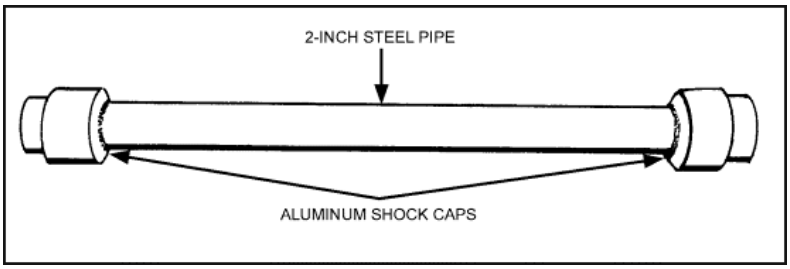


Figure A-3. Filler block.

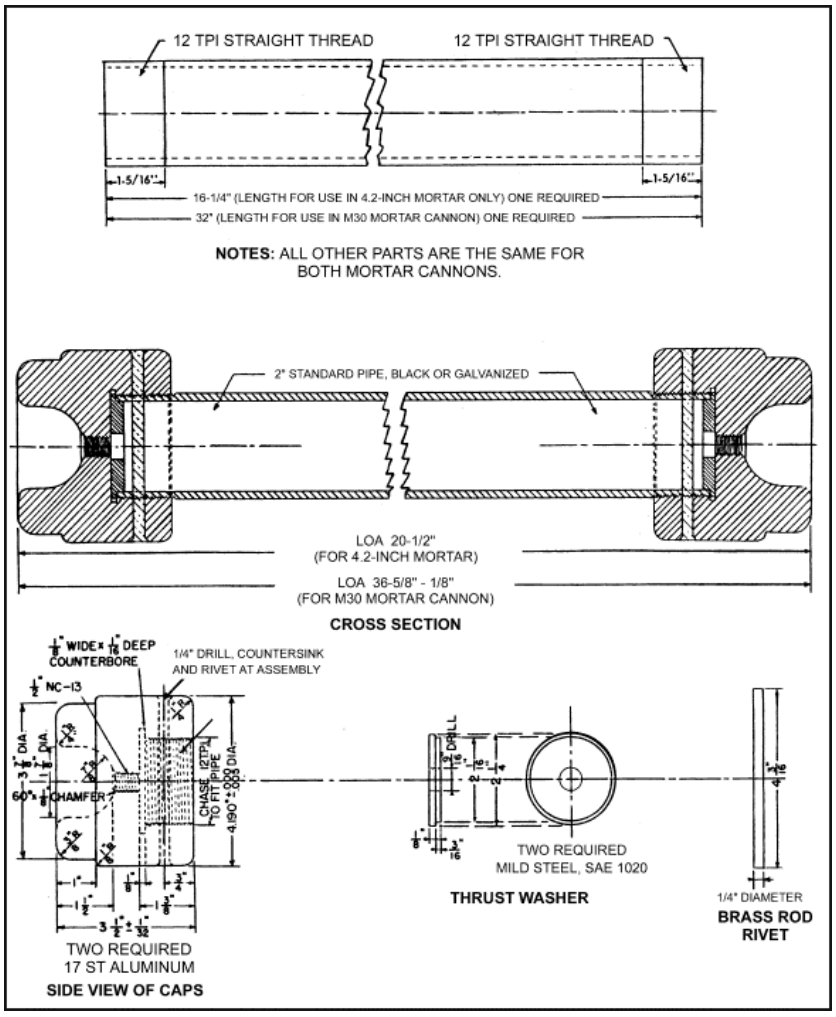


Figure A-4. Construction details of the filler block.

c. The filler block retriever (Figure A-5) is used to remove the filler block from the 4.2-inch mortar. It is a steel rod fitted with a handle on one end. The other end

is threaded so that it can be screwed into the shock cap of the filler block (Figure A-6).

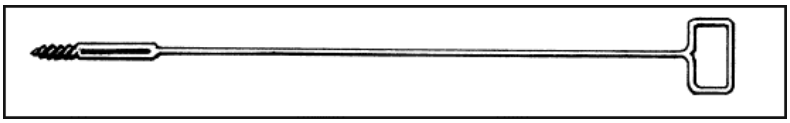


Figure A-5. Filler block retriever.

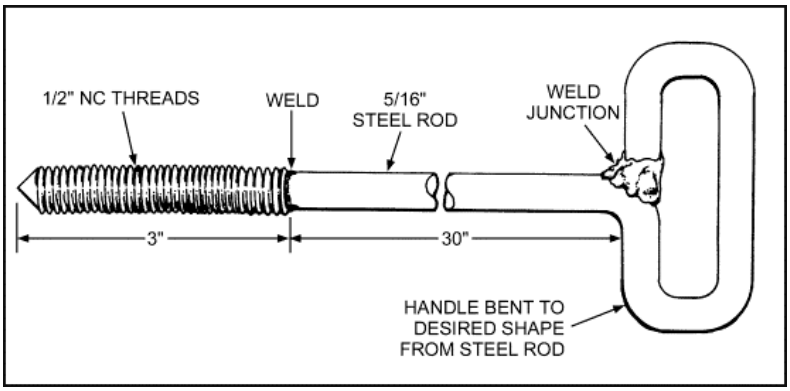


Figure A-6. Construction detail of the filler block retriever.

Note: The subcaliber mortar kit is obtained from the supporting ordnance unit. See TM 9-1015-215-23&P for more information.

A-2. ASSEMBLY

The subcaliber assembly does not affect the use of the sight, traversing assembly slide, or elevation mechanism of the 4.2-inch mortar. To install the subcaliber assembly, the mortar is mounted, and then the filler block is slid down the barrel. The insert (60-mm barrel with rings) is slid down the barrel, protruding about 1 1/2 inches.

A-3. DISASSEMBLY

To disassemble the subcaliber assembly, the protruding barrel of the 60-mm mortar is grasped and lifted out of the 4.2-inch barrel. The retriever is screwed into the filler block and lifted out of the block.

A-4. AMMUNITION

All types of 60-mm mortar ammunition that are listed in FT 60-Q-1, including training, practice, and HE rounds, can be fired from the subcaliber assembly. The 60-mm mortar training round is usually fired on a training range; the practice round and HE round are used on a standard field firing range. When an ammunition shortage prevents field fire training with 4.2-inch rounds, 60-mm practice or HE ammunition can substituted.

a. **High-Explosive Round, M49-Series**. This round is the standard B ammunition for the M224 60-mm mortar.

(1) The M49A2 HE round is painted olive drab. It consists of a hollow body (Figure A-7), fin assembly that screws on the rear of the body, and M525 fuze that is attached to the front of the round. A TNT bursting charge is contained in the body and is ignited by the booster charge in the fuze upon impact. The fin assembly contains the ignition cartridge and provides a means for attaching the propelling increments. The fins keep the projectiles stable in flight. This round weighs 3 pounds, and it can be fired at a maximum range of about 1,800 meters. Each round comes in a separate fiber container complete for firing.

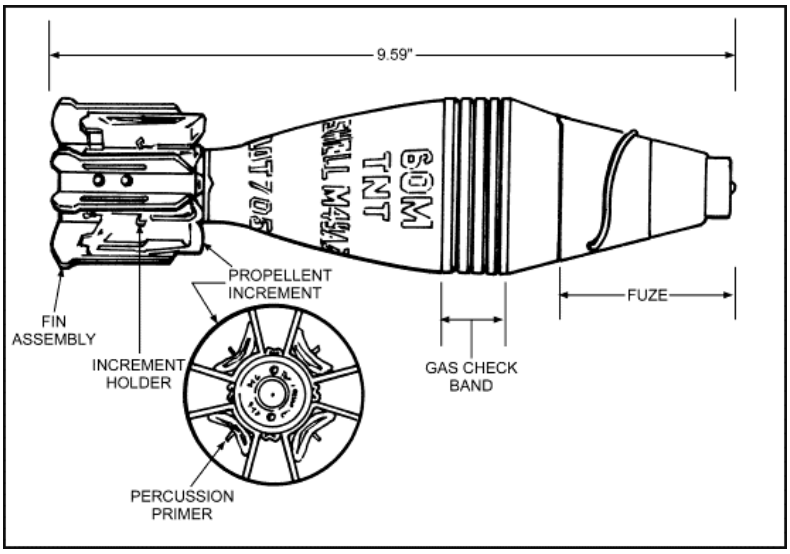


Figure A-7. HE round, M49A2.

Note: For more information see TM 9-1300-203 and FT 60-L-5.

(2) Before firing, the fuze must be checked. The safety wire is removed, and the round is held vertically while pressing the bore riding safety pin inward to check tension. If the pin becomes unseated, the round is considered unsafe and should not be fired. ANY ROUND THAT IS ISSUED WITHOUT A BORE RIDING SAFETY PIN SHOULD NOT BE FIRED.

b. **Practice Round, M50A2**. This round is designed to give mortar crews practice in firing and technique of fire without the expense incident to firing HE ammunition. On impact, the practice round emits a puff of white smoke that is clearly visible to the observer. This round differs from the HE round described above in color and filler only. It is painted blue.

Note: The firing table for this round is FT 60-L-5.

A-5. CARE AND CLEANING

The care and cleaning procedure described in TM 9-1015-215-10 applies to the subcaliber assembly.

A-6. SAFETY

The safety precautions for 4.2-inch ammunition must be observed along with the following safety rules:

a. **During Firing.** Personnel never move forward of the OP area nor do they pound an ignition cartridge into the fin assembly since the primer could detonate.

b. **Misfire Procedure**. The procedure before actual removal of the round is the same as that used with service ammunition.

(1) To remove the round, the assistant gunner gently removes the 60-mm barrel from the 4.2-inch barrel by grasping the 60-mm barrel around the muzzle with both hands and lifting (Figure A-8), ensuring that no part of his hands protrudes over the muzzle. The gunner guides the 60-mm barrel with his thumbs. When the base aluminum ring of the 60-mm barrel reaches the end of the 4.2-inch barrel, the gunner firmly grasps the base aluminum ring to prevent it from dropping and jarring the barrel. The gunner grasps the base end of the 60-mm barrel and lifts it to the horizontal. HE DOES NOT STAND BEHIND IT.

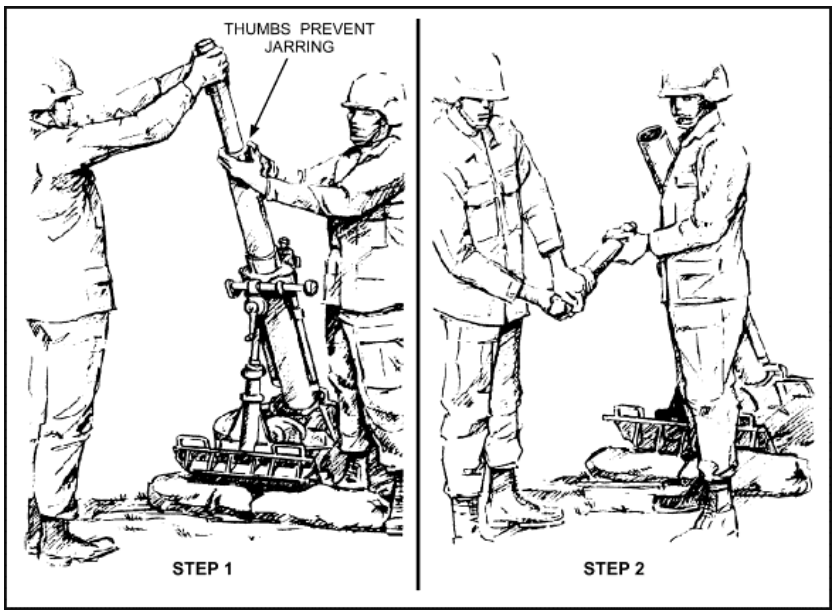


Figure A-8. Misfire procedure (60-mm subcaliber device).

(2) The assistant gunner, hands still positioned around the 60-mm barrel, extends the thumbs of both hands over the edge of the muzzle. When the barrel reaches the horizontal, the gunner continues to lift the base end of the barrel until the round slides forward (Figure A-8). Once the barrel is horizontal, the base end is not lowered until the misfire has been removed.

(3) The assistant gunner's thumb stops the round when the round reaches the muzzle. He then removes it from the barrel and hands it to an ammunition bearer. The gunner shakes the 60-mm barrel to empty any foreign material from the bore and reinserts it into the 4.2-inch barrel. The assistant gunner swabs the bore.

A-7. RANGE CONSTRUCTION

The construction of a training round range is easily accomplished, requiring a minimum of space and effort. The range is measured in meters (Figure A-9) and consists of a target (impact) position area, OP position area, mortar position area, and FDC position area. A range 30.5 meters wide is adequate.

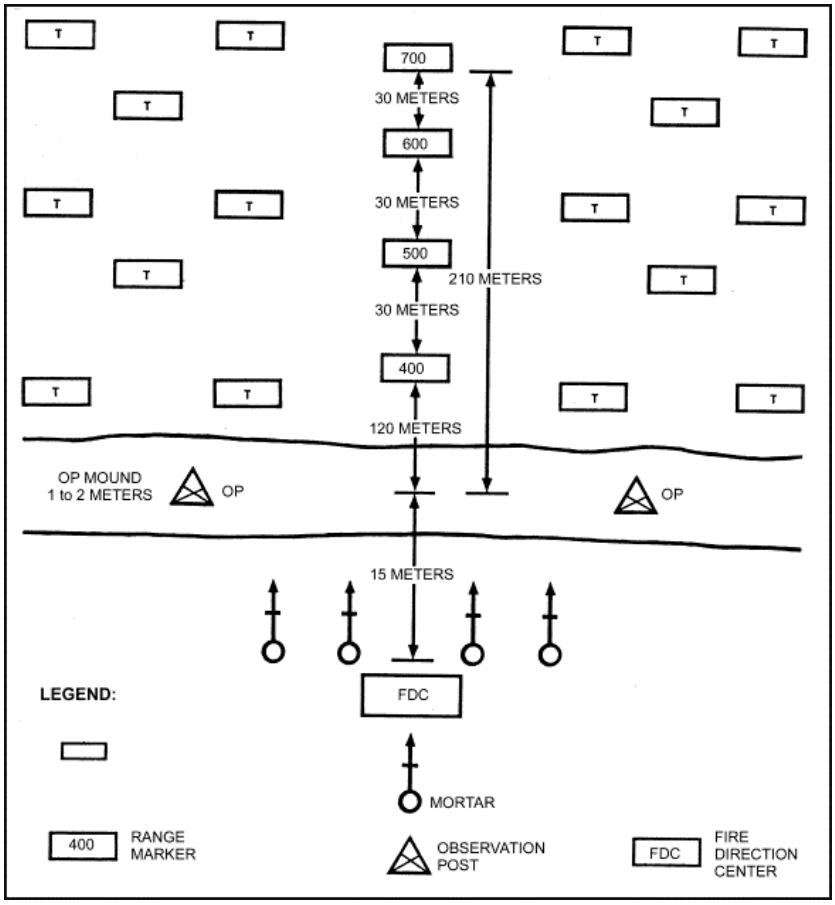


Figure A-9. Training range.

a. The target position area consists of range markers in hundreds of up to 700 meters with various targets staggered throughout. The range markers are placed at 30-meter intervals (each interval represents 100 meters on the ground), the first marker being 120 meters from the OP positions (marked 400). The markers are rectangular, 30.5 by 45.5 centimeters. Targets should be constructed to represent various objects such as trees and houses; however, barrels or boxes placed throughout the area are adequate. These targets and markers can be constructed from scrap lumber and can be made portable, which allows the target area to be

cleared for other purposes. When all practice targets look alike, they should be painted different colors to assist the FO.

b. The OP position area is between the firing position and target area. It should afford full observation of the target area; normally, a mound should suffice. When the range is in use, telephone communication is established between the OP and FDC.

c. The mortar position area is 15 meters to the rear and off-line from the OP position; mortars are mounted laterally 6 meters apart. A mask should exist between the target area and firing position. If it does not, a target cloth screen might need to be placed between the target area and firing position.

d. The FDC is established close enough to the mortar position to permit voice communication between the two. Wire or radio communication is established between the FDC and OP.

A-8. OPERATION

Mortarmen are assembled at the OP for an orientation on range organization.

a. Mortarmen are assigned as FDC members, as crew members at the mortar position, and as FOs, and periodically rotate assignments during training. Training is conducted in the following sequence:

(1) The OP sends a fire request to the FDC to begin a registration point adjustment.

(2) The FDC computes a fire command and sends it to the mortars.

(3) The mortar crew members lay the mortars and fire.

(4) Adjustment is continued until the registration point has been established.

(5) The FDC then directs the OP to adjust the sheaf when ready.

(6) The section is then given a command of referred deflection.

(7) From this point on, various targets can be engaged using different types of adjustment.

b. As the range is laid out in meters, all corrections and computations are in meters; however, the mil-relation formula applies. To obtain the best results, the FDC allows each square on the target grid or M16 plotting board to equal 25 meters.

Section II. SABOT, M1

This section provides the technical information required to employ the sabot. However, trainers should exercise imagination and ingenuity in developing training situations for employing the system.

A-9. DESCRIPTION

The 81-mm sabot (inert), M1, assist crews in reaching technical and tactical proficiency, thus, strengthening their ability to be effective on the modern battlefield. With the 22-mm subcaliber practice cartridge, the sabot (M1) provides an economical means of training personnel in all phases of mortar gunnery. These devices consist of two major components: the 81-mm sabot and 22-mm subcaliber cartridge (Figure A-10).

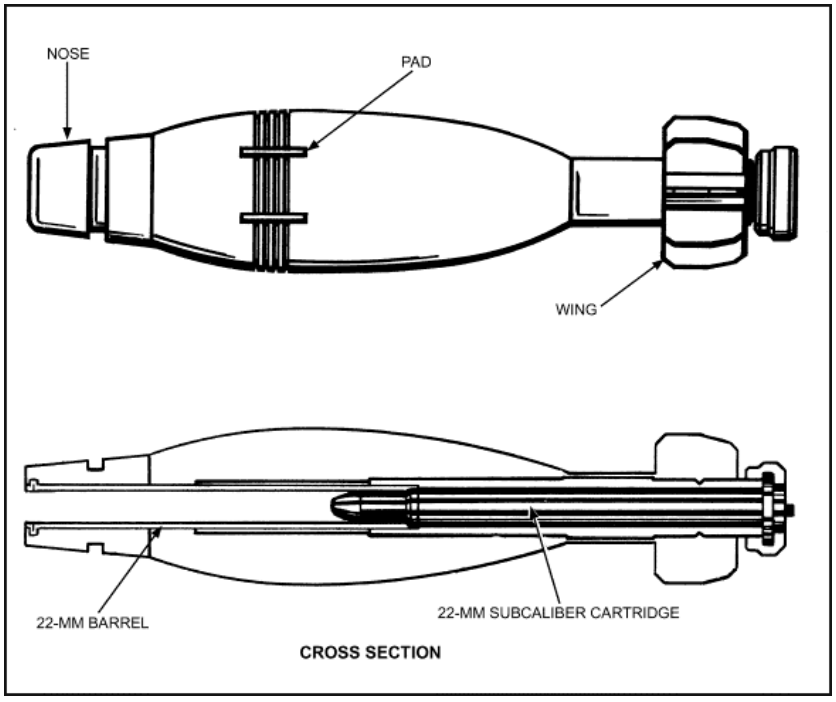


Figure A-10. Sabot, M1, and cross section.

a. The sabot is designed to fire the subcaliber cartridge (Figure A-11) through the barrel. The subcaliber cartridge, when loaded into the sabot, approximates a round of service ammunition both in size and weight. The entire assembly is then fired

from the mortar just as in service firing. The subcaliber projectile travels from 70 to 435 meters, depending on the charge and elevation selected. The projectile emits a puff of smoke and an audible report upon impact, but no fragmentation. At the time of firing, the sabot is also expelled from the mortar and impacts 2 to 15 meters from the mortar (Figure A-12, D). It is then recovered, cleaned, reloaded, and refired.

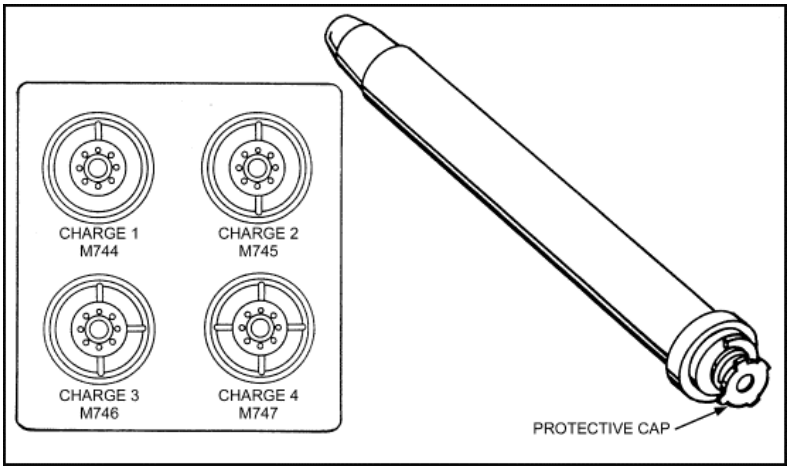


Figure A-11. Subcaliber cartridge.Figure 1.

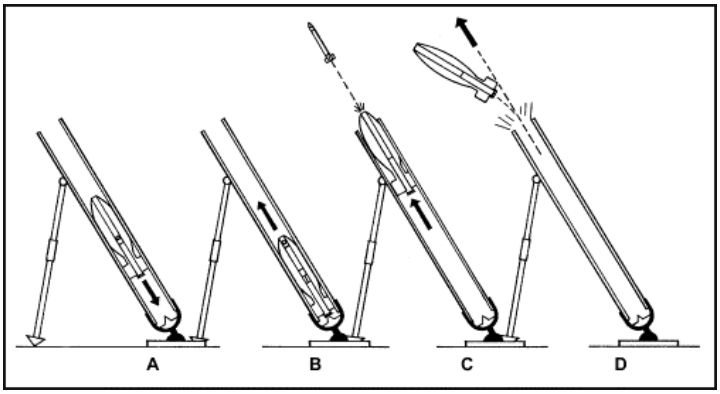


Figure A-12. Firing of mortar training device and cartridge.

b. A scale ratio of 1:10 is used to relate the range and deviation between the subcaliber projectile and standard 81-mm service projectile. Thus, the minimum range requirement for firing through charge 4 is an area 500 meters deep, and wide enough to accommodate the desired number of targets plus a 45-meter safety zone on each side of the flank targets (Figure A-13).

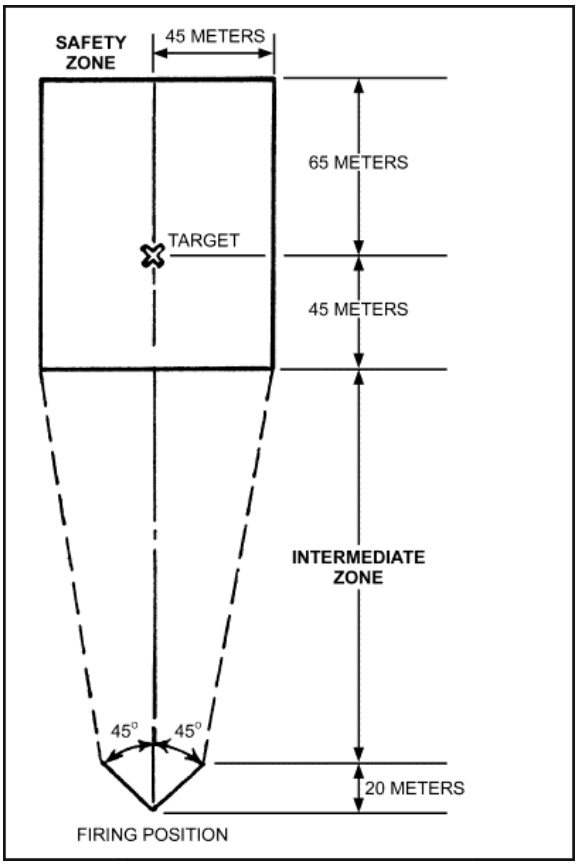


Figure A-13. Minimum range area.

A-10. ADVANTAGES

The advantages of using the 81-mm sabot are:

- Provides the capability for firing in training areas where the firing of conventional mortar ammunition is prohibited.
- Saves time and expenses of long-distance traveling to suitable mortar ranges.
- Saves the expense of firing service ammunition.
- Simplifies operation, maintenance, and training.
- Follows identical mortar crew procedures as service firing, excluding appropriate charge and fuze settings.
- Uses the same equipment required for service firing.

Mortar units using the 81-mm mortar sabot require little training in preparation to use the device. The sabot is used with all standard 81-mm mortar equipment regardless of model. It accommodates prescribed squad drill procedures and can be used by mechanized and ground-mounted mortar sections and squads.

Note: Refer to TM 9-1315-249-12&P for detailed information.

A-11. DISADVANTAGES

The disadvantages of using the 81-mm sabot are:

- Causes excess carbon buildup in the barrel due to subcaliber ignition.
- Increases deterioration of the barrel.

A-12. EQUIPMENT

The following equipment is required to conduct training with the 81-mm sabot:

- All TOE mortar section/platoon equipment.
- Three 81-mm sabots for each mortar.
- Cleaning equipment.
- A piece of canvas or other heavy material, 3 meters by 15 meters, for placement in front of each mortar to catch the sabot when fired. This prevents damage to the sabot and reduces the cleaning time required during firing.
- If mortars cannot be mounted in defilade, a mask of target cloth, canvas, or other suitable material can be built between the mortars and impact area.

A-13. AMMUNITION

The ammunition used in the M1 and M3 sabots is described herein.

a. **The 81-mm Sabot**. The aluminum alloy sabot has dimensions and a configuration similar to 81-mm service ammunition.

(1) The sabot body contains a 22-mm smooth-bore barrel to receive the 22-mm subcaliber cartridge, which is loaded before firing. The boom of

the sabot has fins similar to the fins of the service ammunition, and the body has pads to guide the sabot as it travels out of the barrel. Upon firing, the loaded sabot is ejected from the barrel; the sabot lands on the ground within 15 meters of the mortar while the subcaliber projectile continues its flight to the impact area.

(2) When not loaded with a subcaliber cartridge, the sabot can be used as a dummy round for crew drill or the squad leader can "load" it with an expended cartridge case to induce a "misfire." The sabot can be reloaded and fired repeatedly for training. It is stored without the subcaliber cartridge in a packing box containing three sabot devices.

b. **The 22-mm Subcaliber Cartridge**. The 22-mm subcaliber cartridges (Figure A-14) are boxed and issued by charge: M744, charge one; M745, charge two; M746, charge three; M747, charge four. The charges can readily be identified day or night by the number of slots in the base of the subcaliber cartridge case (Figure A-15).

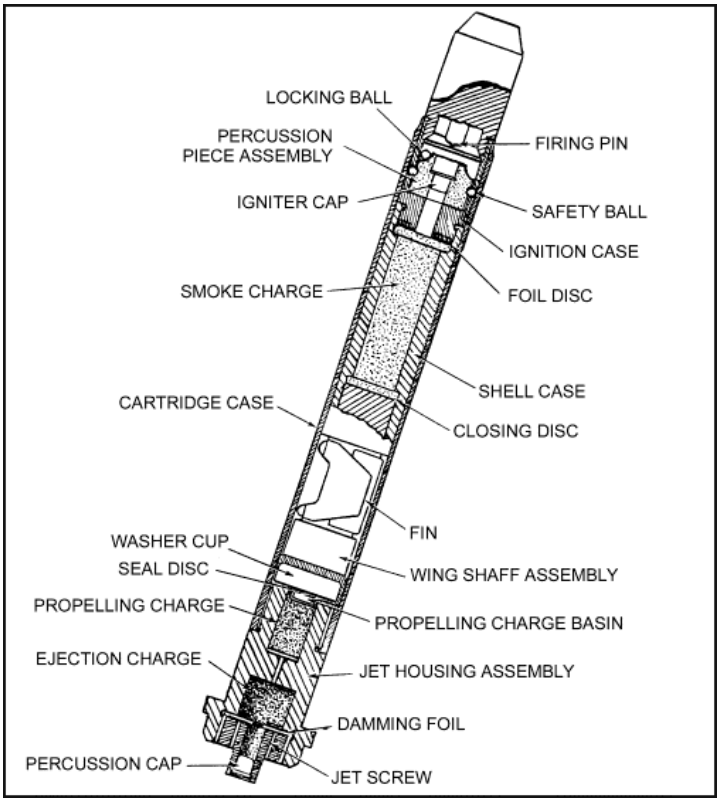


Figure A-14. The 22-mm subcaliber cartridge cross-section.

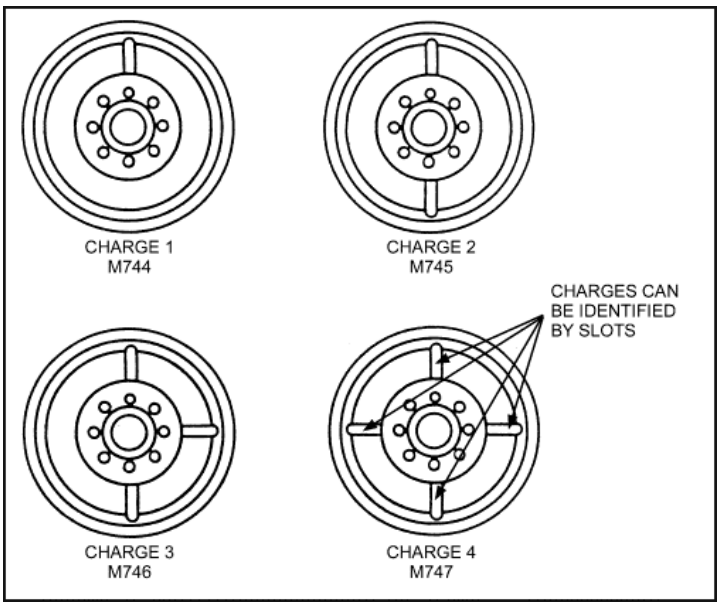


Figure A-15. Base of subcaliber cartridges--charge one through four.

(1) The 22-mm cartridge consists of the projectile with stabilizer fins and cartridge case. The projectile body contains the impact fuze and a smoke signal charge. The propelling and ejection charges are contained in two separate chambers located in an assembly threaded onto the base of the cartridge case. A flash hole between the chambers permits ignition of the propelling charge by the ejection charge.

(2) When the 22-mm subcaliber cartridge is inserted into the sabot, the sabot is ready for firing. The protective plastic cap covering the percussion cap of the subcaliber cartridge is removed before dropping the sabot into the mortar barrel. When fired, the cartridge's percussion cap strikes the firing pin and is ignited. The percussion cap ignites an ejection charge in the jet housing assembly. The propelling gases emerge through the eight holes in the jet screw assembly and initiate travel of the sabot and subcaliber cartridge up the mortar barrel. At the same time, the ejection charge ignites the subcaliber projectile propelling charge contained in the jet housing assembly. This propels the subcaliber projectile out of the cartridge case and through the 22-mm barrel of the sabot. When the sabot clears the muzzle, the subcaliber projectile clears the barrel. The sabot impacts on the ground within 15 meters of the mortar while the subcaliber projectile continues its trajectory.

(3) After the subcaliber projectile has left the sabot barrel, the impact fuze is activated. The percussion assembly, which contains the primer for the fuzing mechanism, is held in position within the ignition case by two safety balls. When the projectile clears the sabot barrel, the safety balls move outward, freeing the percussion piece. The stabilizing fins open as the projectile clears the sabot barrel, providing in-flight stability. When the projectile ascends to its maximum ordinate, a locking ball keeps the percussion piece from moving forward, preventing the cap from contacting the pin. This feature precludes premature functioning should the projectile strike a tree branch or other object (Figure A-16).

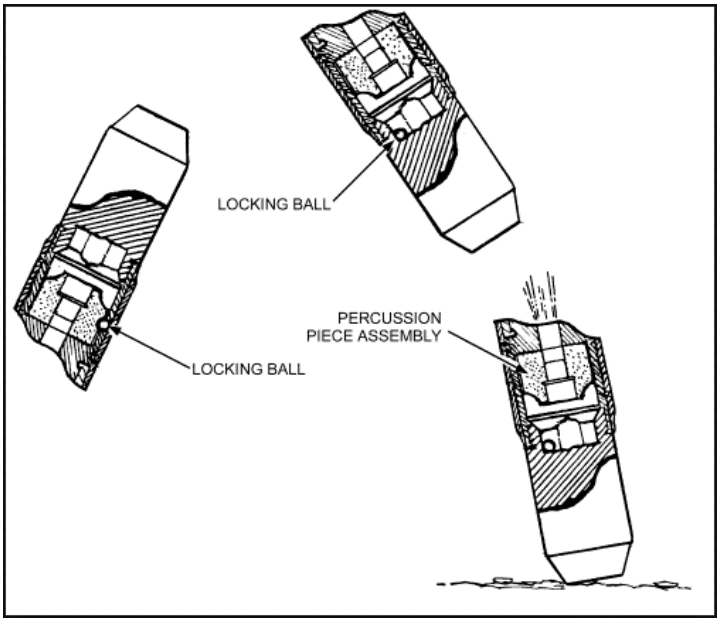


Figure A-16. Safety device.

(a) As the projectile descends from the high point of its trajectory, the locking ball falls into an empty space in the projectile head and the fuzing mechanism is fully armed.

(b) At the moment of impact, the percussion piece moves forward, allowing the igniter cap to strike the firing pin. The igniter cap initiates the smoke charge, and gas pressure produced by the burning smoke charge ejects the wing assembly from the base of the case. The smoke charge produces a yellow cloud of smoke.

The initial release of the smoke by the wing shaft assembly produces a sound (Figure A-17).

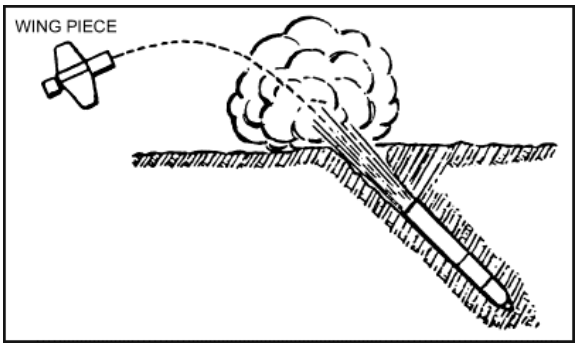


Figure A-17. Optical and acoustical observation of target strikes.

(4) To prepare for firing, the bore and chamber of the sabot are inspected for cleanliness. The flange nut is removed from the sabot by unscrewing counterclockwise. The 22-mm cartridge is inserted into the chamber of sabot, and the flange nut is screwed onto the sabot hand tight. The plastic protector cap is removed from the percussion cap. The ground in front of the mortar should be covered with canvas or a heavy plastic or vinyl-type material to protect the sabot from dirt or mud. The flange nut is removed, the expended cartridge case is extracted, and the sabot is cleaned. The sabot is reloaded with a new subcaliber cartridge, and it is ready to be fired again.

WARNING

Personnel must not stand in front or to the rear of the sabot when inserting the cartridge.

A-14. SAFETY

Sabot training devices are safe to handle and fire. The following safety precautions must be enforced.

WARNING

The 81-mm sabot is inert and can be stored and handled as a

at which time it will be handled as a live mortar round. The sabot can function as a cannon and should be secured in the same manner as any other weapon. When loaded and ready to fire, all safety precautions used during handling of service ammunition are observed.

a. The 22-mm subcaliber cartridge contains propellant and smoke charge, and is always stored and handled as live ammunition.

Note: The general safety precautions for fixed ammunition are located in TM 9-1300-206 and AR 385-63.

b. Practice ammunition is never fired over heads of troops.

c. Personnel never enter the danger area during the firing of the practice ammunition.

Note: Duds are disposed of as prescribed in TM 9-1315-249-12&P.

A-15. MALFUNCTIONS

See Chapter 3, paragraph 3-13 for a detailed discussion of malfunctions.

A-16. REMOVAL OF A MISFIRE

After failure to fire, misfire removal procedures are followed to remove the round from the weapon. If the primer cap of the 22-mm cartridge is dented, the cartridge is removed carefully from the sabot by unscrewing the flange nut, and then tagging the cartridge for disposal according to local SOP. If the primer is not dented, cause of failure to fire could be due to a malfunction of the mortar. Misfire procedures for live rounds also apply when firing the sabot. The only difference is in handling of the round after it has been removed from the mortar.

a. If the primer of the subcaliber cartridge is dented, the cartridge is carefully removed from the sabot, ensuring that the sabot is pointed downrange and that no one is to the front or rear. The subcaliber cartridge is removed to a designated area for disposal IAW local SOP.

b. If the primer is not dented, the round can be refired upon determination of the cause of the misfire.

A-17. ITEM DESCRIPTION AND SUPPLY DATA

The equipment shown in Table A-1 is available at the ammunition supply facility, except for an 81-mm sabot.

DESCRIPTION	NATIONAL STOCK NO.	PART NO.	DODAC NO.
Sabot, 81-mm Practice: M1 (Inert)	1015-00-328-5666	9287906	
Cartridge, Subcaliber, 22-mm Practice: Charge 1, M744	1305-00-334-5920	92787907	1305-A680
Cartridge, Subcaliber, 22-mm Practice: Charge 2, M745	1305-00-334-5922	9287908	1305-A681
Cartridge, Subcaliber, 22-mm Practice: Charge 3, M746	1305-00-334-5934	9287909	1305-A682
Cartridge, Subcaliber, 22-mm Practice: Charge 4, M747	1305-00-334-5935	9287910	1305-A683

Table A-1. Equipment description and supply data.

A-18. TRAINING

An advantage of sabot training is that the unit commander can observe the actions of all members of the indirect fire team while performing all the tasks that are employed during live firing. This enhances the ability of the commander to evaluate the proficiency of all elements of the team, to identify and isolate problem areas, and to begin corrective training. Also, all members of the team are able to view the entire operation and to understand how they fit into the overall plan.

a. **Preparation**. The amount of time spent preparing for training determines the benefits received from using the 81-mm sabot. Three steps must be accomplished before training with the 81-mm sabot:

- Construction of a scaled firing range (permanent, semi-permanent, and temporary).
- Construction of a map of the firing range.
- Instruction of personnel on the use of equipment.

(1) Sometimes it is desirable for gunners to observe the impact of the sabot. However, mortars are usually mounted in a defilade position so that a mask exists between the impact area and the firing position. If such a mask does not exist, one can be constructed of target cloth or other suitable material. The mask must be removed when firing direct lay missions.

(2) A heavy canvas or other suitable material should be placed on the ground to a distance of 15 meters in front of each mortar to catch the sabot. On a permanent sabot range, it is desirable to construct a permanent impact area for the sabot--a sawdust or sandpit covered with heavy canvas would be ideal.

(3) When positioning the mortars, the lateral distance between the center of the baseplates should not exceed 4 meters. Special corrections can be applied to fire for effect if the weapons are more than 4 meters apart, but it is unrealistic to habitually apply special corrections during training.

(4) When using the sabot with each of the weapons separated by 3.5 to 4 meters, some special techniques must be used. Aiming posts should be identified by squad to preclude a mix-up of aiming posts between two mortars. Numbers, colors, or any other easily discernible method can be used.

(5) Problems can be encountered when traversing carrier-mounted mortars during large deflection changes of more than 300 mils left or right of direction of fire (Figure A-18). The carriers should be traversed to avoid the possibility of hitting adjacent carriers with the sabot. Due to the minimum range of the sabot, it must be fired only over the rear of the carrier with the ramp in the up position.

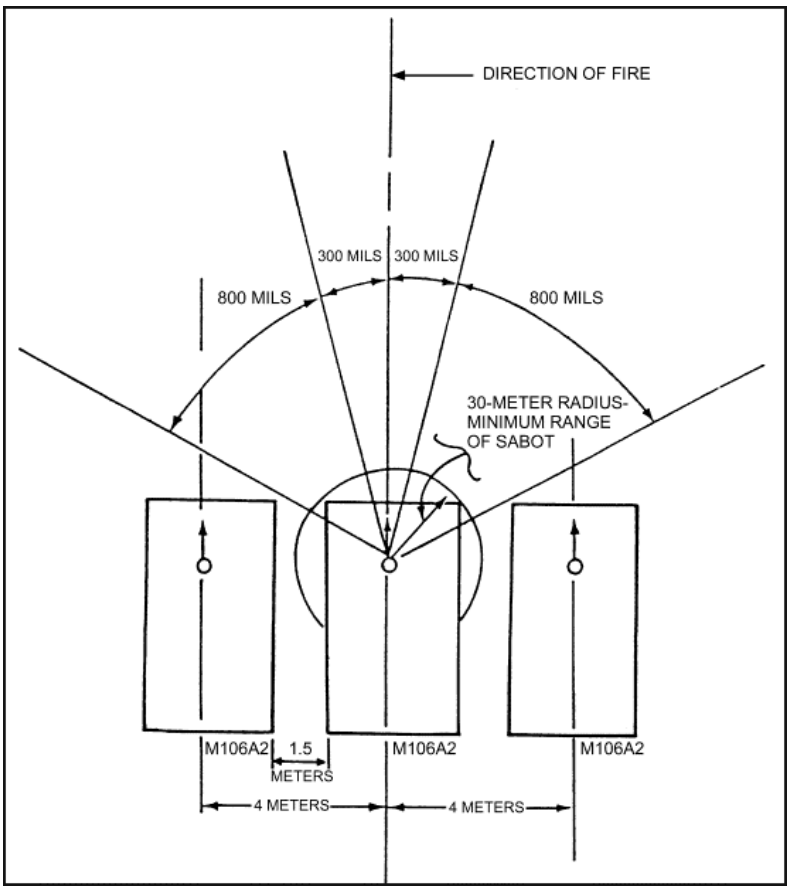


Figure A-18. Large deflection changes.

b. **Section Procedures.** When firing the sabot, organic fire control equipment, and traversing and elevating mechanisms are used to lay the mortars for direction and elevation. The crew consists of the gunner, assistant gunner, ammunition bearer, and driver.

- The gunner and assistant gunner perform their duties as though firing service ammunition.
- The ammunition bearer and driver perform their assigned duties.
- Personnel can be rotated for cross training.

(1) During the conduct of firing, realistic commands are announced to the sectionXfor example, SECTION, NUMBER TWO, ONE ROUND, DEFLECTION TWO SEVEN EIGHT FIVE (2785), CHARGE THREE, ELEVATION ONE ZERO SIX SIX (1066). Each command requires the section to respond as though service ammunition were being fired. The ammunition bearer then:

(a) Secures a sabot and selects the appropriate 22-mm subcaliber cartridge; in this case, charge 3 (three slots in the base of the cartridge case).

(b) Removes the flange nut.

(c) Ensures that the sabot is pointed downrange and no one is to the rear.

(d) Loads the subcaliber cartridge into the sabot.

(e) Replaces the flange nut.

(f) Removes the plastic cap from the primer and passes the round to the assistant gunner.

(2) The assistant gunner fires the round just as he would service ammunition. After the sabot impacts, it is retrieved, cleaned, and is ready to refire. (Retrieving the sabot after each round is recommended unless a fire-for-effect mission is underway. Retrieval prevents damage to either the sabot being fired or a sabot laying on the ground, which could occur by the rounds impacting together.)

WARNING

Weapons must not be fired during sabot retrieval to avoid injury to personnel downrange. Normally, it is best for only one round to be fired before retrieval to avoid damage to sabots. Do not fire over the head of maneuvering troops.

(3) The barrel should be cleaned after every 10 rounds to reduce the possibility of a misfire, and the sabot should be cleaned after each firing. There is considerable buildup of carbon in the barrel during firing; if not removed, there is a decrease in range.

c. **Forward Observer Procedures.** Regardless of which unit provides the FO fire support, the FO procedures are the same.

(1) The observer-target (OT) factor determined by the FO is based upon a scale of 1:10 rather than thousands of meters--for example, an OT distance of 380 meters is scaled to 3,800 meters, resulting in an OT factor of 4.

(2) The FO measures deviation just as he would in service firing--by using the mil scale in his binoculars or aiming circle, compass, or finger method discussed in FM 23-91, Chapter 4. The FO corrects for deviation by multiplying the measured deviation by the OT factor and announcing his corrections to the nearest 10 scale meters--for example, "Right eight zero (80)."

(3) The FO can use any of the methods of range adjustment that are used during service firing. However, when using the bracketing method, caution should be exercised in establishing the range bracket, since the FO usually assumes his rounds are much closer to the target than they actually are. For example, if the round is 60 meters (600 scale meters) short of the target, the FO should announce, "Add eight hundred (800)," to obtain a range bracket.

(4) Only missions that use point-detonating fuzes can be fired with the sabot. This includes direct-lay and direct-alignment (fire without an FDC) missions. Also, coordinated illumination can be conducted with the illumination provided by handheld flares or flares fired from an M203.

(5) Air observer training can be conducted using a helicopter. The aircraft should fly at an altitude of about 200 feet and to the rear of the firing position. The air observer should be told "SHOT" at least 10 seconds before the mortar fires to properly position the aircraft for observation.

(6) Due to range dispersion, credit for a target hit should be given whenever the subcaliber projectile impacts within $\pm$ 25 meters in range and left or right 4 meters of the adjusting point. This "target hit" area could be outlined in engineer tape for each target to help in accurate spotting by the FO, who is the responsible member of the indirect fire team for determining target hits. Table A-2, illustrates the range and deflection dispersion for each subcaliber projectile.

CHARGE	RANGE (in meters)	RANGE DISPERSION (in meters)	DISPERSION (in meters)
1	70-195	$\pm$21	LEFT or RIGHT 2.5
2	140-235	$\pm$26	LEFT or RIGHT 4.0

3	210-330	±30	LEFT or RIGHT 5.0
4	280-435	±39	LEFT or RIGHT 6.0

Table A-2. Range and deflection dispersion.

d. **Fire Direction Center Procedures.** FDC procedures prescribed in FM 23-91 are used without modifications when controlling fires of the 22-mm subcaliber projectile. The most current firing tables for the subcaliber projectile are used when computing ranges, elevations, and maximum ordinate.

e. **Individual Skills**. The sabot is well suited to train, cross train, and test soldiers in individual skills. One method is to establish a series of concurrent stations near a sabot range firing position. Both firing and nonfiring tasks can be performed by having all unit members actively training at the same time and performing several tasks in a short period, which keeps interest high. The suggested concurrent stations are as follows:

Station 1. Refer and realign aiming posts; boresight.
Station 2. Ammunition handling, fuze setting, cutting charges (both sabot and service ammunition).
Station 3. Direct lay (M1 sabot required).
Station 4. Direct alignment (M1 sabot required).
Station 5. Indirect fire (M1 sabot required).
Station 6. Adjustment of fire.

(1) The sabot can be used to simulate the live-fire collective tasks. To support the realistic firing afforded by the sabot, the platoon and section leaders can also perform the following tactical training in conjunction with sabot firing:

- Assembly area procedures.
- Camouflage and concealment.
- Road marches and convoy procedures.
- Reconnaissance of the firing position.
- Occupation of the firing position.
- Displacement by section.
- Maintenance of weapons, vehicles, and equipment.
- Fire support planning.
- Fire support coordination.

(2) The unit can plan an operation for firing the sabot as if live fire were actually going to occur. A sample sequence that allows the unit to train against the ARTEP standards follows:

(a) The platoon/section leader arranges for--

- A time to fire on the sabot range.
- Sabot ammunition.
- Vehicles.
- Weapons.
- Food.
- An assembly area close to the firing position but not in view.

(b) At the appointed time, the unit crosses their starting point en route to the assembly area while practicing--

- Road march and convoy procedures.
- Unit loading plan.

(c) Upon arrival at the assembly area, the unitX

- Opens the fire control net.
- Boresights mortars.
- Constructs firing charts.
- Receives the platoon/section leaders orders for occupation of the firing position.
- Maintains vehicles.

(d) The reconnaissance party departs the assembly area and upon arrivalX

- Locates positions for the mortars, FOs, and FDC.
- Lays wire between the FDC and mortar positions.
- Orients the aiming circle and prepares to lay the section for direction.
- Plans for the occupation of the position by the rest of the section.
- Transmits orders for the rest of the unit to displace to the firing position.

(e) Upon arrival at the firing position, the unit--

- Occupies designated positions.
- Plans fires based on the tactical situation presented in the assembly area.
- Assigns target numbers.
- Lays the mortars.
- Prepares ammunition.
- Conducts firing.

(f) At the conclusion of firing, the unit displaces to its company area to perform maintenance of vehicles, weapons, and equipment.

(g) While monitoring sabot firing, the unit leader can make valuable use of the close proximity of each element to each other. He can allow members of the element to visit another element to observe their duties and procedures. He can also call all unit members together at the conclusion of a task to critique and set the stage for the mission or task.

(3) Live-fire missions, such as Engage an Area Target and Fire Final Protective Fire, can be easily performed with only one firing position for the 81-mm sabot. Tasks that require the mortars to displace can be trained and tested by setting up more than one impact area or by plotting multiple firing points (Figure A-19).

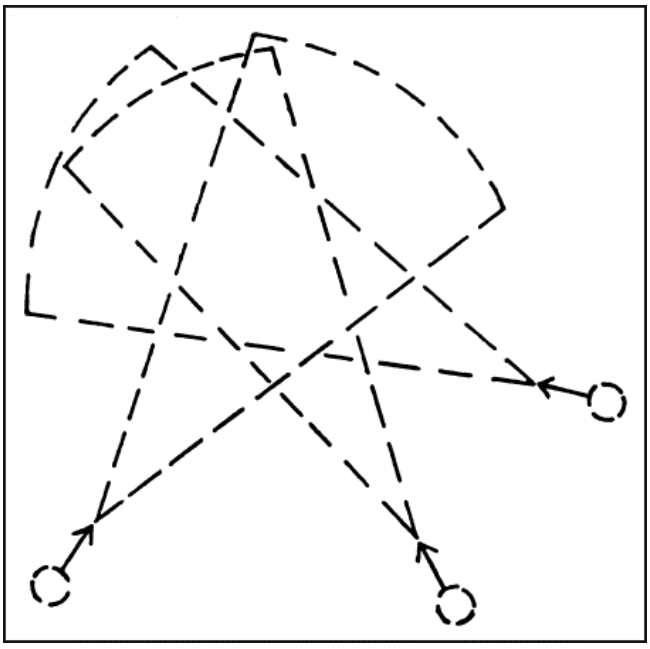


Figure A-19. Multiple firing points.

Section III. SHORT-RANGE TRAINING ROUND

This section provides the technical information required to employ the SRTR. Trainers should exercise imagination and ingenuity in developing training situations for employing the SRTR. The SRTR enables units to train in locations where mortar training facilities are limited or do not exist. The SRTR cartridge provides an economical means of realistically training personnel in all phases of mortar gunnery.

A-19. DESCRIPTION

The SRTR is effective for training all elements of the indirect fire team. It provides the FO with a sound and visual signal by which he can spot rounds and make adjustments. The FDC computes data received from the FO, who observes the impact of the SRTR on a 1:10 scaled range. The gunner places data obtained from the FDC on the mortar and the assistant gunner drops an SRTR down the barrel. The entire indirect fire team functions the same as if they were firing service ammunition with one exception--the FO observes the SRTR impact on a 1:10 scaled range instead of the service ammunition at a normal distance in an impact area. The characteristics of the SRTR are as follows:

- Overall length: 14.5 inches.
- Firing weight: 6.84 pounds.
- Maximum range: 458 meters.
- Minimum range: 47 meters.

Note: The 1:10 scale is based on 81-mm 300-series ammunition.

A-20. COMPONENTS

The SRTR practice cartridge consists of eight major components (Figure A-20).

- Fuze, point detonating M775.
- Projectile body.
- Obturating ring.
- Plastic charge plugs.
- Dud plugs.
- Fin assembly.
- Ignition cartridge, M987.
- Breach plug assembly.

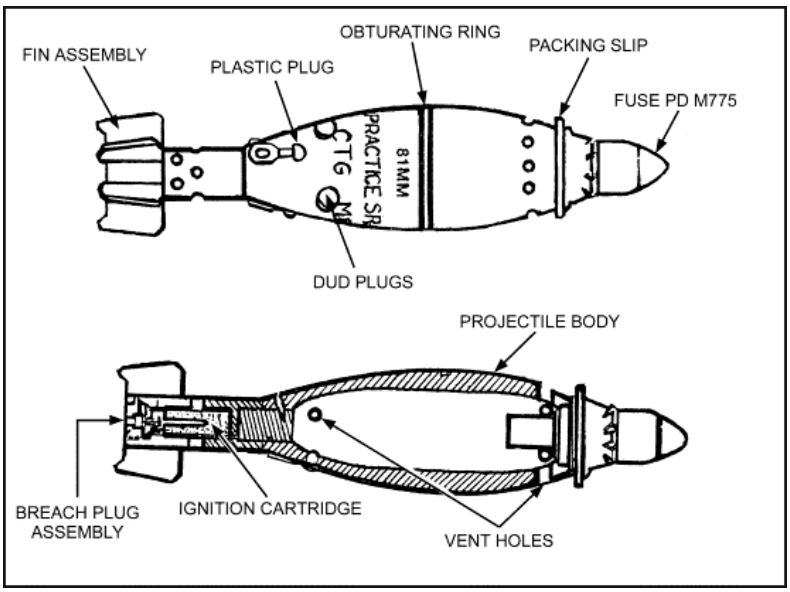


Figure A-20. SRTR practice round.

The SRTR is designed as a training round for the 81-mm mortar (M29 and M252) and the 120-mm mortar (Figure A-20). The SRTR is designed to be fired, recovered, refurbished, and refired. The round is fired from the mortar the same as service ammunition. When fired, the SRTR travels from 47 to 458 meters, determined by charge and elevation. Upon impact, the SRTR emits a flash, bang, and smoke discharge but no fragmentation.

A-21. RANGE RECOMMENDATIONS

A scale of 1:10 is used to relate the range and deviation between the SRTR projectile and the standard 81-mm service projectile. The minimum range requirement for firing, through charge 3, is an area 700 to 900 meters in depth and 300 meters in width. This is necessary to accommodate the desired number of targets and provide a maneuver area to operate in. When using 81-mm mortars, the mortars can be no closer than 4 meters apart, but can be as far apart as the range permits (check with the local range control regulations). The range must be cleared of all unexploded ammunition, concrete, and steel objects (Figure A-21).

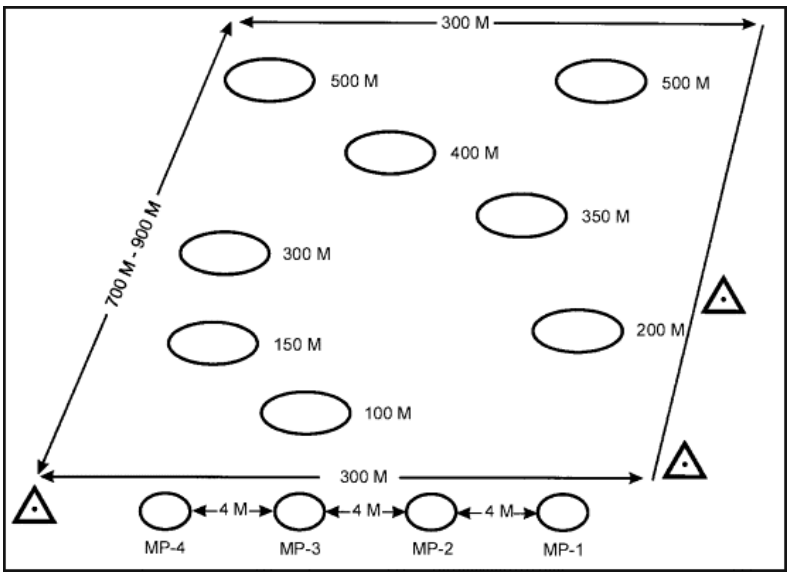


Figure A-21. SRTR scaled range.

A-22. ADVANTAGES

The SRTR is used with all 81-mm mortars and 120-mm mortars by way of the M303 insert. It also accommodates prescribed crew drill procedures, and it can be used by mechanized and ground-mounted elements. The SRTR has the following advantages:

- Provides the ability for firing in training areas where the firing of service ammunition is not allowed.
- Saves time by eliminating long-distance traveling to suitable mortar ranges.
- Saves in cost of firing service ammunition.
- Can be taught to operate and maintain in a short period of time.
- Has the same procedures used by the entire indirect fire team when firing service ammunition, excluding appropriate charge and fuze settings.
- Uses all of the equipment required when firing service ammunition.

A-23. AMMUNITION

The projectile body is made from cast iron and is machined to accept the M775 fuze, the tail fin, three charge plugs, three dud plugs, and the obturator ring. It is painted blue with white lettering and one brown band to identify it as a practice round. The charge and dud plugs are fitted into holes drilled in the base of the projectile body. The obturator ring is plastic and shaped like a split ring so that it will expand to fit over the projectile body and

will seat into the band groove. The M775 fuze assembly includes a pyrotechnic spotting cartridge, which is retained in the fuze body by a threaded aluminum cup. This assembly is threaded into the nose of the projectile body. The M775 fuze replicates the M734 multi-option fuze used with service ammunition. Even though the M775 has four fuze settings for ammunition bearer training, it will only function upon impact. The tail fin assembly is threaded onto the stud at the base of the projectile body. Inside the tail fin is the propellant cartridge. It is a primed 12-gauge shotgun shell casing loaded with a double base propellant. The breech plug/firing pin is threaded into the rear of the tail fin and retains the propellant cartridge in the fin cavity.

a. Prepare the M880 short-range training ammunition for firing.

(1) The M880 is issued ready to fire. When the round is unpacked, inspect the following:

- No red showing on top of fuze.
- Packing clip is in place.
- Obturating ring is present and flush with body.
- Three plastic charge plugs seated in body.
- Three dud plugs seated in body.
- Ignition cartridge inside fin assembly.
- Breech plug seated in fin assembly.

WARNING

1. If red can be seen above the windshield on the fuze, the fuze has been armed. Place the entire round in the dud pit until you are ready to defuze the round.

2. If the packing clip is loose, attempt to place the packing clip back into the fuze. If it will not go back into the fuze, place the entire round into the dud pit until you are ready to defuze the round.

(2) To prepare a newly issued round for firing, set the desired charge by pulling one of the plastic charge plugs from the body of the round. Set the desired fuze setting by rotating the multi-option fuze clockwise or counterclockwise until the desired fuze setting is lined up with the notch on the body of the round. Present the round to the squad leader for his inspection. When the assistant gunner is ready to fire the round, pull the packing clip from the round and hand it to him.

WARNING

Do not pull the packing clip from the round until the assistant gunner is ready to fire the round.

Note: The fuze setting is for training only and will not affect the functioning of the fuze.

(3) Charge settings for the round are as follows:

(a) Charge 0--pull all the plastic charge plugs from the body.

(b) Charge 1--pull two of the plastic charge plugs from the body.

(c) Charge 2--pull one of the plastic charge plugs from the body.

(d) Charge 3--do not pull any of the plastic charge plugs from the body.

(4) To refurbish a previously fired round, ensure that the round is clean. All portholes must be free of dirt to allow the gas to escape, and all of the threads must be clean.

(5) Inspect the refurbishing kit to ensure that all equipment is present.

- Three plastic charge plugs.
- One obturating ring.
- One M987 ignition cartridge.
- One breech plug.
- One M775 point detonating fuze.
- Three dud plugs.

WARNING

1. If any red can be seen above the fuze windshield, place the fuze in the dud pit and dispose of the fuze IAW unit sop.

2. If the packing clip is loose, attempt to place the packing clip back into the fuze. If it will not go back into the fuze, place the fuze into the dud pit and dispose of the fuze IAW unit sop.

3. Inspect the breech plug firing pin for freedom of movement. If it does not move freely, a misfire could occur or premature ignition of the ignition cartridge could take place when assembling the round.

(6) To assemble the round do the following:

(a) Install the three plastic plugs with the tangs pointed to the rear of the projectile body.

(b) Install the three dud plugs.

(c) Secure the fin assembly onto the projectile body hand tight.

(d) Install the obturating ring onto the projectile body.

CAUTION

If the obturating ring does not seat flush or below the surface of the projectile body, send the body back to the maintenance table for further cleaning. If the obturating ring still does not seat flush, the body must be disposed of.

(e) Install the fuze assembly hand tight and flush with the top of the round.

(f) With the round laying horizontally on the table, install the M987 ignition cartridge into the tail fin assembly.

WARNING

Do not force the ignition cartridge into the tail fin assembly.

(g) Install the breech plug by hand and use the breech plug wrench to secure the breech plug hand tight.

(7) Place the round back into its canister until it is ready to be fired.

Note: Do not refurbish the M880 round if it will not be fired that same day.

(8) To fire the round, follow the same procedures as if the round was newly issued.

b. Clean and service the M880 SRTR.

(1) Fill two trash cans with water and leave another trash can empty.

(2) Dip the spent M880 into the first water bucket and scrub off the heavy dirt with a wire brush.

(3) Place the M880 round on the work table and secure the projectile body with the strap wrench.

(4) Remove the fuze (if necessary, use the long handle pliers) and discard.

WARNING

When the fuze is removed from the body, it must be inspected to ensure that it has detonated by inspecting the coin to see if it is missing.

(5) Using the breech plug wrench, unscrew the breech plug and discard.

(6) Using the fin wrench, unscrew the fin assembly from the projectile body.

(7) Place the tail fin assembly upright on the cartridge block, place the punch into the tail fin assembly, strike the punch with the ball peen hammer, and drive out the spent ignition cartridge. Discard the spent ignition cartridge.

(8) Place the tail fin assembly into the second wash bucket and clean it with a wire brush for the final cleaning. Ensure that all dirt and residue are removed from the round.

(9) Remove all remaining plastic plugs and the obturating ring from the projectile body and discard them.

(10) Place the projectile body into the second wash bucket and remove all dirt and residue. Take the M16 bore brush and thoroughly clean the vent holes and the thread.

(11) With a clean, dry rag, dry both components of the M880. Ensure no dirt or residue are present on the projectile body and tail fin assembly.

(12) Examine the M880 for cracks and any type of damage that may prevent the projectile from being refired. If there is evidence of cracks or some type of damage, discard the entire projectile body and tail fin assembly.

(13) If the M880 is not going to be fired the same day, lightly oil the projectile body and tail fin assembly. Screw the tail fin assembly back on the body and store it in its canister.

Note: The M880 must be recovered, cleaned, and serviced within 24 hours after it is fired.

c. Recover a previously fired M880 round from downrange.

WARNING

Failure to follow the proper recovery procedures may result in personal injury.

(1) Ensure the range is closed and all weapon systems have ceased firing.

(2) Issue a shovel, a grappling hook, heavy duty leather work gloves, and an ammunition box to the assistants.

(3) Walk downrange with the assistants and locate the M880 round.

(4) Pick up the round and verify that the round has functioned by observing that all of the dud plugs on the body are missing. Have a second soldier verify that all of the dud plugs are missing.

WARNING

When picking up the M880, ensure that your hand and fingers are not covering the vent holes.

(5) If all of the dud plugs are missing, place the round in the ammunition box.

WARNING

If any of the dud plugs are present and the fuze has not functioned, place the round in a marked pit and follow the defuzing procedures outlined in paragraph A-23d.

Note: It may be necessary to dig the round out with the shovel. The grappling hook may be used to assist in recovering the round.

(6) Ensure that each hole left by the M880 round is filled.

(7) Once the M880 rounds have been recovered, transport them to the maintenance table.

d. Defuze a dud M880 round.

Note: The dud M880 round may be defuzed when first located or at the end of that day's firing as long as it is recovered within 24 hours after it has been fired.

(1) Set the defusing device (boom box) on the platform with the holes facing downrange and away from the troops. Pull out the four retaining pins that secure the top portion of the boom box, then pull the top off the base of the boom box.

(2) Turn the round until the packing clip portion of the round is facing upward.

(3) With the chisel over the fuze, secure the top portion of the boom box to the base, then attach the four retaining pins.

(4) Kneeling on the opposite side of the holes on the boom box, strike the chisel with the 4-pound hammer until the chisel moves freely from the base of the boom box to the top of the boom box.

WARNING

1. All personnel must be on the solid side of the boom box before the chisel is struck with the hammer.

2. When defuzing an M880 round, ear plugs and goggles must be worn.

(5) Remove the cover of the boom box and inspect the fuze to verify that the spotting charge has functioned.

WARNING

If the spotting charge has not functioned or the fuze has pulled away from the thread well, transport it to the dud pit and dispose of it IAW the unit SOP.

(6) Remove the M880 round from the boom box and return the cartridge to the firing line for cleaning.

A-24. TRAINING USAGE

SRTR training enables the unit commander to observe the actions of the indirect fire team and the tasks being performed by the indirect fire team. This enhances the ability of the commander to evaluate the proficiency of all elements of the training, to identify and isolate problems, and to begin corrective training. All members of the team can view the overall operation to understand each member's part.

a. The time used for preparation determines the benefits gained from training with the SRTR. Three steps must be accomplished before training begins:

(1) Build a scaled firing range (permanent, semi-permanent, or temporary).

(2) Construct a map of the firing range.

(3) Train the personnel with the SRTR. Personnel should be trained in the recovery, refurbishment, and maintenance of the M880 before range firing begins.

b. Gunners should not be allowed to observe the impact of the SRTR, unless firing a direct-lay mission. Normally, mortars are mounted in a defilade position so that mask exists between the impact area and the firing position. If mask does not exist, using a referred deflection of 0700 when firing is recommended.

c. When positioning 81-mm mortars, the lateral distance between the center of each baseplate should have a minimum distance of 4 meters (40 meters when firing service ammunition, 1:10 scale for the SRTR = 4 meters).

d. The SRTR can also be fired from the 120-mm mortar using the M303 81-mm insert. When positioning 120-mm mortars, the lateral distance between the center of each baseplate should be a minimum of 6 meters (60 meters when firing service ammunition, 1:10 scale for the SRTR = 6 meters).

A-25. CONSTRUCTION OF A SCALED MAP

The range limitations associated with the M880 SRTR make a standard 1:50,000-scale military map difficult to use. Therefore, a new map 1/10 the size (1:5,000) must be constructed.

a. Use a blank sheet of paper to draw grid squares the same size as the 1:50,000-scale map and renumber them based on 100 meters per square.

b. Determine the 8-digit grid coordinates to the mortar position on a 1:50,000-scale military map and convert it to a 1:5,000 scale (Figure A-22).

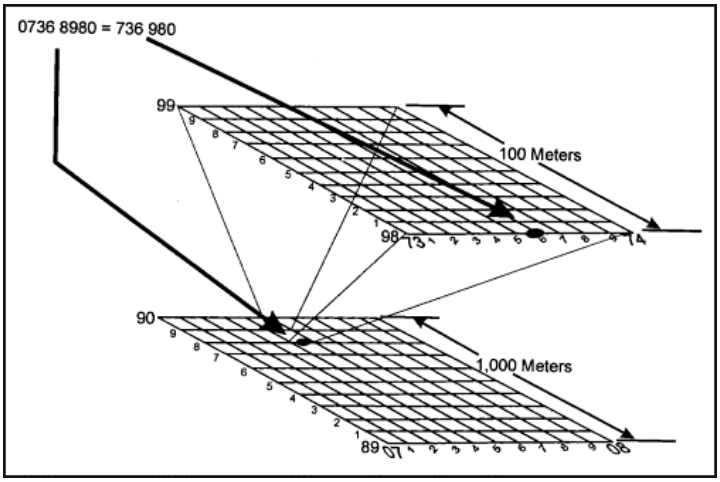


Figure A-22. Converting 1:50,000 grid to 1:5,000 grid.

Note: The first number of a grid coordinate is the 10,000-meter designator; the second number is the 1,000-meter designator; the third number is the 100-meter designator; and the fourth number is the 10-meter designator.

(1) To make a 1:5,000-scale map, drop the 10,000-meter designator and use the 1,000-meter designator as the first number for each grid. For example, a mortar location of 07368980 becomes 736980. The 7 and the 9 will precede each grid location since they identify the 1,000-meter increments. To make an 8-digit grid from this 6-digit grid, add a 0 at the end of the easting and northing grid location. For example, the mortar grid becomes 73609800. The 0 is the 1-meter designator.

(2) Before constructing the 1:5,000-scale map, determine the direction of fire from the mortar position to the RP. (Surveying a point on the range should be done at least one day before training. If a point on the range has already been surveyed, it can be used to make the map.) For example, if the direction of fire is southeast, the mortar position would be in the northwest corner of the grid sheet. Using the example grid coordinates, the most westerly grid line would be 73 and the second most northerly grid line would be 98. Number the rest of the grid lines accordingly.

c. To plot the mortar position on the 1:5,000-scale map, use the same protractor that is used for the 1:50,000-scale map, but instead of the protractor measuring 1,000 meters, it will measure 100 meters.

d. To determine the direction of fire, place a target downrange, set up the M2 aiming circle at the base gun position, and measure an azimuth to the target. To accurately plot targets on the map, measure the distance by pace count from the base piece to the target and then plot it on the map. This procedure allows the creation of a surveyed firing chart. The FO's location can be plotted in the same manner. After all plotting is done, give a copy of the map to the FO (Figure A-23). He can call for fire using this map the same as if firing service ammunition.

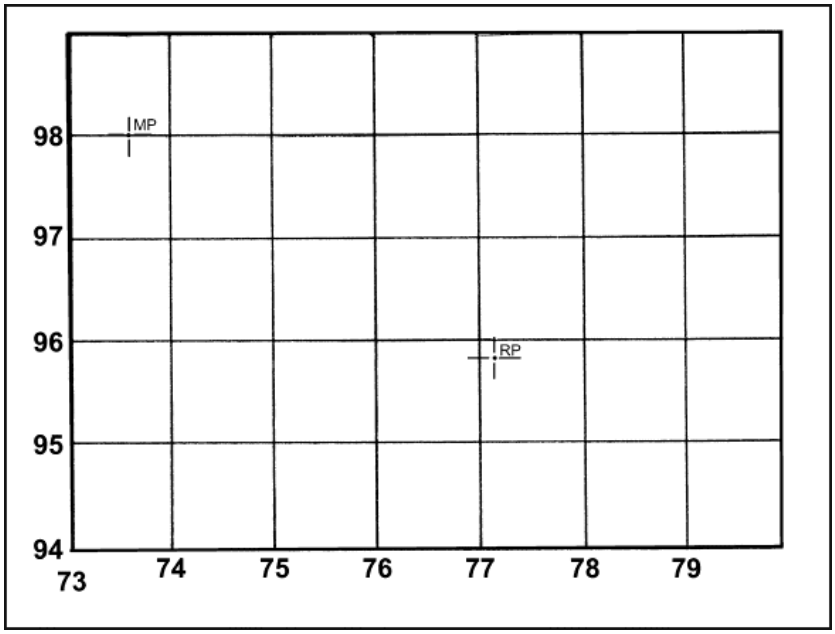


Figure A-23. Plotting targets on the 1:5,000-scale map.

e. Before putting the map on the M16 plotting board, determine the grid intersection to represent the pivot point in the same manner as if firing service ammunition.

(1) Place the grid system on the plotting board the same as if firing service ammunition. Number every other black line. Every small green square equals 5 meters and every black square equals 50 meters.

(2) Place the mortar position and target on the plotting board the same as if firing service ammunition. The grids plotted are to the nearest 1 meter instead of 10 meters.

f. To determine the mounting azimuth, line up the mortar position and the RP. Read the azimuth on the azimuth scale at the top of the plotting board. Round off the azimuth to the nearest 50 mils, and superimpose this azimuth over the referred deflection. Number the azimuth scale every hundred mils using the LARS rule (Figure A-24).

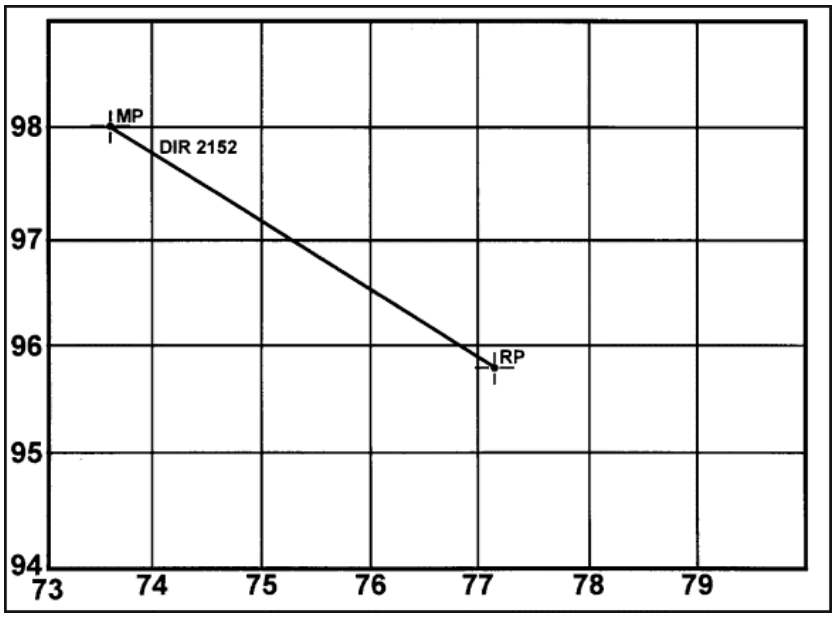
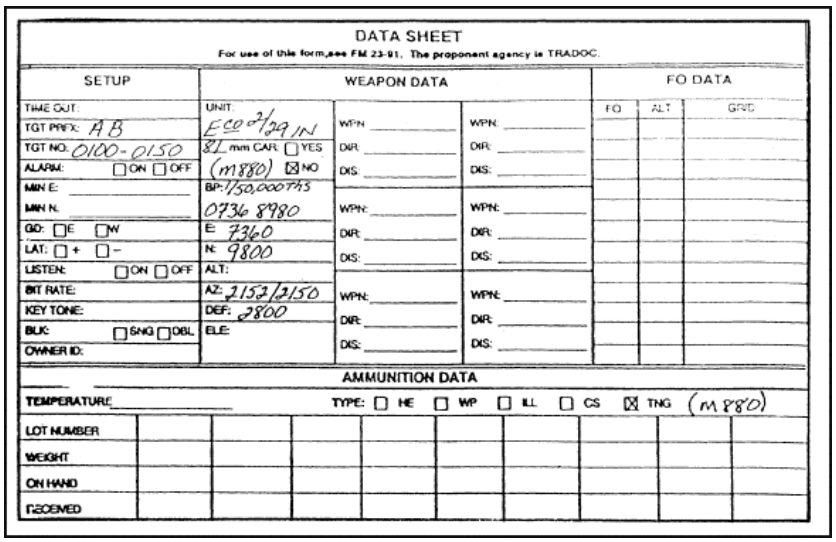


Figure A-24. Determining direction from MP to RP.

g. When firing the M880 SRTR, range control must know exactly where the firing position is. The 1:50,000-scale grid must be annotated on the data sheet (DA Form 2188-R), labeled, and placed in the BP box (Figure A-25).



DATA SHEET

For use of this form, see FM 23-91. The proponent agency is TRADOC.

SETUP		WEAPON DATA				FO DATA		
TIME OUT:	UNIT: ECO 2/29 IN	WPN:		WPN:		FO	ALT	GRID
TGT PREF: AB	81 mm CAR ☐ YES	DIR:		DIR:				
TGT NO. 0100-0150	(M880) ☒ NO	DIS:		DIS:				
ALARM: ☐ ON ☐ OFF	BP: 1/50,000 THS							
MAN E:	0736 8980	WPN:		WPN:				
MAN N:	E: 7360	DIR:		DIR:				
GD: ☐ E ☐ W	N: 9800	DIS:		DIS:				
LAT: ☐ + ☐ −	ALT:							
LISTEN: ☐ ON ☐ OFF	AZ: 2152/2150	WPN:		WPN:				
BIT RATE:	DEF: 2800	DIR:		DIR:				
KEY TONE:	ELE:	DIS:		DIS:				
BLK: ☐ SNG ☐ DBL								
OWNER ID:								

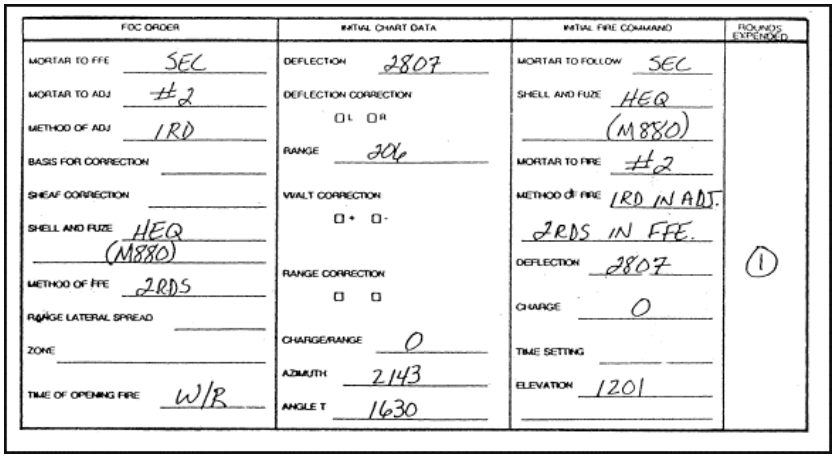
AMMUNITION DATA

TEMPERATURE: _____ TYPE: ☐ HE ☐ WP ☐ ILL ☐ CS ☒ TNG (M880)

LOT NUMBER									
WEIGHT									
ON HAND									
RECEIVED									

Figure A-25. Example completed DA Form 2188-R.

h. The computer's record (DA Form 2399) is also altered. For safety, as well as range control's information, "M880" should be placed in the "SHELL AND FUZE" spaces in both the FDC ORDER and INITIAL FIRE COMMAND (Figure A-26).



FDC ORDER	INITIAL CHART DATA	INITIAL FIRE COMMAND	ROUNDS EXPENDED
MORTAR TO FFE: SEC	DEFLECTION: 2807	MORTAR TO FOLLOW: SEC	
MORTAR TO ADJ: #2	DEFLECTION CORRECTION ☐ L ☐ R	SHELL AND FUZE: HEQ (M880)	
METHOD OF ADJ: IRD	RANGE: 20c	MORTAR TO FIRE: #2	
BASIS FOR CORRECTION:	WALT CORRECTION ☐ + ☐ −	METHOD OF FIRE: IRD IN ADJ. 2RDS IN FFE.	
SHEAF CORRECTION:	RANGE CORRECTION ☐ ☐	DEFLECTION: 2807	(1)
SHELL AND FUZE: HEQ (M880)	CHARGE/RANGE: 0	CHARGE: 0	
METHOD OF FFE: 2RDS	AZIMUTH: 2143	TIME SETTING:	
RANGE LATERAL SPREAD:	ANGLE T: 1630	ELEVATION: 1201	
ZONE:			
TIME OF OPENING FIRE: W/R			

Figure A-26. Example completed DA Form 2399.

A-26. SAFETY

The SRTR is safe to handle and fire. The following safety precautions must be enforced.

> **WARNING**
>
> **The SRTR is inert and can be stored and handled as a weapon until it is loaded with the refurbishment kit at which time it will be handled as a live mortar round. When loaded and ready to fire, all safety precautions used during handling of service ammunition are observed.**

a. The SRTR refurbishment kit contains a propellant and smoke charge, and is always stored and handled as live ammunition.

b. Practice ammunition is never fired over the heads of troops.

c. Personnel never go forward of the firing line until a cease fire has been called by the range OIC or safety officer.

Note: Duds are disposed of as prescribed in paragraph A-23.

A-27. MALFUNCTIONS

See Chapter 3, paragraph 3-13 for a detailed discussion of malfunctions.

A-28. REMOVAL OF A MISFIRE

After failure to fire, misfire removal procedures are followed to remove the round from the weapon. Misfire procedures for live rounds also apply when firing the SRTR.

a. If the primer cap of the SRTR is dented, the whole round is placed in the dud pit for disposal IAW the local SOP.

b. If the primer is not dented, the round can be refired upon determination of the cause of the misfire.

A-29. SUPPLY DATA

The equipment shown in Table A-3 is available at the ammunition supply facility:

DESCRIPTION	NATIONAL STOCK NO.	PART NO.	DODAC NO.
Cartridge, 81-mm Practice: M880	1315-01-216-7070		1315-C876
Refurbishment kit, M80	1315-01-219-3936	19200	1315-C045

Table A-3. Supply data for SRTR.

Section IV. M303 SUBCALIBER INSERT

The M303 subcaliber insert (Figure A-27) is a low-cost training aid that provides effective training for the entire platoon, including the FO, on a live-fire exercise. It uses 300-series HE, WP, and illumination ammunition. Currently, the FDC will use the M16 plotting board for plotting. The subcaliber insert will be issued to the unit for accountability. The unit is also responsible for maintaining the insert and the DA Form 2408-4.

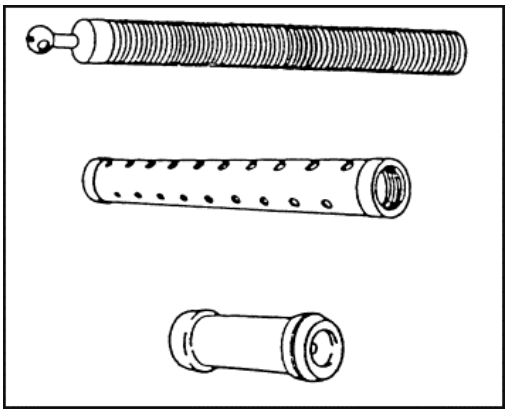


Figure A-27. M303 subcaliber insert.

A-30. CHARACTERISTICS

This paragraph describes the characteristics of the M303 subcaliber insert.

a. The 300-series ammunition has a minimum range of 73 meters and a maximum range of 4,789 meters. It can be fired at a sustained rate of three (charge 8) or five (charge 6). It can be fired indefinitely at a period rate of fire. The 300-series

ammunition has a maximum rate of fire of 12 (charge 8) for two minutes and 12 (charge 6) for five minutes.

b. The barrel is a M29A1 that has been refurbished. This is the only M29 barrel approved to use the M303 subcaliber insert. The barrel is 51 inches long and weighs 28 pounds. It has a smooth bore with one circular cooling ring and a removable firing pin.

c. The insert sleeve is 42 inches long and weights 5.9 pounds. It is tubular shaped with cooling holes. It has a threaded end on top and a smooth end on the bottom. The sleeve slides over the barrel and is threaded onto the barrel until it is flush with the breech cap. It is held in place by three hex screws on the muzzle end. Approximately 2 inches of the M29 cannon will be showing at the muzzle end.

Note: After every fire mission, the hex screws on the upper sleeve ring should be checked for tightness to ensure the interior of the 120-mm cannon is not damaged.

d. The filler block is 15.9 inches long and weighs 17 pounds. It is tubular shaped with the top and bottom the same diameter as the interior of the 120-mm cannon. The top and bottom have a concave slope with a threaded hole, which is used in the removal of the filler block.

e. The M303 subcaliber insert comes with a filler block adapter, a 0.0625-inch hex wrench, and a firing pin wrench.

A-31. MAINTENANCE

Maintenance must be performed on the M303 subcaliber insert before, during, and after firing. This paragraph describes the procedures to follow to perform this maintenance.

a. **Before.**

(1) *Cannon*.

(a) Update the DA Form 2408-4 to reflect days firing. Ensure that all standards for bore scope and pullover gauging have not been exceeded (within the past 180 days).

(b) Check the M120/M121 mortar for cracks, broken welds, rust, and missing or damaged parts.

(c) Check the M29A1 cannon for foreign matter in the barrel, then wipe dry. Clean and lubricate the exterior surface. Check for bulges, dents, and visible cracks. Check for evidence of gas

leakage (grayish color) around the firing pin located in the base of the spherical projectile.

(d) Check the insert sleeve for cracks, broken welds, rust, and missing or damaged parts. Check that the insert sleeve assembles onto the cannon assembly, can be secured with set screws, and is free of any nicks and burrs.

(2) *Filler block.*

(a) Check the filler block for cracks, broken welds, rust, and nicks or burrs.

(b) Check that the filler block fits with breech plug of the M29A1 cannon, seats in the base of the 120-mm bore, and can be employed or retrieved using the adapter tool.

b. **During.**

(1) Check the bore after approximately every 50 rounds for bulges, dents, and visible cracks. Check for evidence of gas leakage around the firing pin (grayish discoloration).

(2) Dry swab the barrel bore after firing every 10 rounds or after every end of mission (EOD).

c. **After.**

(1) Check DA Form 2408-4 to ensure it reflects the days firing.

(2) Ensure rifle bore cleaning compound (RBC) is used to thoroughly clean the barrel bore after firing and for two consecutive days thereafter. Be sure to wipe dry and lubricate with GPL after each cleaning.

Note: For nonfiring periods, clean and lubricate the barrel on a weekly basis.

(3) Check the insert sleeve for cracks, broken welds, rust, nicks, burrs, and damaged parts.

(4) Check the filler block for cracks, broken welds, rust, nicks, burrs, and damaged threads.

(5) Intervals are based on usual conditions. For unusual operating conditions, lubricate more often. When the weapon is not being used, the intervals may be extended if proper lubrication procedures have been

followed. Clean the barrel bore weekly with RBC, and lubricate the barrel, firing pin, insert sleeve, and filler block weekly with GPL.

WARNING

Dry cleaning solvent is flammable. Do not clean parts near an open flame or in a smoking area. Dry cleaning solvent evaporates quickly and has a drying effect on the skin. When used without protective gloves, this chemical may cause irritation to, or cracking of, the skin.

Note: Before firing, dry swab the barrel bore of the M29A1 and the 120-mm cannon. Wipe dry the exterior of all components of the subcaliber insert.

A-32. MISFIRE PROCEDURES

This paragraph describes the misfire procedures for an M303 subcaliber insert.

a. When a misfire occurs, any member of the squad who notices a misfire immediately announces, "MISFIRE!"

b. All personnel except the gunner move 100 meters to the rear of the mortar. When carrier-mounted, they exit through the cargo hatches and climb over the front of the carrier.

c. The gunner stands to the left rear and kicks the cannon several times with the heel of his boot to attempt to dislodge the round. If the round fires, the mortar is re-laid and the fire mission continues. If the round fails to fire, the gunner moves to the rear of the mortar, joins the crew, and waits one minute.

WARNING

Keep the head and body away from the front of the cannon. Do not stand behind the cannon. At no time will the buffer housing assembly be loosened.

d. After one minute, the gunner returns to the mortar (if carrier-mounted, he remounts the carrier over the front) and feels the cannon for heat using his fingertips.

WARNING

on the exterior of the cannon or the rate of fire exceeded the sustained rate (four rounds per minute), the gunner rejoins the crew and waits an additional three minutes. (When excessive heat is felt below or around the lower collar stop on the cannon, the subcaliber insert is too hot to handle.)

e. After three minutes, the gunner returns to the mortar (if carrier-mounted, he remounts the carrier) and feels the 120-mm cannon for heat. If the 120-mm cannon still radiates excessive heat, he attempts to cool it with water or snow.

Note: Low and high range pertains to carrier-mounted only.

f. If the cannon is cool enough to handle, the gunner locks down the data on the sight, removes the sight (and extension if carrier-mounted), and places them in a safe place. He then calls the crew forward. The gunner grasps the insert just below the muzzle with both hands ensuring no part of his body is in front of the muzzle and his fingers are not in the holes of the insert. On an M374 HE series misfire, he slides the insert approximately 12 inches out of the 120-mm cannon and releases the insert taking one step with his left foot, bending at the waist, and bringing his hands down alongside the cannon. (The same as if he were firing a round.) On an M301 illumination series misfire, he slides the insert approximately 3 to 6 inches out of the 120-mm cannon. This procedure is to attempt to dislodge the round before removing the insert. If the round fails to fire, the gunner depresses the cannon to its lowest elevation, leaving approximately 1/4 turns on the elevation shaft. If the mortar is in low range (carrier-mounted), the gunner depresses the cannon to its lowest elevation.

Note: With an M301 illumination series misfire, if the round fails to fire after releasing the insert 3 to 6 inches out of the cannon, the gunner rejoins the crew for 5 minutes. If the round does not initiate, he continues the procedures in paragraph **f**.

g. The assistant gunner grasps the insert just below the muzzle with both hands. Ensuring that no part of his body is in front of the muzzle, he lifts the insert. When the upper sleeve ring of the insert sleeve clears the mortar, the gunner grasps the sleeve and helps in removing the insert.

h. When the insert clears the 120-mm cannon, the gunner holds the insert while the assistant gunner positions himself to receive the round. (If carrier-mounted, the gunner stabilizes the insert while the assistant gunner exits the carrier. For added support, the gunner may rest his left elbow on the cross-member of the carrier.) The assistant gunner places his hands just behind the muzzle of the insert. At this time, the assistant gunner gives the command to lift the insert. NEVER LOWER THE BASE OF THE INSERT BELOW HORIZONTAL BEFORE THE

ROUND HAS BEEN REMOVED. The assistant gunner places the meaty portions of his thumbs at the muzzle end and waits for the round to exit the tube. The assistant gunner grasps the round, removes it from the tube, and gives it to the ammunition bearer who disposes of the round according to SOP. The insert is turned upside down to shake out any debris, inserted back into the 120-mm mortar, swabbed, and re-laid to continue the fire mission.

Note: If the round is not dislodged, take the entire insert downrange and place it in a dud pit or a designated area ensuring that the cannon is pointing in the direction of fire. Notify EOD personnel.

APPENDIX B

MORTAR TRAINING STRATEGY

This appendix provides a comprehensive unit training strategy for training mortarmen. Leaders have the means to develop a program for training their mortar units to full mission proficiency. This training strategy applies to all mortars in all organizations of the US Army. Although not prescriptive in nature, it must adapt to a unit's mission, local training resources, commander's guidance, and unit training status.

B-1. TRAINING PHILOSOPHY

This training strategy synchronizes institutional and unit components to produce units that are trained to win on the battlefield. It includes the training documents, institutional training, unit training, and training resources needed to achieve and sustain the required outcome. It covers the skills required for individual, crew, leader, and collective proficiency and ensures that the strategy is linked horizontally within CMF and vertically between officer and enlisted. This strategy integrates information from several publications, including this manual, into a single-source document (see References).

B-2. UNIT MORTAR TRAINING

Technical and tactical proficiency is based on sound training. The importance of skilled and proficient mortarmen must not be overlooked within the context of the battalion's overall training strategy. Unless leaders have a mortar background, they may not understand the distinct training requirements and tactical role of mortars. This ensures they will allocate priorities and resources to mortars, which are required for effective training. Therefore, leaders may also require training. This can be achieved by OPD and NCOPD instruction on mortars, which include both technical and tactical mortar subjects.

a. Once mortarmen have mastered their own tasks, they must be fully integrated into the training exercises of the company, battalion, or both. Only within the context of a full maneuver exercise can the mortar unit's indirect fire support ability be fully trained and evaluated. However, mortars suffer from not having a training device (such as MILES) to simulate the terminal effects of mortar rounds. As a result, maneuver units tend to under-employ their supporting mortars. Despite the current absence of such devices, there are other techniques to assess the effects of indirect fire. (These are outlined in GTA 25-6-7 and Appendix F of FM 25-4.) Fire missions not specifically using enemy targetsXsuch as registration and adjusting final protective fireXshould also be routinely conducted in maneuver exercises.

b. A training plan that employs mortarmen only as OPFOR riflemen is not effective for many reasons. Firstly, mortarmen are not being trained in the technical and tactical tasks pertinent to their mission. Secondly, riflemen are deprived of a valid training experience as OPFOR. Thirdly, maneuver units are not trained to employ their mortar indirect fire support.

B-3. MORTAR TRAINING AT TRAINING BASE

The mortar unit training strategy begins with the training base. Leaders must know what skills mortarmen bring with them when they report to their unit. This forms the base to build mortar training in the unit. The career pattern for NCOs and officers (lieutenants) is depicted in individual training. It entails alternating between the training base and units with progressively advanced levels of training and responsibility. Mortar training in the institution focuses on preparing the soldier for these positions. Depending on the course, the training focus includes technical training in mortar skills, mortar familiarization, and mortar issues update (Table B-1).

COURSE	SKILL LEVEL					COURSE FOCUS
	1	2	3	4	OTHER	
One Station Unit Training	X	X				A
Basic NCO Course		X	X			C,D
Advanced NCO Course				X		C,D
Infantry Mortar Leader Course			X	X	X	B,C,D
Officer Candidate School					X	C
Infantry Officer Basic Course					X	C
Infantry Career Captain Course					X	D
Pre-Command Course					X	C,D

A = MOS-PRODUCING
B = ADDITIONAL SKILL IDENTIFIER FOR OFFICERS
C = FAMILIARIZATION
D = REVIEW/UPDATE

Table B-1. Institution courses.

a. **One Station Unit Training (11C)**. OSUT trains new soldiers for their initial assignment in infantry or mechanized units. Training is divided into two phases. Phase I (seven weeks) teaches common entry-level infantry tasks. Phase II continues to foster the self-discipline, motivation, physical readiness, and proficiency in combat survivability started in Phase I. The 11C soldiers receive instruction in mortar systems to prepare them for their specific unit assignments (light units 60-mm and 81-mm mortars; heavy units 81-mm, 4.2-inch, and 120-mm mortars). Soldiers receive familiarization on FDC and FO procedures and are required to pass a mortar gunner's examination to be awarded their MOS.

b. **Basic Noncommissioned Officer Course (11C)**. BNCOC teaches junior NCOs to lead, train, and direct subordinates in the maintenance, operation, and employment of weapons and equipment. The instruction includes FDC procedures, fire planning, tactical employment of mortars, and maintenance.

c. **Advanced Noncommissioned Officer Course**. ANCOC prepares NCOs to lead a mortar platoon in combat as part of the battalion team. This includes fostering an understanding of the battalion task force concept and how it fights. Training that applies to mortars includes fire planning, FDC, and FO procedures.

d. **Infantry Mortar Leader Course**. IMLC provides lieutenants and NCOs (sergeant through master sergeant) with the working knowledge to supervise and direct the fire of a mortar platoon. Instructions include tactical employment of the mortar platoon, graphics, fire planning, mechanical training, FO procedures, and mortar ballistic computer procedures. Officers are awarded the additional skill identifier of 3Z. Commanders must ensure that IMLC graduates fill mortar leadership positions. The skills personnel have learned are complex and perishable and must be sustained in the unit.

e. **Infantry Officer Basic Course**. IOBC trains lieutenants in weapons, equipment, leadership, and tactics. It also teaches them how to instruct their subordinates in the maintenance, operation, and employment of weapons and equipment for combat. Students receive instruction in mechanical operation of the mortar as well as detailed instruction on FO procedures.

f. **Infantry Career Captain Course**. ICCC trains first lieutenants and captains in leadership, war fighting, and combat service support skills required to serve as company commanders and staff officers at battalion and brigade levels. Mortar training focuses on supervisory tasks.

g. **Pre-Command Course**. PCC is intended for field-grade officers (majors through colonel) designated for battalion and brigade command. Training consists of a review and update on mortar issues such as battle drills and safety.

B-4. TRAINING IN UNITS

A unit training program consists of initial and sustainment training. Both may include individual and collective skills. Resources, such as devices, simulators, simulations, ranges, and ammunition, further develop skills learned in the institution. The critical aspect of unit training is to integrate soldiers into a collective, cohesive effort as a mortar squad or platoon member. Drills, STXs, and live fire drills develop these collective skills.

a. **Training Plan Development**. Training plans are developed at higher headquarters and published in the form of command guidance so that subordinate units can develop their plans. The process begins with identifying the unit's METL. The METL contains all the collective tasks that a unit must perform to be successful in combat. FM 25-100 contains specific information on the METL development process.

(1) Commanders assess the unit's proficiency level in each METL task. Information for this assessment is obtained by reviewing past gunner's and FDC examinations, ARTEP results, and external evaluation AARs, and by observing the execution of current training.

(2) Once the assessment is complete, the commander lists the tasks in priority. Tasks that are identified as untrained (U) and are critical to the mission have training priority, followed by tasks that need practice (P) and tasks that are trained (T) to standard. Resources (ranges, ammunition, equipment, and time) are requested to train those tasks that do not meet the standard (U and P), while sustaining the proficiency of the tasks that do meet the standard (T). The commander refines his plan in the form of a training guidance and training schedules. FM 25-2 contains specific information on the training plan development process.

(a) Initial training trains soldiers and units to a high degree of proficiency. New soldiers have not yet trained on all tasks associated with the mortar. Initial training ensures that each soldier, squad, and platoon has the basic core skills proficiency for their skill levels or their collective team. Initial training must be trained correctly to a rigid standard so that proficiency will be retained longer. Decay in skill proficiency will occur due to available training time, skill difficulty, or personnel turnover.

(b) Sustainment training reduces skill decay and maintains proficiency within the band of excellence described in FM 25-100. Retraining may be required if a long period elapses between initial and sustainment training. Once proficiency is demonstrated in a task or collective event, more difficult scenarios and exercises should be developed to train to a higher level of proficiency, while sustaining previously learned skills.

b. **Integrated Training Strategy**. Figure B-1 outlines a logical progression of events that a mortar platoon can adapt to their training strategy. Mortar squads and the FDC are dual-tracked to focus on their specific training needs. Both tracks must be integrated to develop a mortar platoon that fights as one unit. Individual and collective training must be evaluated against specific standards and discussed in AARs. Objective evaluations provide readiness indicators and determine future training requirements.

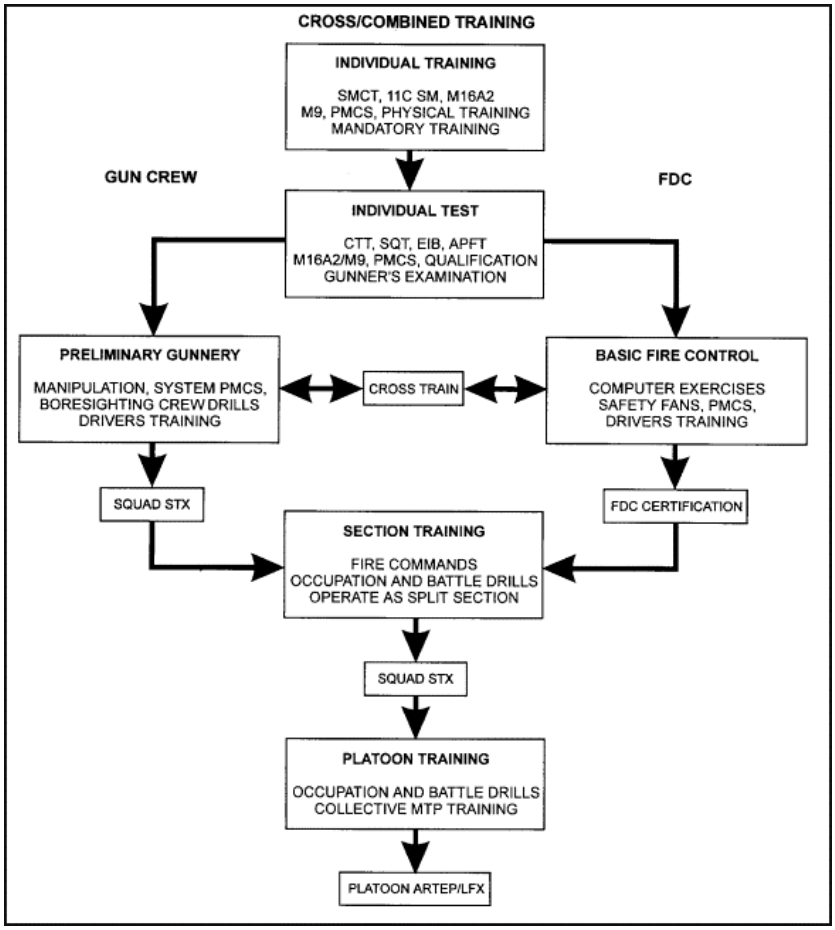


Figure B-1. Integrated training strategy.

(1) *Common tasks*. These tasks are found in STP 7-11-BCHM1-SM, Skill Level 1 and in STP 7-11-BCHM24-SM-TG, Skill Levels 2-4. These manuals contain the common tasks that all soldiers must know, regardless of MOS or duty position, to help them fight, survive, and win in combat. Mastery of these common tasks are a prerequisite for individual training specific to mortars. The communications and land navigation common tasks are vital.

(2) *MOS 11C tasks*. These tasks are found in STP 7-11C14-SM-TG for MOS 11C. This manual contains the individual tasks specific to mortarmen. The trainer's guide provides leaders the information to develop the individual portions of a unit training plan. Each 11C task is listed in this guide along with the following:

(a) Training extension courses (TECs). Service schools use TECs to support their expertise directly to units in the field. This is accomplished through lessons in the form of booklets, video slides, audio tapes, videotapes, and electronic information delivery system (EIDS) machines. These lessons focus on individual tasks and are stocked in unit learning centers and the local training support centers. TEC materials provide standardized instruction, which is helpful to soldiers as they move from unit to unit. Preparation time is also saved. However, trainers must ensure the lessons directly and fully support the training objectives.

(b) Army Correspondence Course Program. The ACCP provides printed training courses through the mail to soldiers. It is a valuable program for training the trainer, skill progression, and functional training for a specific specialty, MOS, or duty position. However, planning is needed. Leaders must identify courses that support the goals of the long-range training plan; soldier's enrollment must then be arranged. (ACCP includes the infantry mortar platoon leaders' course.)

c. **Cross Training**. A soldier's individual training tends to focus on his duty position. The assistant computer concentrates on FDC tasks while the squad leader concentrates on mortar mechanical tasks and leading the squad. However, this focus should not exclude other mortar training. Continuous training in duty-specific tasks can become boring to soldiers and deprive them of gaining broad proficiency in their MOS. Casualties (whether in war or in training) can quickly render the mortars ineffective if key personnel are lost. These variables make cross training essential. For example, cross training ensures that a squad leader can assume the duties of a computer and that subordinates are ready to assume the roles of their supervisors.

d. **Collective Training**. Collective training includes squad, section, and platoon drills and exercises.

(1) *Squad training*.

(a) The core of squad training is crew drills. Squad-level mortar tasks are in the infantry MTP. This training can be performed in garrison (using devices or live ammunition). Once these tasks are mastered, an increased challenge is introduced by performing them under different conditions such as urbanized terrain, limited visibility, or NBC. Cross training is accomplished at this level by rotating soldiers among duty positions, such as squad leader and FDC positions, while providing coaching.

(b) The foundation of squad training is sound individual training. If individual proficiency is effectively sustained, new soldiers can be readily integrated into the unit during collective training. They arrive at the unit proficient in specific tasks learned in the training base. These new soldiers learn additional tasks while training with their experienced peers and their squad leaders.

(2) *Section and platoon training.*

(a) The core section and platoon tasks are found in the ARTEP MTP. This training usually consists of an exercise in the field: LFX, STX (either alone or with a rifle company), or FTX as part of the battalion. LFXs may involve subcaliber, sabot, SRTR, or service ammunition. STXs and FTXs may entail dry fire, live fire, or devices, either alone or in combination.

(b) The FIST must be a part of this training. An LFX must never take place without the FISTs normally associated with the battalion. Trainers may wish to integrate these artillerymen into the mortar unit. This teaches the capabilities, limitations, and unique requirements of operating mortars.

(c) Another important area is the mortar's role in overall task force operations. This collective training mainly involves leaders in an FTX. However, mortars must be considered along with other fire support assets when conducting a MAPEX, CFX, TEWT, or CPX.

(3) *Collective training resources.*

(a) Drill books. Crew and battle drills are published in a pocket-sized ARTEP manual called a drill book for each unit organized under a different TOE. (See ARTEP 7-90-DRILL.)

- Battle drills are a specific category of collective tasks performed at squad, section, or platoon level. They are vital to the mortar's success in combat. Battle drills are mostly independent of METT-T and require minimal leader actions to execute. They are usually executed or initiated on a cue such as an enemy action or a simple leader order. Battle drills are standardized throughout the US Army and may not be modified in training. The mortar unit is required to be proficient in all battle drills contained in the drill book. Less critical drills are published in other sources such as training circulars or field manuals.
- Mortar drills are divided into two general areas. The first are those battle drills that previously were termed "crew drills." These focus on the mechanical manipulation of the mortar such as Lay for Small Deflection Change or Remove Misfire. Full proficiency in these tasks is a prerequisite for performing fire support missions. The second area encompasses those battle drills essential to combat survival. These include such tasks as React to Chemical Attack, React to Indirect Fire, or React to Nuclear Attack.

(b) Mission training plan. The MTP is a descriptive ARTEP document for training mortarmen to critical wartime mission proficiency. It gives the mortar platoon or section a clear description of "what" and "how" to train. This is achieved through comprehensive, detailed T&EOs, guidance on training exercises, and other related training management aids. While its focus is on collective training, the MTP also provides matrixes that identify individual tasks, common 11C SM tasks, and MQS tasks. Like the drill book, the mortar MTP applies to platoons or sections organized under a specific TOE. (See ARTEP 7-90-MTP.)

(c) Standards in training commission. STRAC outlines DA requirements for weapons training programs. It provides weapons standards, strategies, and resourcing for the 60-mm, 81-mm, 4.2-inch, and 120-mm mortars for different levels of unit training readiness. It specifies the amount and type of ammunition allocated to each mortar training event, and the annual frequency of that training event. For TRC A and TRC B units, the STRAC specifies that 90 percent of all squad leaders, gunners, and assistant gunners will have passed the mortar gunner's examination within the past six months and FDC personnel will have passed the FDC examination within the past six months (FM 23-91). Also, it states that all mortar sections and platoons will have received a

satisfactory rating IAW ARTEP MTP standards within the past six months.

(d) Battalion-level training model. BLTM is a means to qualify the cost of maintaining training readiness. This cost is expressed in terms of types of training events, their annual frequency, and the equipment miles/hours expended. This model is used to forecast and resource requirements to support the units specified training readiness level. It does not, however, prescribe what training a unit must conduct to maintain this level. Rather, BLTM provides a basis for understanding the trade-off between a unit's training resources and its training strategy developed. This helps leaders program training alternatives to achieve and maintain combat readiness. The frequency of training events under BLTM are reflected in the battalion's long-range training plan. When fully developed, BLTM encompasses and replaces STRAC.

e. **Example Annual Mortar Training Programs**. Figures B-2 and B-3 are examples of battalion-level programs for training mortar units. Figure B-2 depicts a light infantry battalion in CONUS, and Figure B-3 depicts a mechanized infantry battalion in USAREUR. These examples are consistent with current guidance under the STRAC and BLTM.

JANUARY IND WPN QUAL/SUST CREW WPN QUAL/SUST MAINTENANCE SQD/SEC/FDC DRILL (SRTR) PLT/SEC LFX GUNNER'S EXAM FDC CERTIFICATION	**FEBRUARY** SQD/SEC/FDC DRILL (LITR) PLT FTX CO FTX BN FTX DEPEX MAINTENANCE PLT STX (81-mm ONLY) SUPPORT CO STX	**MARCH** POST SUPPORT/BN CPX SQD/SEC/FDC DRILL (SRTR) ITEP/CMT CO TEWT
APRIL IND WPN QUAL/SUST CREW WPN SUST MAINTENANCE SQD/SEC/FDC DRILL (LITR) SEC/PLT LFX	**MAY** SQD DRILL PLT STXs CO FTXs DEPEX BN FTX MAINTENANCE SUPPORT CO FTX	**JUNE** POST SUPPORT BN CPX CO MAPEX ITEP (EIB) SQD/SEC/FDC DRILL (LITR)
JULY NG & ROTC SUPPORT SQD/SEC/FDC DRILL (SRTR)	**AUGUST** IND WPN QUAL/SUST CREW WPN QUAL/SUST BN FTX	**SEPTEMBER** SQD DRILL MAINTENANCE CO FTXs

	MAINTENANCE FDC EXAM GUNNER'S EXAM SQD/SEC/FDC DRILL (LITR)	BN FTX (EXT EVAL) SQD/SEC/FDC DRILL (SRTR/LITR) PLT STX (81-mm) DEPEX
OCTOBER POST SUPPORT ITEP (CTT) CMT BN TEWT CO MAPEXs CPX (81-mm) SQD/SEC/FDC DRILL (LITR)	**NOVEMBER** IND WPN QUAL/SUST CREW WPN/SUST DEPEX MAINTENANCE SQD/SEC/FDC DRILL (SRTR) GUNNER'S EXAM FDC CERTIFICATION	**DECEMBER** POST SUPPORT ITEP CMT SQD/SEC/FDC DRILL (LITR)

Figure B-2. Example training program for light infantry battalion in CONUS.

JANUARY CMT ITEP BN CPX MAINTENANCE SQD DRILLS PLT STX SQD/SEC FDC DRILL (SRTR) IND WPN QUAL/SUST FDC CERTIFICATION	**FEBRUARY** MAINTENANCE CO FTX BN FTX DEPEX SQD/SEC/FDC DRILL (SABOT) PLT FTX	**MARCH** MAINTENANCE POST SUPPORT/CO MAPEX BN TEWT ITEP CMT IND WPN QUAL/SUST SQD/SEC/FDC DRILL (SRTR)
APRIL GUNNERY QUAL (MTA) CALFEX (MTA) MAINTENANCE GUNNER'S EXAM LFX (M60, .50-CAL, 4.2-INCH) CALFEX/LFX DRILL (SABOT, 60-mm SUBCAL)	**MAY** ITEP BN CPX PLT STX MAINTENANCE SQD/SEC BATTLE DRILLS (SRTR/LITR) GUNNER'S EXAM	**JUNE** CO FTX BN FCX BN DEPEX BN FTX (EXT EVAL [HTA]) MAINTENANCE SQD/SEC/FDC DRILL BN EXT EVAL/LFX
JULY POST SUPPORT ITEP (EIB) BN MAPEX IND WPN QUAL/SUST CMT SQD/SEC/FDC DRILL (SRTR) MAINTENANCE	**AUGUST** IG INSPECTION ITEP BN CPX MAINTENANCE SQD/SEC/FDC DRILL (SABOT, 60-mm SUBCAL) PLT STX FDC EXAM	**SEPTEMPER** CO FTX MAINTENANCE BN DEPEX BN FTX-(REFORGER) SQD/SEC/FDC DRILL (SRTR) PLT STX

	GUNNER'S EXAM	
OCTOBER MAINTENANCE POST SUPPORT CO TEWT ITEP (CTT) CMT SQD/SEC/FDC DRILL	**NOVEMBER** IND WP QUAL/SUST GUNNERY QUAL (MTA) MAINTENANCE BN CFX SQD/SEC/FDC DRILL (SRTR) FDC EXAM GUNNERY QUAL (.50-CAL, M60) LFX	**DECEMBER** MAINTENANCE DEPEX POST SUPPORT ITEP IND WPN QUAL/SUST CMT SQD/SEC/FDC DRILL

Figure B-3. Example training program for mechanized infantry battalion in USAREUR.

B-5. TRAINING EVALUATION

Evaluation cannot be separated from effective training. It occurs during the top-down analysis when planners develop the training plan. Planners use various sources of information to assess their unit's individual and collective training status. Evaluation is continuous during training. Soldiers receive feedback through coaching and AARs. Leaders also assess their own training plan and the instructional skills of their subordinate leaders. After training, leaders evaluate by sampling training or reviewing AARs. Much of this evaluation is conducted informally. Formal evaluations occur under the Individual Training and Evaluation Program (ITEP) and the Army Training and Evaluation Program (ARTEP) to assess individual and collective training respectively.

a. **Individual Training**.

(1) *Commander's evaluation*. The commander's evaluation is routinely conducted in units. Commanders select and evaluate individual tasks that support their unit mission and contribute to unit proficiency. This may be performed through local tests or assessments of soldier proficiency on crucial MOS tasks or common tasks. The commander's evaluation is based on year-round, constant evaluation by the chain of command. It is supported by the MOS 11C soldier's manuals, trainer's guides, and job books.

(2) *Common tasks test*. The CTT is a hands-on test that evaluates basic survival and combat tasks. It is taken directly from STP 7-IIBCHM1-SM, STP 7-11BCHM24-SM-TG, and STP 7-llCl4-SM-TG. The CTT gives the unit commander regular, objective feedback on common task proficiency.

(3) *Gunner's examination*. The gunner's examination is a continuation of the mortar-based drills in which a mortarman's proficiency as a gunner is

established. The examination is contained in Chapter 9 of this manual. It includes tasks, conditions, standards, and administrative procedures. It focuses on the individual qualification of the soldier in the role of a gunner. However, the gunner's success also depends on the collective performance of his assistants. Within these limitations, evaluators should try to standardize the examination. STRAC specify that the squad leader, gunner, and assistant gunner should pass the gunner's exam semiannually. All gunners should have a current qualification before an LFX (whether using service or subcaliber ammunition).

(4) *FDC certification.* This provides commanders a means to verify that their FDC mortarmen have the knowledge and skills for their positions: squad leader, FDC computer, section sergeant, platoon sergeant, and platoon leader. Certification helps ensure that ammunition is widely expended and that training is conducted safely and effectively. Mortarmen are certified when they receive a passing score on the two-part examination (90 percent on the written and 70 percent on the hands-on). (See FM 23-91 for FDC certification.)

b. **Collective Training**.

(1) *Army Training and Evaluation Program*. The aim of collective training is to provide units the skills required to perform unit-level tasks. The ARTEP is the overall program for this collective training. It prescribes the collective tasks that a unit must successfully perform to accomplish its mission and to survive in combat. These tasks include conditions and performance standards, and they are located in MTPs and drill books.

(2) *External evaluation*. The commander formally determines the status of his collective training through external evaluation. The external evaluation gives the commander an objective appraisal of this status by using mortar expertise found outside the normal chain of command. The external evaluation is not a test in which a unit passes or fails; it is a diagnostic tool for identifying training strengths and weaknesses. It must be emphasized that an external evaluation is not a specific training event but a means to evaluate a training event. Mortar units undergo external evaluations during an LFX, FTX, or a combination thereof. The unit may be evaluated alone, as part of its parent unit, or with other mortar units. The MTP provides guidance on planning, preparing, and conducting an external evaluation.

(3) *Evaluation of forward observer.* The mortars can be no more effective than the FOs. It is critical that FIST FOs are present and evaluated during an externally evaluated mortar LFX. If an FO fails to meet his performance standards, the mortars should not be penalized. However, only as a last resort should the fire mission be deleted from the evaluation.

The mortars should be given the opportunity to successfully complete the fire mission. This can be accomplished in the following ways:

(a) Start the fire mission over. Although ammunition constraints during live-fire may not permit this, tasks can be repeated using devices or, less preferably, dry fire.

(b) Correct the call for fire or correction. The mortars should not have to use wrong firing data if the FO has made an incorrect call for fire or correction. This also wastes valuable training ammunition. The FO evaluator at the observation point can change the call for fire or correction to reflect proper procedures.

GLOSSARY

AAR	after-action review
AC	Active Component; aiming circle
ACCP	Army Correspondence Course Program
amp	ampere
ANCOC	Advanced Noncommissioned Officer's Course
APFT	Army Physical Fitness Test
AR	Army regulation
ARTEP	Army Training and Evaluation Program
ATTN	attention
BAD	blast attentuator device
BDU	battle dress uniform
BFV	Bradley fighting vehicle
BLTM	battalion-level training model
BNCOC	Basic Noncommissioned Officer's Course
cm	centimeter
CMF	career management field
CONUS	continental United States
CS	combat support
CSS	combat service support
CTT	common task test
D	delay; drop-fire
DA	Department of the Army
dc	direct current
DLY	delay (M734 multioption fuze)
DODAC	Department of Defense ammunution code
DS	direct support
EIB	Expert Infantryman Badge

EIDS	electronic information delivery system
EOD	explosive ordnance disposal
F	Fahrenheit; fire
FDC	fire direction center
FFE	fire for effect
FIST	fire support team
FM	field manual
FO	forward observer
FSE	fire support element
FT	firing table
FTX	field training exercise
GFS	graphical firing scale
GM	grid-magnetic angle
gpm	gallons per minute
GT	gun-target
GTA	graphics training aid
HE	high explosive
HHC	headquarters and headquarters company
HQ	headquarters
hr	hour
IAW	in accordance with
IET	initial entry training
ILLUM	illumination
IM	impact (M734 multioption fuze)
IMLC	Infantry Mortar Leader Course
IMP	impact
IOAC	Infantry Officer's Advance Course
IOBC	Infantry Officer's Basic Course
ITEP	Individual Training and Evaluation Program
kg	kilogram

LARS	left add, right substract
lb	pound
LFX	live-fire exercise
MAPEX	map exercise
MBC	mortar ballistic computer
METL	mission-essential task list
METT-T	mission, enemy, terrain, troops and time available
MILES	multiple integrated laser engagement system
mm	millimeter
MOS	military occupational specialty
mph	miles per hour
mps	meters per second
MQS	military qualification standards
MT	mechanical time
MTP	mission training plan
MTSQ	mechanical time superquick
N	North
NA	not applicable
NATO	North Atlantic Treaty Organization
NBC	nuclear, biological, chemical
NCO	noncommissioned officer
NCOES	Noncommissioned Officer Education System
NDI	nondevelopmental item
NSB	near-surface burst
OES	Officer Education System
OIC	officer in charge
OP	observation post
OPFOR	opposing force
OSUT	one station unit training
OT	observer-target

Pam	Pamphlet
PCC	Pre-Command Course
PD	point-detonating
PMCS	preventive maintenance checks and services
PROX	proximity
prx	proximity (M734 multioption fuze)
psi	per square inch
PWP	plasticized white phosphorus
QSTAG	quadripartite standardization agreeement
RC	Reserve Component
RDX	cyclonite
RP	red phosphorus; release point
RPO	radiation protection officer
S	South; safe
S3	operations and training officer
SM	soldier's manual
SMCT	soldier's manual of common tasks
SOP	standing operating procedure
SQ	superquick
SRTR	short-range training round
STANAG	Standardization Agreement
STRAC	Standards in Training Commission
STX	situational training exercise
T&EO	training and evaluation outline
TB	technical bulletin
TEC	training extension course
TEWT	tactical exercise without troops
TM	technical manual
TOE	table of organization and equipment
TNT	trinitrotoluene
TP	training practice

TRADOC	US Army Training and Doctrine Command
TRC	type requisition code
USAIS	US Army Infantry School
USAREUR	United States Army in Europe
US	United States
VT	variable time
WP	white phosphorus
w/o	without

REFERENCES

Documents Needed

These documents must be available to the intended users of this publication.

DA Form 2188-R	Data Sheet. March 1991
DA Form 2399	Computer's Record. December 1991
DA Form 2408-4	Weapon Record Data. 1 January 1979
DA Form 5964-R	Mortars, Ground-Mounted, Carrier-Mounted, Support. September 1990
FM 23-91	Mortar Gunnery. 6 December 1991
FT 4.2-H-2	Mortar, 4.2-Inch, M30 Carrier, 107-mm Mortar: M106A1 and M106; Firing Cartridge, HE, M329A1; Cartridge, Smoke, WP, M328A1; Cartridge, Tactical CS, XM630 and Cartridge, Illuminating: M335A1 and M335A2. 30 August 1968
FT 4.2-K-2	Mortar, 4.2-Inch, M30, and Firing Cartridge, HE, M329A2. 30 June 1984
FT 60-L-5	Mortar, 60-mm: M19 and M2 Firing Cartridge, HE, M49A4 Cartridge, TP, M50A3 Cartridge, Smoke, WP, M302A1 and M302A2 Cartridge, Illuminating, M83A1. 15 March 1974
FT 60-P-1	Mortar, 60-mm: M224, Firing Cartridge, HE, M720; Cartridge, HE, M49A4; Cartridge, HE, XM888; Cartridge, TP, M50A3; Cartridge, WP, M302A1 and Cartridge, Illuminating, M83A3. 22 March 1980
FT 60-Q-1	Firing Table for Mortar, 4.2-Inch, M30 with Mortar, 60-mm, M31, Subcaliber Assembly Firing Cartridge, HE, M49A4, Cartridge, TP, M50A3, Cartridge WP, M302A1, Cartridge, Illum, M83A3. 30 April 1987

FT 81-AI-3	Mortar, 81-mm: M29A1 and M29; Mortar, 81-mm, Self-Propelled: M125A1 and M125; Carrier, 81-mm Mortar: Tracked, XM755; Firing Cartridge, HE: M374A2 and M374; Cartridge, WP, M375A2 and M375; Cartridge, Illuminating: M301A3; Cartridge, Training: M68 and Training Device, M1. 22 March 1973
FT 81-AQ-1	Firing Table for Mortar, 81-mm: M29A1 and M29; Mortar, 81-mm, Self-Propelled: M125A1 and M125; Carrier, 81-mm Mortar: Tracked, M755 and Firing Cartridge, HE, M374A3. 31 August 1981
FT 81-AR-1	Mortar, 81-mm, M252, Firing Cartridge, HE, M821, Cartridge, HE, M889, Cartridge, RP, M819. 31 October 1986
TM 9-2350-261-10	Operator's Manual for Carrier, Personnel, Full-Tracked: Armored, M113A2; Carrier, Command Post, Light: Tracked, M577A2; Carrier, Mortar: 107-mm, M30; Self-Propelled: M106A2 CArrier, Mortar, 81-mm, M29A1; Self-Propelled, M125A2 Carrier, Smoke Generator, Full Tracked M1059. 12 July 1990

Readings Recommended

These readings contain supplemental information.

AR 385-63	Policies and Procedures for Firing Ammunition for Training, Target Practice, and Combat. 15 October 1983
ARTEP 7-90-Drill	Drills for the Infantry Mortar Platoon, Section, and Squad. 14 February 1990.
ARTEP 7-90-MTP	Mission Training Plan for the Infantry Mortar Platoon, Section, and Squad. 10 August 1989
DA Pam 25-30	Consolidated Index of Army Publications and Blank Forms. 1 October 1999
DA Pam 350-38	Standards in Weapons Training. 3 July 1997
DA Pam 351-20	Army Correspondence Course Program Catalog. 1 October 1998
DA Pam 738-750	Functional Users Manual for the Army Maintenance Management System (TAMMS). 1 August 1994
FM 5-103	Survivability. 10 June 1985
FM 6-30	Tactics, Techniques, and Procedures for Observed Fire. 16 July 1991.

FM 7-10	The Infantry Rifle Company. 14 December 1990
FM 7-20	The Infantry Battalion. 6 April 1992
FM 7-90	Tactical Employment of Mortars. 9 October 1992
FM 9-207	Operation and Maintenance of Ordnance Materiel in Cold Weather. 20 March 1998
FM 20-3	Camouflage. 14 November 1990
FM 21-11	First Aid for Soldiers. 27 October 1988
FM 21-26	Map Reading and Land Navigation. 7 May 1993
FM 24-1	Signal Support in the AirLand Battle. 15 October 1990
FM 24-18	Tactical Single-Channel Radio Communications Techniques. 30 September 1987
FM 25-4	How to Conduct Training Exercises. 10 September 1984
FM 25-100	Training the Force. 15 November 1988
FM 25-101	Battle Focused Training. 30 September 1990
FM 71-2	The Tank and Mechanized Infantry Battalion Task Force. 27 September 1988
FM 101-5-1	Operational Terms and Graphics. 30 September 1997
STP 7-11C14-SM-TG	Soldier's Manual, Skill Levels 1/2/3/4 and Trainer's Guide, MOS 11C, Indirect Fire Infantryman. 16 August 1994
TB 9-1300-256	Ammunition: National Stock Numbers and Department of Defense Codes. 30 June 1999
TB 34-9-93	NATO Design Mark. 28 August 1961
TM 9-1010-223-10	Operator's Manual for Lightweight Company Mortar, 60-mm: M224. 15 September 1998
TM 9-1015-200-10	Operator's Manual for Mortar, 81-mm, M29A1. 23 October 1985
TM 9-1015-200-20&P	Organizational Maintenance Manual Including Repair Parts and Special Tools List for Mortar, 81-mm, M29A1. 25 October 1985
TM 9-1015-200-30&P	Direct Support Maintenance Manual Including Repair Parts and Special Tools List for 81-mm Mortar, M29A1. 22 October 1985
TM 9-1015-215-10	Operator's Manual for 4.2-Inch Mortar, M30. 15 December 1993
TM 9-1015-215-23&P	Unit Direct Support Maintenance Manual With Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Mortar 4.2-Inch: M30 (Barrel M30 on Mount M24A1) and Trainer, Subcaliber, 60-mm: M31. 8 December 1993
TM 9-1015-250-10	Operator's Manual for Mortar 120-mm: Towed M120 and Mortar, 120mm: Carrier-Mounted M121. 19 August 1996
TM 9-1290-262-24&P	Unit, Direct Support, and General Support Maintenance Manual (Including Repair Parts and Special Tools List) for Aiming Circle,

	M2A2 W/E. 22 September 1994
TM 9-1290-333-15	Operator's, Organizational, Direct Support, General Support and Depot Maintenance (Including Repair Parts and Special Tools List): Compass, Magnetic, Unmounted: M2. 7 November 1963
TM 9-1300-200	Ammunition, General. 3 October 1969
TM 9-1315-249-12&P	Operator's and Unit Maintenance Manual (Including Repair Parts and Special Tools List) for 81-mm Mortar Training Device, 81-mm Sabot (Inert) M1 and 22-mm Subcaliber Practice Cartridges M744, M745, M746, and M747. 1 September 1990
TM 43-0001-28	Army Ammunition Data Sheets for Artillery Ammunition: Guns, Howitzers, Mortars, Recoilless Rifles, Grenade Launchers, and Artillery Fuzes. 28 April 1994