

B-GL-306-013/PT-001

FIELD ARTILLERY

VOLUME 13

GUN DRILL 155 mm HOWITZER SP, M109A2/A3

(BILINGUAL)

Issued on Authority of the Chief of the Defence Staff

CHANGE 1 TO B-GL-306-013/PT-001

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A
i, ii
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| 4-1 to 4-11 | 0 | | |

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FOREWORD

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1. B-GL-306-013/PT-001, Field Artillery, Volume 13, Gun Drill, 155 mm Howitzer SP, M109A2/A3, is issued on authority of the Chief of the Defence Staff.
2. This manual is effective upon receipt.
3. Suggestions for amendments should be forwarded through normal channels to Headquarters Mobile Command, Attention: SSO Arty.

RECORD OF CHANGES

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CHAPTER 1
GENERAL DUTIES

SECTION 1
INTRODUCTION

SECTION 1

INTRODUCTION

1. This manual is written primarily for detachment commanders and instructors. The duties of the gun position officer (GPO) and section commanders are given in B-GL-306-004/FP-001, Field Artillery, Volume 4, Duties at RHQ and the Gun Position.
2. The maintenance of the howitzer is described in C-30-621-000/ M B-00 1 (TM 9-2350-217-10), operator, manual for 155 mm, M109A3, with Canadian Supplement. For a general description of the howitzer and ammunition, and for full details of routine maintenance and action of all working parts, refer to that manual.
3. To prevent damage to the equipment and injury to personnel, no attempt to practice drills shall be made until detachments are completely familiar with all safety precautions.

SECTION 2

DUTIES OF THE DETACHMENT

SECTION 2

DUTIES OF THE DETACHMENT

GENERAL

1. The summary of duties in this section is not a comprehensive list. Specific duties are detailed in the relevant sections of the gun drill.

DUTIES

2. Responsibilities and Duties of 1

- a. 1 commands the detachment and is responsible for all aspects of servicing and maintaining the howitzer and its associated vehicle(s), both in and out of action.
- b. In particular, he is responsible that his howitzer is fired safely at all times by ensuring that it is laid at the correct bearing and correct elevation.
- c. The correct ammunition is loaded by checking the -
 - (1) projectile,
 - (2) charge, and
 - (3) fuze setting.
- d. The howitzer is not fired at any elevation which would result in the projectile hitting any crest or obstacle visible from the howitzer.

3. 1 is responsible for the discipline, welfare, and protection of the detachment and for arranging proper reliefs, whilst ensuring that the howitzer can be fired when required.

4. His specific duties are detailed under drills in the relevant Sections.

5. General duties of the detachment in action are:

- a. 1 supervises the work of the detachment.
- b. 2 sets the gun correction counter and the elevation counter and lays for elevation.
- c. 3 sets the gunners aid counter, the shooting scale, and lays for bearing.
- d. 4 loads and fires the howitzer.
- e. 5 assists in the preparation of ammunition.

- f. 6 is the driver and is responsible for servicing the vehicle and assisting in the preparation of ammunition.
- g. 7 assists in the preparation of ammunition, drives, and is responsible for servicing the ammunition vehicle.
- h. 8 is the second in command of the detachment. He supervises the preparation of ammunition and rides in the ammunition vehicle.

INTER-CHANGEABILITY OF PERSONNEL

6. It is essential that the duties of each member of the detachment be known by all other members so that reliefs are possible and drills can be performed with reduced detachments.

7. All members of the detachment must be able to perform the duties of 2, 3, 4, 5, 6, 7, and 8. In addition, 8 must be able to perform the duties of 1. The following assignment of duties may be taken as a guide.

- a. **With Seven Men**, one man performs the duties of 7 and 8.
- b. **With Six Men** -
 - (1) one man performs the duties of 5 and 6, and
 - (2) one man performs the duties of 7 and 8.
- c. **With Five Men** -
 - (1) one man performs the duties of 2 and 3,
 - (2) one man performs the duties of 5 and 6,
 - (3) one man performs the duties of 7 and 8.
- d. **With Four Men** -
 - (1) one man performs the duties of 2 and 3, and
 - (2) one man performs the duties of 5, 6, 7, and 8.
- e. **With Less than Four Men**, 1 will order the duties performed as necessary.

FORMING DETACHMENT FRONT/REAR

8. The term **front** means the direction in which the vehicle is pointing. The terms **right**, **left**, and **rear** are always in relation to the front.

9. On the order DETACHMENT FRONT/REAR, the detachment falls-in in two ranks, three paces in front or three paces to the rear of the vehicle. 1 covers off the right track of the howitzer and the detachment dress by the right with one pace between ranks and stand at ease, see Figure 1-1.

10. On the order DETACHMENTS, FRONT/REAR, the detachment doubles to its new position, odd numbers around the left side of the howitzer and even numbers around the right side.

TELL OFF

11. This drill is carried out at DETACHMENT FRONT/REAR and is designed to ensure that members of the detachment know their numbers in action. On the order TELL OFF, members of the detachment report their numbers in action, in numerical sequence.

12. On the order TELL OFF, the detachment commander numbers himself 1, the right-hand man of the rear rank numbers himself 2; the second man in the front rank numbers himself 3; and so on.

CHANGE ROUND

13. It is essential that all members of the detachment be familiar with each others duties. Therefore, it is necessary to change numbers of the detachment round during training.

14. **Drill.** On the order CHANGE ROUND:

- a. **1** takes a pace to the left rear and a pace to the left;
- b. **3, 5 7** and **8** take two short paces to their right;
- c. **6** takes a pace to the left and a pace to the front; and
- d. **2** and **4** take two short paces to their left. The detachment is then ordered to TELL OFF. Members report their new, numbers in action.

NOTE

Drill can be used instead of moving.

MOUNT AND DISMOUNT

15. The detachment is divided, for travelling, between the howitzer (see Figure 1-2) and the subsection ammunition vehicle. 1, 2, 3, 4, 5 and 6 travel with the howitzer, while 7 and 8 travel with the subsection ammunition vehicle.

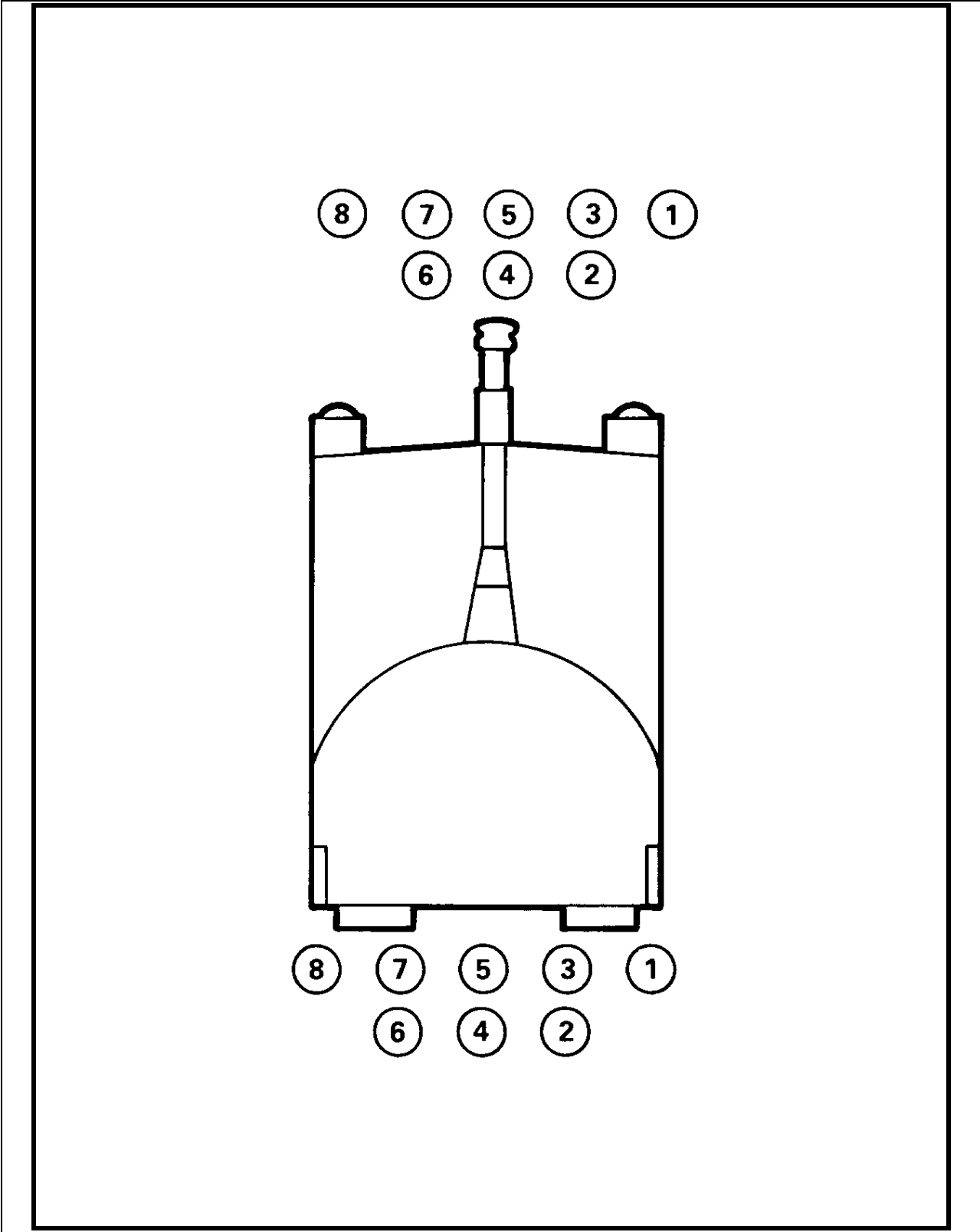


Figure 1-1 Positions of the Detachment at Detachment Front/REAR

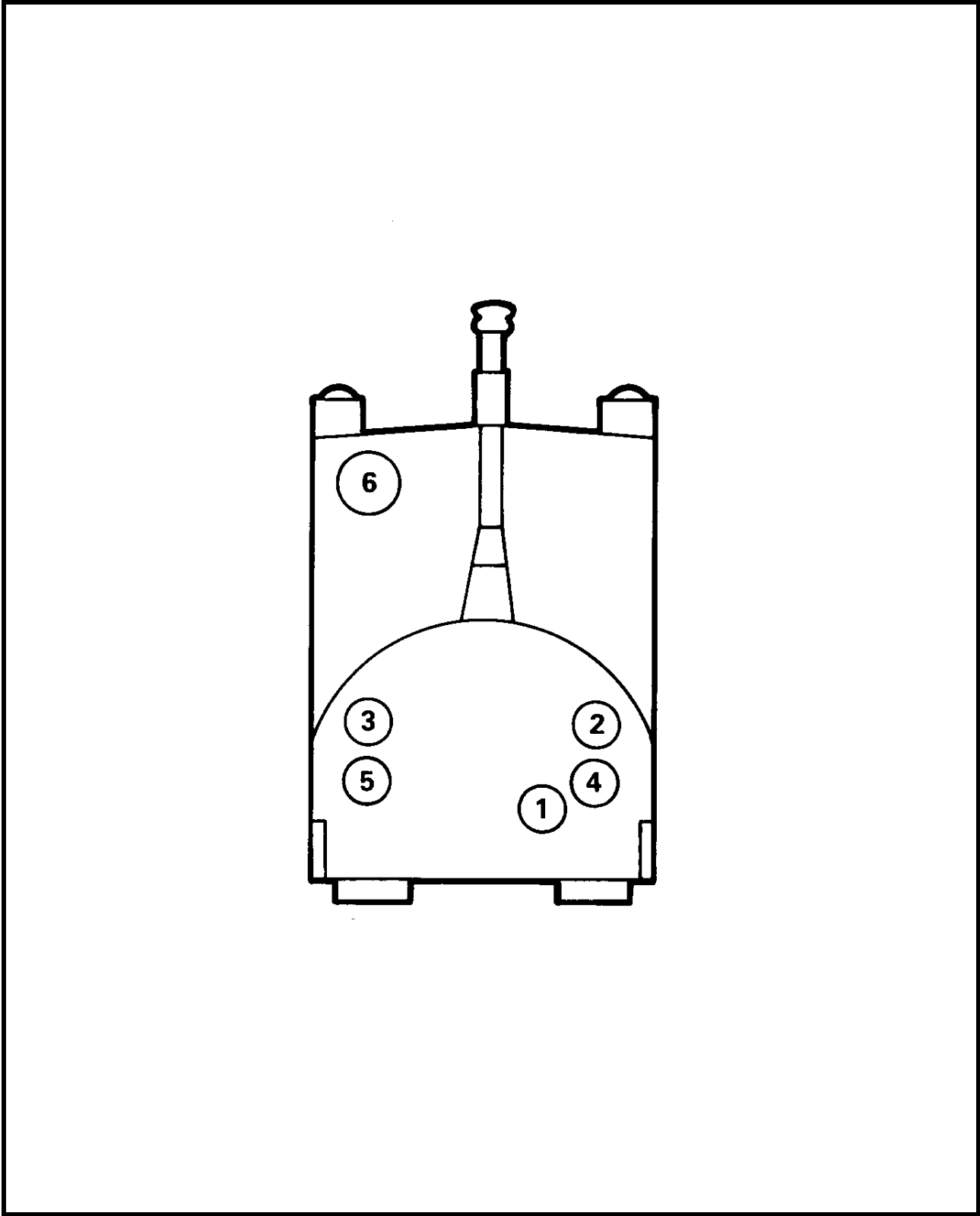


Figure 1-2 Positions in the Howitzer for Travel

16. **Drill.** On the order MOUNT, the detachment doubles to its appropriate vehicles and mount:

- a. 2, 3, 4, 5 and 1, in that order, enter the fighting compartment by the rear door; 2 and 4 occupy the right-hand seat, 3 and 5 occupy the left-hand seat.
- b. 1 locks the rear door and occupies the commanders; seat.
- c. 6 enters the driving compartment (entry may be made through the fighting compartment).
- d. The detachment fastens its seat belts when seated.
- e. 7 and 8 double to the subsection ammunition vehicle and mount, 7 drives and 8 crew commands.

EMERGENCY ESCAPE DRILL

18. Every member of the detachment must be aware of the possibility of a cab fire, the action he must take should a fire occur and his emergency escape route should he be required to evacuate the cab. 6,11 possible situations cannot be portrayed however. As a minimum, the following standard escape drill must be practised.

19. Should a member of the detachment discover a fire, he will shout FIRE, FIRE, FIRE. On the report of FIRE, 1 will direct the detachment to evacuate the cab through the following exits:

a. **In Action**

- (1) 2 through the right cab door,
- (2) 3 through the left cab door,
- (3) 4 through the rear door, and
- (4) 1 will assess the situation and direct the fighting of the fire or exit the cab through the commander's cupola or through the rear door as required.

b. **When Moving**

- (1) 1 orders HALT,
- (2) 3 and 5 will exit through the gunner's escape hatch,
- (3) 2 and 4 will exit through the right cab door or through the commander's cupola as directed by 1, and

(4) 6 will exit through the driver's hatch.

20. Detachment commanders are encouraged to discuss other possible situations with their detachments and give directions as to what action they are to take should the occasion arise.

POSITIONS IN ACTION AND LAYOUT OF GUN STORES AND AMMUNITION

21. The detachment will take up their positions in action, on the order:

- a. FIRE MISSION ;
- b. TANK ALERT; or
- c. TAKE POST.

22. Their positions in action are as follows (see Figures 1-3 and 1-4):

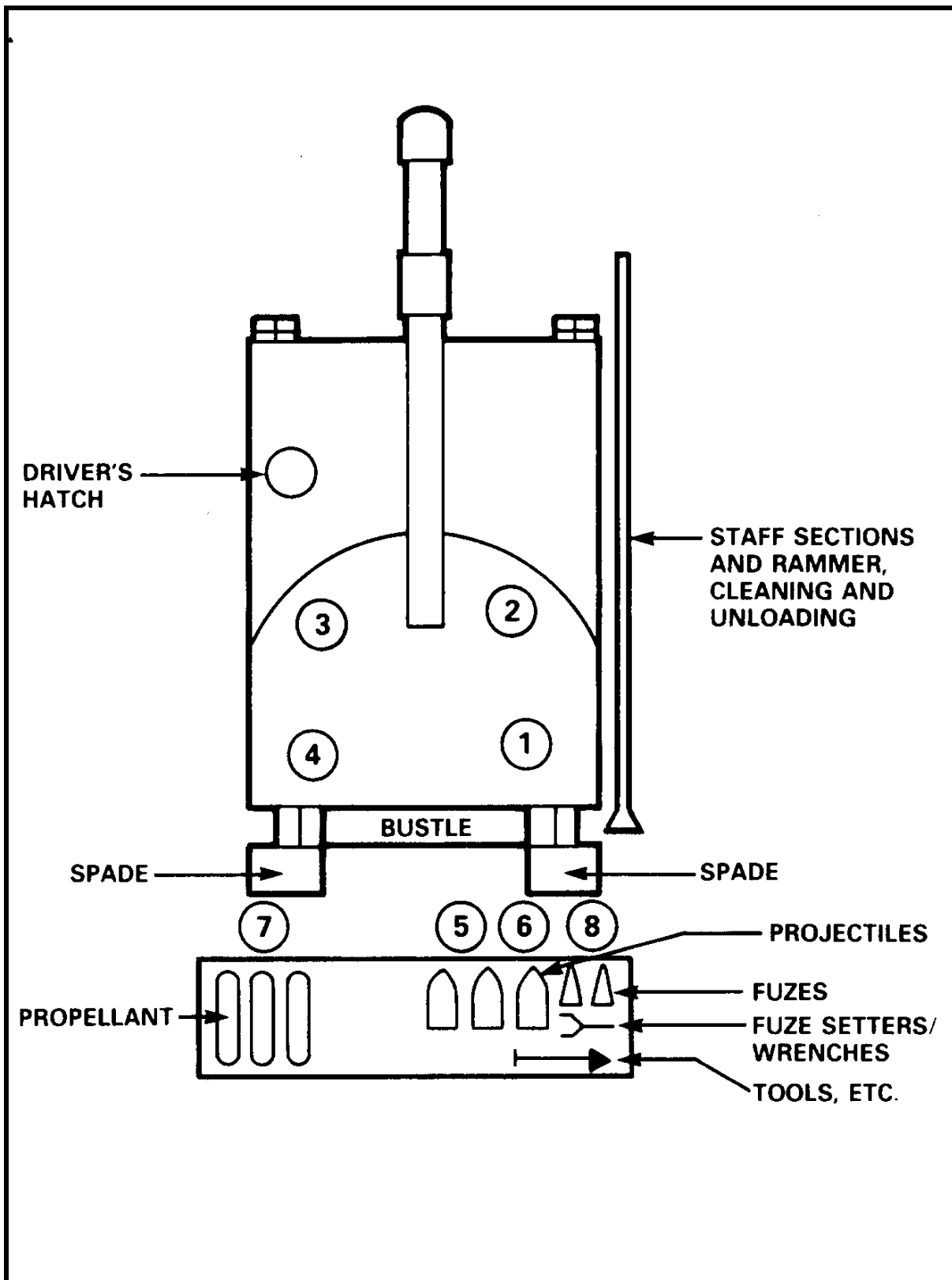


Figure 1-3 Positions in Action and Layout of Ammunition and Stores

- a. 1 stands where he can best supervise the detachment, normally to the right rear of the cab;
- b. 2 stands on the right facing the elevation quadrant;
- c. 3 stands on the left facing the panoramic telescope;
- d. 4 stands to the left rear of the cab where he can operate the rammer; and
- e. 5, 6, 7, and 8 are outside the cab preparing and fuzing ammunition. If ammunition is piled on the ground, it shall be placed on a tarpaulin six paces to the rear of the howitzers, projectiles on the right and propellant on the left. When ammunition is used from the cab, 5 stands to the rear of 2; 6 is in the driver's compartment (see Figure 1-4).

UNCLAMPING AND CLAMPING THE HOWITZER

23. The howitzer must be clamped before there is any vehicle movement. In addition, the howitzer travel lock must be securely locked in the closed position to prevent accidental unclamping during vehicle movement. This is necessary to avoid damage to the elevating and traversing system.

24. Drill for Unclamping the Howitzer

- a. 3 rotates the cab traverse lock to the unclamped position,, places the manual power selector switch in the UP position, turns the cab power switch ON, and ensures that the selector switch is in the Gunners position.
- b. 6 unlocks the howitzer travel lock.
- c. 6 orders ELEVATE and supports the travel lock. He orders STEADY when the barrel is clear of the travel lock.
- d. 3 elevates the howitzer.

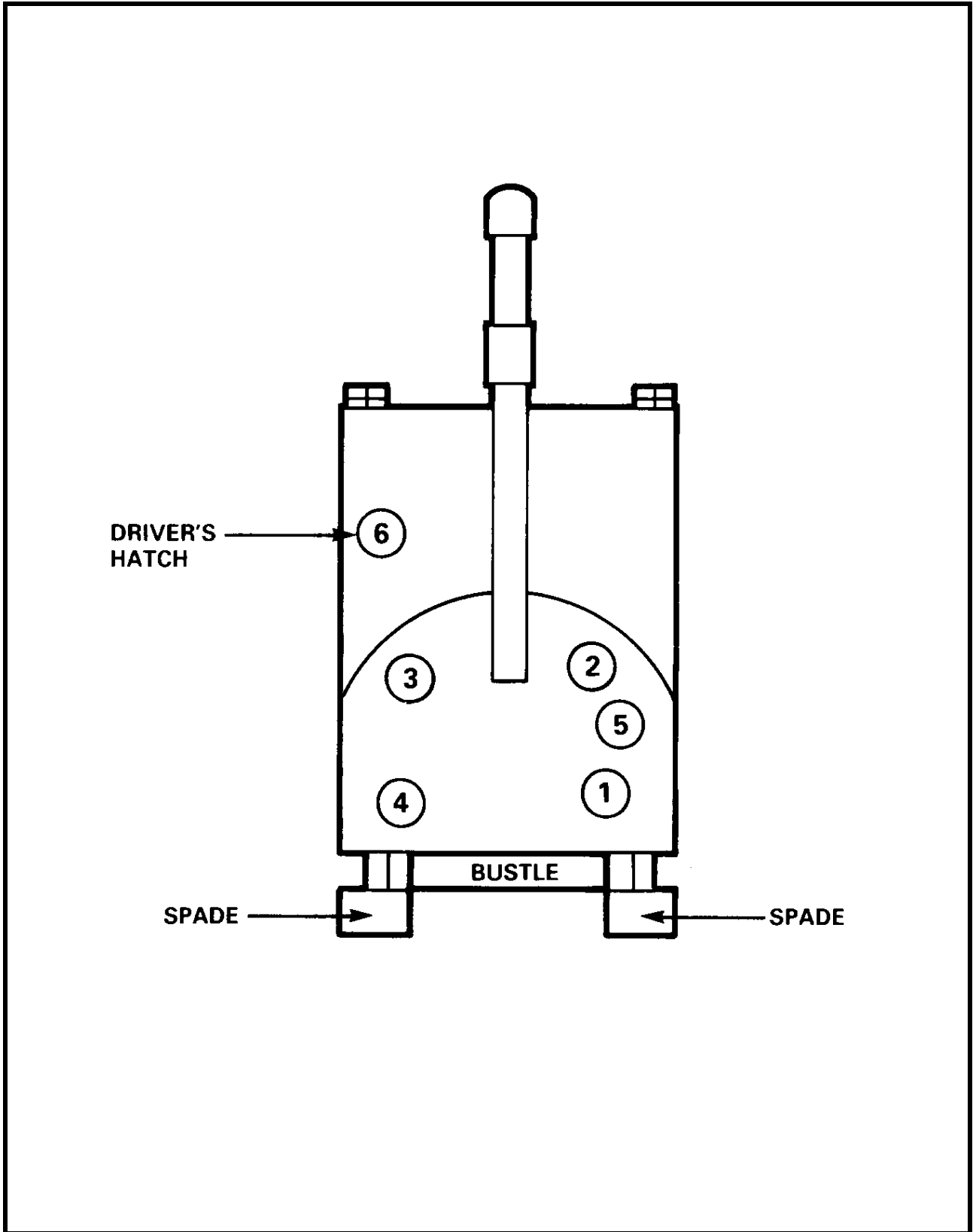


Figure 1-4 Positions in Action (Ammunition Used from the Cab)

- e. 6 lowers the travel lock under control and secures it to the engine cover.
- f. 6 orders MAXIMUM DEPRESSION and removes the muzzle cover.

25. **Drill for Clamping the Howitzer**

- a. 6 orders MAXIMUM DEPRESSION and replaces the muzzle cover.
- b. 6 orders ELEVATE and raises the howitzer travel lock to the travel position and supports it.
- c. 3 ensures that the selector switch is in the Number 1 position. 6 orders TRAVERSE RIGHT/LEFT, STEADY ELEVATE/DEPRESS till the barrel is in the Howitzer travel lock.
- d. 6 secures the travel lock and reports CLAMPED.
- e. 3 turns the cab power switch to OFF and rotates the cab traverse lock to the LOCKED position.
- f. 3 places the manual power selector switch in the manual (DOWN) position.

OPENING AND CLOSING THE BREECH

26. The breech mechanism is of the semi-automatic type, ie, it opens automatically after firing. It is closed by spring tension when the cradle cam is lifted clear of the operating crank pin. To avoid damage, the breech is kept closed during instruction in gun drill, when travelling or parked, and during long periods of inactivity.

27. **Drill for Operating the Breech by Hand.** To operate the breech by hand, grip the operating handle with the right hand. Depress the plunger with the thumb and pull the operating handle to the rear and to the right until the operating crank roller is engaged in the cradle cam. Return the operating handle to the housed position.

28. **Drill for Closing the Breech.** Ensure that the operating handle is housed and that no one is in the path of the breech screw. Grip the handle of the cradle cam and report STAND CLEAR CLOSING BREECH. Raise the handle clear of the operating crank roller and allow the breech to swing closed.

CAUTION

1 must ensure that the reference lines on the breech lock are matched when the breech is closed. If they are not matched, the breech must be closed manually using the operating handle.

29. **Drill for Manually Closing the Breech.** If the spring tension is not sufficient to close the breech fully, grasp the operating handle with the right hand. Release the operating handle from its stowed position by depressing the plunger with the right thumb and pulling the handle to the right. Align the plunger on the hinge of the operating handle with the recess on the breech hinge and push in the plunger. Holding the plunger in, apply a steady forward pressure on the operating handle and push the breech screw to the fully closed position. Return the operating handle to its stowed position.

OPERATING THE RAMMER

30. The following precautions must be taken to prevent the rammer from operating inadvertently:

- a. the rammer must not be activated unless a projectile is on the rammer tray; and
- b. care must be taken to ensure that nothing is leaned on or bumped against the rammer latch handle when it is in the stowed position.

31. Rammer Drills

- a. 2 brings the howitzer to a convenient loading elevation (below 800 mils).
- b. 4 grasps the rammer main release handle with his right hand and the cylinder release handle with his left hand. 4 pulls to the rear with both hands, operating the main release handle, and slides the rammer assembly to the rear.
- c. With his left hand on the cylinder release handle, 4 rotates the rammer assembly and pushes forward until the rammer assembly is locked (an audible click should be heard and the release catch is in the locked position marked with black paint).
- d. 4 pulls on the cylinder release handle, unlocks and rotates the rammer cylinder to the side.

CAUTION

1 must ensure that the rammer actuator handle mounted on the cab roof is not activated while the rammer is in the unlatched/loading position.

- e. 4 picks up a projectile and places it on the rammer tray and advances the projectile until the base is within the limits of the rammer head reference line.
- f. 4 rotates the rammer cylinder over onto the rammer tray.
- g. On the order LOAD from 1, 4 pushes the rammer actuator handle forward for 5 seconds and then releases the actuator handle (see notes 1 and 2).

- h. When ramming is complete, 4 grasps the rammer main release handle with his right hand and the cylinder release handle with his left hand and pulls the rammer assembly fully to the rear. He rotates the rammer assembly to the left and pushes the rammer assembly forward to the stowed position, ensuring that it is locked (an audible click is heard and the release catch indicator is in the locked position marked with black paint).

NOTES

1. The rammer actuator handle **MUST** be forced to its fullest extent, held for 5 seconds, then released completely.
2. If the rammer fails to ram, 1 orders **HAND RAMMING**. At the first opportunity 1 will notify the weapons technician.

LOWERING AND RAISING THE SPADES

32. Lowering the Spades

- a. 4 and 5 dismount.
- b. 5 closes the rear door.
- c. 2 and 3 release the left and right pedal latches.
- d. 4 and 5 release the spade struts, 4 working on the right spade and 5 working on the left spade remove the spade latch safety pins, release the spade latches, and lower the spades to the ground.
- e. 4 and 5 position themselves so that they can see the spade strut housings.
- f. 1 orders 6 to reverse until 4 signals that the spade struts are fully housed and that the spades are firmly embedded. 4 cannot signal 1 until he has received a confirmatory signal from 5.
- g. 4 and 5 return to their positions in action.

33. Raising the Spades

- a. 1 orders **RELEASE THE SPADES**.
- b. 2 and 3 press down on the pedal latches and ensure that they are locked.
- c. 1 orders 6 to advance the vehicle forward until the spades are free.

- d. Working together, 4 and 5 raise the spades to the travelling position, replace the spade latch safety pins, and lock the spade struts.

ZERO PRESSURE CHECK

34. The zero pressure check is carried out during the prepare for action drill or whenever the rammer or the traversing or elevation systems seem sluggish, to ensure that there is sufficient nitrogen pressure (500 to 550 psi) in the main accumulator and an adequate amount of hydraulic oil in the reservoir.

35. To carry out the zero pressure check:

- a. 1 orders ZERO PRESSURE CHECK.
- b. 1 orders 3 CAB POWER OFF.
- c. 1 orders 3 MASTER SWITCH OFF.
- d. 3 moves the cab traversing lock handle to the lock position and moves the manual power selector switch down to the manual position.
- e. 1 disconnects the circuit connector.
- f. 1 orders 3 to turn on the master switch.
- g. 1 orders 3 to turn the cab power ON and to move the gunner control handle to the left or right.
- h. 1 observes the pressure gauge needle as it drops from operating pressure until it flutters. Then the needle will drop sharply to ZERO psi. The reading at which the needle fluttered is the amount of pre-charged nitrogen in the main accumulator. It should read between 450 to 550 psi. If the main nitrogen pressure is below 450 psi, notify a weapons technician.
- j. 1 orders 3 CAB POWER OFF.
- k. 1 orders 6 MASTER SWITCH OFF.
- m. 1 observes the sight gauge on the main hydraulic reservoir. Oil appearing in the gauge should be level with the mark of the scale: Full at Zero Pressure Check. If the oil is low, replenish by adding hydraulic oil.
- n. 1 connects the circuit connector.
- p. 1 orders 3 to turn the master and cab power switch ON. 3 keeps his hand on the cab power switch, ready to turn it off on the order of 1 (see CAUTION below).

- q. 1 observes the needle moving from ZERO on the pressure gauge. It should stop between 1175 and 1275 psi.

CAUTION

If the accumulator pressure rises to 1400 psi when the cab power switch is turned ON, immediately turn the cab power switch OFF and notify a weapons technician.

TESTING AND ADJUSTING THE EQUILIBRATOR

36. The equilibrator is tested and adjusted during the prepare for action drill and periodically when in action, to compensate for temperature changes in order to maintain the balance of the weapon. If the howitzer is used in an unbalanced state, it will be difficult to maintain smooth movement of the elevating system. The drill is carried out at an elevation of 266 mils.

37. To test and adjust the equilibrator:

- a. 1 orders BALANCE CHECK ELEVATION 266.
- b. 2 elevates and depresses two or three times using the manual elevation hand pump to detect any difference in hand effort. He reports either DIFFICULT TO ELEVATE/DEPRESS or BALANCE OKAY.
- c. If 2 reports DIFFICULT TO ELEVATE, 1 orders 3 to increase the equilibrator pressure by means of the equilibrator hand pump. The tests and adjustments are continued until 2 reports BALANCE OKAY.
- d. If 2 reports DIFFICULT TO DEPRESS, 1 orders 3 to open the equilibrator globe valve (red handle) slowly to allow a small amount of hydraulic oil to be drained into a container. The test and adjustments are continued until 2 reports BALANCE OKAY.

CHAPTER 2

GUN DRILL

CHAPTER 2

GUN DRILL

PREPARE FOR ACTION

1. The prepare for action drill is carried out to ensure the equipment is serviceable in all respects. Under no circumstances will PREPARE FOR ACTION delay deployment. The order is given by the GPO or TL and may be ordered in a hide, at a rendezvous, or on the gun position. The drill is written for numbers 1 to 6, as 7 and 8 are with the sub-section ammunition vehicle.

2. Preparation

- a. 1 orders PREPARE FOR ACTION.
- b. 2 opens the right cab door.
- c. 3 opens the left cab door.
- d. 5 opens the rear door and the projectile door.
- e. 1, assisted by 3, performs a zero pressure check (see Chapter 1, paragraphs 34 and 35).
- f. 3 unlocks the cab traverse lock, turns the cab power switch to ON, and ensures that the selector switch is on GUNNER.
- g. 6, assisted by 3, unclamps the howitzer travel lock. 3 reports if there are any obstructions to traversing.
- h. 6 removes the muzzle cover and places it on the engine deck. He opens and locks the direct fire telescope dust cover.

3. Examination

- a. 1 examines the replenisher indicator, recuperator, accumulators, variable recoil cylinders, bore and chamber, and the radio and intercommunications system.
- b. 2 examines the elevation quadrant, elevating the gear both manually and hydraulically and the direct fire telescope. He assists 3 in adjusting the equilibrator if required.

- c. 2 opens and checks the operation of the breech and cleans it with a dry cloth. When 1 has checked the bore and chamber, 2 ensures that no one is in the path of the breech, reports CLOSING BREECH, STAND CLEAR, and closes it. He then checks the gunners quadrant, vent bit, and the primer seat cleaning tools. 2 checks the stowage and security of ammunition and equipment, inside and right of the vehicle, and assisted by 4 closes the right cab door.

WARNING

Before traversing 3 must warn the detachment by reporting TRAVERSING.

- d. 3 assisted by 2 adjusts the equilibrator if necessary. 3 removes the panoramic telescope from the stowage box, examines the telescope and mount, and then secures the panoramic telescope in the mount. The telescope remains in the mount until ordered removed by 1. 3 checks the traverse manually and the traverse and elevation hydraulically. 3 checks the stowage and security of ammunition and equipment, inside and left of the vehicle, and assisted by 5 closes the left cab door.
- e. 4 examines the right spade, lanyard, primer belt, sponge, bucket, collimator, collimator cable, and rammer. 4 assists 5 in cleaning the bore when ordered.
- f. 5 examines the left spade, fuze setters, and the externally mounted machine-gun and checks the communication cable. 5 assists 4 in cleaning the bore when ordered.
- g. 6 examines the muzzle brake, bore evacuator, aiming posts, and cleaning staff sections. He checks the ballistic covers, closes the direct fire telescope window, and replaces the muzzle cover.
4. **Assembly**
- a. 6 assisted by 3 clamps the howitzer.
- b. 3 locks the cab traverse lock, places the manual power selector lever in the MANUAL position, and turns the cab power switch to OFF.
- c. On completion of the drill, 1 orders DETACHMENT REAR, collects reports, and orders MOUNT. 1 reports the condition of his equipment together with an ammunition state to the Troop Leader.

COMING INTO ACTION

5. If the howitzers are brought into action as a troop, the order or signal ACTION shall be given as they approach their positions. Normally, each platform shall be marked by a gun marker. 1 shall ensure that his howitzer is aligned with the arrow and that the panoramic telescope is as close to the marker as possible. Care must be taken to ensure there is no tension on the tracks. When the position is not marked, the choice of platform rests with 1.

6. Although the equipment has a 6400 mil traverse capability, it is preferable to point the front of the howitzer as close as possible to the bearing of the centre of arc. The signals shown in Figure 2-1 can be used to direct the movement of the vehicle. To prevent damage, hydraulic lines will not be used as handholds.

| Serial | Order | Signal |
|--------|---------|--|
| 1 | ACTION | The hands are clenched and the arms extended straight to the front of the body, facing the required bearing of fire. |
| 2 | HALT | One arm is raised vertically above the head. |
| 3 | ADVANCE | Face the driver and beckon him to advance by extending one arm to the front of the body and bringing the hand upward and toward the face, bending the arm at the elbow. |
| 4 | REVERSE | Extend one arm to the front, elbow bent and palm of the hand upright and toward the driver. Move the forearm backwards and forwards as long as the reverse movement is required. |
| 5 | CHANGE | Extend one arm with the fist clenched and in line with the shoulder, in the direction in which the vehicle is to move. |

Figure 2-1 Table of Signals for Controlling Vehicle Movement

7. The duties of 1 are:
- to direct 6 in lining up the howitzer on the marker;
 - to order HALT ACTION or HALT ACTION, SPADES; and
 - to order 6 to cut the engine and set the brakes. 6 ensures that the proper cooling down drill is observed.

8. The duties of 2 are:
 - a. to fold the right cab seat;
 - b. to open the right cab door,
 - c. to ensure that the correction counters are set to 0 and to leave the howitzer at maximum depression;
 - d. to centre the cross level bubbles;
 - e. to open the breech;
 - f. to obtain the sponge and chamber swab and to fill the water bucket; and
 - g. to obtain the vent bit and reamer and to place them nearby.

9. The duties of 3 are:
 - a. to fold the left cab seat;
 - b. to open the left cab door;
 - c. to receive the master control panel from 6 and place it in its receiver;
 - d. to turn the cab power switch to ON;
 - e. to unlock the cab traverse lock and place the manual power selector switch to POWER;
 - f. to assist 6 in unclamping the howitzer travel lock; and to install the panoramic telescope, set the azimuth bearing and gunners aid counter to 0, and level the bubbles.

10. The duties of 4 are:
 - a. to obtain the primers and the primer belt;
 - b. to obtain the lanyard and place it in a convenient place;
 - c. to assemble and set up the collimator when ordered; and
 - d. to assemble the aiming posts and plant them, when ordered.

11. The duties of 5 are:
- a. to open rear cab door;
 - b. to assist in preparing ammunition;
 - c. to obtain the fuze wrenches and fuze setters;
 - d. to take the communicator cable and marker to the command post, and must inform the CP of his number in action as well as his alpha call sign; and
 - e. to open the charge bag door.
12. The duties of 6 are:
- a. to align the howitzer as ordered by 1;
 - b. to set the brakes and carry out the closing down drill;
 - c. leaving the master switch ON, to pass the master control panel to 3;
 - d. assisted by 3, to unclamp the howitzer travel lock and secure it in the firing position;
 - e. to open the direct fire dust cover and secure it in the locked position;
 - f. to remove the muzzle cover and place it in the driver's compartment;
 - g. to pass the cleaning staff sections and aiming posts to 4;
 - h. to close and secure the driver's hatch; and
 - j. to assist in the preparation of ammunition.
13. On completion of their tasks, the detachment takes up their positions in action.

PASSAGE OF ORDERS

14. Howitzers in action are numbered 1, 2, 3, etc, from right to left as viewed from the rear. In case of doubt because of staggered siting, the GPO shall allot numbers. The numbers shall stand throughout the action, regardless of the bearing on which the howitzers are laid.
15. Orders shall normally be passed and acknowledged through the communications system. If this fails, orders shall be passed by radio or voice and acknowledged by reporting, in succession from the right, ie, NUMBER ____ ROGER OUT/THROUGH.

16. Repetition of an order shall be demanded, or attention shall be called to omissions or obvious errors, by the use of VERIFY, ie, VERIFY BEARING.
17. 1 shall repeat orders affecting his detachment in a voice no louder than necessary and only when the order has not been heard by the men concerned.
18. Reports from 1 to the GPO shall be acknowledged by ordering DOWN ____ (number of howitzer).
19. Orders from the GPO always take precedence over reports from 1.

LAYING THE HOWITZER IN THE CENTRE OF ARC (C OF A)

20. During training, before detailing this and subsequent drill, the instructor/detachment commander shall ensure that the men who are to perform the duties of 1, 2, and 3 are familiar with the drill for sight setting and laying as detailed in Chapter 4.
21. The drill/procedure to be followed when using the Gun Alignment and Control System (GACS) will be written as an Annex to this manual when the system is brought in service.
22. The GPO is responsible for ensuring that all howitzers are laid in the C of A.
23. When the individual angle method is to be used, and if the passage of orders by voice is likely to be difficult, the GPO shall.
 - a. establish a radio at or near the director position and pass orders over the air;
 - b. order runners to be sent from each detachment to the director (all orders and reports shall be written and the detachment commander shall not call back the angle to the GPO); or
 - c. pass the angles to the howitzers through the communications systems, 1 calling the angle back to the GPO.
24. The GPO will repeat his measurement of angles to each howitzer after 1 has reported FINISHED WITH DIRECTOR. If the GPO finds that the original angle is correct, he will order NUMBER ____ RECORD AT _____. If a new angle is required, the GPO will order the new angle followed by NUMBER_ RECORD AT.

25. Individual Angle Method

- a. On the order from the GPO, AIMING POINT DIRECTOR, NUMBER ____, _____, 1 repeats the angle to the GPO. If the repetition is correct, the GPO will acknowledge.
- b. 3 sets the angle ordered on the main scale of the panoramic telescope.

- c. 1 checks the setting and orders LAY,
- d. 3 reports TRAVERSING, lays on the director, and levels the bubbles. When 3 is finished, 1 checks the lay and reports NUMBER ____ FINISHED WITH DIRECTOR.

26. **Aiming Point Method**

- a. The GPO orders the aiming point, description, angle to the aiming point, and bearing of C of A, eg, AIMING POINT, CHURCH STEEPLE 0200, RECORD AT 3600.
- b. 1 turns the setting knob to MS and sets the bearing of C of A on the shooting scale. He turns the gunners aid counter to 0 and the setting knob to M.
- c. 3 sets the angle ordered on the main scale.
- d. 1 checks the setting and lays on the aiming point.
- e. If 1 cannot identify the aiming point, he will double to the GPO and obtain verification.
- f. 1 and 3 complete the drill for recording C of A.

27. **During a Night Occupation**

- a. Having received the record of the first angle, 3 sets the angle ordered on the main scale.
- b. 1 checks the setting and orders LAY.
- c. 3 reports TRAVERSING and lays on the director.
- d. When laid, 1 checks the lay and reports to the GPO, NUMBER ____ FINISHED WITH DIRECTOR.
- e. The drill for recording C of A is then carried out.

TO RECORD C OF A

28. When the drill for laying the howitzer in the C of A is completed, the GPO shall order the C of A to be recorded. The possible combinations in priority are:

- a. **By Day**

- (1) GACs with beacon on;
- (2) collimator;
- (3) aiming posts; and
- (4) close GAP.

b. **By Night**

- (1) GACs with beacon on;
- (2) collimator;
- (3) aiming posts with TRI-LUX lights; and
- (4) night picket.

29. Three independent records shall be made:

- a. main scale reading to the first GAP;
- b. main scale reading to the second GAP (for night laying, the troop picket shall be recorded and used as a close GAP); and
- c. C of A.

30. When laying and recording the C of A, both the longitudinal and cross-level bubbles of the telescope mount must be central and the gunners aid counter must be set to 0. The elevation of the howitzer does not affect the accuracy of this drill; it shall remain at maximum depression.

31. **Drill.** On the order RECORD AT ___:

- a. 1 ensures the gunners' aid counter is set to 0. He turns the setting knob to MS, sets the bearing C of A on the shooting scale, and turns the setting knob to M.
- b. 3 records the bearing C of A ordered.
- c. 1 turns the panoramic telescope onto his selected GAP 1 and orders 3 LOOK, READ.
- d. 3 identifies GAP 1 by looking through the panoramic telescope. He reads the setting on the main scale and records it on the record plate.

- e. 1 reads the setting on the main scale and checks it with 3's record. He then turns the setting knob to MS. He turns the panoramic telescope onto his selected GAP 2.
 - f. 1 orders 3 LOOK, READ.
 - g. 3 identifies GAP 2 by looking through the panoramic telescope. He reads the setting on the main scale and records it on the record plate.
 - h. 1 reads the setting on the main scale and checks it with 3's record.
 - j. 1 orders GAP 1.
 - k. 3 turns the panoramic telescope back onto GAP 1. He reports the main scale reading and closes the index door. He reports the bearing counter reading. 1 ensures the readings agree with those recorded on the record plate. If they do not, he will take the necessary steps to correct them.
32. As soon as all three records listed in paragraph 29 are completed, 1 will report NUMBER _____ RECORDED.
33. After the C of A has been recorded, 1 shall point out the GAPS to all members of the detachment.
34. If fire orders are received before the drill is completed, the GPO may order DEFER SECOND RECORD. 1 shall then report NUMBER _ RECORDED, as soon as the first GAP is recorded.
35. When the record to the second GAP has been deferred in this way, 1 shall complete his record at the earliest opportunity without further orders from the GPO.
36. The records of the C of A shall stand until cancelled by a subsequent order from the GPO, ie, RECORD AT _____.
37. Under no circumstances shall 1 amend his C of A records without orders from the GPO. Should it be obvious to 1 that his C of A is wrong, he shall report this fact to the GPO. The GPO shall arrange for a check and if necessary, order a fresh record to be made.
38. **Altering the Bearing C of A.** The original bearing on which the howitzer is laid may be altered, eg, on a change of grid, by the GPO.
39. On receipt of the order: CONVERGE 0, BEARING , RECORD AT _____, 1 shall order the previous records to be erased and the howitzer laid on the new C of A.

40. **Drill**

- a. 1 ensures the gunners' aid counter is set at 0.
- b. 3 sets the bearing on the shooting scale and lays on GAP 1.
- c. 1 checks the lay and sets the bearing C of A on the shooting scale then turns the setting knob to M.
- d. 1 turns the panoramic telescope onto his selected GAP 1 and orders 3 LOOK, READ.
- e. 3 identifies GAP 1 by looking through the panoramic telescope. He reads the setting on the main scale and records it.
- f. The drill described in subparagraphs 31.e. to 31.k. shall be carried out with the howitzer laid on the new C of A. At the conclusion of the drill, the GPO shall, if necessary, order the howitzer laid on the last target or on the FPF task, as applicable.

TO RECORD C OF A AT NIGHT

41. This drill applies when aiming posts have been planted prior to the howitzers coming into action.

42. **Drill.** Having received the angle to the aiming posts and the bearing C of A:

- a. 1 sets the bearing C of A on the shooting scale and turns the setting knob to M.
- b. 3 sets the angle on the main scale.
- c. 1 checks the setting and orders LAY.
- d. 3 lays on the aiming posts by directing 6 to pivot either left/right or advance/retire and makes due allowance for displacement.
- e. 1 checks the lay and turns the setting knob to MS.

43. The troop picket shall be recorded and used as GAP 2.

PLANTING AIMING POSTS

44. The order to plant aiming posts may be given by the GPO if he deems it necessary or desirable, eg, when visibility is poor, when no GAPs are available, or for night laying.

45. To reduce the risk of confusion, the GPO shall order the aiming posts planted alternately to the front or rear, eg, RECORD AT _____, AIMING POSTS 1 AND 3 FRONT, 2 AND 4 REAR.

46. When aiming posts are to be planted, 1 shall indicate to 4 where the near post is to be planted. The distance from the howitzer to the near post should be approximately 50 metres; the near post should be midway between the far post and the howitzer. During the drill, 1 must be in position where he can signal 4 and also receive verbal instructions from 3.

47. Figure 2-2 describes the signals used when planting aiming posts.

48. **Drill.** On the order RECORD AT ____, AIMING POSTS ____, FRONT:

- a. 4 obtains the aiming posts and doubles to a position about 50 metres to the front/rear of the howitzer, as indicated by 1. As near as can be judged and in the line indicated, 4 plants the first post.
- b. 4 doubles a further equal distance with the second post; lines it up with the panoramic telescope and the near aiming post; faces the howitzer and awaits instructions from 1.
- c. 1 sets the bearing C of A on the shooting scale and turns the setting knob to M, ensuring the gunners' aid counter is at 0.
- d. 3 turns the panoramic telescope accurately onto the near aiming post. 1 then directs the planting of the far post exactly in line with the near one on instructions from 3.
- e. 1 signals 4 to come in to the near aiming post and if necessary to straighten it. He then signals 4 to come in.
- f. 1 checks the alignment.
- g. 1 and 3 complete the drill for recording C of A.

PLANTING AIMING POSTS DURING A NIGHT OCCUPATION

49. During a night occupation, the C of A is recorded by:

- a. GACs with beacon on;
- b. collimator;
- c. two aiming posts with TRI-LUX lights; and
- d. night RO.

| Serial | Order and Signal | Action by ④ |
|--------|---|---|
| 1 | MOVE IN THE DIRECTION INDICATED. The right arm is extended upward to the right, or the left arm extended upward to the left, with the palm of the hand in the direction required. | He holds the post upright, clear of his body, and moves in the direction indicated. He continues to move until the HALT signal is given. |
| 2 | HALT. The arm is dropped. | He halts and allows the post to slip through his fingers until the point rests on the ground. |
| 3 | PLANT. Both arms are dropped from above the head. | He presses the point firmly into the ground. He ensures that the post is upright and then stands clear. |
| 4 | MOVE THE TOP OF THE POST IN THE DIRECTION INDICATED. Both arms are extended above the head and moved laterally in the direction required. | He moves the top of the post in the direction indicated, continuing until the HALT is given. He then ensures that the post is firmly planted and steps clear. |
| 5 | PICK UP. Both arms are extended to the front and raised upwards with the palms of the hands upwards. | He pulls the post out of the ground and waits further signals. |
| 6 | COME IN. The body is turned in the direction required. Both arms extended above the head and lowered in the direction required. | When at the far post, he doubles to the near post; when at the near post, he doubles back to his position in action. |

Figure 2-2 Signals Used When Planting Aiming Posts

50. The GPO shall order the C of A to be recorded by ordering RECORD AT _____, COLLIMATOR AND TROOP PICKET.

51. To reduce the possibility of confusion, howitzers may alternate the arrangement of lights on their posts, eg, NUMBERS ONE, THREE AND FIVE FAR POST RED, NEAR POST GREEN; NUMBERS TWO, FOUR AND SIX FAR POST GREEN, NEAR POST RED.

52. The light on the far post should be adjusted to appear above the light on the near post. To accomplish this, it may be necessary to remove the top section of the near post.

53. **Drill.** On the order RECORD AT _____:

- a. 4 obtains the aiming posts and proceeds to a point 50 metres to the front/rear of the howitzer as directed by 1. He plants the first aiming post, fits the appropriate light, red or green, and turns the light so that it is facing the howitzer.
- b. 1 ensures that the gunners' aid counter is at 0, and the panoramic telescope light is ON. He sets the bearing C of A on the shooting scale and turns the setting knob to M.
- c. 3 aligns the graticule of the panoramic telescope with the light on the first post and, as a signal to 4, momentarily turns the panoramic telescope light OFF.
- d. On this signal, 4 turns the light through 3200 mils and proceeds a further distance equal to the first interval. He lines up the second post with the light on the near post and the light in the panoramic telescope. He fits the other light, ensures that it is facing the howitzer, and then returns to the near post. He rotates the light on the near post so that it is facing the howitzer.
- e. 1 checks the alignment.
- f. 1 and 3 then complete the drill for recording the C of A.

CHECK BEARING DIRECTOR METHOD

54. The aim of this drill is to ensure that the howitzers are parallel with the director. The drill should be carried out:

- a. as soon as possible after the C of A has been recorded;
- b. as soon as possible after the spades are embedded by firing;
- c. before the beginning of a fire plan;
- d. at least once daily;

- e. at first light following a night occupation; and
- f. when an error in bearing has occurred that cannot otherwise be detected.

55. The drill is carried out with the howitzers laid at the nearest 100 mils to the last bearing ordered.

56. **Drill.** On the order CHECK BEARING, AIMING POINT DIRECTOR, CANCEL CONVERGE, BEARING _____ (to the nearest 100 mils):

- a. 3 sets the gunners' aid counter to 0, sets the bearing ordered on the shooting scale, and then lays the howitzer onto the GAP. 1 checks to ensure that the shooting scale is set to the bearing ordered, that the gunners' aid counter is set to 0 and that the howitzer is laid on the GAP. 3 then turns the panoramic telescope onto the director.
- b. 1 checks the lay, notes the reading on the main scale, and orders READ.
- c. 3 reads aloud the angle on the main scale.
- d. On the order NUMBER ____ from the GPO, 1 reports the reading by calling out NUMBER __, _____. The GPO repeats the angle as reported.
- e. If the repetition is correct, 1 acknowledges. If the repetition is incorrect, 1 reports the angle again.
- f. If the angle reported by 1 is correct, the GPO order NUMBER ____ CORRECT.
- g. If the angle reported by 1 is incorrect -
 - (1) The GPO orders NUMBER __, _____. This new angle will cause the howitzer to be laid on the current bearing of fire.
 - (2) 1 repeats the angle to the GPO. If the repetition is correct, the GPO orders NUMBER __, RECORD AT _____ (current bearing). The drill for recording C of A is then carried out.
- h. At the conclusion of the check, the GPO shall give the necessary orders for relaying the howitzer on the last target or on the FPF task, as applicable.

MEASURING ANGLE OF SIGHT TO A CREST

57. Immediately following the howitzers coming into action, the GPO may need to know the angle of sight from each howitzer to any crest visible from the gun position.

58. **Drill.** On the order, MEASURE ANGLE OF SIGHT TO THE CREST:

- a. 1 assisted by 2 and 3 lays the howitzer on the crest indicated by sighting along the bottom of the bore.
- b. 2 ensures the elevation correction counter is set at 0. 2 crosslevels the elevation quadrant and, by means of the elevation knob, centres the elevation bubble. He reads and reports the elevation.
- c. 1 checks the elevation and reports to the GPO, NUMBER __, ANGLE OF SIGHT to CREST ____.

LOADING

59. The howitzer shall not be loaded without the order LOAD from 1 except when engaging tanks (see Chapter 3).

60. When a charge bag only is to be loaded, 1 shall order CHARGE BAG ONLY LOAD.

CAUTION

Only the M82 primer will be used.

61. **Rules.** 1 shall observe the following rules of fire discipline in deciding when to order LOAD:

a. **Rules Applicable when Impact Fuzes Ordered -**

- (1) **Initially.** A howitzer is initially loaded as soon as a method of adjustment or a method of FFE has been ordered for that howitzer.
- (2) **During Adjustment.** Only those howitzers ordered to adjust fire shall be loaded.
- (3) **Throughout Adjustment.** The adjusting howitzers shall be reloaded on receipt of an elevation or the order LOAD from the GPO.
- (4) Howitzers shall not be loaded sooner than is necessary to maintain the rate of fire ordered. After an order for FFE has been carried out, howitzers shall not be reloaded until a new method of adjustment, a new method of FFE, or the order LOAD is received.

b. **Rules Applicable when Time or CVT Fuzes Ordered -**

- (1) No howitzer shall be initially loaded until a method of adjustment or FFE has been ordered for that howitzer together with a fuze setting.

- (2) Once having been loaded, howitzers shall be reloaded as follows -
 - (a) **During Adjustment.** The adjusting howitzer shall be reloaded immediately after the fuze setting and elevation for each succeeding round is ordered.
 - (b) **During FFE.** The howitzers shall not be reloaded sooner than necessary to maintain the rate of fire ordered.

c. **Rules Applicable when Time Fuzes Ordered -**

- (1) When the order FUZE M564 IMPACT is received, the rules for impact fuzes are followed, with the fuzes being set to 90 seconds.
- (2) When the order FUZE M ____ TIME is given, the rules for time fuzes are followed, with fuzes being set to burst in the air.

62. **Ammunition**

- a. Throughout a fire mission, unless a specific number of rounds has been ordered, six ready rounds shall always be available.
- b. When time fuzes are ordered, they shall be set only on those rounds which are included in the method of adjustment or FFE, as follows -
 - (1) Fuzes are set by 8.
 - (2) 1 shall check the setting of every fuzed round before it is loaded, except when ammunition has been prepared in advance, eg, fire plan. If ammunition has been prepared in advance, 1 must ensure that the projectile is taken from the correct stack.
- c. Except when engaging tanks -
 - (1) 1 shall check every cartridge before it is loaded to ensure that the proper bags are enclosed.
 - (2) 1 shall periodically check the bore for residue and deposit on the chamber walls and order it cleaned when necessary.
- d. 1 is responsible for ensuring that his howitzer is never left loaded while it is hot. If orders are received which will result in a round being left loaded in a hot howitzer, 1 shall report NUMBER _____ LOADED, GUN HOT. A howitzer is considered to be hot when it has fired in excess of three rounds per minute for more than 10 minutes.

- e. As soon as the ammunition is ordered, 5, 6, and 7, and 8 shall prepare the rounds for loading.
- f. Fuzes shall not be set until the method of adjustment or FFE for that howitzer has been ordered.
- g. 8 shall set CVT, TIME, and IMPACT fuzes to the setting ordered.
- h. 7 shall adjust the charge to the charge ordered.
- j. 4 shall load on the order from 1.
- k. If a howitzer is loaded with other than the type of projectile ordered, 1 will report this fact to the GPO, eg NUMBER _____ LOADED, WP. The GPO shall order -
 - (1) NUMBER ___ FIRE,
 - (2) NUMBER ___ UNLOAD,
 - (3) NUMBER ___ FIRE AS FIRST ROUND OF FIRE FOR EFFECT.

63. Drill for Loading with Impact Fuzes

- a. When the ammunition is ordered, 8 shall adjust the charge to the charge ordered and place it in the charge bag door.
- b. 5, 6, and 7 unplug the projectiles and fit the fuzes.
- c. 5 or 6 place the fuzed projectile on the floor to the right of the rammer. Projectiles are not dropped or thrown.
- d. 2 lays the howitzer at a convenient elevation for operation of the rammer.
- e. 4 places the rammer into the loading position and places the projectile on the rammer tray (see Chapter 1, paragraphs 30 and 31).
- f. When 1 orders LOAD, 4 activates the rammer actuator handle.
- g. 4 returns the rammer to the stored position.
- h. 4 shows and reports CHARGE _____ to 1 who orders CORRECT or WRONG. If the charge is wrong, 1 will order CHARGE (the correct charge). The charge will be made up and brought forward.

- j. 4 places the charge in the breech, ensuring that it is placed on the swiss groove with the igniter pad to the rear.
- k. 4 reports STAND CLEAR CLOSING BREECH and raises the cradle cam allowing the breech to close.
- m. 2 and 3 lay the howitzer.
- n. 4 obtains the M82 primer and fits it into the primer chamber.
- p. 4 slides the block assembly to the left to position the firing mechanism over the primer.

NOTE

The firing mechanism lanyard lever must be rotated to the desired firing position before loading.

64. **CVT or Time Fuze Loading Drill.** 1 inspects the fuze and reports CORRECT or WRONG. If the fuze setting is not correct, 1 orders FUZE (the correct fuze setting). The fuze will be set as ordered by 1 and brought forward. 1 orders LOAD and the howitzer is loaded.

UNLOADING

65. When a change in charge or END OF MISSION is ordered after the howitzer has been loaded:

- a. 1 shall order CHARGE BAG ONLY UNLOAD.
- b. If a change in charge was ordered, the charge is made up and 1 shall order CHARGE BAG ONLY LOAD.
- c. If END OF MISSION was ordered, the chamber swab shall be leaned against the breech to indicate that there is a projectile loaded in the bore.
- d. It may be necessary to unload the projectile when, for safety reasons, the howitzer cannot be fired. The howitzer shall be unloaded as detailed in paragraph 67.
- e. A projectile must not be left in the bore when the howitzer is hot (see paragraph 62d).
- f. When a charge bag has been loaded and subsequently withdrawn, the igniter pad shall be examined. If it is dry and serviceable, the charge bag may be loaded again. If it is damp, the charge bag shall be set aside for disposal, as prescribed for defective ammunition.

66. **Drill for Unloading Charge Bag Only**

- a. 1 orders **CHARGE BAG ONLY UNLOAD**.
- b. 2 returns the howitzer to maximum depression.
- c. 4 opens the firing mechanism and gently removes the primer.

WARNING

Care must be taken to ensure that the primer does not strike anything that would cause it to activate.

- d. 4 opens the breech.
- e. 1 receives the charge and examines the igniter for dampness.
- f. The chamber swab is leaned against the breech.

67. **Drill for Unloading the Complete Round**

- a. 1 orders UNLOAD.
- b. 2 returns the howitzer to maximum depression.
- c. 4 removes the primer and opens the breech.
- d. 1 receives the charge and examines the igniter pad for dampness.
- e. 4 places some rags on the swiss groove and closes the breech.
- f. 1 inspects the cleaning and unloading rammer to ensure that it is free from obstructions and thoroughly clean.
- g. 1 assisted by 5 inserts the cleaning and unloading rammer into the muzzle until the head encloses the fuze and contacts the shoulders of the projectile.
- h. 1 and 5 push on the projectile and, if necessary, use short sharp raps of the unloading rammer to dislodge the projectile.
- j. 4 opens the breech and removes the rags. He gently removes the projectile from the chamber and disposes of it as directed by 1.

LAYING

68. During adjustment, the non-adjusting howitzers shall maintain the sights at the current data and the howitzer at maximum depression. This procedure will assist in conserving power. On receipt of an order to join the adjustment or FFE the howitzers shall be loaded, laid, and fired.

69. **Normal Indirect Laying** (see Figure 2-3).

70. **Indirect Laying Using the Gunners Quadrant** (see Figure 2-4).

71. **Indirect Laying, One-man Lay** (see Figure 2-5).

TO MEASURE THE QUADRANT ELEVATION

72. During a fire mission, the need may arise to change to laying by gunners' quadrant. The GPO will order QUADRANT LAYING, REPORT QE. The angle measured will include the correction for index error and the gun correction (see Chapter 5, paragraph 11.). Therefore, 1 must add/subtract the known correction for index error from the measured elevation before reporting it to the GPO.

| Serial | Order | Action |
|--------|----------------------|--|
| 1 | CONVERGE_____. | ③ moves the gunners' aid counter in the required direction and sets the number of mils ordered. |
| 2 | BEARING_____. | ③ sets the bearing ordered on the bearing counter. |
| 3 | GUN CORRECTION_____. | ② sets the gun correction ordered on the gun correction counter and reads back. |
| 4 | ELEVATION_____. | ② sets the elevation ordered on the elevation counter and reads back the setting. He lays for elevation. ③ lays for bearing and when all apparent motion of the howitzer has ceased and reports ON. ② makes final adjustments and reports READY. ① checks and ensures the howitzer is correctly laid. |

Figure 2-3 Sequence of Laying - Normal Indirect Laying

| Serial | Order | Action |
|--------|-----------------------|---|
| 1 | CONVERGE_____. | ③ moves the gunners' aid counter in the required direction and sets the number of mils ordered. |
| 2 | BEARING_____. | ③ sets the bearing on the bearing counter. |
| 3 | QUADRANT LAYING_____. | ① obtains the gunners' quadrant. ② cleans the quadrant seat on the elevation quadrant. |
| 4 | GUN CORRECTION_____. | ① notes the gun correction. |
| 5 | ELEVATION_____. | ① applies the gun correction and correction for index error to the elevation ordered and sets it on the gunners' quadrant. He then hands the quadrant to ② and orders READ. ② reads the setting to ① and hands it back. ① holds the gunners' quadrant on the quadrant seat with the words LINE OF FIRE at the bottom and the arrow pointing towards the muzzle. ②, directed by ①, lays for elevation. ③ lays for bearing and when all apparent motion of the howitzer has ceased, reports ON. |

Figure 2-4 (Sheet 1 of 2) Sequence of Laying - Indirect Laying Using the Gunner's Quadrant

| Serial | Order | Action |
|--------|-------|--|
| | | <p>② makes final adjustments and reports READY.</p> <p>① removes the gunners' quadrant from the quadrant seat.</p> <p>① checks and ensures the howitzer is correctly laid.</p> |

Figure 2-4 (Sheet 2 of 2) Sequence of Laying - Indirect Laying Using the Gunner's Quadrant

| Serial | Order | Action |
|--------|----------------------|---|
| 1 | CONVERGE._____. | ③ moves the gunners' aid counter in the required direction and sets the number of mils ordered. |
| 2 | BEARING_____. | ③ sets the bearing ordered on the bearing counter. |
| 3 | GUN CORRECTION_____. | ③ sets the gun correction ordered on the gun correction counter and reads back the setting. |
| 4 | ELEVATION_____. | <p>③ sets the elevation ordered on the elevation counter and reads back the setting. He then lays for bearing and elevation, the last motion being one of elevation, and reports READY.</p> <p>① checks and ensures the howitzer is correctly laid.</p> |

Figure 2-5 Sequence of Laying - Indirect laying, One-man Lay

73. **Drill.** On the order QUADRANT LAYING REPORT QE:

- a. 2 and 3 lay at the last bearing and elevation ordered.
- b. 1 places the gunners' quadrant on the quadrant seat of the breech ring and centres the bubble by moving the arm and micrometer. He notes the setting, passes the quadrant to 2, and orders READ.
- c. 2 reads and calls out the setting as a check.
- d. 1 adds/subtracts the index error from the reading and reports the resulting angle as NUMBER ____, QE _____.

TO FIRE

74. The howitzer shall not be fired without the order NUMBER _____ FIRE from 1, except when engaging tanks (see Chapter 3) or when the sentry fires the howitzer on an FPF task.

- a. Before ordering FIRE, 1 must be satisfied that his turn to fire has come, that his howitzer is ready, that the detachment is clear of the recoil, and that the trajectory will clear any crest or obstacle such as a tree or camouflage.
- b. The opening round of a fire mission shall not be fired until the GPO has ordered the method of adjustment or FFE.
- c. When AT MY COMMAND is in force, the order to fire must come from the GPO.
- d. AT MY COMMAND remains in force until a new fire mission is ordered or CANCEL AT MY COMMAND is given. When AT MY COMMAND is in force and the order FFE includes more than one round, the order FIRE authorizes all rounds specified to be fired without further orders.
- e. When the executive order to fire must come from the GPO, 1 shall order NUMBER ____, and shall then report ready.

75. After the opening round of a fire mission, and when AT MY COMMAND is not in force, 1 shall order his howitzer fired -

a. **During Adjustment**

- (1) Each elevation is the order for 1 of the adjusting howitzer to fire as soon as his howitzer is ready.

(2) When BATTERY RIGHT/LEFT is ordered, howitzers fire one round in succession from the right or left as ordered. If no interval is ordered, the standard 5-second interval shall be used. This order should be coupled with AT MY COMMAND, to ensure that all howitzers are ready before the order FIRE is given.

b. **At FIFE.** Each howitzer independently fires the number of rounds ordered, 1 ordering FIRE as soon as his howitzer is ready, unless an interval is given.

76. **Interval.** The interval ordered is in seconds, eg, ELEVATION 320, THREE ROUNDS FIRE FOR EFFECT 60 SECONDS. ELEVATION 320, BATTERY RIGHT, 10 SECONDS:

a. At FFE, the interval is the time between the firing of successive rounds by any one howitzer.

b. At BATTERY RIGHT/LEFT, the interval is the time between firing of successive howitzer.

77. **Drill.** To fire:

a. 1 orders NUMBER __, shortly before it is his turn to fire.

b. 2 stands facing inwards.

c. 3 stands facing the front.

d. 4 grasps the lanyard, ensuring that it is firmly attached to the lanyard lever. He positions himself to the left rear of the breech.

e. At the appropriate moment 1 orders FIRE.

f. 4 fires the howitzer by a strong smooth pull of the lanyard. When the howitzer has fired, the breech opens automatically.

g. 2 cools the obturator assembly with a wet sponge after each round.

h. 1 orders 4 to swab the chamber when necessary, usually after every third round fired.

MISFIRES

78. The howitzer is said to have misfired if the firing lanyard has been pulled twice to the rear and the howitzer has twice failed to fire.

79. The misfire drill is designed to disclose the cause of a failure to fire and thus to indicate the correct remedial action. When this remedy is of a temporary nature, 1 shall later carry out a full examination and ensure that the defect is corrected. He shall then report the cause of the failure to the GPO.

80. In the case of defective ammunition, 1 shall place the defective primer or charge bag at a safe distance from the howitzer platform, and at the earliest opportunity shall notify the GPO, who will examine the defective ammunition and have it disposed of in accordance with C-74-050-005/MS-000.

81. Throughout the misfire drill, 1 will ensure that the detachment remains clear of the path of recoil. The detachment and any uncased charge bags must also be clear of line of possible flashback when the breech is opened.

82. When a misfire occurs, a regulation pause, as detailed in paragraph 84, will be observed and the misfire drill carried out. A summary of misfire causes is given in Figure 2-6.

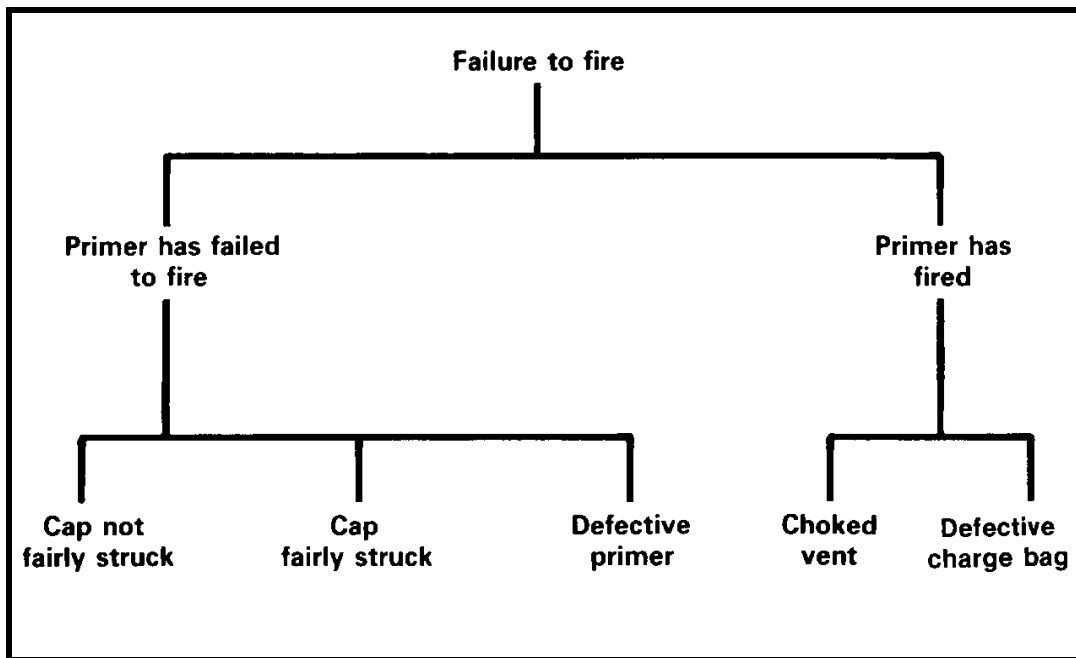


Figure 2-6 Summary of Misfire Causes

83. Failure to fire can be divided into two main classes depending on whether or not the primer has fired:

- a. **If the Primer Has Failed to Fire.** The probable causes are -
 - (1) Cap Not Fairly Struck. This fault may be due to a broken firing pin or insufficient force of blow.

- (2) **Cap Fairly Struck.** This failure is due to a defective primer.
- b. **If the Primer has Fired.** Failure to ignite the charge indicates a defective primer, choked vent, or defective cartridge. The following pause will be observed before opening the breech -
 - (1) **When Not in Action Against the Enemy.** The detachment stands clear and a pause of 30 minutes is observed.
 - (2) **When in Action Against the Enemy.** The pause may be reduced on the order of the GPO.

84. **Drill.** If the howitzer fails to fire:

- a. 4 immediately pulls the firing lanyard a second time. If the howitzer again fails to fire, 1 reports to the GPO NUMBER MISFIRE.

WARNING

1 must ensure that the detachment is kept clear of the recoiling parts. 4 must use extreme caution and expose only the hand and arm when removing the primer.

- b. After a pause of 10 minutes, 1 orders REMOVE THE PRIMER.
- c. 4 removes the primer and hands it to 1.
- d. 1 examines the primer and proceeds as follows -
 - (1) **If the Primer has Not Fired and the Cap is Not Fairly Struck.** 1 orders 4 to remove the M35 firing mechanism. 4 withdraws the firing pin assembly and replaces the firing pin, if necessary. If the firing pin is not broken, 4 replaces the firing pin assembly and fits the spare M35 firing mechanism.
 - (2) **If the Primer has Not Fired and the Cap is Fairly Struck.** 1 orders FRESH PRIMER and 4 fits a fresh primer.
 - (3) **If the Primer has Fired.** 1 orders FRESH PRIMER and 4 fits a fresh primer. If the primer fires a second time but fails to ignite the charge 1 will order STAND CLEAR and wait 30 minutes.
 - (4) 1 places a bucket of water in a convenient position. 4 opens the breech and 1 removes and drowns the char(e) bag. inspects the vent and primer chamber and, if necessary, cleans them using the vent bit and reamer. 1 orders CHARGE BAG ONLY LOAD. The faulty charge bag is placed at a

safe distance from the gun platform. At the earliest opportunity 1 will notify the GPO, who will examine the faulty charge bag and have it disposed of as detailed in C-74-050-005/MS-000.

- f. As soon as his howitzer is ready, 1 reports READY to the GPO or fires without further orders as follows -
 - (1) If gun programs are in use, 1 orders the correct bearing and elevation for the time at which he is ready and continues the program. Rounds detailed for the time that his howitzer was out of action shall not be fired.
 - (2) At all other times 1 reports NUMBER _____ READY, and waits further orders.

RECORDING A TARGET

85. A record may be required from each howitzer that has engaged a target. The record will show the complete details of the final fired data. The GPO orders the target recorded and includes the letters and numbers, eg RECORD AS TARGET ZP 1234.

86. A record is prepared by 1 on a Target Record Form. An example is shown in Figure 2-7. 1 will record the actual setting on the sights, the fuze, and fuze setting and, where applicable, the gunners' quadrant.

87. **Drill.** On the order RECORD AS TARGET:

- a. The detachment commander of each howitzer that has fired during the fire mission inspects the ammunition and sights and completes a target record.
- b. On completion of the target record, 1 calls for reports of the relevant details from 2, 3, 7, and 8 and compares the reported data with his own record, eg REPORTS, NUMBER TWO, etc. After correcting any discrepancy, he sends or reads the target record to the command post.

CHECK FIRING

88. On the order CHECK FIRING, all work on the howitzer is continued. The howitzer is not fired until the order CANCEL CHECK FIRING or orders for a new fire mission are given.

STAND FAST

89. STAND FAST is only used in connection with safety where an accident or injury may result. All action on the gun position shall cease immediately and detachment members will stand motionless,. STAND FAST is cancelled by CANCEL STAND FAST, given only by the originator of the order.

CEASE LOADING

90. Following the order CEASE LOADING, no howitzer shall be loaded until CANCEL CEASE LOADING or orders for a new fire mission are received. The detachment continues with its duties and any howitzer already loaded shall fire at the appropriate moment.

| Target Record (Number 1 to GPO) | | |
|---------------------------------|---|-----------|
| 1 | TARGET LETTERS AND NUMBER | ZP 1234 |
| 2 | NUMBER IN ACTION | 3 |
| 3 | SHELL | HE |
| 4 | FUZE | M557 |
| 5 | PROPELLANT | GREEN BAG |
| 6 | CHARGE | 5 |
| 7 | BEARING (ON SIGHT) | 3316 |
| 8 | CONVERGENCE | DR5 |
| 9 | GUN CORRECTION | + 6 |
| 10 | FUZE SETTING | DELAY |
| 11 | ELEVATION (ON SIGHT OR GUNNERS' QUADRANT) | 442 |
| 12 | INDEX ERROR CORRECTION | — |

Figure 2-7 Example of a Number 1's Target Record

MAKE SAFE

91. The order MAKE SAFE is normally given by 1. This order is also used by the GPO when howitzers are to be laid on their FPF and left loaded.

92. If the howitzer is loaded, 1 must order MAKE SAFE when -

- a. the order REST is given;
- b. personnel are required to work in front of the howitzer or in the path of recoil; or
- c. the GPO so orders.

93. MAKE SAFE is cancelled by CANCEL MAKE SAFE, or orders for a new fire mission.

94. **Drill**

a. 1 orders MAKE SAFE.

b. 4 opens the firing mechanism being careful not to eject the primer violently. He obtains the primer and replaces it in the belt.

REST

95. On the order REST, the detachment remain at their position in action, ready to fire at short notice. 1 does not acknowledge subsequent orders nor does the detachment follow up orders.

96. The howitzer must remain laid as last ordered.

97. **Drill.** On the order REST:

a. 1 orders MAKE SAFE if his howitzer is loaded.

b. 1 gives orders for any necessary work to be carried out around the howitzer and when the work is completed, orders NUMBER _____ REST. The detachment rests at its positions in action .

c. REST is cancelled by CANCEL REST or orders for a new fire mission.

STAND EASY/END OF MISSION

98. When the order STAND EASY or END OF MISSION is given, the detachments concerned are withdrawn from their howitzers to a position previously ordered by the GPO. 1 does not acknowledge subsequent orders pertaining to the current mission.

99. At STAND EASY, 1 shall order any necessary work to be carried out. The howitzer must remain laid at the last data ordered.

100. When laid on an FPF task, it may be necessary to leave the howitzers loaded. In this case, the GPO must order MAKE SAFE before ordering STAND EASY.

101. STAND EASY is cancelled by TAKE POST or orders for a new fire mission.

102. END OF MISSION is cancelled by orders for a new fire mission.

103. **Drill.** On the order STAND EASY or END OF MISSION:

- a. 1 orders CHARGE BAG ONLY UNLOAD, if his howitzer is loaded, and orders any necessary work to be carried out.
- b. When this work has been completed, 1 orders DETACHMENT REAR.
- c. 1 marches the detachment to the position ordered by the GPO and orders FALL OUT.

TAKE POST

104. TAKE POST may be used by the GPO or 1 when the detachment is required to resume its position in action. TAKE POST is cancelled by STAND EASY.

PREPARE TO ADVANCE/WITHDRAW

105. The order PREPARE TO ADVANCE/WITHDRAW is given as a warning that a move is anticipated. 1 shall order ammunition and stores not required for the immediate service of the howitzer to be repacked. Preparations for coming out of action shall be made as far as possible. The howitzers must remain in action until CEASE FIRING is ordered.

106. The propellant repacking drills are as follows:

- a. The fibre cap will be replaced over the igniter pad.
- b. The complete charge, when properly made up, will be inserted into the canister with the igniter pad covered by the fibre cap, facing toward the bottom or closed end of the canister.
- c. The lid will be securely fastened to the canister.
- d. Except when ammunition is to be returned to ammunition supply agencies, primers will not be replaced in the foam plastic packing in which they were originally packed, but will be carried in the cartridge belt or placed securely in the container provided for this purpose.

EMPTY GUNS

107. The order EMPTY GUNS is in itself an order to fire; no additional order is required even if AT MY COMMAND is in force. Omission of this order need only be verified if the howitzer is loaded. On the order EMPTY GUNS, any howitzer already loaded shall be laid at the last bearing and elevation ordered, and shall be fired.

108. As soon as the howitzer is empty, 1 shall report NUMBER _____ EMPTY.

109. Ammunition which has been removed from its containers shall be examined and if serviceable shall be dealt with as follows:

- a. **Time Fuzes.** Time fuzes are set to S (safe) and the pins reinserted. Fuzes are removed from the projectile and placed in the fuze containers.
- b. **Impact Fuzes.** Impact fuzes are set to SQ (superquick) removed from the projectiles and placed in their containers.
- c. **VT Fuzes.** VT fuzes are set to S (safe), if applicable, removed from the projectiles, and placed in their containers.
- d. **Cartridges.** These are made up to full charge and repacked in their containers.
- e. **Plugs and Supplementary Charges.** These are reinserted as applicable in the projectiles.

110. Unserviceable ammunition shall be reported to the GPO. The following ammunition is unserviceable and shall not be fired or replaced in the vehicle under any circumstances:

- a. fuzes which cannot be set to S or SQ; and
- b. projectiles from which VT fuzes cannot be removed.

111. **During Training.** Defective ammunition shall be set aside for examination by an Ammunition Technician.

112. **During Operations.** Defective ammunition shall be dumped and clearly marked.

CEASE FIRING

113. The howitzers must be empty before CEASE FIRING is ordered.

114. **Drill.** When CEASE FIRING is ordered:

- a. 1 orders CEASE FIRING.
- b. 2 stows the sponge, water bucket, and swab. 2 reports CLOSING BREECH, closes it, and secures the lanyard. He ensures all applicable gun stores are secured on the right side and, assisted by 5, closes the right cab door. On the order RELEASE SPADES 2 steps on and unlocks the right spade pedal.
- c. 3 centres the traverse and assists in clamping the howitzer. He places the manual power selector lever in MANUAL and locks the cab traverse lock. He turns the cab power switch to OFF and passes the drivers' remote master panel to 6. Assisted by 4, he closes the left cab door. On the order RELEASE SPADES 3 steps on and unlocks the left spade pedal.

- d. 4 replaces the primers and disassembles the collimator or aiming posts. 4 assisted by 5 cleans off and raises the spades if required.
- e. 5 reels in the communications cable, assists 2 in closing the right cab door, and assists in loading ammunition and stores. He closes the projectile door. 5 assisted by 4 cleans off and raises the spades.
- f. 6 opens the driver's hatch and closes the direct fire dust cover. Assisted by 3, he clamps the howitzer travel lock and replaces the muzzle cover. 6 receives the remote master panel from 3 and places it in the external position, if required.
- g. 1 directs all numbers to assist in packing and stowing ammunition and stores.
- h. 1 ensures his equipment is in all respects ready for movement.
- j. When all preparations are complete, 1 orders MOUNT, closes the rear cab door, and directs his howitzer to the position of assembly.

SNIPING GUN

115. **Introduction.** A special procedure using a single gun is sometimes used to destroy small targets by direct or close indirect fire, eg, pillboxes, road blocks, fortified OPs, or fortified anti-tank guns.

116. Great accuracy is required. This implies that:

- a. a large calibre gun firing at a high charge is preferable;
- b. the gun, preferably SP, should be deployed as close to the target as possible since the vertical PE increases rapidly with an increase in range, thereby decreasing accuracy; and
- c. very accurate laying is required. This may be achieved by the use of a gunners' quadrant, thus permitting corrections of one-tenth of a mil for elevation.

117. Deliberate preparations are required for the occupation of the position, engagement of the target, and the withdrawal of the gun.

118. The fire mission is conducted by normal indirect fire Methods due to the danger of the target becoming obscured. The detachment may be accompanied by an officer or NCO for the observation of fire task or an OP party may be detailed for this role. 1 must be prepared to carry out the observation of fire task in the event that an observer is not available.

119. **Preparations for the Task.** When ordered by the artillery commander authorized to order the movement of guns, the GPO/observer and detachment commander shall ensure that they:

- a. know the task, route, and RV;
- b. know the originator of the task;
- c. know with whom to effect liaison on arrival;
- d. have the necessary stores for the completion of the task, ie, binoculars, prismatic compass, GFT or firing tables, the correct type and amount of ammunition, radios or telephones, map, protractor, etc;
- e. have instructions on where to report or whom to contact on completion of the task;
- f. brief the detachment on all aspects of the operation;
- g. deploy and orient the gun;
- h. order the initial sequence of orders to the gun, excluding ADJUSTING FIRE; and
- j. occupy an OP, if required.

120. During the Mission

- a. Corrections to bearing and elevations will be ordered by the observer in mils, following the normal rules for adjustment of fire (ie, correct for line and then bracket for range). Rules for adjustment of fire are detailed in B-GL-306-003/FP-001, Duties of the Battery Commander and Observer, Chapter 2, Section 3, Adjusting Fire.
- b. Adjustment is carried out until a target round is attained.
- c. Fire for effect is ordered with any necessary corrections.
- d. Confirmation is obtained from the originator of the task that the mission has been completed to his satisfaction and the mission is terminated.

121. On Completion of the Task. 1 shall:

- a. withdraw by the selected route;
- b. return to the selected RV; or
- c. carry out any further orders.

122. **Detailed duties of 1.** On arrival at the RV, 1 will:

- a. order 8 to PREPARE FOR ACTION -
 - (1) 3 will set all scales to 0 mil and turn the setting knob to M,
 - (2) ammunition will be prepared and carried in the ammunition storage racks, and
 - (3) charge 7 is the normal charge used in the sniping gun role;
- b. report to the originator of the task to determine -
 - (1) the target location and description,
 - (2) the gun area, and
 - (3) restrictions, if any;
- c. conduct a detailed reconnaissance of the area allotted and select -
 - (1) a suitable gun platform and mark it,
 - (2) the route IN and OUT,
 - (3) a suitable aiming point/GAP (care must be taken to ensure that the aiming point/GAP will not become obscured by the gun or by smoke during firing),
 - (4) the method of orienting the gun (see paragraphs 124. to 128. below),
 - (5) the bearing and range to the target, and
 - (6) a position from which to observe the target (the position should be forward and upwind of the gun);
- d. on completion of the reconnaissance, return to the RV and brief the detachment on the operation;
- e. accompanied by the driver and 3, return to the gun platform and show the driver the IN route, OUT route, and the gun platform;
- f. show 3 the target and aiming point/GAP and brief him on the method of orientation. 1 will return with his driver to the RV leaving 3 at the gun platform to observe the target;

- g. deploy and orient the gun;
- h. order the initial sequence of orders to the detachment, excluding the order ADJUST FIRE;
- j. if no observer is available, occupy the OP and when ready to observe, order ADJUST FIRE, and
- k. complete the task.

123. **Drill**

- a. 1 brings the howitzer into action on the selected platform in the normal manner with the howitzer pointing in the general direction of the target.
- b. 1, by use of the prismatic compass and the bearing previously obtained, directs the howitzer by ordering RIGHT/LEFT until the barrel is laid on the target.
- c. 1 reports ON.
- d. 1 ensures all scales are set to 0 and the setting knob is at M.
- e. 1 turns the head of the panoramic telescope onto the selected GAP by using the azimuth knob.
- f. 3 identifies the GAP by looking through the panoramic telescope.
- g. 1 turns the setting knob to MS.
- h. 8 will assume the duties of 1. All other duties are carried out as per normal.
- j. 1 issues all orders for the fire mission including AT M)(COMMAND prior to taking up the best position to observe the target, correct the fall of shot, and pass orders to the detachment.
- k. 8 reports READY to 1 when the howitzer is loaded and laid.
- m. 1 will order FIRE when he is ready to observe and has received the order READY from 8.

124. The most suitable method of orienting a sniping gun is the reference point (aiming point method). After the gun platform has been marked, 1 takes up a position at or near the gun marker and, using a compass, determines the angle between the target and the reference point. If the reference point is to the left of the target, the angle found is the bearing ordered to the gun.

- EXAMPLE -

- bearing to the target - 5850 mils,
- bearing to the reference point - 3640 mils,
- the bearing ordered to the gun is - 2210 mils.

125. If the reference point is to the right of the target, the angle found is subtracted from 6400 and the result ordered to the gun as a bearing. Example: the angle found between the target and the reference point was 1800 mils; then, 6400 minus 1800 equals 4600 mils. The bearing ordered to the gun would be 4600 mils.

126. If the bearing to the target is determined from the map, then the compass bearing to the reference point must be converted to a grid bearing before proceeding to find the angle between the target and the reference point.

127. The range to the target will be determined from the map and verified by estimation.

128. 1 is not restricted to the aiming point method of orientation.

QUICK ACTION

129. A quick action is a rapid deployment ordered when the battery is not in action and circumstances require a speed of deployment that will not permit normal procedures.

130. **Drill - Pistol Gun.** On the receipt of the order ACTION, FIRE MISSION or by a prearranged signal by the GPO, 1 of the pistol gun will deploy his howitzer in the direction indicated by the GPO.

131. While the howitzer is being put into action, 1 will order 3 to traverse RIGHT/LEFT as directed by the GPO.

132. When the howitzer is on line, the GPO will order ON and RECORD AT , (current bearing of fire rounded to the nearest 100 mils) DEFER SECOND RECORD:

- a. 1 orders ON and 3 ceases traversing.
- b. The GPO shall then issue the necessary orders to fire the howitzer, ie, FIRE MISSION, HE QUICK, GREEN BAG CHARGE , BEARING AS LAID, ELEVATION , PISTOL GUN ADJUST FIRE.
- c. At the same time 3 sets the C of A on the shooting scale.
- d. 1 turns the setting knob to M.

- e. After the howitzer has fired, 1 orders 3 to turn the head of the panoramic telescope onto the director.
- f. 1 checks the lay.
- g. 1 turns the setting knob to MS and reports PISTOL GUN RECORDED.
- h. 1 opens the main scale door, reads the angle, and orders 3 to read.
- j. 3 reads the angle. If correct, 1 reports the angle to the director.
- k. 1 closes the main scale door and awaits further orders.
- m. The remaining howitzers shall receive line from, and use the director as GAP 1.

133. After the mission has terminated, the GPO may elect to develop the gun position. At this time, new angles will be passed and the howitzers recorded as detailed in paragraphs 28. to 40.

OPEN ACTION

134. Open action is a procedure used to engage targets which are visible from the gun position or targets that the battery may encounter while on the move. The GPO may order direct or indirect fire. The highest possible charge will be used.

135. The GPO will act as his own observer.

136. If indirect fire is to be used, the GPO may:

- a. select an unmistakable reference point from which he will measure the angle to the target using either the hand or, if time permits, the prismatic compass; and
- b. give his initial sequence of orders (see Figure 2-8).

137. If a detachment commander has any difficulty in identifying the reference point, he will double to the GPO, who will indicate the reference point and order the bearing to it.

| Serial | GPO's Orders | Action |
|--------|--|---|
| 1 | FIRE MISSION FOUR GUNS (OR NUMBER _____). OPEN ACTION. HE QUICK, CHARGE 7. | Howitzers are brought into action facing in the direction indicated by the GPO. |
| 2 | REFERENCE POINT, CHURCH STEEPLE BEARING 3450. | On the order Reference/Point ① will ensure that the shooting scale and gunners' aid counter are set to zero. ③ sets the bearing ordered on the bearing counter. ① traverses the howitzer onto the reference point. The howitzers are laid using the reference point as a gap. C of A is not recorded. |
| 3 | GUN CORRECTION _____. ELEVATION _____. NUMBER _____ ADJUST FIRE. | Howitzers are laid in the normal manner. |
| 4 | BEARING _____ OR BEARING (RIGHT OR LEFT _____). ELEVATION _____. | Alterations to bearing may be ordered as right or left provided no confusion can arise. |

Figure 2-8 The GPO's initial Sequence of Orders for an Open Action

138. **Drill.** On the order FIRE MISSION _____ OPEN ACTION the howitzers are brought into action in the normal manner:

- a. On the order REFERENCE POINT _____, eg, CHURCH STEEPLE, BEARING 3450, 1 will ensure 3 has set all counters on the panoramic telescope to 0.
- b. 1 turns the setting knob to MS.
- c. 3 sets the bearing to the reference point on the bearing counter.

- d. 1 checks the setting on the bearing counter and traverse the howitzer onto the reference object.
- e. 3 identifies the reference point by looking through the panoramic telescope and accurately lays the howitzer.
- f. 2 through 8 perform their normal duties.
- g. Subsequent bearings may be ordered as BEARING RIGHT or LEFT or as a new bearing.

CHAPTER 3

ANTI-TANK DRILL

CHAPTER 3

ANTI-TANK DRILL

PREPARATION FOR OPENING FIRE

1. In choosing the battery Position, the GPO will have considered its suitability for anti-tank defence and will have sited individual howitzers to achieve the best defence consistent with the need for concealment, ease of control, and the ability to call out the normal field artillery tasks.
2. To ensure an all-round watch for tanks and to provide a rapid means of indicating targets, the GPO shall allot zones of observation to each howitzer.
3. To provide a means of indicating difficult targets, the GPO will normally choose one or two reference objects in each zone and indicate these, together with the name of each reference object and the range to them, to the detachment commanders.
4. The GPO will normally order the maximum range at which fire is to be opened.
5. Each detachment commander shall determine and memorize the ranges to various reference objects and points in his zone of observation. The GPO is responsible for ordering the special states of preparedness, for the general control of fire of the battery including the allotment of targets to howitzers and for giving the executive order to engage the targets.
6. As soon as possible after coming into action, 1 will ensure that his detachment knows the sector for which they are responsible and the reference objects in all sectors, their names, and the ranges for opening fire as ordered by the GPO.
7. **States of Preparedness**
 - a. **General.** When a threat of a tank attack is reported, the GPO shall order PREPARE FOR TANKS or TANK ALERT. When the threat has passed, the normal state shall be restored by ordering CANCEL PREPARE FOR TANKS, or CANCEL TANK ALERT.'
 - b. **Prepare for Tanks**
 - (1) The order PREPARE FOR TANKS means that, a tank attack is considered likely, but not necessarily imminent. The howitzers remain laid on their present task.
 - (2) 1 ensures that all preparations for the normal state have been completed and at least one member of the detachment is keeping a close watch on the zone allotted.

- (3) PREPARE FOR TANKS is cancelled by CANCEL PREPARE FOR TANKS or TANK ALERT.
- (4) Ten rounds of HE QUICK (DELAY) WHITE BAG CHARGE 7 is prepared and kept ready.
- (5) 2 ensures that the proper reticle pattern is seen through the direct fire telescope and that the vertical and horizontal micrometres are set to 4.

c. **Tank Alert**

- (1) The order TANK ALERT means that a tank attack is considered imminent.
- (2) All other tasks on which the howitzers are engaged lapse.
- (3) Howitzers are loaded and traversed onto their allocated sectors.
- (4) Sights are set to 0.
- (5) A close watch is maintained on the allotted sector.

d. **Anti-Tank Action**

- (1) When tanks are seen, the GPO indicates the direction to some or all howitzers by means of the prearranged zones and reference objects.
- (2) Until the GPO orders ENGAGE, 1 shall not order FIRE, but shall issue all other necessary orders and follow up the movement of the tanks with his howitzer.
- (3) When the tanks are identified as hostile and are within effective range, the GPO shall pass control of fire to all or some of the detachment commanders by ordering NUMBER _____ or NUMBER and NUMBER ENGAGE.
- (4) ENGAGE is cancelled by CHECK FIRING.
- (5) TANK ALERT is cancelled by CANCEL TANK ALERT.

APPLICATION OF FIRE

8. **General.** The effective application of fire depends on:

- a. Correct initial order by 1, including a clear indication of the target.

- b. Correct choice of initial range and lead by 1.
- c. Accurate laying by 2 and 3.
- d. Immediate response by 4 to the order FIRE from 3.
- e. Correct observation and accurate corrections by 1.

9. Fire Control

- a. **Initial Orders.** To quicken drill and to ensure that errors or omissions are more readily detected, orders are given by 1 in a standard sequence as follows -
 - (1) **Indication of Target.** This indicates the beginning of a mission, eg, TARGET, HULL-DOWN TANK. Hull-down is used if only the turret is visible.
 - (2) **Range.** This will assist 2 and 3 in locating the target and tells them the sight graticule to use.
 - (3) **Traverse Right/Left.** This order is used to direct the howitzer at the target, eg, TRAVERSE RIGHT/LEFT.
 - (4) **Description.** A description of the target may be necessary if 2 and 3 do not recognize it.
 - (5) **On.** This order tells 2 and 3 that the howitzer is pointed at the target.
 - (6) **Lead.** This tells the lead to be used, eg, RIGHT ONE ZERO.
 - (7) **FIRE.** This tells that he shall order FIRE as soon as the howitzer is laid.
- b. **Initial Range.** 1 orders the estimated range to the target. All ranges are ordered in metres, eg, FOUR HUNDRED or SIX FIVE ZERO. 2 lays the range line ordered by 1 on the centre of the visible mass. Characteristics of the trajectory at difference ranges are shown in Figure 3-1.
- c. **Description of Target.** No description need be given when the target is obvious. When a description is required, it should be brief and the most obvious features should be named first, eg -
 - (1) by the direction of movement, eg, MOVING RIGHT; HEAD ON,
 - (2) by the position or size of the group, eg, CLOSE GROUP; SMALL GROUP, and

- (3) by the position of the tank in a group, eg, FRONT TANK; LAST TANK; SECOND TANK FROM LEFT.
- d. **Initial Lead.** Figure 3-2 shows the correct initial leads for a crossing tank.
- e. **Form of Lead Orders.** All leads are ordered in units, eg, RIGHT 5; LEFT 10. Each lead cancels the previous lead. 3 lays with the panoramic telescope using the graticule corresponding to the lead ordered in the centre of the visible mass. He reports back each lead.

10. **Observations and Corrections**

- a. **Observation of Fire.** Whenever possible, 1 shall observe the path of the projectile to the target and not the fall of shot. Wrong deductions may be made if the projectile is observed before or after passing the target.
- b. **Corrections**
 - (1) The object is to hit with the first round. if the first round misses, either the range or lead must be altered at once with the object of hitting with the second round.
 - (2) Except for a short round, it will seldom be possible to judge the range of a round Which is incorrect for line. 1 should normally ensure that the line is correct before altering the. range.
 - (3) If a round misses widely, a bold correction must be ordered. In all other cases, the rules given in the following subparagraph shall apply.
- c. **Corrections to Lead**
 - (1) If a round misses to the right or left, 1 orders a fresh lead. The alteration required depends on the range and the width of the target presented.
 - (2) The correct alterations in lead for targets between 400 and 600 metres are as follows -
 - (a) for direct or diagonal crossers - 10 mils,
 - (b) for head-on targets - 5 mils, and
 - (c) for hull-down targets - 5 mils.
 - (3) These alterations to lead should be doubled for targets at ranges under 400 metres and halved for targets at ranges over 600 metres.

ANTI-TANK LAYING

11. The duties of 1 are:
 - a. To select the most dangerous target in the direction indicated by the GPO.
 - b. To indicate this target to 2 and 3 by directing the howitzer onto it.
 - c. To give the initial orders for the engagement.
 - d. To take up a position from which the commander's periscope can best be observed or used.
 - e. To order FIRE when -
 - (1) he is ready to observe,
 - (2) the target is within range for opening fire, and
 - (3) the GPO has ordered ENGAGE.
 - f. To observe and if necessary correct the fire of his howitzer. He makes no correction to any round for which 2 and 3 have reported WRONG unless a correction is necessary due to the movement of the target. He does, however, repeat back WRONG.
 - g. To order CHECK FIRING when satisfied that the target has been destroyed or has disappeared. He then selects a fresh target if available and engages it. If the lead and range do not change, 1 gives a description of the new target and orders - CANCEL CHECK FIRING; otherwise he gives a complete set of initial orders.

12. The duties of 2 are:
 - a. To lay for range using the direct fire telescope unless 1 has ordered ONE-MAN LAY. The two-man lay is normal for anti-tank shooting.
 - b. To apply the range by laying the appropriate range line of the direct fire telescope on the centre of the visible mass.
 - c. To ensure that he has recognized the target indicated by 1. If 2 is uncertain, he reports TARGET LOST. He reports ON when laid at the correct range.
 - d. To keep the howitzer laid for range as ordered throughout the mission, except on the order STANDBY from 3, at which time he removes his eye from the eyepiece until the howitzer has fired.

- e. To report WRONG if the howitzer has fired at an incorrect range.
 - f. To report TARGET LOST when he cannot see the target.
13. The duties of 3 are:
- a. To give the order to FIRE when the howitzer is to be fired. He lays for line using the panoramic telescope.
 - b. To lay ahead of the target for line, making allowance for loading when necessary. As the target approaches the correct line, he orders STANDBY and then FIRE at the appropriate moment, provided that -
 - (1) 1 has initially ordered FIRE,
 - (2) 2 has reported ON, and
 - (3) 4 has reported READY.
 - c. To ensure that he has recognized the target indicated by 1. if uncertain, he reports TARGET LOST.
 - d. To repeat all leads ordered by 1.
 - e. To report WRONG if the howitzer has fired when laid incorrectly for line.
 - f. To report TARGET LOST when he cannot see the target.
14. The duties of 4 are:
- a. To load, operate the breech, and fire the howitzer.
 - b. As soon as he has loaded, to grasp the firing lanyard and report READY. He fires on the order FIRE from 3. It is vital that there be no delay between 3's order to fire and the firing of the howitzer.
15. The duties of 5, 6, 7 and 8 are:
- a. 5, 6, 7, and 8 continue to prepare ammunition from the external source if possible.
 - b. If it is not possible because of enemy activity, 5 and 6 prepare ammunition from the cab, and 7 and 8 take cover.

ANTI-TANK DRILL

16. **Preparation.** On the order from the GPO, TANK ALERT, the following drill is carried out:

- a. 1 orders TANK ALERT and the howitzer is traversed to face its sector. 1 orders HE QUICK/DELAY WHITE BAG CHARGE 7, LOAD.
- b. 3 sets the panoramic telescope to 0 and ensures that the gunners' aid is set to 0. He then centres the pitch and cross-level bubbles.
- c. 2 checks the reticle for optimum illumination and checks the level-bubble mirror for convenient viewing.
- d. 4 loads the howitzer, fits the primer, grasps the lanyard, and reports READY.

17. **Engagement.** On the order from the GPO, TANKS _____ SECTOR; or TANKS _____ REAR:

- a. 1 selects his target, estimates the range, and orders TARGET _____, RANGE _____. 2 repeats the range.
- b. 1 directs the howitzer at the target and at the same time orders the description of the target and the lead.
- c. 3 repeats the lead.
- d. 1 orders ON when the howitzer is directed at the target. 2 and 3 identify the target.
- e. 2 lays the range line of the direct fire telescope on the centre of the visible mass and when correctly laid for range reports ON.
- f. 1 takes up his position for observation.
- g. 3 lays the graticule of the panoramic telescope corresponding to the lead ordered on the centre of the visible mass.
- h. On the order from the GPO, ENGAGE, and he is ready, 1 orders FIRE.
- j. 3 orders STANDBY, then FIRE, and at the same time steps clear.
- k. 2 steps clear on the order STANDBY from 3 and resumes laying immediately after the howitzer has fired.
- m. 4 fires on the order FIRE from 3.

- n. 1 observes and orders corrections as required.
- p. 4 reloads as soon as the howitzer is fired and reports READY.
- q. The howitzer is always reloaded without further orders and is fired on 3's order.
- r. If no orders or corrections are given by 1, 2 and 3 continue to fire at the current data.

| Range (m) | Elevation (mils) | Trajectory Characteristics | Firing Data |
|--|--|--|--|
| 100 200 300 | 2 3 5 | For ranges from 0 to 400 m, the trajectory is flat enough to prevent an 8 ft tank from passing under it. A range of 400 m is ideal for opening fire, because fire can be conducted for the maximum time without misses, if deflection is correct. | Start firing with the estimated range at the closest 100 m range line. |
| 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 | 6 8 10 12 13 15 17 18 20 22 24 26 | For ranges from 400 to 1500 m, the trajectory is sufficiently flat to permit direct estimate of range without bracketing the target. If a hit is obtained at the bottom of an 8 ft tank, while firing at the upper range limit, the addition of a 100 m range change will result in a round that will just brush the top of the tank. Range changes will seldom be more than 100 m, and 50 m changes will frequently be sufficient. A range of 1500 m is the maximum range at which a tank should be fired on, unless tactical conditions require otherwise. | <ol style="list-style-type: none"> 1. Start firing with the estimated range at the closest 100 m range line. 2. Make range changes with 50 or 100 m increments. 3. Bracket adjustment of the target (overs and shorts) is not required. |

Figure 3-1 (Sheet 1 of 2) Trajectory Characteristics - HE Projectile Charge 7W

| Range (m) | Elevation (mils) | Trajectory Characteristics | Firing Data |
|------------------|-------------------------|---|---|
| 1600 | 27 | For ranges from 1500 to 2200 m, hits are only reasonably possible. Bracket adjustment of the target is normally required. | <ol style="list-style-type: none"> 1. Start firing with the estimated range at the closest 100 m range line. 2. Adjustment on the target by bracketing (overs and shorts) is required. 3. Surprise effect on the target must not be important. |
| 1700 | 29 | | |
| 1800 | 31 | | |
| 1900 | 33 | | |
| 2000 | 35 | | |
| 2100 | 37 | | |
| 2200 | 39 | | |
| 2300 | 41 | | |
| 2400 | 43 | | |
| 2500 | 45 | | |
| 2600 | 47 | | |
| 2700 | 50 | | |
| 2800 | 52 | | |
| 2900 | 54 | | |
| 3000 | 56 | | |

Figure 3-1 (Sheet 2 of 2) Trajectory Characteristics - HE Projectile Charge 7W

| Lateral Speed of Target (kph) | Lead (mils) |
|--|--------------------|
| 15 | 10 |
| 30 | 20 |
| 50 | 30 |
| NOTES | |
| <ol style="list-style-type: none"> 1. For a target crossing diagonally, half the lead is ordered. 2. For stationary or head-on target the lead is 0 except a small lead may sometimes be required to allow for wind. | |

Figure 3-2 Initial Leads for a Crossing Target

CHAPTER 4

LAYING

CHAPTER 4

LAYING

PANORAMIC TELESCOPE

1. **Counters.** The panoramic telescope has two horizontal counters:
 - a. **Main Scale**
 - (1) The main scale indicates the clockwise angle between the bearing at which the howitzer is laid and the line at which the telescope is laid.
 - (2) This scale is used to lay in the original bearing, to record the angles to aiming points, and to check the bearing at which the howitzer is currently laid.
 - (3) To ensure that this scale indicates true horizontal angles during these important operations, the cross-level and pitch-level bubbles of the telescope mount must be in the centre of their run. With these conditions satisfied, the setting of the elevation counter is immaterial.
 - b. **Shooting Scale**
 - (1) The shooting scale, when oriented on an aiming point, provides a means of laying the howitzer at any desired bearing.
 - (2) This scale indicates the bearing at which the howitzer is laid.
2. **Position the Shooting Scale**
 - a. This is an operation which is performed only by 1. The object is to ensure that the shooting scale reads the bearing at which the howitzer is laid when the telescope is laid on the aiming point.
 - b. With the howitzer laid at the correct bearing, 1 ensures the setting knob is at MS, turns the azimuth knob until the shooting scale reads the bearing ordered, then turns the setting knob to M.
3. **Setting the Shooting Scale**
 - a. This is the operation by which all bearings are set on the sights during a mission. When 3 relays on the aiming point, the howitzer is laid on the bearing at which the sight is set.

- b. 3 turns the azimuth knob until the ordered bearing is visible in the shooting scale window.

4. **Gunners' Aid Counter**

- a. The gunners' aid counter has two small circular windows, one labelled R for right, the other L for left.
- b. 3 sets the convergence ordered by turning the knob on the gunners' aid counter until the convergence ordered is displayed in the appropriate window.
- c. The gunners' aid counter must be set to zero on laying and recording the C of A and in anti-tank shooting.
- d. By setting a convergence on the gunners' aid counter, it will be automatically applied to each bearing set on the panoramic telescope.

5. **Reticle Pattern.** The reticle pattern of the panoramic telescope is scribed with a centred vertical and horizontal line. The horizontal line is scribed left and right of the vertical line from 0 to 80 mils, graduated every 5 mils and numbered every 10 mils.

6. **Setting Knob.** The setting knob locks the shooting scale and the main scale together. When set to MS, both the shooting scale and the main scale operate. When set to M, only the main scale operates; the shooting scale remains stationary.

7. **Azimuth Knob.** The azimuth knob is used to set angles and bearings on both the main scale and the shooting scale.

8. **Direct Fire Telescope.** The direct fire telescope contains one reticle pattern, with a facsimile for a second pattern for different combinations of ammunition. The pattern desired can be selected by moving the reticle lever arm. The proper ammunition is identified in the field of view of the telescope. The telescope eyepiece can be positioned at a convenient angle for viewing. Safety release levers prevent damage if the arm is up and the barrel is depressed.

SIGHT SETTING

9. In order to avoid errors, the following action must be taken:
 - a. bubbles must be centred exactly; and
 - b. bubbles must be checked for cross and pitch-level after traversing or elevating.

Drill

10. To set the angle to an aiming point (ensure the gunners' aid is set to 0):
 - a. On the order AIMING POINT or AIMING POINT DIRECTOR, 3 opens the main scale door and ensures the cross and pitch-level bubbles are level.
 - b. 3 rotates the azimuth knob (set at INDIRECT) until an angle ordered is visible in the window.

NOTE

A direct-indirect knob is part of the azimuth knob. At DIRECT an audible click will indicate a 5 mil movement. At INDIRECT, the azimuth knob rotates freely.

- c. 3 sights through the telescope and traverses the cab until the sight is laid on the aiming point. 3 rotates the telescope elevation knob as required to centre the image.
- d. 3 centres the cross and pitch-level bubbles.
- e. 3 repeats the steps in subparagraphs c. and d. as required, until the telescope is exactly on the aiming point and the bubbles are level.
- f. The howitzer is now laid in the C of A.
- g. 3 closes the main scale door.

SETTING A BEARING

11. On the order BEARING:
 - a. 3 turns the azimuth knob until the bearing ordered appears on the shooting scale, ensuring the setting knob is at MS.
 - b. 3 traverses onto the GAP, levels the cross and pitch-level bubbles, and then traverses accurately onto the GAP and reports ON.
 - c. On the order CONVERGE, 3 turns the knob on the gunners' aid until the convergence ordered appears in the appropriate counter window.
 - d. On the order BEARING RIGHT or BEARING LEFT, 3 counts the number of mils ordered by moving the azimuth knob in the appropriate direction.

SETTING A GUN CORRECTION

12. On the order GUN CORRECTION, 2 turns the correction knob until the ordered correction appears in the appropriate correction window and reads back GUN CORRECTION _____.

SETTING AN ALTERATION TO A GUN CORRECTION

13. On the order GUN CORRECTION, RAISE/LOWER _____, 2 counts the number of mils ordered by turning the correction knob and reads back the new gun correction.

SETTING AN ELEVATION

14. On the order ELEVATION, 2 turns the elevation knob until the ordered elevation appears in the elevation counter window. He reads back the elevation.

SETTING AN ALTERATION TO AN ELEVATION

15. On the order ELEVATION, ADD/DROP _____, 2 counts the number of mils by turning the elevation knob and reads back the elevation.

SETTING AN ELEVATION ON THE GUNNERS' QUADRANT

16. When QUADRANT LAYING is ordered, 1 applies the gun correction and the correction for index error to all elevations ordered. 1 sets the quadrant by moving the index arm to the nearest 10 mils below the elevation ordered, then sets the index micrometer to the nearest 0.1 mil (see Chapter 2, paragraphs 74 to 77).

ONE MAN ONE-SIGHT SYSTEM (ELEVATION)

17. This operation is done on the M145 mount:

- a. **Setting a Gun Correction.** On the order GUN CORRECTION, 3 turns the elevation correction knob until the correction is shown in the appropriate elevation correction window and reads back the gun correction.
- b. **Setting an Alteration to a Gun Correction.** On the order GUN CORRECTION, RAISE/LOWER, 3 turns the elevation correction knob to the ordered number of mils and reads back the gun correction.
- c. **Setting an Elevation.** On the order ELEVATION _____, 3 turns the elevation knob until the elevation appears in the elevation counter window and reads back the elevation.

- d. **Setting an Alteration to Elevation.** On the order ELEVATION, ADD/DROP _____, 3 turns the elevation knob and counts the correction. He then reads back the elevation.

CHOICE OF GAPS 1 AND 2

18. 1 is responsible for choosing the GAPS. If a suitable GAP is not available, he will report NUMBER ___ GAP NOT AVAILABLE. The priority for GAPS is detailed in Chapter 5, paragraph 28.

19. The requirements of a good GAP are:

- a. it must be conspicuous and unmistakable,
- b. it must have a definite laying edge, and
- c. its positions must be such that it can be used for all targets within the zone of fire of the howitzer, and that it is not likely to be obscured by the muzzle of the howitzer at high elevation., by the detachment, or by the other howitzers and their detachments.

20. If a distant GAP is to be used as GAP 1, it must meet the requirements of a good GAP and must also be as far distant as possible. Approximately 1500 m is a good distance generally. The most suitable position is to the left front or left rear.

21. GAP 2 must satisfy the requirements of a good GAP and must also be near enough to ensure that it will not be obscured by a change in weather conditions, but not so near that inaccuracies in bearing will result as the howitzer is moved in traverse. Approximately 300 to 600 m is a good distance generally.

POINTS OF AIM

22. At indirect laying, 3 lays the vertical cross-hair of the telescope as follows:

- a. **When Using an Aiming Point.** He lays on the left edge of the aiming point unless otherwise ordered.
- b. **When Using Aiming Post.** He lays on the left edge of the aiming posts, provided they appear in line. Otherwise, he lays in such a manner that the far aiming post appears exactly midway between the near aiming post and the vertical hairline. The horizontal hairline is laid at ground level of the near aiming post (see Figures 4-1 and 4-2).

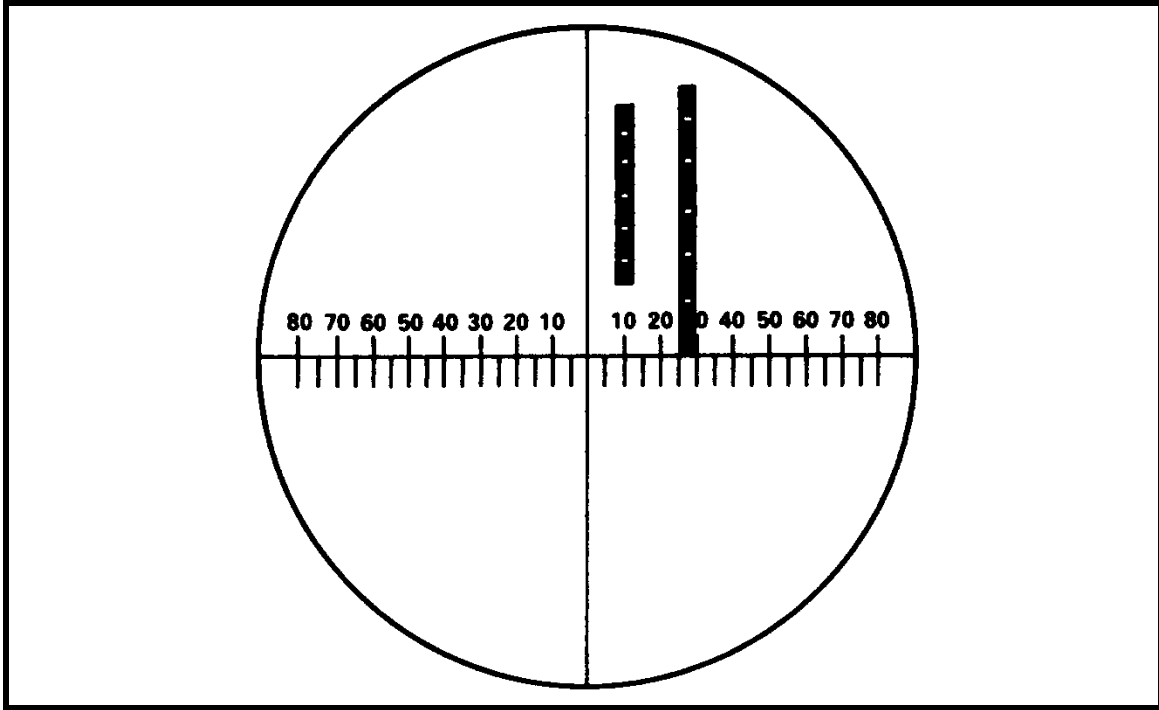


Figure 4-1 Displacement Laying Using Aiming Posts (Left Displacement)

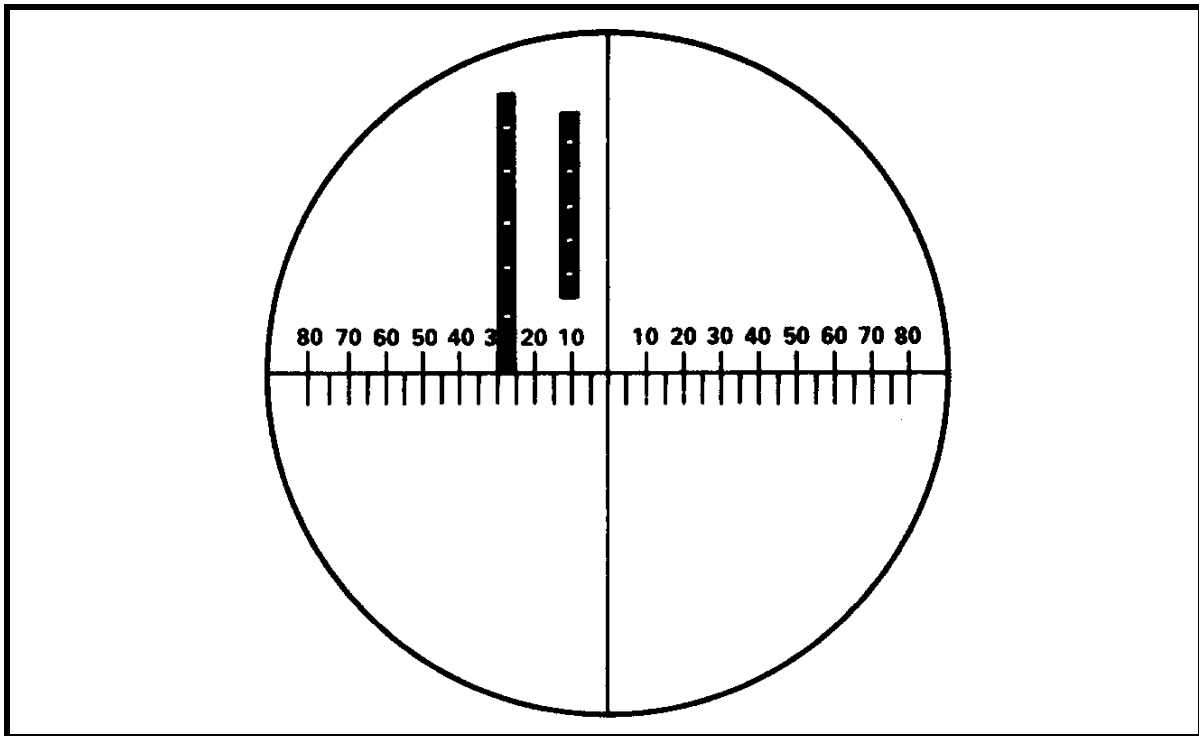


Figure 4-2 Displacement Laying Using Aiming Posts (Right Displacement)

- c. **When Using the Collimator.** The drill when using the collimator is detailed in Annex A.
- d. **Direct Laying.** The point of aim is the centre of visible mass of the target.

SEQUENCE OF LAYING

23. The sequence of laying drill must be rigidly followed. If an incorrect sequence is followed, one adjustment may upset a previous one and result in delay or an incorrect lay.
24. The howitzer is laid for elevation when the elevation correction counter and the elevation counter are correctly set and the cross and elevation level bubbles are centred.
25. The howitzer is laid for bearing when the shooting scale and gunners' aid counters are correctly set, the cross-hairs of the panoramic telescope are laid on the correct point of aim and the cross-level and pitch-level bubbles are centred.
26. Unless the trunnions are accurately levelled, a small adjustment to either bearing or elevation will alter the other. However, a small adjustment to elevation will have less effect on the bearing than a small adjustment for bearing will have on the elevation. Thus, in indirect laying, it is desirable that final adjustments for bearing and elevation be carried out simultaneously, with 3 reporting ON when laid and all apparent motion of the barrel has ceased. 2 may make a further fine adjustment (up to 5 mils) and then report READY. If 2 must make other than a fine adjustment, he must wait for another report of ON from 3 before reporting READY.
27. The following illustrates the sequence of operations as they should be carried out. The sequence is designed for accurate and consistent laying with a minimum of delay:
- a. **Laying for Elevation.** 2 elevates or depresses rapidly until the elevation level bubble is approximately centred. He then centres both bubbles by operating the cross-levelling knob and the elevation control handle.
 - b. **Laying for Bearing.** 3 traverses rapidly until the vertical cross-hair of the panoramic telescope is laid on the aiming point. He then alternately levels the cross and pitch-level bubbles and traverses back on the aiming point until the howitzer is laid for bearing. He should make every effort to keep the bubbles centred during any movement of the barrel by 2. The cross and pitch-level knobs can be adjusted simultaneously.

CHANGING FROM ONE AIMING POINT TO ANOTHER

28. It is sometimes necessary to change from one GAP to another, eg, from GAP 1 to aiming posts, the current aiming point having become obscured.

29. **Drill**

- a. If during a fire mission the current aiming point becomes unusable, 3 reports this fact to 1, GAP OBSCURED.
- b. 1 notes the reading on the gunners' aid counter and on the shooting scale and orders REPORT.
- c. 3 reports the reading on the gunners' aid counter and the shooting scale to 1.
- d. 1 orders 3 change to (new aiming point ie, collimator if GACs was being used).
- e. 3 sets the gunners' aid counter to 0. 1 sets the C of A on the shooting scale and turns the setting knob to M.
- f. 3 sets the angle to the new aiming point on the main scale.
- g. 1 checks the reading and turns the setting knob to MS.
- h. 1 orders the converge and bearing to 3.
- j. 3 sets the converge on the gunners' aid counter and the bearing on the shooting scale.
- k. 1 checks the readings and orders LAY.
- m. 3 traverses the howitzer until the sight is laid on the new aiming point.

RE-POSITIONING THE SHOOTING SCALE

30. If the shooting scale is correctly set, it should not slip. If it does, it can be re-positioned using the drill detailed below.

31. **Drill.** To re-position the shooting scale (using the collimator as an example):

- a. 1 orders, C of A.
- b. 3 sets the gunners' aid to 0 and sets the bearing C of A on the shooting scale.
- c. 1 turns the setting knob to M, sets the recorded angle to GAP 1 (collimator) onto the main scale, and then turns the setting knob to MS.
- d. 1 obtains the current convergence and bearing from the GPO or from the nearest howitzer.
- e. 1 orders, CONVERGE _____ BEARING _____.

- f. 3 sets the gunners' aid counter and shooting scale then relays on the collimator.

COMPLETING A DEFERRED C OF A RECORD

32. If DEFER SECOND RECORD is ordered, or if a fire mission is ordered during the recording of the C of A, 1 will report NUMBER ___ RECORDED as soon as the record of the first aiming point has been completed.

33. A record of the reading to GAP 2 must be completed without further orders, at the first opportunity, eg, as soon as END OF MISSION is ordered.

34. Before beginning this drill, 1 must note the bearing at which the howitzer is laid. On completion of the drill, 1 will order his howitzer laid on the last ordered data.

35. Drill

- a. 1 records the current reading on the shooting scale and on the gunners' aid counter, and then orders REPORT.
- b. 3 reports the reading on the shooting scale and gunners' aid counter.
- c. 1 checks the reported readings against his recorded data and having corrected any discrepancy, orders C of A.
- d. 3 sets the gunners' aid counter to 0 and the shooting scale to the C of A, and lays on GAP 1.
- e. 1 checks that the main scale reading agrees with the reading to GAP 1 as recorded on the record plate. -
- f. The drill for recording GAP 2 is then carried out in the normal manner.
- g. 1 then orders the howitzer to be laid at the last ordered data.
- h. 3 sets the shooting scale and the gunners' aid counter and relays on GAP 1.

PASSING PARALLEL LINE

36. Passing parallel lines from one howitzer to another is used when howitzer cannot be seen from the director or vice versa. The drill involves passing an angle from a howitzer that has been laid in the C of A, to a howitzer which could not observe or be observed from the director.

37. The GPO will order a recorded howitzer to pass parallel line to a designated howitzer, eg, NUMBER TWO, PASS PARALLEL LINE TO NUMBER THREE.

38. **Drill.** The detachment commander of both howitzers acknowledge the order and proceed as follows:

a. **Recorded Howitzer**

- (1) 1 records the readings on the shooting scale and on the gunners' aid counter, and then orders REPORT.
- (2) 3 reports the readings on the shooting scale and gunners' aid counter.
- (3) 1 checks the reported readings against his recorded data and, having corrected any discrepancy, orders C of A.
- (4) 3 sets the gunners' aid counter to 0 and the shooting scale to the C of A, and then lays on GAP 1.
- (5) 1 checks the lay and ensures that:
 - (a) the gunners' aid counter is set to 0;
 - (b) the shooting scale is set to the bearing C of A;
 - (c) the panoramic telescope is laid on the GAP in use; and
 - (d) the cross-level and pitch-level bubbles are levelled.
- (6) 1 orders 3 to lay on the centre of the panoramic telescope of the receiving howitzer by rotating the head of his sight.
- (7) 1 checks the lay, opens the index door of the panoramic telescope, reads the angle, and orders 3 to READ.
- (8) 3 reads the angle on the main scale; if correct, 1 reports this angle to the GPO who adds or subtracts 3200 mils and passes the resulting angle to the receiving howitzer, eg, THREE, LAY ON NUMBER TWO AT _____.

b. **Receiving Howitzer**

- (1) 1 repeats the angle to the GPO. If correct, 1 orders LAY ON NUMBER _____ at ____.
- (2) 3 sets the angle on the main scale.
- (3) 1 checks the setting and orders LAY.

- (4) 3 reports TRAVERSING, lays accurately on the panoramic telescope of the recorded howitzer, and levels his bubbles.
- (5) 1 checks the lay and reports FINISHED WITH SIGHT.
- (6) The GPO shall order RECORD AT _____, (C of A).
- (7) 1 and 3 complete the drill for recording C of A.
- (8) When 1 of the recorded howitzer has received the order FINISHED WITH SIGHT from the GPO, he orders his howitzer laid at the recorded data.

CHAPTER 5

SIGHT TESTING

CHAPTER 5

SIGHT TESTING

INTRODUCTION

1. **Object.** The object of sight testing is to ensure that the sights are maintained in direct and precise relation to the bore.
2. **Checking.** After an adjustment has been made as the result of any test, the test will be repeated to verify that the adjustment has been accurately made.
3. **Training.** During training, sight tests will be carried out frequently so that all ranks concerned are practiced in both tests and adjustments.

SIGHT TESTING

4. **General.** The purpose of sight testing is to ensure accuracy in laying for elevation and direction. Sight testing is the process of aligning the sighting and the fire control equipment so that the lines of sight of the telescopes are parallel to the axis of the bore. Sight testing is conducted before firing and, when necessary, during lulls in firing.
5. **Types of Sight Testing.** There are three types of sight testing:
 - a. periodic sight tests;
 - b. bore sight and elevation tests; and
 - c. quick sight and elevation tests.
6. **Periodic Tests.** The GPO is responsible for ordering that these tests be carried out, and 1 is responsible for carrying out the test. Adjustments will be made only by personnel qualified to make them. These are the basic accuracy tests and will be conducted:
 - a. immediately on receipt of a new howitzer;
 - b. once every three months, if the howitzer is being fired;
 - c. once a year if the weapon is being used for dry training only;
 - d. as soon as possible after extensive use, accident, or the crossing of extremely rough terrain; and
 - e. when the howitzer fires inaccurately for no apparent reason.

7. **Bore Sight and Elevation Test.** The object of this test is to check the scales against the bearing and elevation at which the barrel is laid. The GPO is responsible for ordering the test conducted and 1 is responsible for carrying out the test and for ensuring that the appropriate adjustments are made. It is carried out:

- a. when the quick sight test indicates there is an error; and
- b. immediately after a periodic test.

8. **Quick Sight and Elevation Test.** The GPO is responsible for ordering the test and 1 for ensuring that the test is carried out as detailed. The purpose of the test is to disclose any gross error in bearing and/or elevation. It is carried out:

- a. daily when firing;
- b. on the order PREPARE FOR ACTION;
- c. as soon as possible after the C of A is recorded;
- d. after each change of position;
- e. during any pause in prolonged firing;
- f. immediately before a deliberate fire plan; and
- g. when an error cannot otherwise be discovered.

PREPARATION FOR SIGHT TESTS

9. Before carrying out the periodic or the bore sight and elevation test, the howitzer must be approximately in the centre of traverse. Also, the trunnions will be levelled and the correction for index error in the gunners' quadrant will be determined.

TO TEST THE GUNNERS' QUADRANT

10. **Object.** The object of testing the gunners' quadrant is to determine the correction for index error.

11. Procedure

- a. Set both the index arm and micrometer scale of gunners' quadrant to zero.
- b. Place the quadrant on the breech levelling plates, the Line Of Fire arrow pointing toward the muzzle. Centre the bubble by manually operating the elevating hand-wheel.

- c. Turn the quadrant end for end and replace it on the levelling plates. The bubble should remain central.
- d. If it is not, centre the bubble by means of the quadrant micrometer knob (setting the index arm to read - 10 mils, if necessary) and read the setting.
- e. Half of the reading (subtracted from 10 if the index arm is set to - 10 mils) is the correction for index error. It is plus if the index arm is set to 0 and minus if set to - 10 mils.
- f. The correction for index error will be recorded and must be applied with its correct sign to all elevations when laying by the 3 gunners' quadrant.
- g. For elevations greater than 800 mils the quadrant is reversed, therefore, a plus correction must be subtracted; a minus correction added.

TO LEVEL THE TRUNNIONS

12. **Plumb-Line Method.** Three 10-ton jacks are required. One jack is placed under the front chassis so that the carriage will tilt evenly when raised with either of the rear jacks. Fasten cross-hairs to the muzzle witness marks and insert the breech bore-sight disc. Suspend a plumb-line approximately 6.5 m (22 ft) long, 30 cm (12 in.) in front of the muzzle. Level the trunnions by means of a tested gunners' quadrant using the breech cross-levelling seats. At the same time, ensure the muzzle cross-hairs are coincident with the plumb-line. Elevate the howitzer manually ensuring that the vertical hairline and plumb-line remain coincident. If the hairline fails to track the plumb-line, adjust by means of one of the rear jacks. Verify that the trunnions are level by elevating and depressing until the vertical hairline tracks the plumb-line.

13. **Scribe-Line Method.** Provided the M15 mount has been scribed using the plumb-line method, the trunnions can be levelled fairly accurately by:

- a. setting the elevation and correction counters to 0 mils;
- b. manually elevating or depressing until the elevation bubble is centred;
- c. matching the scribe marks; and
- d. traversing the barrel manually, carefully watching the cross-level bubble. Somewhere in the traverse the bubble will centre. Then the trunnions are level.

14. The periodic tests detailed below can now be conducted.

PERIODIC TESTS

15. The periodic test will be performed using this manual. It need not be memorized.
16. If the maximum allowable error is exceeded during any of the tests, the equipment will be adjusted by a weapons technician.
17. The tests will be performed in the sequence listed below.
18. **Preparation**
 - a. Establish the index error for the gunners' quadrant as per paragraphs 10 and 11.
 - b. Level the trunnions as described in paragraphs 12. to 14.
19. **To Test the Telescope Mount**
 - a. Level the telescope mount by centring both the elevation and cross-level bubbles.
 - b. Place the cross-hairs of the panoramic telescope on any sharply defined aiming point and note the reading on the bearing counter.
 - c. Elevate the barrel by tracking the plumb-line. Re-level the telescope mount in both directions and check for deviations of the line of sight from the aiming point.
 - d. If the vertical hairline is off the aiming point, it is aligned on the aiming point with the azimuth knob. The total allowance deviation is ∇ 0.5 mil.
 - e. If the horizontal hairline is off the aiming point, it is aligned on the aiming point with the elevation knob and the bubble displacement noted. The total allowable error is one-half a dial graduation.
20. **To Test the M15 Elevation Quadrant**
 - a. Set the elevation and correction counters to 0.
 - b. Level the elevation bubbles by manually elevating or depressing the barrel; level the cross-level bubble.
 - c. Set the elevation counter to 600 mils and manually elevate the barrel, track the plumb-fine, and level the bubble.
 - d. The cross-level bubble should remain within one vial graduation of centre.
 - e. Accurately cross-level.

- f. Set the elevation counter to 0 and manually depress the barrel until the bubble is centred, again tracking the plumb-fine.
- g. Check the cross-level bubble; it should remain within one vial graduation of centre.

21. **To Scribe the M15 Mount**

- a. At this point the mount should be scribed.
- b. Using a sharp-bladed knife and a straight edge, cut -
 - (1) a line from the range quadrant mounting bracket to the front side of the quadrant, and
 - (2) a line from the cross-level knob to the side of the quadrant.

22. **To Test the Panoramic Telescope**

- a. Set the main scale dial at 6400 mils.
- b. Traverse and elevate the barrel as necessary to place the panoramic telescope reticle cross-hairs on an aiming point.
- c. Rotate the telescope head through 6400 mils. The cross-hairs should return to within ∇ 1 mil of the aiming point.

23. **Adjustment.** If an error is discovered that exceeds the tolerances as stated in paragraphs 19d and e, 20d. and g, and 22c, then adjustments will be made by a qualified weapons technician.

24. **To Determine the Standard Angle**

- a. On completion of a periodic test and before disturbing the level of the trunnions, the standard angle will be determined.
- b. Set 300 mils on the gunners' quadrant.
- c. Cant the M145 telescope mount to the left until the mechanical stops are met.
- d. Elevate the barrel until the gunners' quadrant is level.
- e. Using the pitch-level knob, level the pitch bubble on the M145 mount.
- f. Using the azimuth and elevation knob, lay the cross-hairs of the reticle pattern on the side and top of the muzzle brake (see Figure 5-1).

- g. Note the reading on the main scale. This is the standard angle which will be recorded below the record plate.
- h. Repeat the test to verify the value.

BORE SIGHT AND ELEVATION TEST

25. **Methods of Sight Testing.** There are three methods of sight testing. They are the:

- a. testing target method;

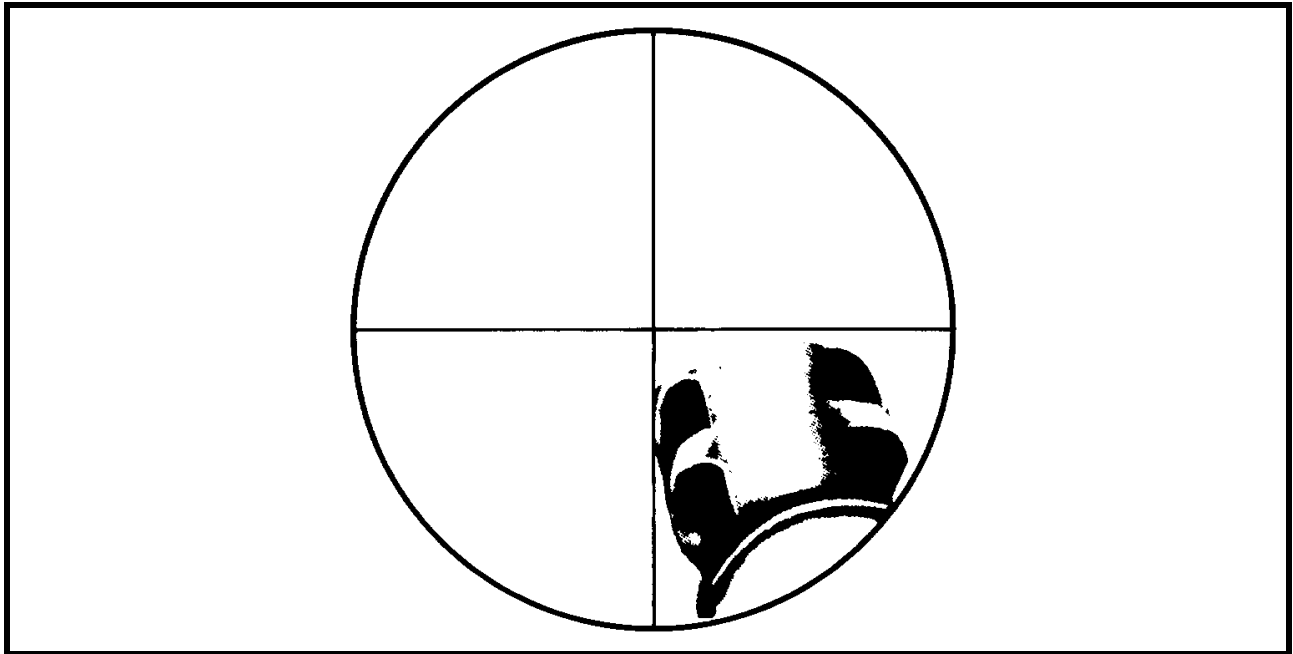


Figure 5-1 Quick Sight Lay

- b. distant aiming point method; and
 - c. collimator method.
26. **Preparation for Sight Tests**
- a. Regardless of the method used, the weapon should be approximately in the centre of traverse and pointed in the general direction of the distant aiming point or testing target.
 - b. To sight test using the target testing method level the howitzer using the scribe-line method (paragraph 13.). For sight testing using a distant aiming point the trunnions should be as level as possible; however, they need not be accurately levelled.

- c. The bore sighting equipment is fixed by -
- (1) securing cross-hairs over the witness marks on the muzzle end of the barrel,
 - (2) opening the breech and placing the breech boresight disc forward in the chamber, or
 - (3) placing the firing mechanism in the open position and relating the breech block sufficiently with the breech operating handle so that the handle is clear of the quadrant seats on top of the breech ring. The breech block remains in the closed position and sighting is done through the open vent tube. Binoculars may be used for alignment but parallax must be avoided.

27. **Testing Target Method.** To sight test using the testing target method, level the vehicle as accurately as possible. Fit the boresight equipment by fixing threads to the muzzle witness marks, open the firing mechanism, and proceed as follows:

- a. Using the gunners' quadrant and applying any correction determined by the gunners' quadrant test plus the reading stamped on the howitzer breech ring, set the barrel at 0 mil elevation.
- b. Turn all numerical counters and correction counters to 0 on both the panoramic telescope sight mount M145 and the elevation quadrant M15 and cross-level the bubbles. The longitudinal bubbles should now be centred within ∇ 0.5 mil. If they are not, the mount should be referred to a weapons technician.
- c. Place the panoramic telescope in the mount and -
 - (1) check the gunners' aid counter to ensure that it has been set at 0 and adjust the azimuth counter to read 6400 mils, and
 - (2) centre the pitch-level bubble by rotating the pitch-level knob and centre the cross-level bubble with the cant corrector knob.
- d. Place the testing target (see Annex B) 50 to 100 m in front of the muzzle and position the target so that the bore diagram is aligned in the boresights.
- e. Adjust the panoramic telescope to the testing target as follows -
 - (1) adjust the horizontal line of the panoramic telescope to the testing target by means of the elevation knob on the telescope,
 - (2) adjust the vertical line in the reticle of the panoramic telescope to the testing target diagram by rotating the azimuth knob, and

- (3) the main scale should read 6400 mils. if the main scale does not read 6400 mils, fully depress the boresight adjusting shaft and rotate the shaft until the main scale reads 6400 mils. The weapon is now sight tested for direct fire.

CAUTION

To prevent extensive damage to the panoramic telescope, depress the boresight detent shaft fully before attempting to rotate it.

28. **Distant Aiming Point Method.** A distant aiming point may be used for sight testing if a testing target is unavailable or if the tactical situation makes the use of a testing target impractical. The aiming point selected should be a sharply defined point at least 2000 m from the howitzer and as near the howitzer 0 elevation as possible. All steps prescribed for the testing target method apply in the distant aiming point method, except that the boresights and the optical sights are aligned on the same distant aiming point rather than on displaced points as on the testing target. Accurate levelling of the trunnions is unnecessary when a distant aiming point is used for sight testing.

29. **Collimator Method** (See Annex A)

- a. The collimator may be used to sight test the M109A2/A3 for direction. It should be set up at the same level as the trunnions. The collimator lighting system must be used.
- b. **Drill**
 - (1) Prepare the howitzer for boresight as for the distant aiming point method.
 - (2) Place the collimator approximately 9 m (30 ft) in front of the muzzle, level with the trunnion.
 - (3) Align the zero line of the collimator with the vertical hairline on the muzzle by sighting through the barrel and moving the collimator.
 - (4) Sight on the collimator with the panoramic telescope (do not move the barrel) matching the right side of the reticle numbers in the collimator. The reading on the main scale should read 6400 mils. If not, follow the drill as described in subparagraph 27.e.(3).

30. **Sight Testing the Direct Fire Telescope.** To sight test the direct fire telescope:

- a. centre the cant-level bubble by turning the cant corrector knob;

- b. rotate the azimuth and elevation knobs on the direct fire telescope mount by laying the centre of the N line of the reticle precisely on the right aiming diagram; and
- c. set the telescope mount slip scales to elevation 4 mils and azimuth 4 mils.

NOTE

Do not move the elevation or azimuth knob when setting the slip scales.

31. To test for elevation:
- a. Ensure trunnions have remained level.
 - b. Using the correction stamped on the breech ring plus the correction for index error, lay the barrel at 0 mil elevation using the gunners' quadrant.
 - c. Ensure that the M15 and M145 mounts are accurately cross-levelled.
 - d. Set the correction counters to 0 mil on both mounts.
 - e. Set 0 mil on the gunners' quadrant (include the correction for index error only) and place it on the quadrant seats of the M15 and M145 mount. Level the bubble of the gunners' quadrant using the micrometer. The tolerance is ∇ 1 mil.
 - f. Level the elevation level vial using the elevation knob. The elevation counter should read 0 mil ∇ 1 mil.
 - g. Repeat the test at 300 mils and 700 mils elevation. The tolerance is ∇ 1 mil.

NOTE

If mounts M15 and M145 exceed the tolerances, inform the weapons technician. If the howitzer must be fired, it will be laid for elevation using the gunners' quadrant.

QUICK SIGHT AND ELEVATION TESTS

32. **General.** A quick sight test is used with all artillery equipment as an aid in ensuring no gross error exists in the sighting and elevation mechanism.
33. **Drill.** On the order QUICK SIGHT TEST, ELEVATION :300:
- a. 1 will obtain the gunners' quadrant and note the recorded index error if any.

- b. 1 will set the gunners' quadrant at 300 mils, apply the index error, pass the quadrant to 2, and order READ.
- c. On the report of correct from 1, 2 will place the gunners' quadrant on the quadrant seat of the M 1 5 mount and ensure that no gun correction is set on the elevation quadrant.
- d. 2 elevates and levels the bubble in the gunners' quadrant.
- e. 2 rotates the elevation knob until the bubble is level. He operates the cross-level knob and centres the cross-level bubble. 2 checks that the lay is correct and reports to 1.
- f. 1 checks the lay and ensures that the reading on the elevation counter dial is 300 mils ∇ 1 mil.
- g. While 2 is carrying out his duties, and when the barrel is at 300 mils, 3 will ensure no correction is set on the gunners' aid counter.
- h. 3, using the cross-level knob, will cant the panoramic telescope and mount M145 to the left until the mechanical stops are met.
- j. 3, using the pitch-level knob, will centre the pitch-level bubble.
- k. 3, using the azimuth and elevation knobs, will lay the cross-hairs of the reticle pattern on the side and on top of the muzzle brake and report LAID to 1 (see Figure 5-1).
- m. 1 will check 3's lay and by reading the M scale, compare the reading with the standard angle. The angles should agree to within ∇ 2 mils.
- n. 1, when satisfied that the quick sight and elevation test is complete, will report to the GPO NUMBER __, QUICK SIGHT TEST COMPLETE AND FOUND CORRECT, or report the nature of the error found.

NOTE

If, as a result of the quick sight and elevation test, an error in bearing and/or elevation is detected, the boresight and elevation test will be conducted to establish the cause and the necessary adjustments to be made as a result of the error.

CHAPTER 6

ZEROING

CHAPTER 6

ZEROING

GENERAL

1. **Object.** The object of zeroing is to ensure that the mean point of impact for elevation/range coincides with the point of aim at the range at which zeroing is carried out.
2. **Frequency.** Zeroing should be carried out at least every 500 EFCs, after any adjustment to the telescope mount M145, or whenever the sights become suspect.
3. **Ammunition.** Ammunition to be used for zeroing is projectile M107 with M4A2 propellant at charge 7.
4. **Information.** In nearly every case, it will be noted that on firing its initial zeroing round, each howitzer will miss the zeroing target despite its having had an accurate boresight and elevation test completed. This is due to the individual nature of each mount and the fitting of each direct-fire telescope within the mount. In order to effectively use the direct-fire telescope, 1 must determine his howitzer's individual shooting correction for both bearing and range. The result of this will allow 1 to engage targets in the direct role using the normal two-man lay and if the panoramic telescope is damaged, he can still engage using the direct-fire telescope for bearing and range.

PREPARATIONS

5. **M109A2/A3.** Prior to zeroing, the howitzer must have a boresight and elevation test completed using the testing target as described in Annex B. The drill detailed in Chapter 5, paragraphs 25. to 31. will be followed. If possible, this test should be completed on the firing platform. 1 must ensure that the direct-fire telescope is securely locked in place and that the applicable reticle is used.
6. **Targets.** The zeroing target should be approximately 2.74 m (9 ft) square, made of painted black hession, and mounted on a wooden frame. Each target should have a white cross painted to extend to the edges of the target. This cross should be at least 20 cm (8 in.) wide. The targets must be erected at a precisely measured distance from the gun platform.
7. **Ranges.** The optimum ranges for zeroing are 500, 600, and 700 m, respectively, but due to non-operational conditions, zeroing must be conducted at 1000 m to satisfy current safety restrictions. The number of targets erected should exceed the number of howitzers being zeroed. The bottoms of the targets should be raised clear of the ground and ideally, the altitude of the howitzer and target should be the same.
8. **Observation.** It will assist 1 if some independent means of observation is established on a flank or to the rear. An aiming circle or battery commander's telescope will simplify:

- a. correcting rounds onto the target;
- b. verifying target rounds; and
- c. assisting in determining the mean point of impact.

Drill

9. 1 satisfies himself that the conditions specified in paragraph 5. have been fully met.
10. 1 orders LOAD.
11. 3 sets the gunners' aid counter to 0, the MS scale to 0, and levels the bubbles.
12. 3 lays the central cross-hair of the panoramic telescope on the centre of the vertical line of the zeroing target.
13. 2 lays the appropriate range line of the direct-fire telescope on the horizontal line of the zeroing target.
14. 2 levels his bubbles (see Note 1).
15. 2 and 3 report ON and SET respectively.
16. 1 checks the lay.
17. 4 fits a primer and reports READY.
18. 1 ensures the observers are in position and, when ready, orders FIRE.
19. 1 acting on the reports of the observers, adjusts his range by elevating or depressing until a mean point of impact of three rounds has been established on the zeroing target (see Note 2).

NOTA

1. At this point it may be noticed that the vertical centre line of the direct-fire telescope does not lay on the centre of the zeroing target.
2. No adjustment for line should be necessary but, if a line correction is required, 1 must suspect the accuracy of his boresight and elevation test.

20. Having established the mean point of impact, 1 will adjust the vertical and horizontal micrometers of the direct-fire telescope mount until the correct range and vertical line of the direct-line telescope are laid on the mean point of impact. In doing so, 1 will alter the micrometer reading from the original micrometer setting of 4.

21. 1 will record the differences for line and elevation. These differences are his shooting corrections.

22. 1 will fire a check round to ensure no inadvertent movement of the sights has occurred.

SUBSEQUENT APPLICATION

23. Having completed a boresight and elevation test, 1 need only apply his shooting corrections to ensure accurate direct fire.

24. The shooting corrections will remain accurate only as long as all conditions remain the same. For this reason, frequency of zeroing is essential.

25. To avoid confusion and multiplicity, no scribe-lines should be placed on either the mount or the telescope.

ANNEX A

ANNEX A
INFINITY AIMING REFERENCE

INFINITY AIMING REFERENCE

COLLIMATOR M1

1. The collimator is an optical instrument used for indirect laying of artillery equipment by establishing an optical reference from which bearings can be measured. It consists of a tripod with telescoping hinged legs, a mount base, and a yoke sub-assembly which houses the bearing and elevation controls. The bearing clamping knob is below the yoke and the elevation clamping knob is at the top of the yoke. The elevation yoke allows the collimator to be adjusted plus or minus 853 mils in the vertical plan (see Figure A-1).

2. The collimator assembly consists of an optical system, a mechanical housing, and a light source. The reticle pattern is a bearing reference scale repeated at vertical intervals, thus forming a grid in the field of view. The reticle pattern is cross-levelled using the cross-level bubble and the collimator locked in the level position by means of the clamping knob. Open sights on the collimator permit alignment between the collimator and the panoramic telescope. The lighting system is powered by the electrical system of the vehicle.

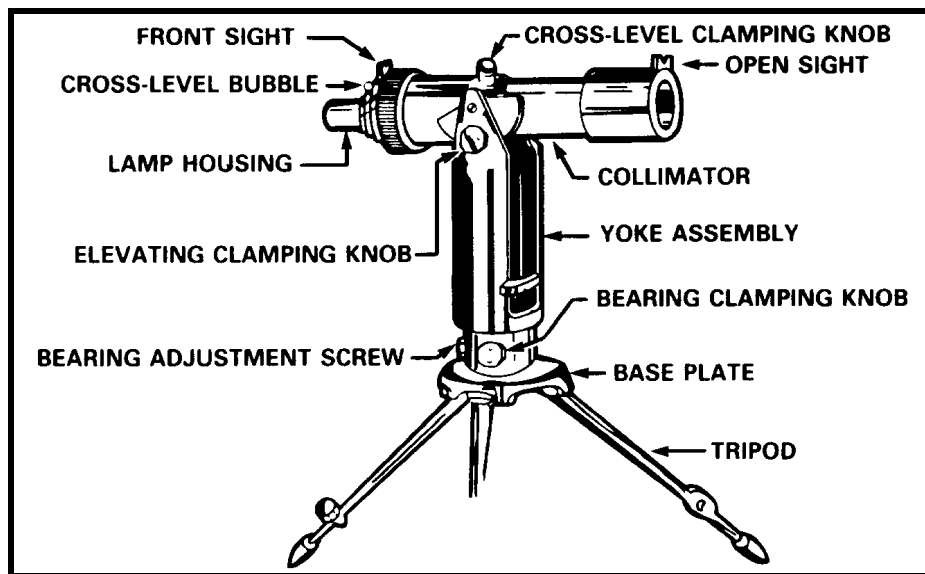


Figure A-1 Collimator M1

3. When not in use, the optical system is protected by a fibre-glass reinforced plastic cover. The cover is attached to the collimator by three snap locks. A strap restrains the tripod legs when folded.

4. The collimator is designed to replace aiming posts as the primary means of laying. When the howitzer has been laid in the C of A, the collimator is placed between 5 to 12 m to the left front of the panoramic telescope.

SETTING UP THE COLLIMATOR

5. Drill

- a. Undo the strap on the instrument cover. Fold down the legs, extend as required, and plant them firmly in the ground. Undo the latches between the cover and collimator base and remove the cover.
- b. The collimator should be as level as possible approximately 1 m high. Precise leveling is not necessary.
- c. Loosen the elevation and bearing clamps. Sight through the front and rear sights until the optical system is sighted on the panoramic telescope.
- d. Release the collimator clamping knob and level the cross-level bubble; tighten the clamping knob. The reticle pattern is now cross-levelled.

RECORD C OF A

6. When GACs beacon is not available, the collimator is recorded and used as GAP 1 and the aiming post as GAP 2.
7. The C of A is recorded in the normal way, the collimator being used as GAP 1. A close GAP is recorded as GAP 2.

Drill

8. 4 is positioned at the collimator taking direction from 3. 3 with his hand extended out the left cab door, signals 4 to move the collimator's fine adjust knob left or right as indicated by the direction off his palm. 3 indicates clamp by making a fist.

LAYING

9. The numbers shown in the reticle pattern are in increments of 5 mils. Individual mils are marked by short vertical lines in the V format of the pattern. This V format indicates left or right displacement of the weapon. To correct for displacement, 3 sights on the collimator and matches the reticle of the panoramic telescope with the reticle of the collimator. For example, if 3 sees 10, and 15 in the collimator and the reticle slopes upward from right to left, which indicates a right displacement, he matches the left portion of the panoramic telescope reticle with the collimator reticle pattern as shown in Figure A-3.

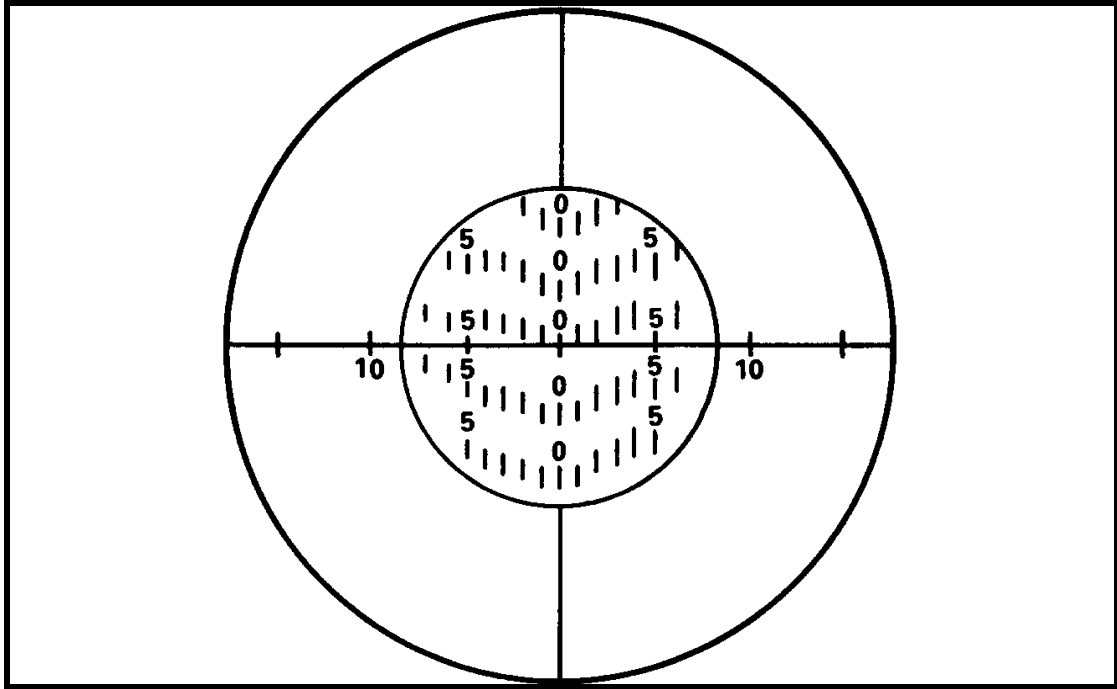


Figure A-2 Initial Alignment

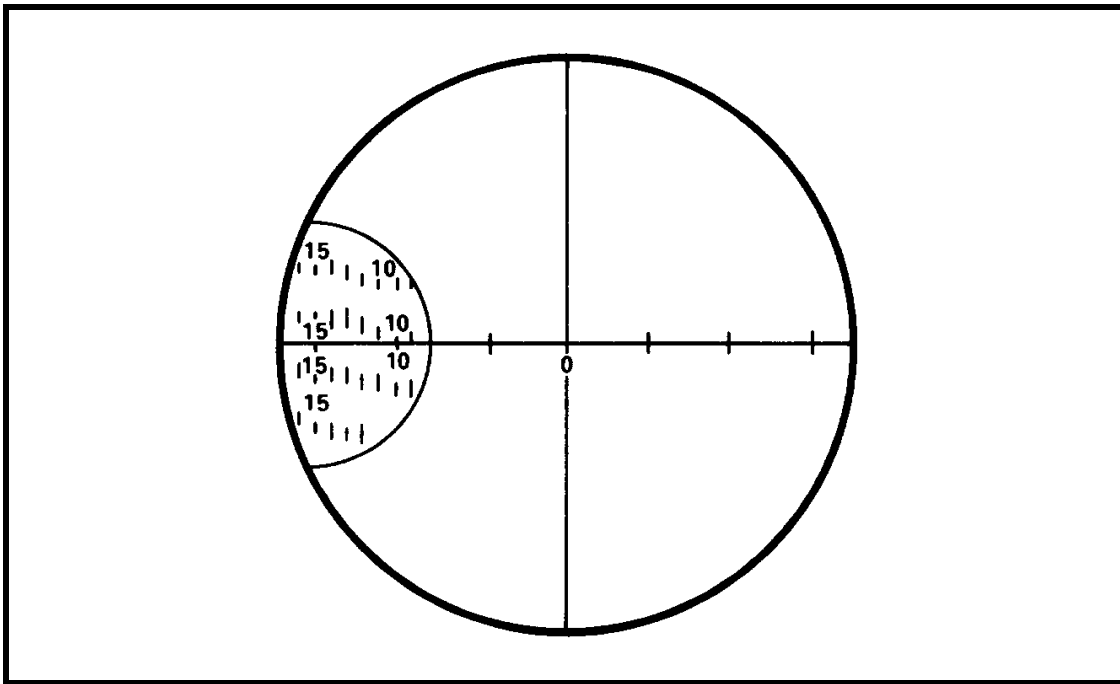


Figure A-3 Right Displacement

ANNEX B

ANNEX B

M109A2/A3 TESTING TARGET

M109A2/A3 TESTING TARGET

GENERAL

1. The testing target is used to boresight the howitzer for line and permits the correct alignment of the barrel with both the panoramic and direct-fire telescope.

CONSTRUCTION

2. The testing target should be reproduced locally on one-half inch plywood, to the exact measurements specified in Figure B-1.

3. The target should be painted matt white and the laying marks in contrasting black to ensure a clearly defined pattern.

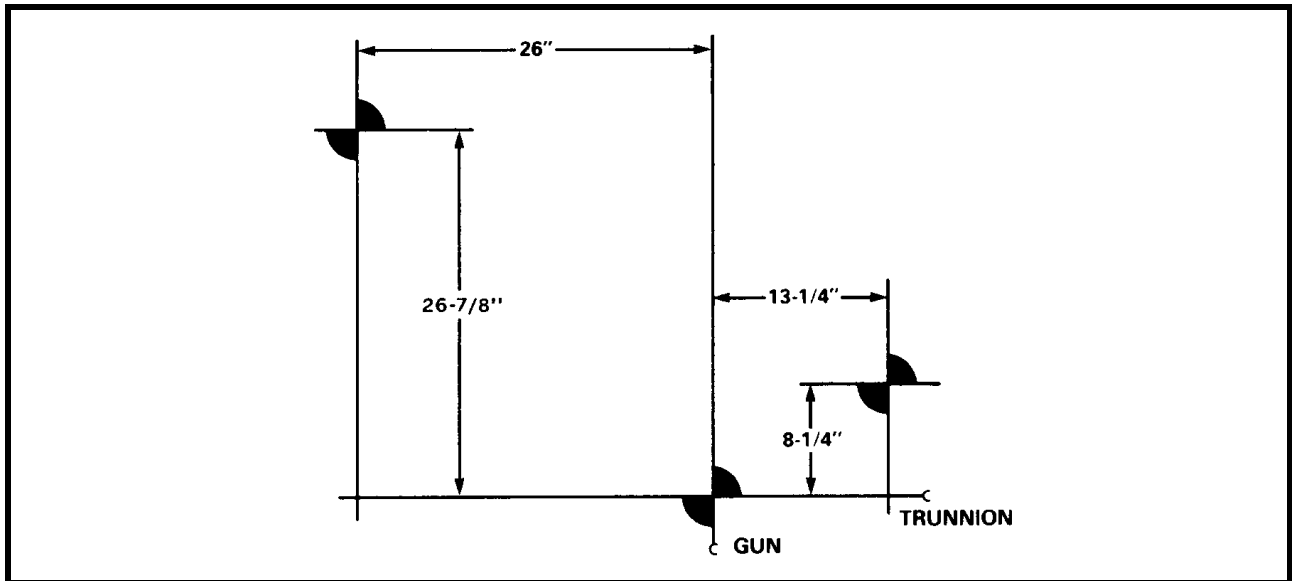


Figure B-1 M109A2/A3 Testing Target

4. Because of its large size, it may be convenient to hinge the target at the centre. If the target is hinged, extreme care must be taken to ensure retention of target parallelism and measurements.

ANNEX C

ANNEX C

GUN PITS

GUN PITS

GENERAL

1. For a number of tactical reasons, the situation may require that the howitzer be dug in. The priority of guns and vehicles to be dug in, and the degree to which the defences must be prepared, are specified in the digging policy.
2. This annex outlines the design and dimensions for the M109A2/A3 gun pit (see Figure C-1).

DESIGN REQUIREMENTS

3. The siting and design of the gun pit must take into account the following factors:
 - a. **Routes.** The access must generally be easy, and must not compromise the position. Routes are required for resupply and movement to alternate positions.
 - b. **Concealment.** The gun pit should be camouflaged from ground and air observation. Efforts must be made to remove track marks and evidence of spoil heaps. The howitzer can be concealed by use of camouflage nets and existing natural foliage.
 - c. **Shelters.** Protection for the detachment is provided through personnel and support weapon shelters.
 - d. **Revetments.** Revetment of gun pits may be necessary and is normally dictated by the type of soil. Gun positions are likely enemy targets and should be revetted to resist damage from enemy fire.
 - e. **Sandbags.** Sandbagging of the excavated soil increases the strength of the gun pit and decreases damage to it, the howitzer, and the detachment from enemy fire.
 - f. **Drainage.** Drainage may be required for either short or long term occupations.

SEQUENCE OF CONSTRUCTION

4. The sequence of construction for a gun pit is as follows:
 - a. Mark the perimeter of the gun on the ground. For night digging, white mine tape should be used.
 - b. Remove the sod and store it for later use.
 - c. If the pit is to be revetted, ensure that the revetment materials are pre-positioned.

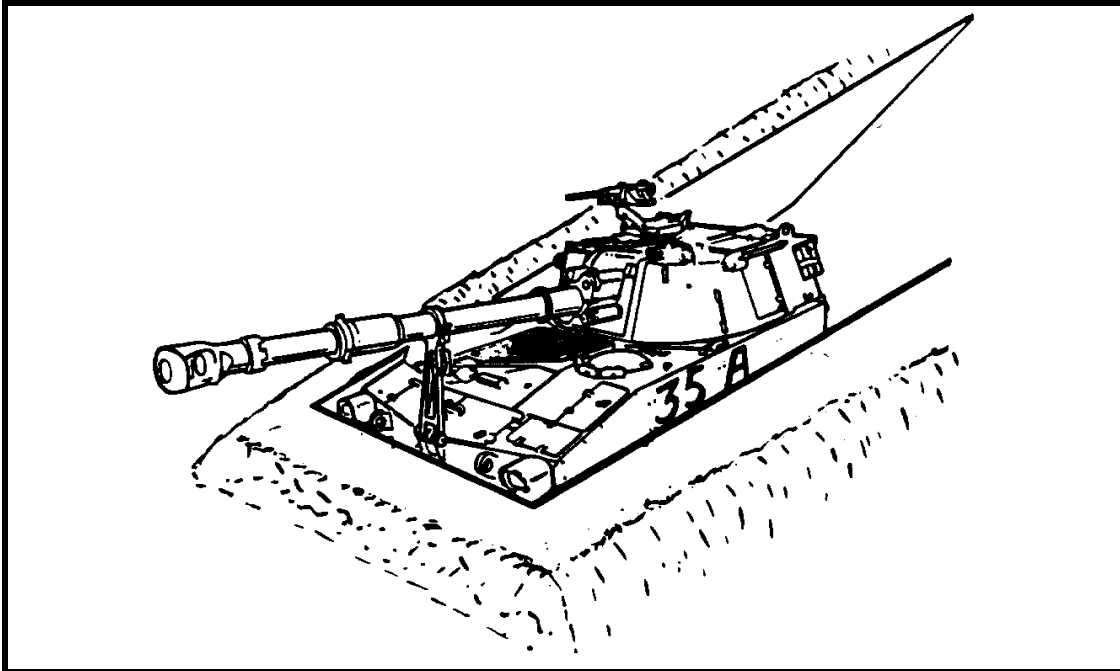


Figure C-1 Example of an M109A2/A3 Gun Pit

- d. Excavate the pit and trenches for, personnel, ammunition, etc.
- e. Revet each part of the gun pit as it is dug.
- f. Camouflage the position with sod, nets, and natural foliage.
- g. Provide drainage as required.

DIMENSIONS OF GUN PITS

5. Gun pits for the M109A2/A3 shall use the dimensions shown in Figure C-2.

| | |
|---------------------------|--------|
| Depth of pit | 1.3 m |
| Width of pit | 4.8 m |
| Length of pit bottom (L1) | 8.0 m |
| Overall length (L) | 12.0 m |
| Ramp slope | 1 in 2 |

Figure C-2 Dimensions of an M109A2/A3 Gun Pit

6. A modified form of a gun pit is the simple scrape (see Figure C-3) the only type which can be dug by a bulldozer or AFV with a dozer blade.

| | |
|----------------------|--------|
| Depth of pit | 1.3 m |
| Width of pit | 4.8 m |
| Length of pit bottom | 8.0 m |
| Overall length (L) | 17.0 m |

Figure C-3 Dimensions of an M109A2/A3 Modified Gun Pit

7. It may be necessary to dig in the M548 ammunition carrier as part of the overall digging policy. The dimensions for an M548 pit are given in Figure C-4.

| | |
|----------------------|--------|
| Depth of pit | 1.5 m |
| Width of pit | 3.0 m |
| Length of pit bottom | 6.0 m |
| Overall length (L) | 15.0 m |

Figure C-4 Dimensions of an M548 Pit

ANNEX D

ANNEX D

FIRST AID TREATMENT FOR WHITE PHOSPHORUS BURNS

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GENERAL

1. White phosphorus coming in contact with the skin will cause severe and painful burns. Every person handling or storing white phosphorus ammunition shall be familiar with the emergency first aid treatment of white phosphorus burns.
2. Wherever there is a possibility of white phosphorus burns the unit shall be equipped with the following first aid appliances:
 - a. buckets/jerricans of water;
 - b. suitable eye-wash bottles or fountains;
 - c. asbestos gloves (Mittens, Cloth, Asbestos NSN 8415-21-104-2107); and
 - d. gauze pads, etc, as necessary.

FIRST AID TREATMENT

3. The first aid treatment for white phosphorus burns is as follows:
 - a. Move patient from immediate area and remove contaminated clothing and footwear.

CAUTION

Do not use oils, grease dressings, tannic acid, or other preparations. White phosphorus is soluble in oils and could be absorbed more readily and cause serious systemic phosphorus poisoning.

- b. White phosphorus burning on the skin should be extinguished by immediately submerging the affected part in water and by covering the affected area with a dressing kept completely and continuously wet.
- c. If white phosphorus is splashed into the eyes, wash the eyes with copious quantities of water for at least 15 minutes and apply a wet pad. This pad must be kept wet or burning will resume.
- d. After neutralization and/or removal of all loose particles of white phosphorus, the treatment is the same as for a thermal burn. General principles of patient management apply, especially for any extensive burns.

4. Embedded visible pieces of phosphorus should be removed surgically and it is important that any person burned by white phosphorus be taken to the nearest medical facility immediately upon completion of this first aid.

NOTE

As long as unoxidized phosphorus remains embedded in the skin, the contaminated area should be kept submerged in water.

ANNEX E

ANNEX E

REFERENCES

REFERENCES

1. The following publications are related to and should be used in conjunction with this manual:
 - a. B-GL-306-004/FP-001, Field Artillery, Volume 4, Duties at Regimental Headquarters and the Gun Position.
 - b. B-GL-306-006/FP-001, Field Artillery, Volume 6, Ballistics and Ammunition.
 - c. C-30-621-000/MB-001, Operator Manual for 155 mm, M109A3.