FM 6-161

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FIELD MANUAL

# RADAR SET

## AN/MPQ—4A



HEADQUARTERS, DEPARTMENT OF THE ARMY
July 1975

FIELD MANUAL
No. 6-161

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DEPARTMENT OF THE ARMY
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# RADAR SET AN/MPQ-4A



*This manual supersedes FM 6-161, 26 June 1969.

# CHAPTER 1

# GENERAL

## 1–1. Purpose and Scope

*a.* This manual is a guide for personnel responsible for employing and operating the weapons locating radar set AN/MPQ–4A. The manual describes the equipment and operating procedures to be used by radar sections in weapon location and radar gunnery missions, decontamination and destruction of equipment, safety precautions, and section training.

*b.* The material presented herein applies, without modification, to both nuclear and nonnuclear warfare.

*c.* The term "radar" as used within this manual applies to weapon locating radar set AN/MPQ–4A only, except when specified otherwise.

## 1–2. Changes and Comments

Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forwarded direct to the Commandant US Army Field Artillery School, ATTN: ATSF–CTD–DL, Fort Sill, Oklahoma 73503.

## 1–3. References

Related publications are listed in the appendix.

# CHAPTER 2

# ORGANIZATION AND EQUIPMENT

## Section I. ORGANIZATION

### 2–1. Organization of Radar Section

*a.* The basic organization of the weapon locating radar system is the radar section. One radar section is organic to each direct support battalion and two radar sections are located in the radar platoon of the Field Artillery Target Acquisition Battalion (FATAB). The number of personnel assigned to the radar section and their duties vary to the type of battalion to which they are assigned.

*b.* The organization of the radar section of the direct support battalion is as follows:

(1) One chief of section
(2) One radar mechanic
(3) One senior radar operator
(4) Four radar operators
(5) One generator operator

*c.* The organization of the radar section of the radar platoon of the FATAB is as follows:

(1) One chief of section
(2) One radar mechanic
(3) One senior radar operator
(4) Four radar operators
(5) One radar plotter
(6) One generator operator
(7) One driver
(8) One RTO

*Note.* See the next paragraph for duties of the above personnel.

### 2–2. Duties of Personnel

The principal duties of key personnel of the weapon locating radar section are listed below:

*a. Section Chief.* Supervises operator maintenance of the radar equipment and evaluates the radar site after occupation of position.

*b. Weapons Support Radar Mechanic.* Performs organizational repair and maintenance of radar equipment, and assists the warrant officer radar technician.

*c. Senior Radar Operator.* Operates and supervises the operation of the radar set, assists in the emplacement and concealment of the radar position, and assists the chief of section in all of his duties.

*d. Radar Operator.* Operates the radar and the computer, using the controls of the control-indicator group.

*e. Radar Plotter.* The plotter sets up the radar chart on a grid sheet, determines the altitudes of the weapon locations from a contour map, plots the final locations, and keeps the necessary records.

*f. Generator Operator.* The generator operator operates and maintains the generator, provides local security, and assists the plotter during periods of intense enemy weapons activity.

*g. Driver.* The driver operates the radar's prime mover, performs organizational maintenance on the prime mover, provides local security, and other duties designated by the chief of section.

*h. Radio Telephone Operator (RTO).* The RTO operates and performs use maintenance on the communications equipment in the radar section.

### 2–3. Organization of Personnel for Operation

*a.* A well trained radar crew is essential to insure accurate, timely locations of hostile weapons. Continuous operation may be required during combat: therefore, every man in the section must be capable of performing each of the duties necessary to obtain and process hostile weapon locations.

*b.* For continuous operation, the section should be organized into three-man teams, excluding the chief of section and the radar repairman, who are on call continuously. These three-man teams must include a radar operator, radar plotter, and generator operator.

*c.* To prevent fatigue and eyestrain, the members of the team should alternate their duties so that no one member serves as the control unit operator more than 30 minutes at a time. When the teams are changed, the personnel on duty should be relieved one at a time. This will allow each person to become familiar with the situation as he assumes his duty, since he will be working with two men who are already familiar with the situation.

## Section II. EQUIPMENT

### 2–4. Description

*a.* The weapon locating radar set AN/MPQ-4A is a mobile, pulse-modulated, nontracking, dual-beam, beam-intercept radar. It can be used to locate mortars and other high-trajectory weapons, howitzers and other low-trajectory weapons, observe registrations, adjust fire, and detect and locate moving targets. The complete set, with its associated equipment, is contained in two trailers—the radar trailer (fig 2–1) and the power unit trailer (fig 2–2).

*b.* The radar set consists of a radar trailer, an antenna group, a receiver-transmitter group, a control-indicator group, a dehydrator, and a power unit.

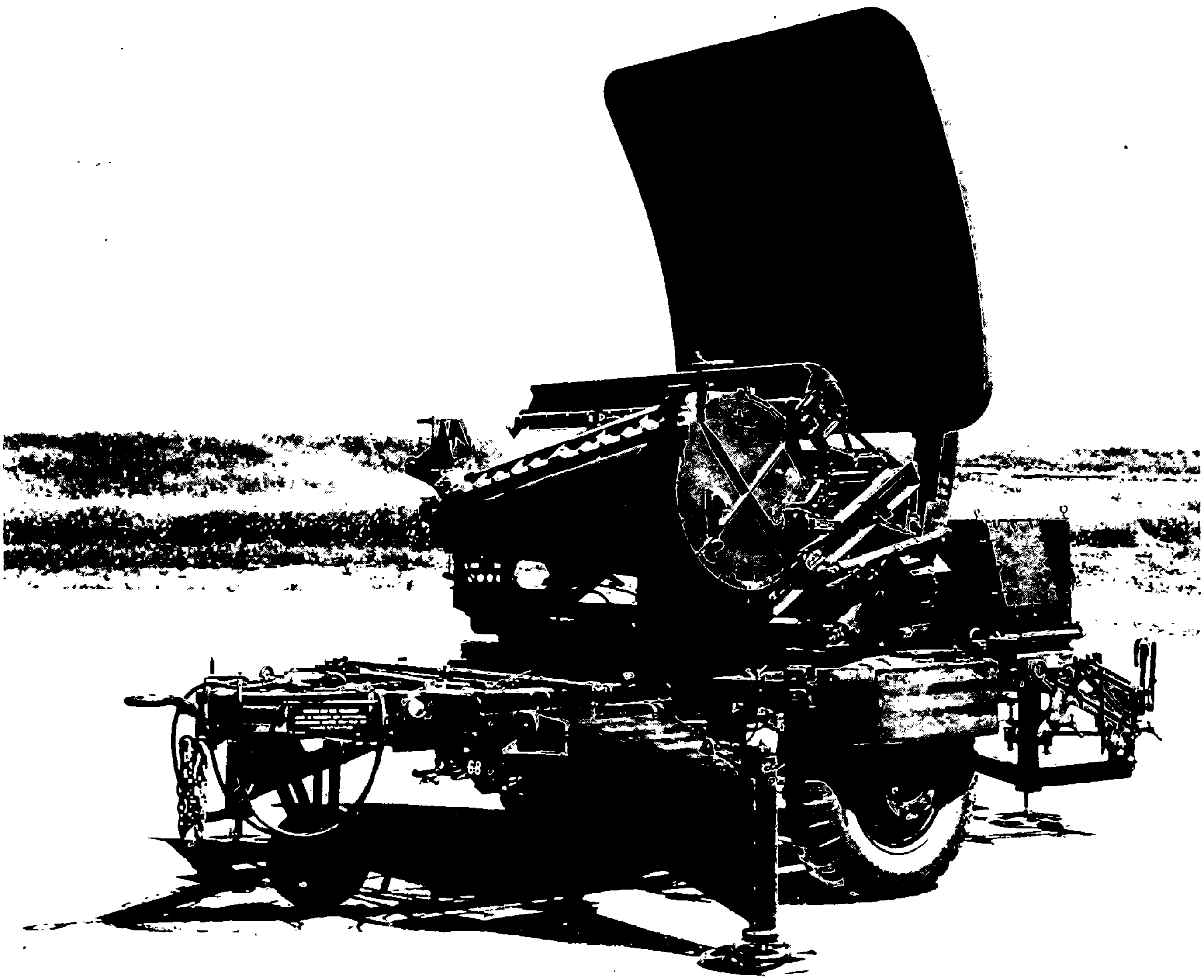

*Figure 2–1. Radar trailer.*

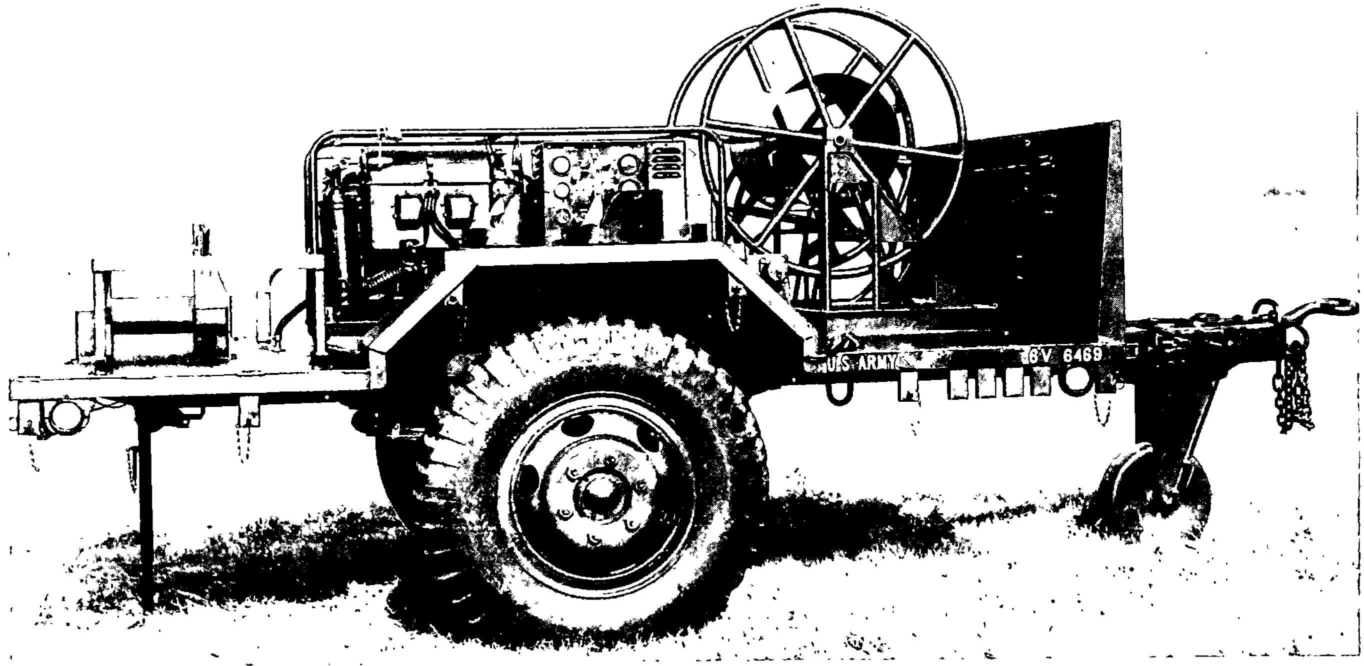

*Figure 2–2. Generator set, gasoline-engine-driven, trailermounted, PU–304C/MPQ–4.*

*c.* The antenna group, receiver-transmitter group, dehydrator, and control-indicator group are mounted on the radar trailer (fig 2–1). This trailer provides transportation and a platform for operation. The control-indicator group may be removed from remote operation and emplaced up to 150 feet away.

*d.* The generator set, gasoline-engine-driven, trailer-mounted PU–304C/MPQ–4 (fig 2–2) consists of a 1½-ton cargo trailer M103A3 on which a power unit generator, 400-hertz, 10-kw, military standard model HF–10–MD is mounted. The power unit provides the 120/208-volt 400-hertz, 3-phase power required for operations of the radar. The power unit trailer is also used to transport the operators' shelter, the interconnecting cables, the spare parts, the control unit stand, and the seat support.

*e.* There are two 2½ ton cargo trucks organic to each radar section. One truck is used to transport the radar trailer and the other is used to transport the power unit.

## 2–5. Performance Data

Pertinent performance data for the radar set are as follows:

*a. Sector Coverage.* 445 mils.

*b. Range.*

(1) *Maximum.* 15000 meters

(2) *Minimum.* 225 meters.

*c. Azimuth Coverage.* 6,400 mils.

*d. Elevation Coverage.* −100 to +200 mils.

*e. Rounds Required for Location.* One.

*f. Accuracy of Location.* 0 to 50 meters for high trajectory weapons, and 0 to 200 meters for low-trajectory weapons.

*g. Weight.* 6,250 pounds.

*h. Mobility.* The same as a towed 155-mm Howitzer.

## 2–6. Technical Characteristics

Technical characteristics of the radar are as follows:

*a. Frequency.* 16.000 megahertz (NHz)

*b. Pulse Repetition Frequency (PRF).* 7000 pulses per second (PPS).

*c. Pulse Width.* 0.25 microsecond.

*d. Peak Transmitted power.* 50,000 watts.

*e. Intermediate Frequency (IF).* 30 megahertz.

*f. Power Requirements.* 120/208-volt, 400-hertz, 3-phase, 4 wire, 4-kilowatt (kw).

# CHAPTER 3

# PREPARATION FOR ACTION

## Section I. EMPLACEMENT AND MARCH ORDER

### 3-1. Emplacement

*a. Radar Set.*

(1) Locate the radar trailer in a suitable position. Set the trailer handbrakes.

(2) Remove the three outrigger pads and place them on the ground to the left, right, and rear of the trailer.

***Caution:*** **Three men are required to lower the rear outrigger arm, one at each end and one at the center post. The rear outrigger must be lowered before the radar trailer is uncoupled from the prime mover. This prevents the radar trailer from tipping backward.**

(3) Loosen the lower transit locking screws (fig 3-1) and release and lower the rear outrigger arm. Secure the rear outrigger arm with the front operational locking screws (fig 3-2). Release the upper transit locking screws (fig 3-1) and loosen the pivot screws. Rotate the outrigger arm to the upright position and secure it with the rear operational locking screws (fig 3-2). Tighten the pivot screws.

(4) Loosen the jack locking screws on the support brace (fig 3-1) and rotate the brace to the forward position. Secure the support brace with the support brace locking screw. Tighten the jack locking screws.

(5) Center the rear outrigger pad (fig 3-2) directly under the jackscrew.

(6) Lower the landing wheel making sure it is secured, and uncouple the radar trailer from the prime mover (fig 3-4).

(7) Lower the side outriggers and secure them with the locking screws (fig 3-3 and 3-4).

***Caution:*** **Two personnel should be employed to raise and lower side outriggers to prevent injury to personnel and damage to equipment.**

(8) Center the right and left outrigger pads under the jackscrews. Lower the jackscrews until they contact the outrigger pads. Disengage the reflector support arm from its stowed position (fig 3-5).

(9) Rotate both wheel fenders outward by disengaging the locking pins. Disengage the azimuth stowlock.

(10) Release the reflector clamps (fig 3-6) and pivot them clear of the reflector.

(11) Raise the reflector. Secure it in position with the locking screws (fig 3-7).

(12) Remove the cover from the receiver-transmitter group.

*Note.* If shelter is to be employed, mount shelter frame prior to leveling radar.

(13) Level the radar.

(14) Open all vents.

(15) Remove the cover from the control-indicator group.

(16) Emplace the grounding stake and attach groundstrap to shelter and grounding stake.

*b. Generator Set.*

(1) Select a level, (within 5 degrees), protected site within 100 feet of the radar control-indicator group. Set the handbrakes, lower the landing wheel, uncouple the trailer from the prime mover, and then lower the support leg.

(2) Connect the power cable between the power unit and the control-indicator group. If remote operation is desired, connect the control cable between the control-indicator group and the radar trailer.

***Caution:*** **The guide keys in the cable head are easily sheared. Extreme care must be taken to prevent breaking the guide keys and to prevent connecting the cable upside down.**

(3) Emplace the grounding stake and attach groundstrap to shelter and grounding stake.

(4) Attach gas hose to gas can.

(5) Raise the canvas flaps around the trailer.

### 3-2. Installation of Operators' Shelter

The detailed procedure for installing the operators' shelter is given in paragraph 45*b*, TM 11-5840-208-10.

The interor of the shelter is shown in figure 3-8.

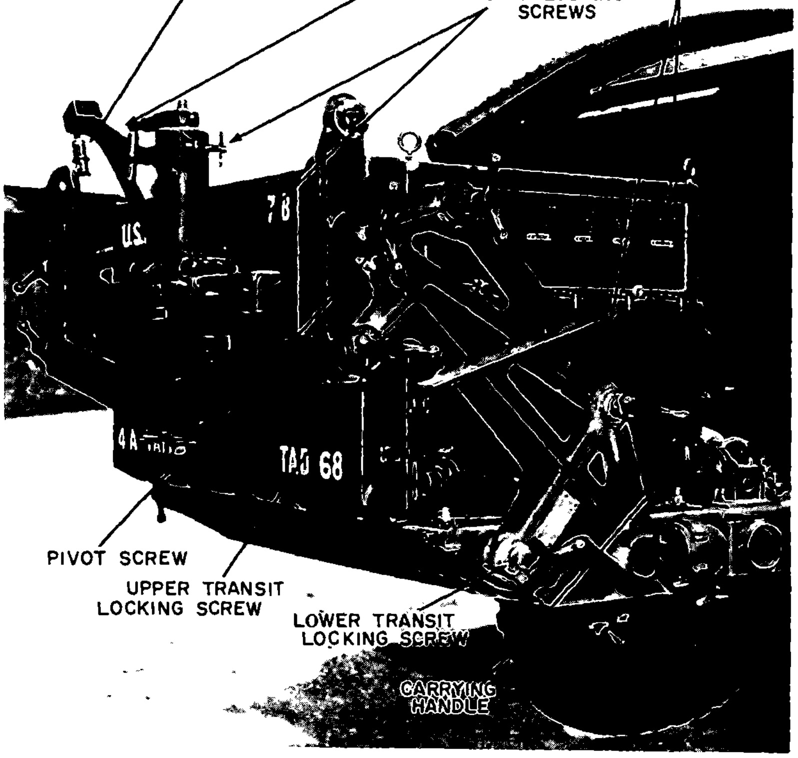


*Figure 3-1. Rear outrigger arm in transit position.*

## 3-3. March Order

*a. Radar Trailer.*

(1) Disassemble the shelter by performing, in reverse order, the procedure outlined in paragraph 45*b*, TM 11-5840-208-10.

(2) Elevate the antenna to approximately +175 mils.

(3) Engage the azimuth stowlock.

(4) Disconnect and reel in the cables, and remove the grounding stake and stow on radar trailer.

(5) Close all vents. Replace the covers on the control-indicator group and the receiver-transmitter group.

(6) Unlock the reflector lock assembly. Lower the reflector into the traveling position and secure it with the reflector clamps.

(7) Place the fenders in the traveling position and secure them with the locking pins.

(8) Release the pressure from all jacks and place the jack pads on the traveling brackets.

(9) Release the locking screws on the side outriggers. Raise and secure the side outriggers to their retaining posts.

(10) Couple the radar to the prime mover.

(11) Raise the landing wheel and release the handbrakes. Release the rear jack brace. Raise the rear outrigger arm.

(12) Place the reflector support arm in its transit position (fig 3-9).

*b. Power Unit.*

(1) Disconnect the gas connecting hose from the gas can, allowing excess gas in the hose to drain back into the can before stowing in the generator trailer.

(2) Disconnect the grounding stake and stow it in the generator trailer.

(3) Lower the canvas and tie it down.

(4) Raise the rear jack stand of the power unit trailer.

(5) Couple the power unit trailer to its prime mover and raise the landing wheel.

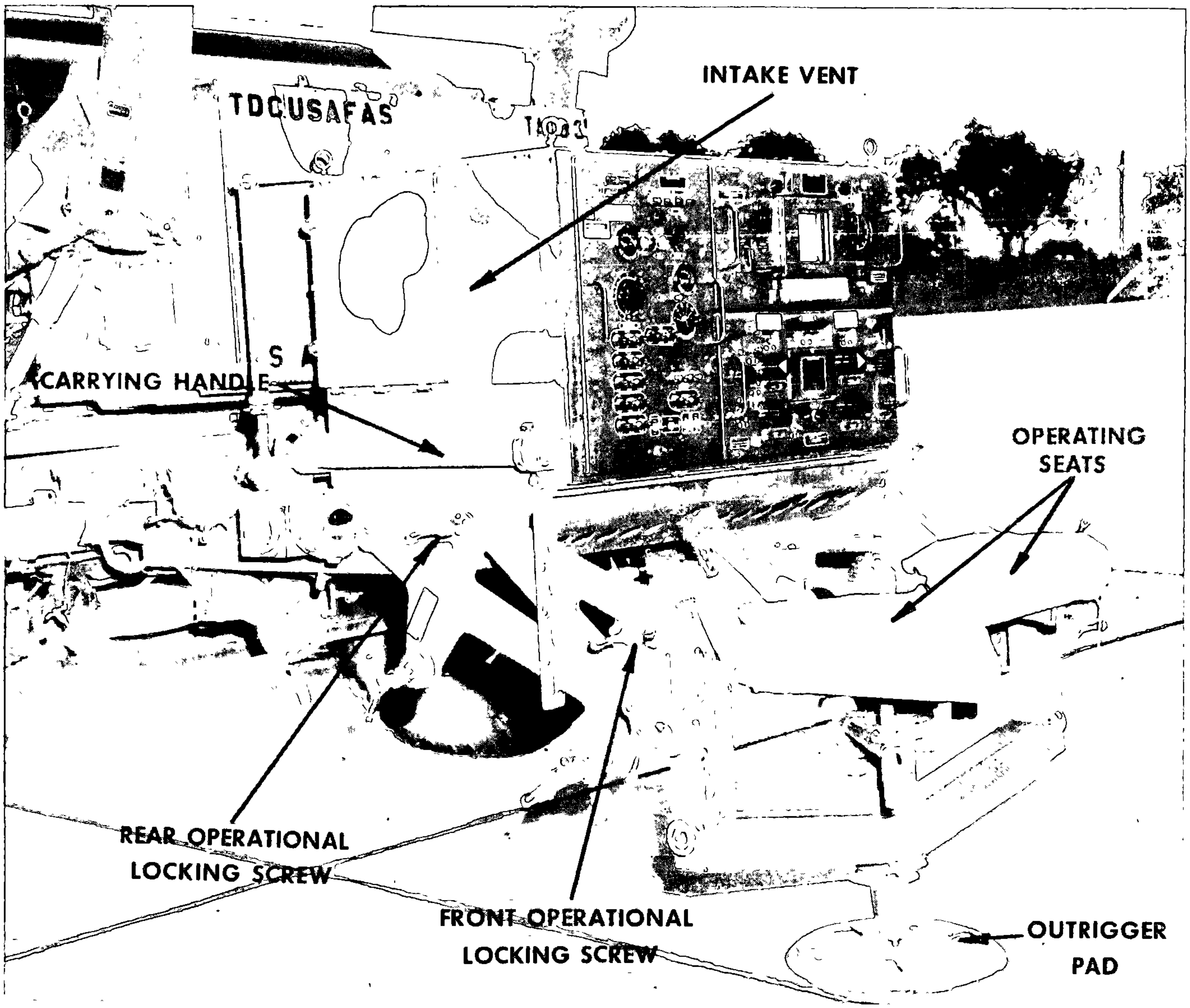


*Figure 3-2. Rear outrigger arm in operational position.*

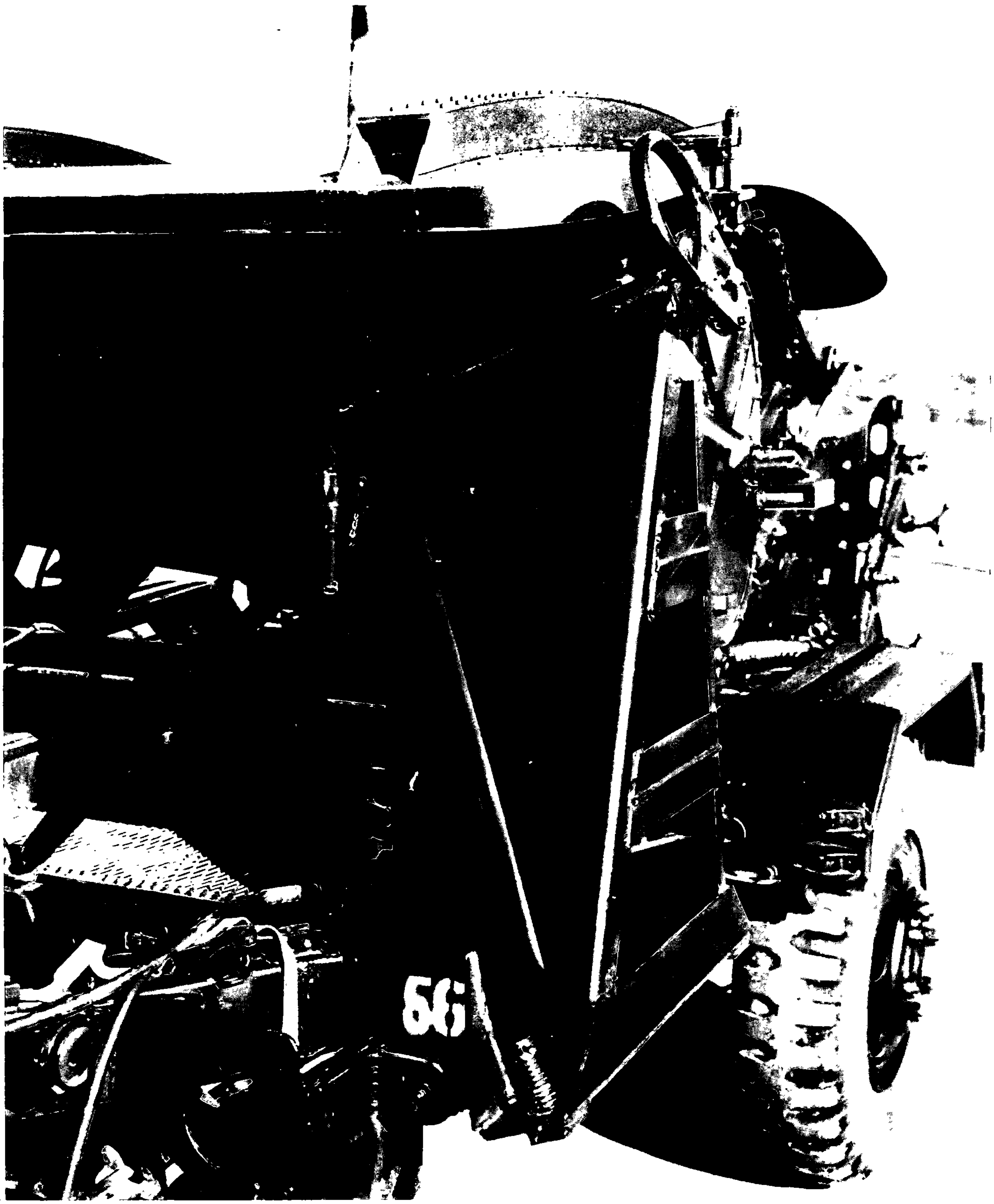


*Figure 3–3. Side outrigger arm in transit position.*

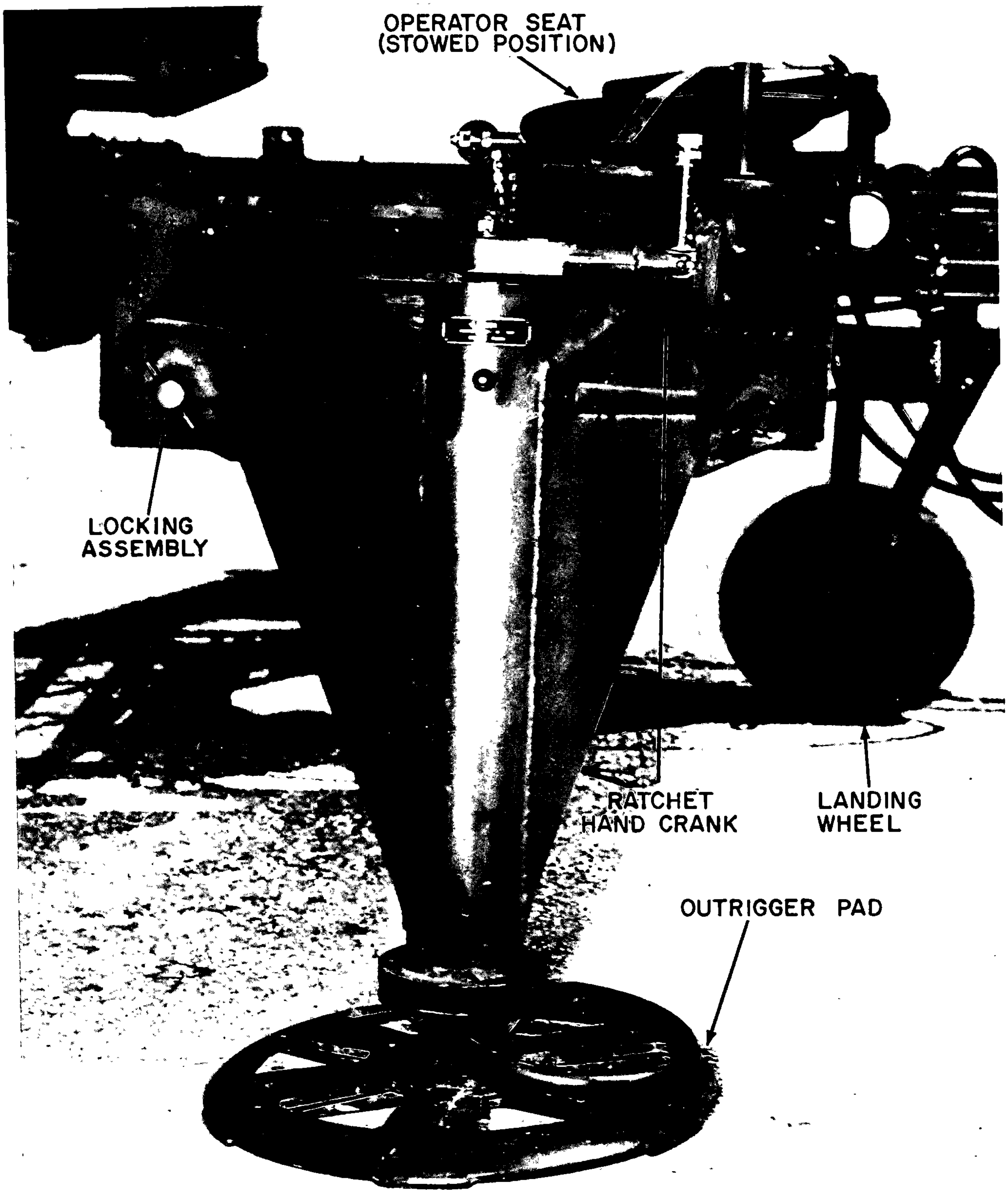


*Figure 3-4. Side outrigger arm in operational position.*

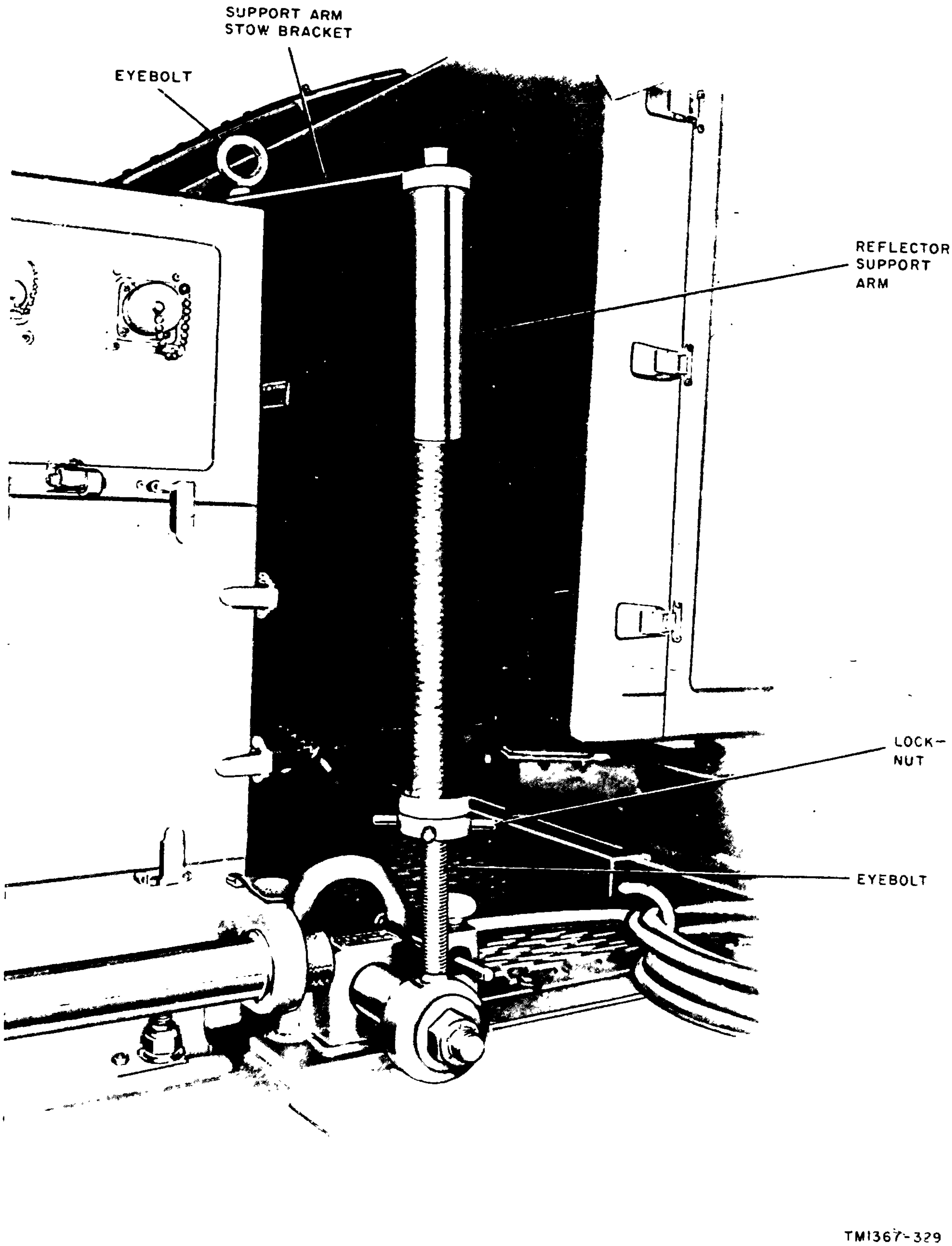


*Figure 3-5. Reflector support arm in stowed position.*

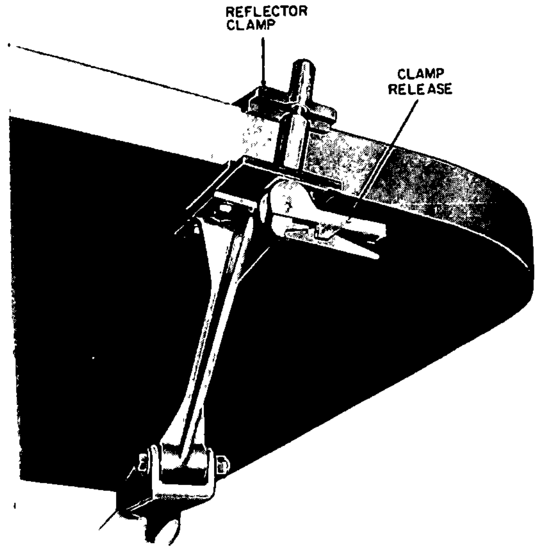


*Figure 3-6. Reflector locking clamps.*

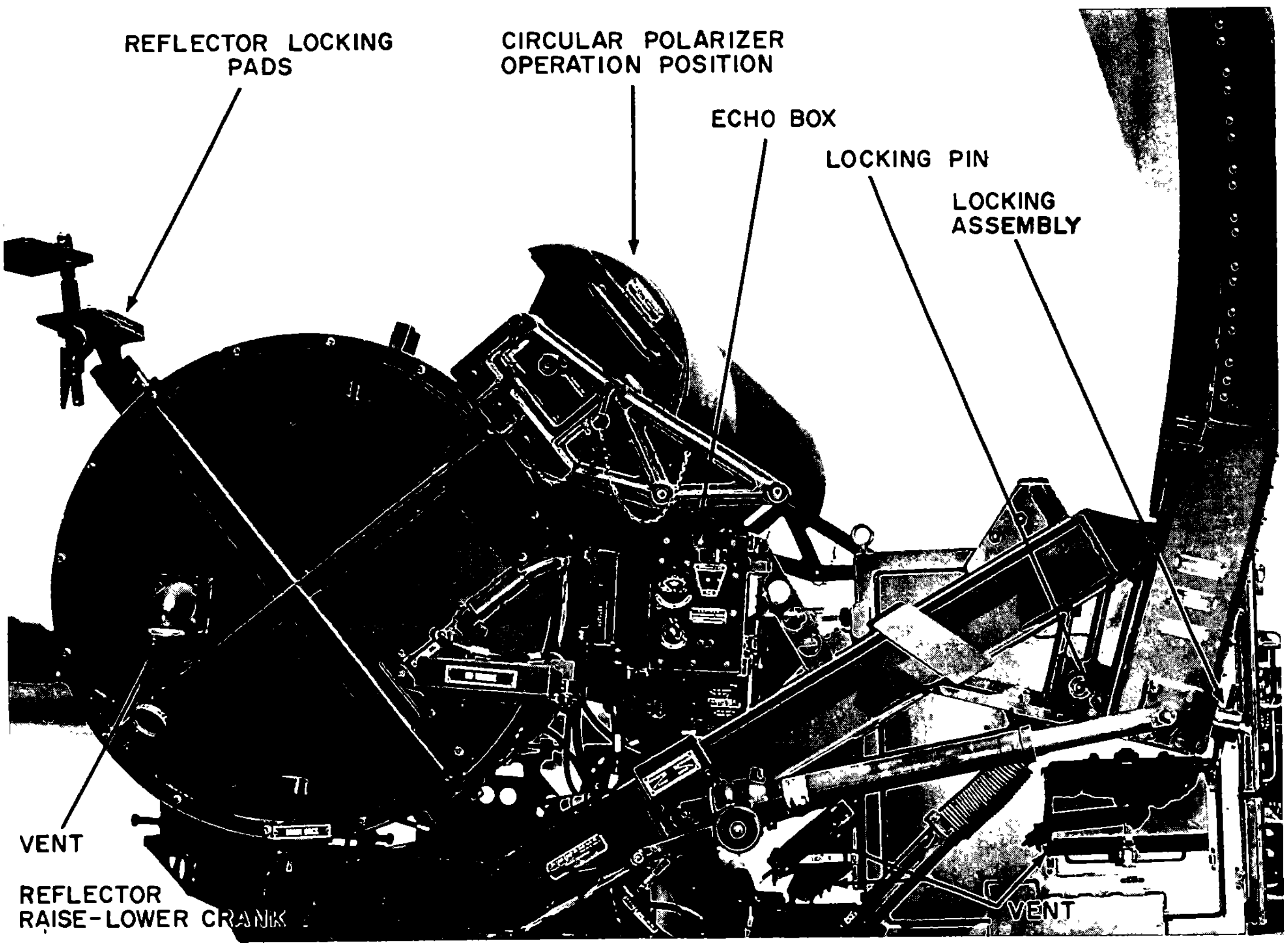


*Figure 3-7. Partial side view of radar trailer.*

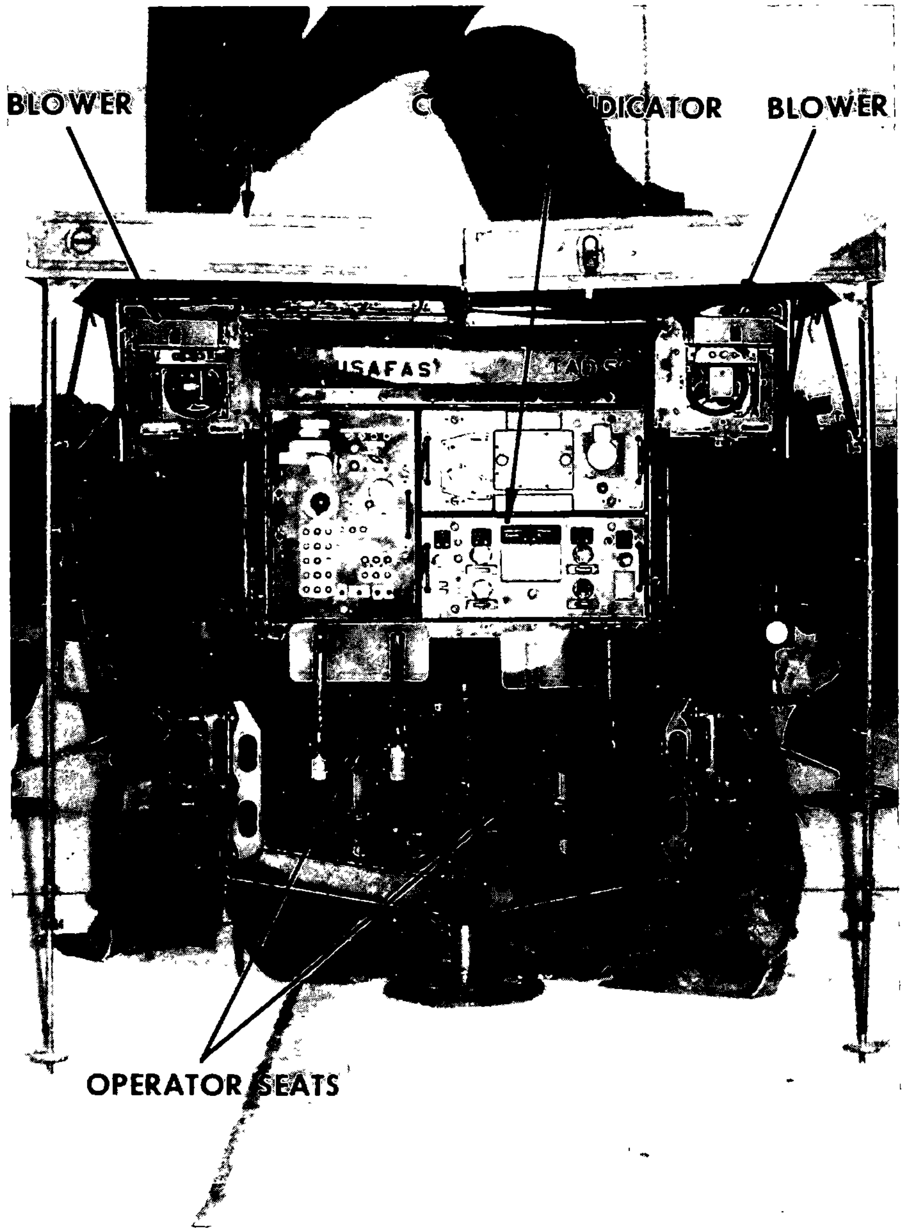


*Figure 3–8. Control-indicator group with shelter cover mounted.*

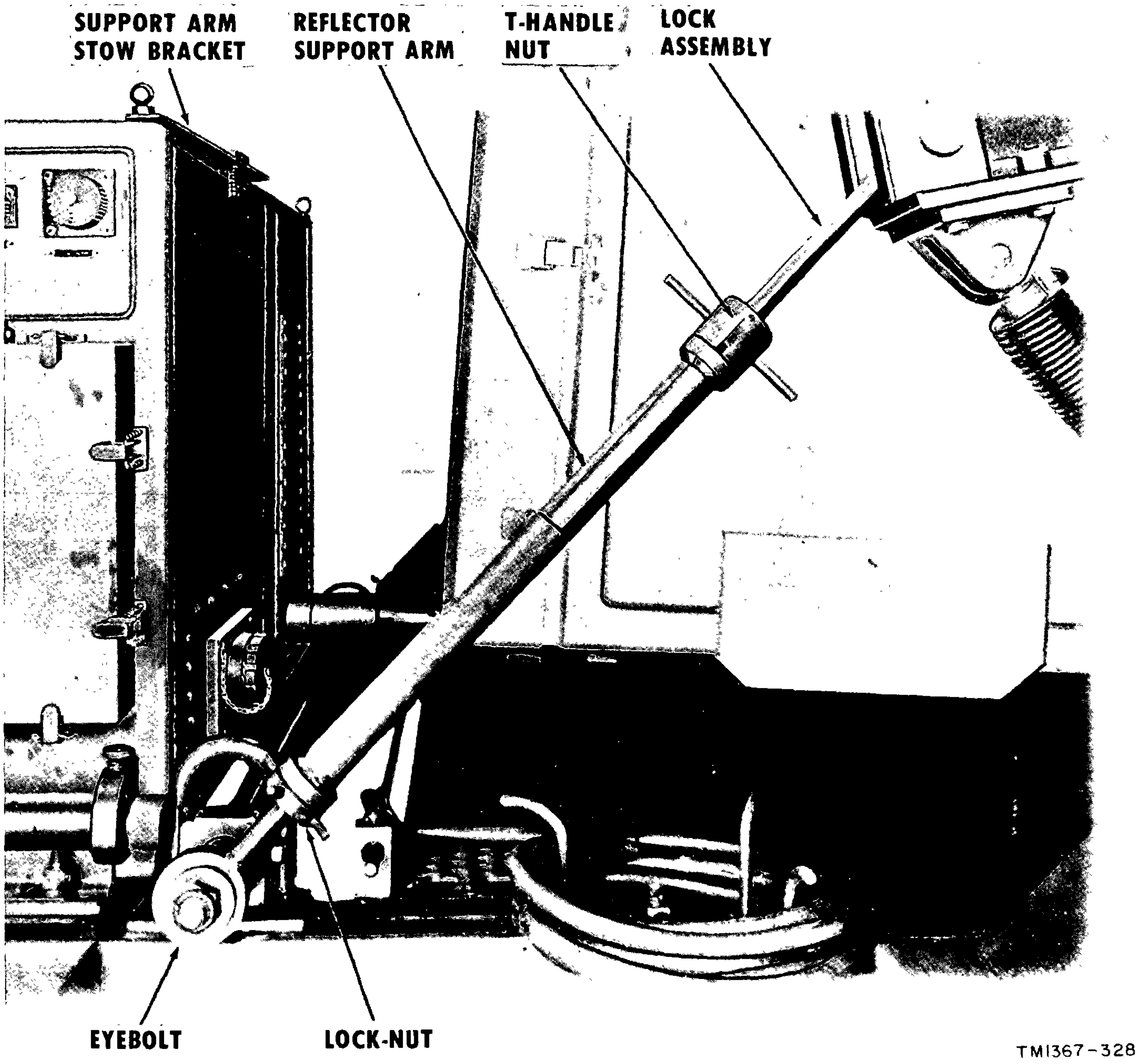


*Figure 3–9. Reflector support arm in transit position.*

## Section II. PREOPERATIONAL CHECKS AND ADJUSTMENTS

### 3–4. Power Unit

Refer to TM 5–6115–450–15 for preoperational checks and adjustments for the power unit.

### 3–5. Radar Set

*a. Receiver-Transmitter Group.*

(1) Set the AFC-MANUAL switch on the control-monitor panel (fig 3–10) to the AFC position.

(2) Secure the control-monitor panel, the power supply drawer, and the transmitter door. Open the air intake and air exhaust panel on the rear of the cabinet and the air exhaust panel on the left side. Remove the cap from the vent at the upper left rear of the cabinet.

*b. Control-Indicator Group.*

(1) Secure the control-power supply, the azimuth and range indicator, and the computer drawers. Open the air intake and air exhaust panels on the left and right sides of the cabinet. Remove the cap from the vent at the upper right rear of the cabinet.

(2) On the control-power supply panel (fig 3–11 and 3–12), set the following switches in positions indicated:

| *Control* | *Position* |
|---|---|
| MAIN POWER switch | OFF |
| AFC-MANUAL switch | MANUAL |
| TEST METER SELECTOR switch | 27 V X10 |

*c. Antenna Group.* Check to insure that the—

(1) Azimuth stowlock is out.

(2) Azimuth handwheel is all the way out.

(3) Fenders are down.

*d. Dehydrator.* Check to insure that the—

(1) Air intake panel on the left side of the front panel is hinged up.

(2) The purge valve is open.

(3) Circuit breaker switch is in the ON position. (HD–264A/MPQ–4A only).

## Section III. STARTING PROCEDURES

### 3–6. Power Unit

Refer to TM 5–6115–450–15 for the starting procedure for the power unit.

### 3–7. Radar Set

*a.* Check the power unit outputs. When the proper voltage and frequency requirements have been met, turn the power unit 400-hertz circuit breaker to ON. The POWER UNIT indicator lamp on the control-power supply panel will light if the output phases of the generator have been connected in the proper sequence.

*b.* On the control-power supply panel, turn the MAIN POWER switch to ON. The MAIN POWER ON & INTLK CLOSED indicator lamp should light, and the TEST METER should indicate 27 volts. If the meter does not indicate 27 volts ±2 volts, immediately turn the MAIN POWER switch to OFF. Check the power input voltages and connections. If the 27-volt fuse blows, immediately turn the MAIN POWER switch to OFF. Check the cable connections between the control unit and the pedestal for proper mating.

*c.* Check the operation of the three system blowers.

(1) Check the blowers in the receiver-transmitter cabinet by holding a piece of paper to the rear of the receiver-transmitter. If the inrushing air draws the paper against the receiver-transmitter compartment, the blower is operating. This check must be performed at both intake vents on the rear of the compartment to insure the operation of both the main blower and the magnetron blower.

(2) Check the blower on the control-indicator group. If air is being discharged at the exhaust vent on the right side of the cabinet, the blower is operating.

*d.* While waiting for the 5-minute delay relay to close, and the waveguide to be purged, perform the following checks and adjustments:

(1) Thirty seconds after closing all drawers, rotate the TEST METER SELECTOR switches on the control-power supply panel and on the control-monitor panel through the positions listed below. The meter readings should be as indicated below. TEST METER SELECTOR switch on the control-power supply (fig 3–12):

| *Position* | *Typical reading* |
|---|---|
| 440 V X100 | 440 volts ±5 |
| 220 V X50 | 220 volts ±5 |
| 27 V X10 | 27 volts ±2 |
| −220 V X50 | −220 volts ±5 |
| AFC XTAL CUR | 2.5 ±0.5 |

*Note.* Return the TEST METER SELECTOR switch, located on the control monitor panel, to the AFC XTAL CUR position (fig 3–10).

| *Position* | *Typical reading* |
|---|---|
| XTAL 1 | 2.5 ±0.5 |
| XTAL 2 | 2.5 ±0.5 |
| AFC XTAL | 2.5 ±0.5 |
| +300 V X100 | 300 volts ±5 |

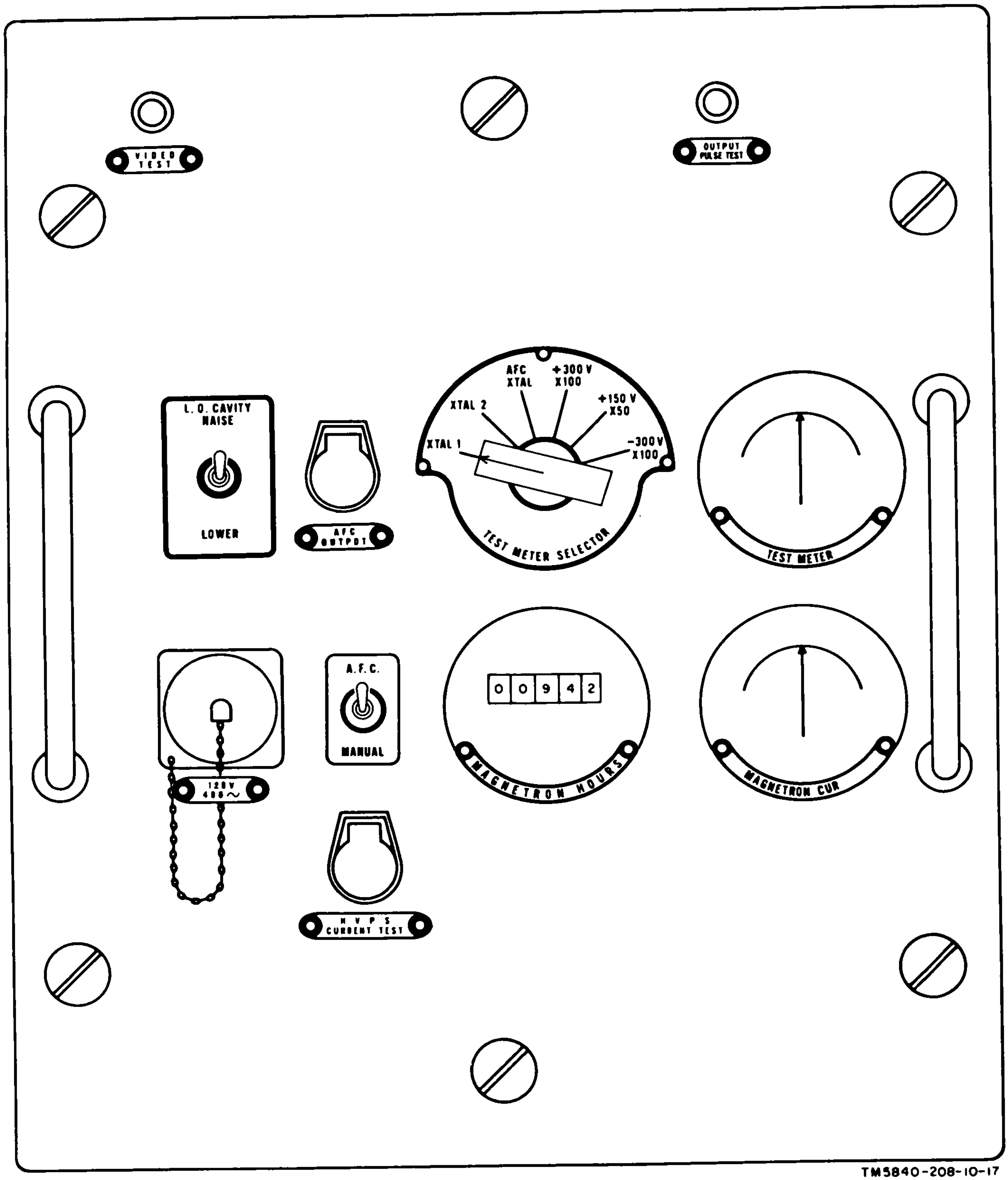


*Figure 3-10. Control-monitor panel.*

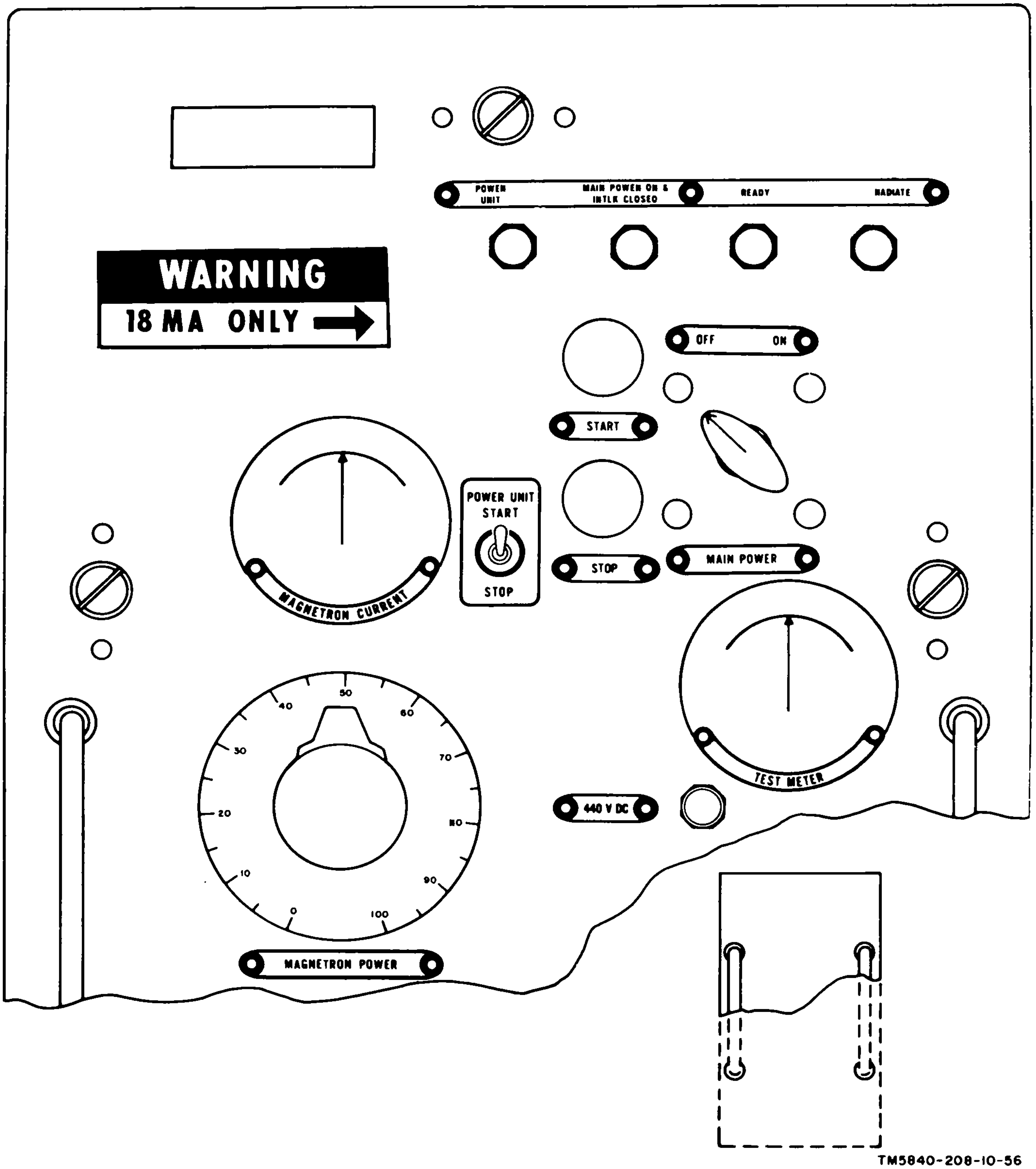


*Figure 3-11. Control-power supply panel, upper half.*

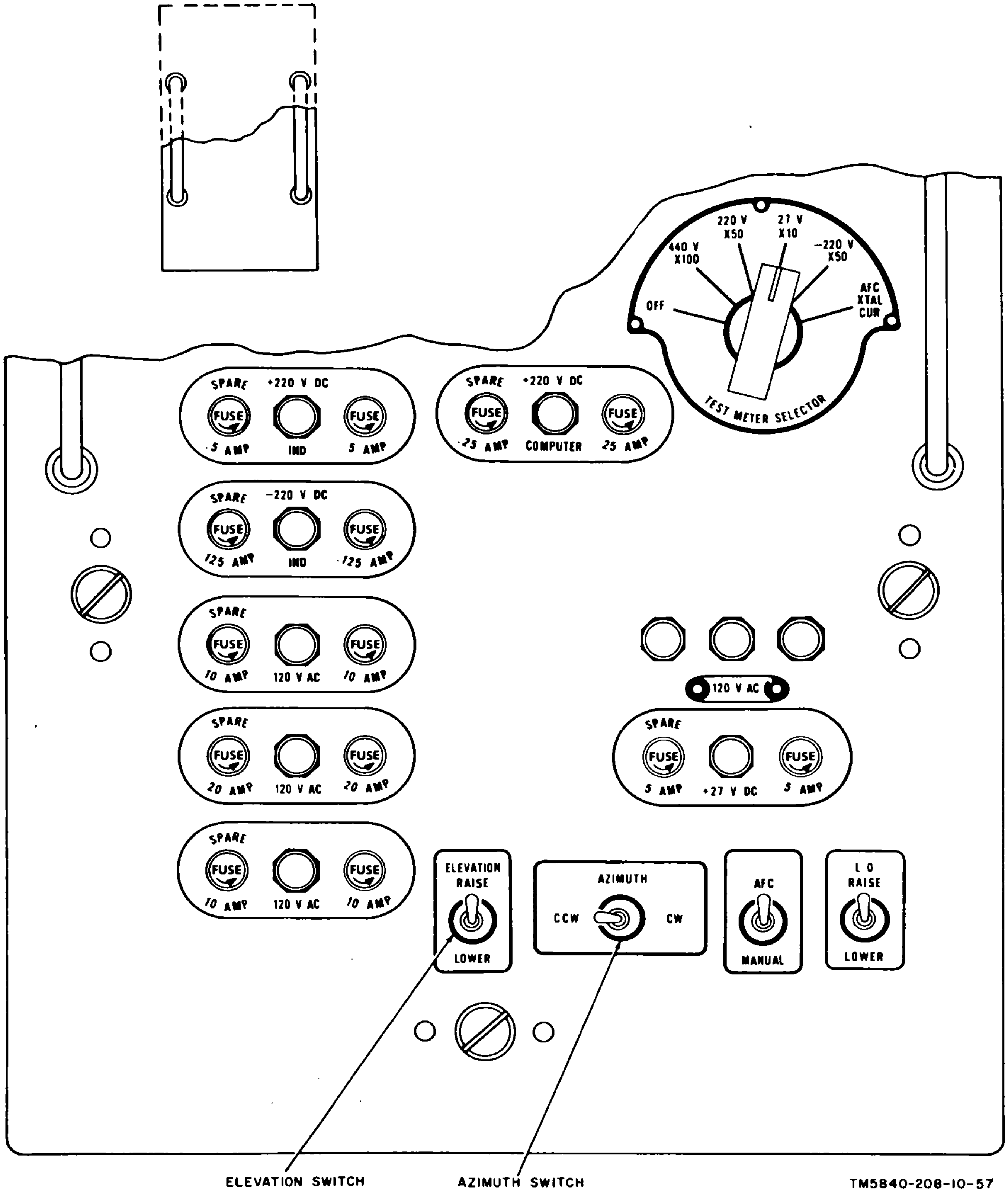


*Figure 3–12. Control-power supply panel, lower half.*

| *Position* | *Typical reading* |
|---|---|
| +150 V X50 | 150 volts ±5 |
| −300 V X100 | −300 volts ±5 |

*Note.* Crystal current readings of 2.5 indicate a current of 0.5 ma.

(2) Turn the AZIMUTH CCW–CW switch on the control-power supply panel to the CW position and then to the CCW position. The antenna and the azimuth counter on the computer should rotate accordingly.

(3) Operate the ELEVATION switch. With the switch in the RAISE position, the reflector should tilt upward and the elevation counter should increase. With the switch in the LOWER position, the reflector should tilt downward and the elevation counter should decrease.

*e.* After the 5-minute delay, the READY indicator lamp on the control-power supply panel should light. Close the purge valve and check to see that the dehydrator pressure guage builds up to approximately 16 pounds per square inch (psi) and that the dry air indicator is blue.

*f.* Adjust the MAGNETRON POWER variac to 0. Press the START button. The RADICATE indicator lamp should light. Adjust the variac until the MAGNETRON CURRENT meter reads 18 milliamperes(ma).

***Caution:*** **Do not operate the magnetron at a current of less than 13 ma.**

*g.* Rotate the VIDEO control (fig 3–13) to its maximum position and the IF GAIN control to its minimum position.

*h.* With the RANGE SELECTOR switch in the 15000 M position, adjust the INTENSITY control until raster is just visible. The raster is a predetermined pattern of scanning lines which provides substantially uniform illumination of the cathoderay tube.

*i.* Move the RANGE SELECTOR switch to the 3750 M position. If the intensity of the raster changes noticeably, have the radar repairman adjust the intensity balance.

*j.* Adjust the FOCUS control for the sharpest lines and images.

*k.* Adjust the IF GAIN control until the background noise is barely visible.

*l.* Adjust the RANGE MARK control until the range strobe is visible.

*m.* Adjust the AZIMUTH MARK control until the azimuth strobe is visible.

*n.* Place the AFC-MANUAL switch in the AFC position.

*o.* Turn the MARKERS switch to the ON position. The range markers should appear on the B-scope at ranges of 2,000, 4,000, 6,000, 8,000, 10,000, 12,000, and 14,000 meters. If the markers do not appear, the most probable cause is improper turning of the local oscillator.

*p.* Turn the local oscillator—

(1) Place the AFC-MANUAL switch in the MANUAL position.

(2) Operate the L. O. Raise-lower switch on the control-power supply panel to the RAISE position until the markers appear. If no markers appear within 40 seconds, move the L.O. switch to the LOWER position. If markers do not appear within 2 minutes, notify the radar repairman.

(3) When the range markers appear, operate the L. O. switch to the RAISE position and then to the LOWER position until maximum marker intensity is obtained. Return the AFC-MANUAL switch to the AFC position. The marker intensity should remain unchanged. If a decrease in marker intensity occurs, the AFC circuit requires adjustment by the radar repairman.

(4) There are two local oscillator frequencies that will cause the range markers to appear at full brilliance—one 30 megahertz above and one 30 megahertz below the transmitter frequency. The lower frequency is correct and is the only frequency at which the AFC circuit will "lock in." The AFC circuit is operating properly if the range marker intensity remains unchanged and the AFC crystal current is steady when the AFC-MANUAL switch is placed in the AFC position. The AFC crystal current may be measured on the TEST METER by setting the TEST METER SELECTOR switch in the AFC XTAL CUR position. The normal meter reading is 2.5. During normal operations, place the TEST METER SELECTOR switch in the AFC XTAL CUR position.

(5) If the range markers fade out entirely when the AFC-MANUAL switch is placed in the AFC position, the local oscillator is probably turned to the wrong frequency. To correct this, place the AFC-MANUAL switch in the MANUAL position and operate the L. O. switch to the LOWER position until the range markers reappear. Adjust the local oscillator for maximum intensity of the range markers. Return the AFC-MANUAL switch to the AFC position. No change in marker intensity should occur.

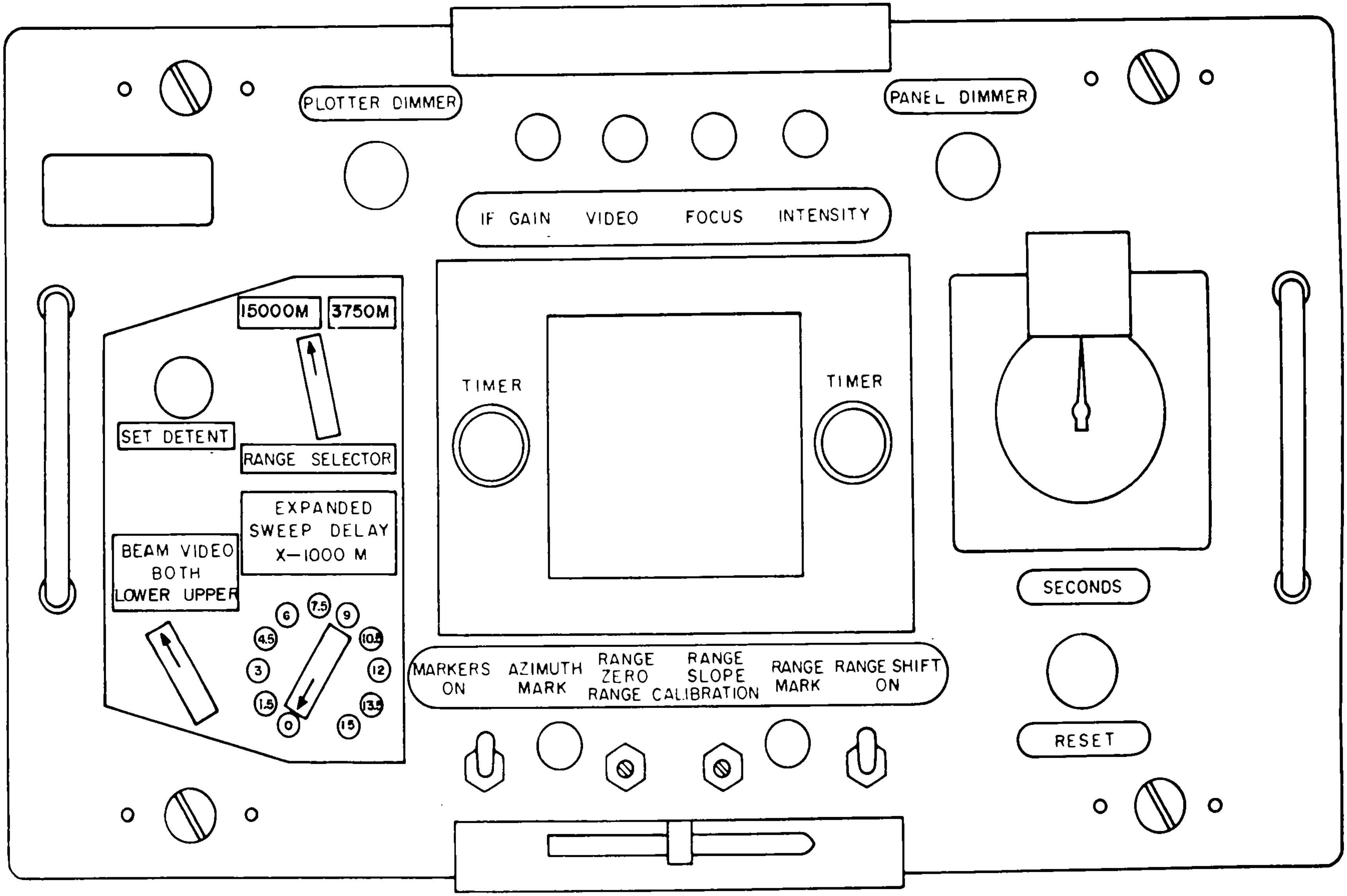


*Figure 3–13. Azimuth and range indicator panel.*

## Section IV. OPERATIONAL CHECKS

### 3-8. Ringtime Check

The purpose of the ringtime check is to determine the overall efficiency of the transmitter and receiver. The ringtime check is performed as follows:

*a.* Turn on the radar set and adjust the antenna elevation to minimize clutter on the B-scope.

*b.* On the control-power supply panel, check the MAGNETRON CURRENT meter reading to insure a reading of 18 millamperes.

*c.* On the indicator panel, set the RANGE SELECTOR switch to the 15000 M position.

***Caution.* Do not operate the magnetron at a current of less than 13 milliamperes.**

*d.* Turn the MARKERS switch to the ON position.

*e.* On the echo box (fig 3-14), rotate the TUNE knob until a peak reading is obtained on the RELATIVE POWER meter.

*f.* On the indicator panel, rotate the EXPANDED SWEEP DELAY switch until the bright band covers the area where the noise on the B-scope starts to build up.

*g.* Set the RANGE SELECTOR switch to the 3750 M position.

*h.* Adjust the IF GAIN control for maximum ringtime display.

*i.* With the LOWER BEAM RANGE control on the radar data computer panel (fig 3-15), place the range strobe over the point where the noise starts to build up.

*j.* Read the RANGE counter to obtain the ringtime distance. The minimum acceptable ringtime is 1,200 meters.

*k.* Detune the echo box.

*l.* Return the RANGE SELECTOR switch on the indicator panel to the 15000 M position.

*Note.* The automatic frequency control can be checked by the ringtime display. The ringtime measured with the AFC-MANUAL switch in the AFC position should not differ by more than 50 meters from the ringtime measured with it in the MANUAL position.

### 3-9. Azimuth Collimation Check

The purpose of the azimuth collimation check is to determine the angular separation between the optical axis and the center of scan. The procedure for performing this check is given in *a* through *e* below.

*a.* Determine the field correction in the following manner:

(1) Turn on the transmitter and allow the set to operate at least 30 minutes.

(2) On the echo box (fig 3-14), rotate the TUNE knob until a peak reading is obtained on the RELATIVE POWER meter.

(3) Read the frequency of the transmitter on the FREQUENCY-MC scale above the echo box TUNE knob.

(4) Apply the frequency obtained in (3) above to the chart on the inside of the echo box cover (fig 3-16), interplating if necessary. The value obtained is called the field correction. Figure 3-17 is a schematic drawing showing the results of a collimation check.

*b.* Select any target which can be positively identified both on the B-scope and through the orienting telescope. This target can be improvised, if necessary, and should be at least 500 meters from the radar. Place the RANGE SELECTOR switch in the 3750 M position, and position the EXPANDED SWEEP DELAY switch to a range which will display the desired target.

*c.* Move the radar in azimuth and elevation until the target is centered in the orienting telescope.

***Caution.* The azimuth handwheel on the frame of the radar should be used to move the antenna in azimuth. If the AZIMUTH switch on the control-power supply panel is used to move the antenna by small amounts, the azimuth brake may be damaged.**

*d.* On the computer panel, set the DETENT switch in the AZIMUTH ORIENT position, and place the Δ AZIMUTH control and the LOWER BEAM AZIMUTH control in detent.

*e.* The azimuth strobe should be off the center of the echo on the B-scope by the amount of the field correction. The strobe should be to the left if the correction is negative or to the right if the correction is positive. To verify the distance between the strobe and the center of the echo, note the azimuth reading; then place the DETENT switch in the OFF position, use the LOWER BEAM AZIMUTH control to move the azimuth strobe over the center of the echo, and read the azimuth counter. The difference between the two readings should be the value of the field correction.

### 3-10. Antenna Azimuth Orientation

The purpose of azimuth orientation is to set the correct azimuth reading on the computer panel AZIMUTH counter. There are two methods of orienting the antenna for azimuth—the electrical method and the optical method.

*a. Azimuth Orientation (Electrical Method)*

(1) On the indicator panel, turn the RANGE


*Figure 3-14. Echo Box.*

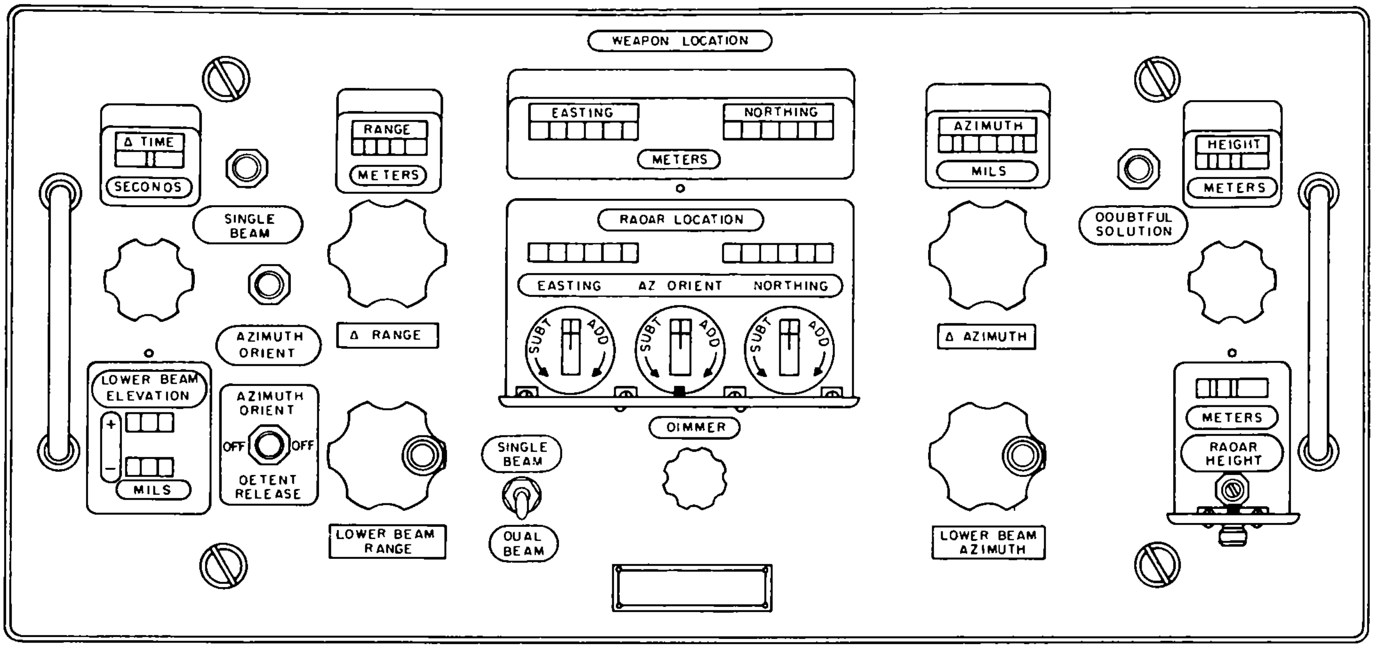


*Figure 3–15. Radar data computer panel.*

| FREQUENCY | FIELD |
|---|---|
| 16192 | +12 |
| 16176 | +11 |
| 16160 | +10 |
| 16144 | +9 |
| 16128 | +8 |
| 16112 | +7 |
| 16096 | +6 |
| 16080 | +5 |
| 16064 | +4 |
| 16048 | +3 |
| 16032 | +2 |
| 16016 | +1 |
| 16000 | 0 |
| 15984 | -1 |
| 15968 | -2 |
| 15952 | -3 |
| 15936 | -4 |
| 15920 | -5 |
| 15904 | -6 |
| 15888 | -7 |
| 15872 | -8 |
| 15856 | -9 |
| 15840 | -10 |
| 15824 | -11 |
| 15808 | -12 |

*Figure 3–16. Frequency correction chart.*

SELECTOR switch to the 3750 M position and the EXPANDED SWEEP DELAY switch to the range which will display the orienting point. Rotate the antenna until it is pointed generally toward the orienting point. Move the antenna in elevation, if necessary, until the orienting point appears as a target on the B-scope.

(2) On the computer panel, set the DETENT switch to the OFF position and place the Δ AZIMUTH control is detent.

(3) Rotate the LOWER BEAM AZIMUTH control until the azimuth strobe bisects the target (orienting point) on the B-scope.

*Note.* It may be necessary to adjust the IF GAIN control on the indicator panel to reduce the size of the echo so that it may be accurately bisected.

(4) On the computer panel, remembering the predetermined azimuth, hold the AZ ORIENT switch in the ADD (or SUBT) position until the AZIMUTH counter indicates the azimuth to the orienting point.

(5) Set the DETENT switch at AZIMUTH ORIENT and place the LOWER BEAM AZIMUTH control in detent. Note the reading of the azimuth counter on the counter. Apply the field correction, with its sign changed, to the computer AZIMUTH counter reading. Set the resulting figure into the azimuth counter on the radar frame.

*b. Azimuth Orientation (Optical Method).* When the optical method of orientation is used, the orienting telescope is used to sight on the orienting point.

(1) Position the antenna so that the orient-

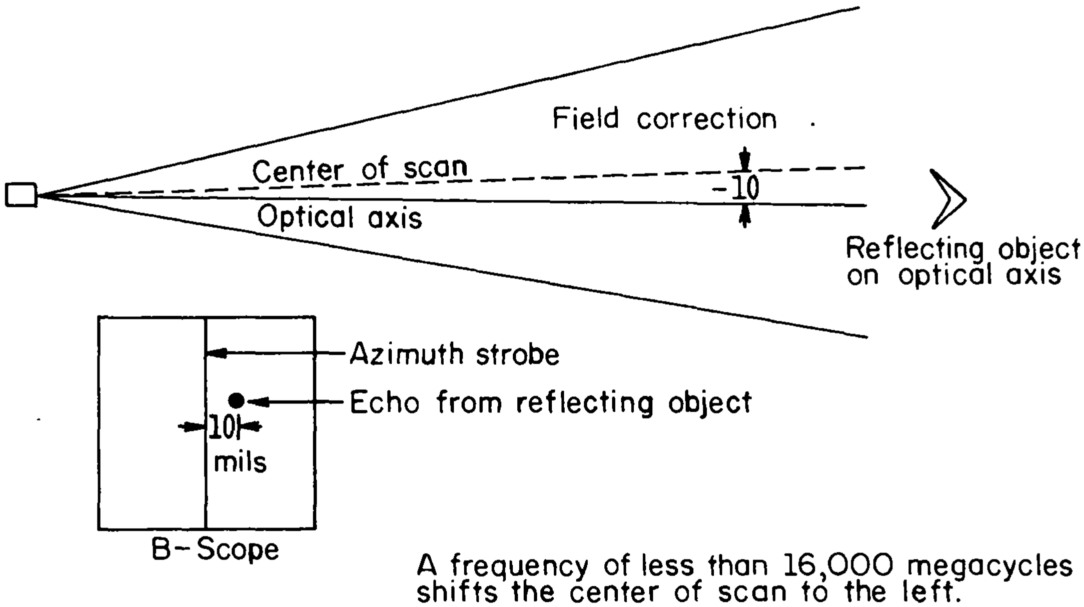


*Figure 3–17. Collimation check.*

ing point is centered in the telescope. Set the azimuth to the orienting point on the azimuth counter on the radar trailer frame.

(2) On the computer panel, set the DETENT switch to the AZIMUTH ORIENT position and place the Δ AZIMUTH control and the LOWER BEAM AZIMUTH control in detent.

(3) Apply the field correction, as indicated by its sign, to the azimuth to the orienting point. The result will be the corrected orienting azimuth.

Example:

When the field correction is positive:

| | |
|---|---|
| Azimuth to the orienting point | 1,653 mils |
| Field Correction | +4 mils |
| Correcting orienting azimuth | 1,657 mils |

When the field correction is negative:

| | |
|---|---|
| Azimuth to the orienting point | 1,653 mils |
| Field correction | −4 mils |
| Corrected orienting azimuth | 1,649 mils |

(4) On the computer panel, hold the AZ ORIENT switch in the ADD (or SUBT) position until the AZIMUTH counter indicates the corrected azimuth.

(5) Move the antenna in azimuth and elevation until a target echo which can be easily identified, is found. Read and record the azimuth and range to this target. This target can be used for future orientation checks and as an electrical orienting point during periods of poor visibility.

(6) If correct results are not obtained during azimuth collimation, notify the radar repairman. If no radar repairman is available, the equipment may still be operated by applying the difference in azimuth between the orienting telescope and the B-scope. The difference should be applied in the same manner as the field correction obtained from the echo box.

## 3–11. Elevation Orientation Check

The purpose of an elevation orientation check is to verify the alinement of the orienting telescope with the elevation dials. This check is used in applications such as a high-burst registration. The checkpoint may be a fixed point of known elevation, or it may be a fire control instrument, such as an aiming circle. To perform the elevation orientation check—

*a.* Check the level of the set.

*b.* Position the antenna so that the checkpoint is centered in the orienting telescope.

*c.* Determine the correct elevation to the checkpoint from the antenna ELEVATION-DEPRESSION counter on the frame of the radar. Record for future reference any error greater than 1mil. Any vertical angle correction (VAC) recorded must be applied to the mean elevation deviation spottings for high-burst registrations.

## 3–12. Range Calibration

The purpose of range calibration is to aline the range circuits so that the actual range will be indicated on the range counter. Before range calibration is performed, the generator must be hooked to the radar and power turned on, the transmitter must be on, and the local oscillator must be tuned.

*a.* The procedure for performing range calibration with the range markers is as follows:

(1) On the indicator panel (fig 3–13), turn the RANGE SHIFT switch to the OFF position.

(2) On the computer panel (fig 3–15), set the DETENT switch to the OFF position and set the Δ RANGE control is detent. This will allow any given range to be set into the computer.

(3) Set the range strobe to 2,000 meters by using the LOWER BEAM RANGE control.

(4) On the indicator panel (fig 3–13), set the RANGE SELECTOR switch to the 3750 M position.

(5) Set the EXPANDED SWEEP DELAY switch to position 0.

(6) Set the markers switch on the ON position. An adjustment of the IF GAIN control may be necessary to cause the markers to appear at proper intensity.

(7) If the range marker does not fall exactly over the strobe, adjust the RANGE ZERO control until it does.

(8) Set the EXPANDED SWEEP DELAY switch to position 12.

(9) Set the range strobe to 14,000 meters.

(10) If the range marker does not appear exactly over the strobe, adjust the RANGE SLOPE control until it does.

(11) Since the RANGE ZERO and RANGE SLOPE control interact, recheck the RANGE SLOPE adjustment at 14,000 meters after each change in RANGE ZERO at 2,000 meters after each change in RANGE SLOPE at 14,000 meters.

*b.* To verify the range calibration, measure the range to an electrical target with the radar set. This reading should be within 20 meters of the surveyed range.

## 3–13. Computer Alinement Checks

The purpose of the computer alinement check is to insure that the computer is providing accurate locations.

*a.* Compare the reading on the ELEVATION-DEPRESSION counter on the antenna with the reading on the LOWER BEAM ELEVATION counter on the computer as follows:

(1) Use the ELEVATION switch on the control-power supply panel to position the antenna in elevation so that the following readings are obtained on the LOWER BEAM ELEVATION counter on the computer panel: −100, −50, 0, 50, 100, 150, and 200 mils.

(2) Check to insure that the readings on the antenna ELEVATION-DEPRESSION counter correspond to those in (1) above. If the readings are not within 2 mils, notify the radar repairman.

*b.* Check the azimuth controls on the computer panel and the B-scope on the indicator panel as follows:

(1) Set the DETENT switch to the OFF position, and place the Δ AZIMUTH control in detent.

(2) Rotate the LOWER BEAM AZIMUTH control clockwise. The AZIMUTH counter reading should *increase,* and the B-scope azimuth strobe should move to the right.

(3) Rotate the LOWER BEAM AZIMUTH control, counterclockwise. The AZIMUTH counter reading should *decrease,* and the B-scope azimuth strobe should move to the left.

(4) With a white grease pencil, make a short, thin, vertical line on the face of the B-scope where the strobe appears.

(*a*) Using the LOWER BEAM AZIMUTH control, superimpose the azimuth strobe over the vertical line. Make the last movement of the LOWER BEAM AZIMUTH control in a clockwise direction. Note the reading on the AZIMUTH counter.

(*b*) Repeat (*a*) above, making the last movement of the LOWER BEAM AZIMUTH control in a counterclockwise direction. Note the reading on the AZIMUTH counter.

(*c*) The two readings obtained in (*a*) and (*b*) above should agree. If the readings do not agree, notify the radar repairman.

(5) Set the DETENT switch to the DETENT RELEASE position and check to see that the SET DETENT indicator light on the indicator panel is on.

(6) Rotate the Δ AZIMUTH control clockwise. The AZIMUTH counter reading should *decrease,* and the B-scope azimuth strobe should move to the right.

(7) Rotate the Δ AZIMUTH control counterclockwise. The AZIMUTH counter reading should *increase,* and the B-scope azimuth strobe should move to the left.

*c.* Check the range controls on the computer panel and the B-scope on the indicator panel as follows:

(1) Rotate the LOWER BEAM RANGE control clockwise. The RANGE COUNTER reading should *increase*, and the B-scope range strobe should move *up*.

(2) Rotate the LOWER BEAM RANGE control counterclockwise. The RANGE counter reading should *decrease*, and the B-scope range strobe should move *down*.

(3) Rotate the Δ RANGE control clockwise. The RANGE counter reading should *decrease*, and the B-scope range strobe should move *up*.

(4) Rotate the Δ RANGE control counterclockwise. The RANGE counter reading should *increase*, and the B-scope range strobe should move *down*.

(5) Move the DETENT switch to the OFF position and place the Δ RANGE and Δ AZIMUTH controls in detent. The SET DETENT indicator light should go out.

*d.* On the computer panel, check the RADAR HEIGHT computer by rotating its adjustment screw. The RADAR HEIGHT counter reading should change, and the weapon HEIGHT counter reading should also change the same amount.

*e.* On the computer panel, check the weapon HEIGHT counter by rotating its control knob. Only the reading on the weapon HEIGHT counter should change.

*f.* On the computer panel, check the RADAR LOCATION counters and the WEAPON LOCATION counters as follows:

(1) Hold the RADAR LOCATION EASTING switch in the SUBT position. Both EASTING counter readings should decrease.

(2) Hold the RADAR LOCATION EASTING switch in the ADD position. Both EASTING counter reading should increase.

(3) Repeat (1) and (2) above with the RADAR LOCATION NORTHING switch for both NORTHING counter readings.

*g.* Check the accuracy of the AZIMUTH counter movement as follows:

(1) Set the antenna azimuth counter to zero by using the counter handcrank.

(2) Turn the RADAR LOCATION AZ ORIENT switch on the computer until the AZIMUTH counter reads zero.

*Note.* Do not disturb any of the computer controls during the next procedure.

(3) Using the AZIMUTH CCW-CW switch, rotate the antenna clockwise in increments of approximately 800 mils from 800 to 6,400 mils. If the antenna passes the specified azimuth positions, do not jog the antenna back in the opposite direction.

(4) At each of the 800-mil increment positions, the computer AZIMUTH counter reading must equal the antenna azimuth counter reading within ± 1 mil.

(5) Repeat the procedure given in (1) through (4) above, rotating the antenna counterclockwise.

*h.* After all the components of the computer have been checked, check the accuracy of the computer. The accuracy check consists of a series of four problems (fig 3–18), which are set into the computer. Each day and/or each time the set is moved, the operator should peform the accuracy check and compare the output data against the solutions furnished by the radar repairman. The accuracy check for dual beam operation is performed as follows:

(1) Insure that the computer drawer is open and that the INTERLOCK SHORT switch is closed (fig 3–19).

***Warning.* Dangerous voltages exist within the cabinet.**

(2) Check that the reading the BEAM SEPARATION dial (fig 3–20) on the left side of the computer drawer is the same as that on the beam separation plate on the antenna.

(3) Insert the radar location data into the computer.

(*a*) Use the EASTING and NORTHING switches to set the EASTING and NORTHING counters to zero.

Radar set serial number_____ Date of alinement________ Alined by_______

| Problem number | Lower beam azimuth | Elevation | Lower beam range | Upper beam azimuth | Upper beam range | Time | Weapon height | Output data Easting | Output data Northing |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0000 | +20 | 8,000 | 0030 | 8,200 | 2.0 | 300 | | |
| 2 | 1600 | +40 | 5,000 | 1620 | 5,100 | 2.0 | 400 | | |
| 3 | 3200 | +10 | 8,000 | 3170 | 7,800 | 1.5 | 50 | | |
| 4 | 4800 | +40 | 5,000 | 4780 | 4,900 | 4.0 | 200 | | |

*Figure 3–18. Computer accuracy check (dual beam operation).*

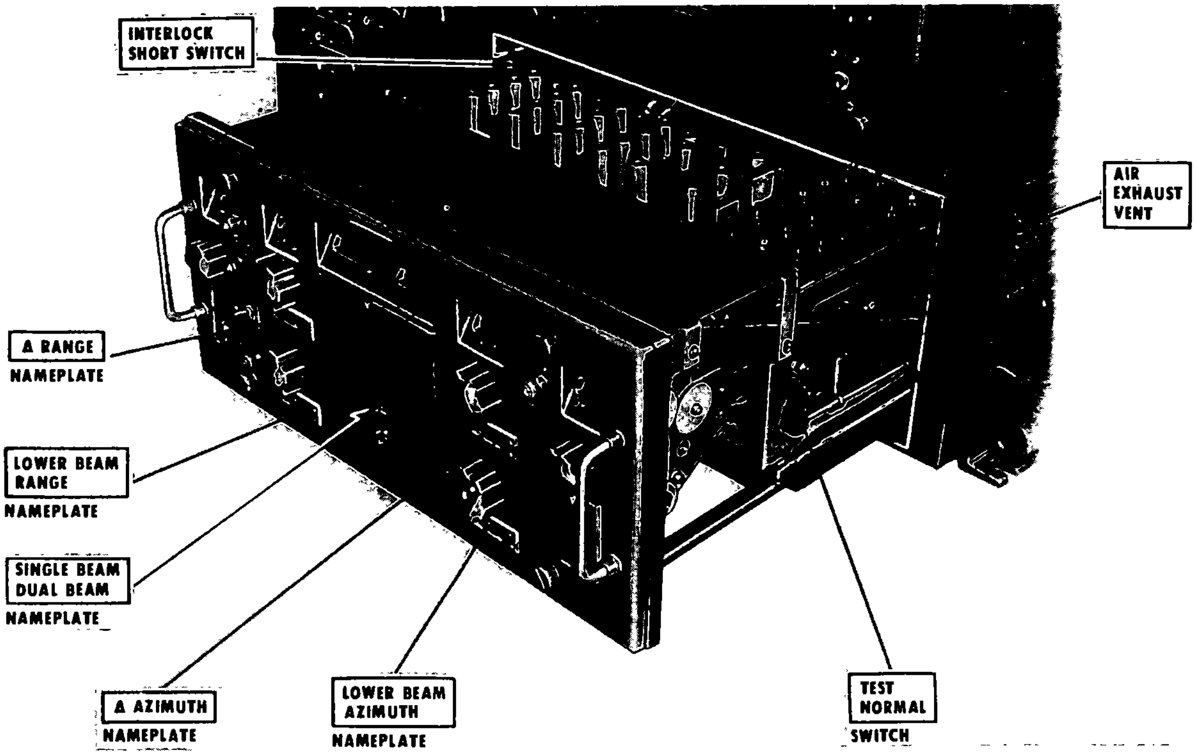


*Figure 3–19. Partial view of radar data computer.*

*Note.* If the actual radar location data has already been inserted into the computer, it is not necessary to set the EASTING and NORTHING counters to zero. Algebraically add the actual radar EASTING and NORTHING to the WEAPON LOCATION EASTING AND NORTHING (the answer to the problem) and compare the resulting values with the problem solution furnished by the radar repairman.

(*b*) Set the RADAR HEIGHT counter to 300 meters.

(*c*) Set the SINGLE BEAM-DUAL BEAM switch to DUAL BEAM.

(4) Set the radar at the proper angle of elevation.

(5) Set the DETENT switch to its OFF position.

(6) Place the Δ RANGE and Δ AZIMUTH controls in detent.

(7) Insert the azimuth, using the AZIMUTH switch on the control-power supply panel and the LOWER BEAM AZIMUTH control on the computer panel.

(8) Insert the lower beam range.

(9) Turn the TEST-NORMAL switch (fig 3–19) to the TEST position.

(10) Set the DETENT switch to DETENT RELEASE.

(11) Insert the upper beam azimuth with the Δ AZIMUTH control.

(12) Insert the upper beam range with the Δ RANGE control.

(13) Turn the TEST-NORMAL switch (fig 3–19) to the NORMAL position.

(14) Insert the time with the Δ TIME control.

(15) Insert the weapon height into the computer.

(16) Check the WEAPON LOCATION EASTING and NORTHING against the problem solution furnished by the radar repairman.

(17) The error in either easting or northing should not exceed 20 meters, the sum of the errors in easting and northing should not exceed 36 meters. If the answer to any problem is out of tolerance, notify the radar repairman.

*i.* The operator can check the accuracy of the computer for single beam operation by performing the test problems in the computer accuracy check chart for single beam operation contained in (fig 3–21). It is assumed that the requirement of normal dual beam operation check (para *h* above) have been met. The accuracy of the computer during single beam operation is not acceptable when the computer solution of any problem contains an error of more than 40 meters for weapon easting or northing; or more than 70 meters for combined easting and north-

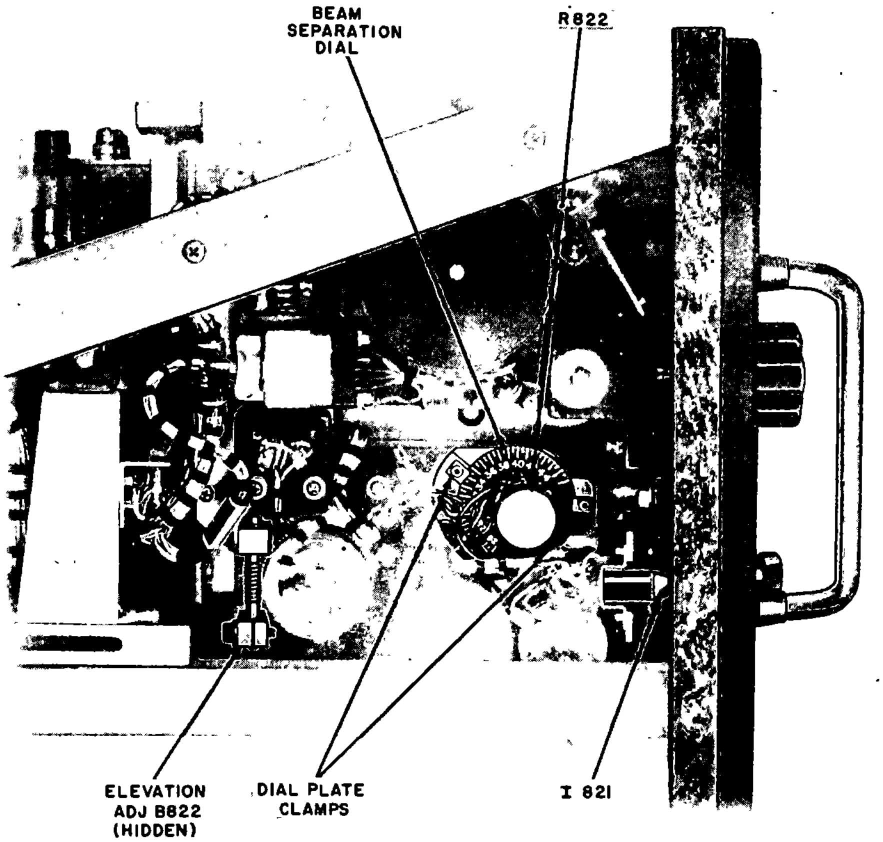


*Figure 3–20. Beam separation dial on radar data computer.*

ing, or more than .15 for "C." Follow the instructions given below for setting the values given in the chart into the computer.

(1) On the computer, set RADAR LOCATION EASTING and NORTHING COUNTERS TO 000000 METERS.

(2) Set SINGLE BEAM-DUAL BEAM switch to SINGLE BEAM.

(3) Set weapon HEIGHT and RADAR HEIGHT counter to 1000 METERS.

(4) With the detent switch in the OFF position, set Δ RANGE and Δ AZIMUTH handwheels in detent.

(5) For each problem in the chart (fig 3–21), with the TEST-NORMAL switch on the right side of the computer at TEST, set Δ T, Hw, R1, AZ, E1, Δ R and Δ A as given in the chart. Then set the TEST-NORMAL switch to NORMAL and read weapon range (Rw), weapon azimuth (Aw), weapon easting (Ew), weapon northing (Nw) and "C" solutions on the computer and compare these solutions with those given in the chart.

*Note.* When setting AZ into the computer, first use the AZ ORIENT switch, followed by a fine setting using the LOWER BEAM AZIMUTH control. Just before setting Δ R and Δ A into the computer, set the detent switch to DETENT RELEASE.

(6) Repeat the above procedures for the remaining problems. If the readings are not within the tolerances outlined above, then notify the radar mechanic.

(7) Return the SINGLE BEAM-DUAL BEAM switch to DUAL BEAM and close the computer drawer.

## 3–14. Radar Location Data

After completing the computer accuracy check, establish the grid reference of the radar by inserting the true radar location into the computer as follows:

*a.* Use the RADAR LOCATION EASTING and NORTHING switches to insert the grid reference of the radar location into the computer.

*b.* Use the RADAR HEIGHT knob to insert the altitude of the radar in *meters* into the computer.

*c.* If maps are available, determine the average altitude of the terrain in the area of interest in meters and insert this altitude into the weapon HEIGHT counter on the computer. If maps are not available, insert the altitude of the radar into the weapon HEIGHT counter.

## Section V. STOPPING PROCEDURES

### 3–15. Radar Set

The procedure for stopping the radar set is as follows:

*a.* Turn the MAGNETRON POWER control fully counterclockwise.

*b.* Press the STOP switch on the control-power supply to turn off the transmitter.

*c.* Elevate the antenna to approximatley + 175 mils.

*d.* Turn the MAIN POWER switch to the OFF position. The READY indicator lamp and the MAIN POWER ON & INTLK CLOSED indicator lamp will go out.

### 3–16. Power Unit

The procedure for stopping the power unit is as follows:

*a.* Place the CIRCUIT BREAKER in the OFF position.

*b.* Allow the engine to run at rated speed for 3 to 5 minutes.

*c.* Place the START-STOP switch in the STOP position.

*d.* Place the fuel selector valve in the OFF position.

*e.* Perform the after-operation maintenance check.

| COMPUTER ACCURACY CHECK (SINGLE BEAM OPERATION) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROBLEMS | | | | | | | | CORRECT SOLUTIONS | | | | | |
| PROBLEM NO. | $\Delta T$ | $H_W$ | $R_L$ | AZ | $E_L$ | $\Delta R$ | $\Delta A$ | $R_W$ | $A_W$ | $E_W$ | $N_W$ | C |
| 1 | 0.0 | 0930 | 5000 | 6390 | 07 | 0 | +10 | 5000 | 0000 | 000000 | 005000 | 1 |
| 2 | 0.0 | 1000 | 5000 | 0000 | 21 | +100 | 0 | 5103 | 0000 | 000000 | 005103 | 1.03 |
| 3 | 0.0 | 1000 | 6000 | 1600 | 28 | −100 | 0 | 5856 | 1600 | 005856 | 000000 | 1.44 |
| 4 | 0.0 | 1000 | 5600 | 0800 | 28 | + 50 | 0 | 5677 | 0800 | 004014 | 004014 | 1.53 |
| 5 | 0.0 | 1070 | 4500 | 5600 | 35 | − 50 | 0 | 4457 | 5600 | 996849 | 003151 | .86 |
| 6 | 0.0 | 1000 | 4900 | 3990 | 21 | 0 | +10 | 4900 | 4000 | 996536 | 996536 | 1 |

*Figure 3–21. Computer accuracy chart, (Single beam operation).*

# CHAPTER 4

# WEAPON AND IMPACT LOCATION

## Section I. WEAPON LOCATION

### 4–1. General

The radar has a capability to detect and locate mortars and a limited capability to detect and locate cannon artillery and rocket-launching sites. The techniques employed in locating mortars may be divided into two phases—detection and location. Both phases can be accomplished with the same projectile.

### 4–2. Detection

*a.* A sector of search will be assigned to the radar normally by the direct support battalion commander. Normally, this sector of search will be the zone of action of the supported unit and, will vary with the tactical situation. The radar should be sited for maximum coverage of its assigned sector of search. Depending on the sector width and the location of the radar, the entire sector may be covered with one position of the radar antenna (445-mil sector width). However, the sector of search may be so large that the radar will be capable of scanning only a portion at any one time. If so, the radar should scan one portion for a short period of time and then another portion until the entire sector has been covered.

*b.* When a projectile is fired so that it passes through both beams of energy sent out by the radar set AN/MPQ–4A (fig 4–1), the point at which the projectile intersects each beam is indicated by a bright spot (echo) on the B-scope. The elapsed time between the appearance of these echoes is measured with the timer. The transparent cover over the B-scope is a reflection-type plotter. As each echo appears on the B-scope, a mark is made on the plotter with a white grease pencil to indicate the exact location of the point at which the projectile intersected the beam of energy. The mark on the plotter is reflected on the cathode-ray tube behind the plotter. This feature eliminates errors due to parallax between the echo on the cathode-ray tube and the white grease pencil mark on the plotter. Careful adjustment of the PLOTTER DIMMER control is necessary to make the reflections clearly visible. The grease pencil marks are placed so that their reflections are centered over the echoes. These two operations, i.e., measuring the elapsed time and marking the B-scope, constitute the direction phase of weapon location.

### 4–3. Operating Procedure

*a.* Move the AZIMUTH switch on the control-power supply panel to the CW (clockwise) or CCW (counterclockwise) position to rotate the antenna to any 445-mil sector of the anticipated target area.

*b.* Move the ELEVATION switch to its RAISE and LOWER position to position the reflector so that the elevation angle will be 10 mils above the highest point on the screening crest. At this point, ground clutter should decrease.

*Note.* Use the radar site evaluation chart, or, if necessary, the telescope to determine the angle of elevation to the top of the screening crest.

*c.* Place the RANGE SHIFT switch on the indicator panel in the ON position. This will displace the video display of the upper and lower beams so that the two target echoes will not appear as one.

*d.* When the projectile passes through the two beams, two target echoes will appear, one from the lower beam and one from the upper beam (fig 4–2). At the instant the first echo is seen on the B-scope, press either of the two TIMER buttons on the indicator panel to start the SECONDS timer and mark the presentation with a white grease pencil. When the second echo appears, press either TIMER button again to stop the SECONDS timer and mark the second presentation with the grease pencil. The elasped time between echoes will appear on the SECONDS timer.

### 4–4. Computing the Weapon Location

*a.* Place the DETENT switch on the OFF position and the Δ RANGE and Δ AZIMUTH controls in detent. Turn the LOWER BEAM

RANGE control until the lower range strobe intersects the first (lower beam) mark on the B-scope (fig 4–3).

*b.* Turn the LOWER BEAM AZIMUTH control until the Azimuth Strobe intersects the lower echo mark.

*c.* Place the DETENT switch in the DETENT RELEASE position.

*d.* Rotate the Δ RANGE control until the upper beam range strobe intersects the upper beam mark on the B-scope (fig 4–4).

*e.* Rotate the Δ AZIMUTH control until the azimuth strobe intersects the upper beam mark.

*f.* Rotate the Δ TIME control until the time lapse between the appearance of the two echoes appears on the Δ TIME counter.

*Note.* If Δ TIME has not been measured, insert 0.8 seconds.

*g.* Read the WEAPON LOCATION EASTING and NORTHING counters to obtain the uncorrected grid coordinates of the weapon. The uncorrected polar coordinates of the weapon are read from the RANGE and AZIMUTH counters.

## 4–5. Corrections for Difference in Altitude

*a.* If, after plotting a weapon location on a contour map, it is determined that the altitude of the plotted point differs from that of the radar by more than 20 meters, set the altitude of the plotted point in meters on the weapon HEIGHT counter. This action may change the weapon location coordinates.

*Note.* Continue until difference in altitude is less than 20 meters.

*b.* Make certain that the DOUBTFUL SOLUTION indicator lamp is off.

*Note.* If the lamp lights, the accuracy of the weapon location is questionable (error probably greater than 50 meters for high-angle weapons, or 200 meters for low-angle weapons).

*c.* Read and record the final values on the WEAPON LOCATION EASTING and NORTHING counters to obtain the location of the weapon position.

*d.* Place the DETENT switch in the OFF position.

*e.* Reset the Δ RANGE and Δ AZIMUTH controls to their detent positions.

*f.* On the indicator panel, press the RESET switch to return the SECONDS timer to zero. The radar equipment is now prepared for the next mission.

*g.* If the RANGE SELECTOR switch on the indicator panel is in the 15000 M position, set the EXPANDED SWEEP DELAY switch so that the bright band on the B-scope includes the approximate position of the target, as shown in figure 4–5. Turn the LOWER BEAM RANGE

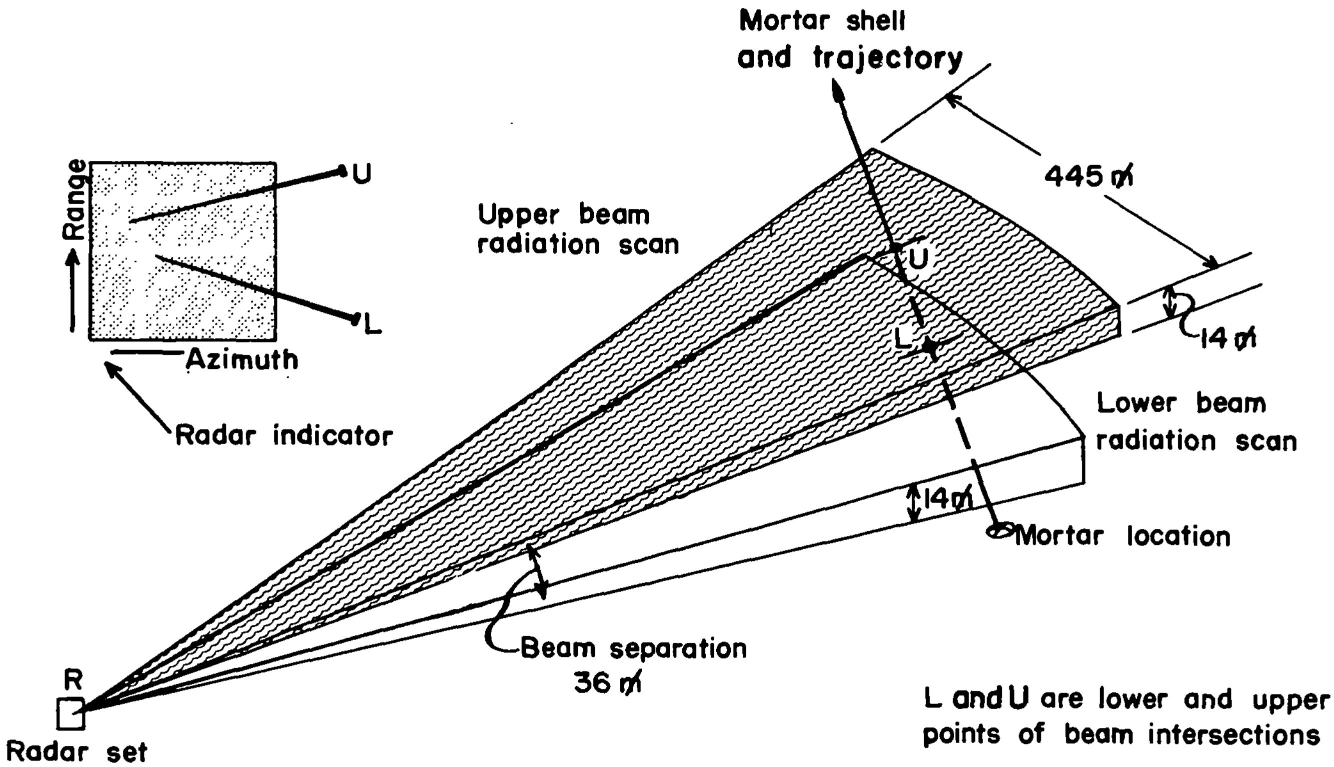


*Figure 4–1. Scanning pattern for weapon location.*

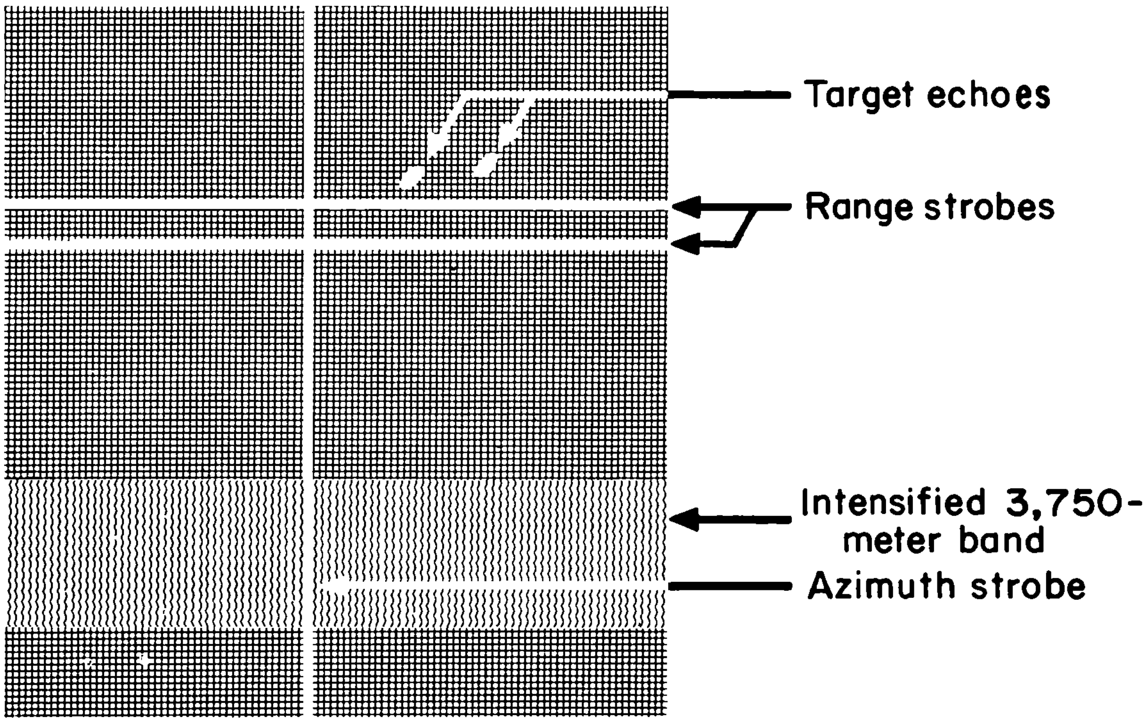


*Figure 4–2. B-scope presentation (15,000-meter range sweep).*

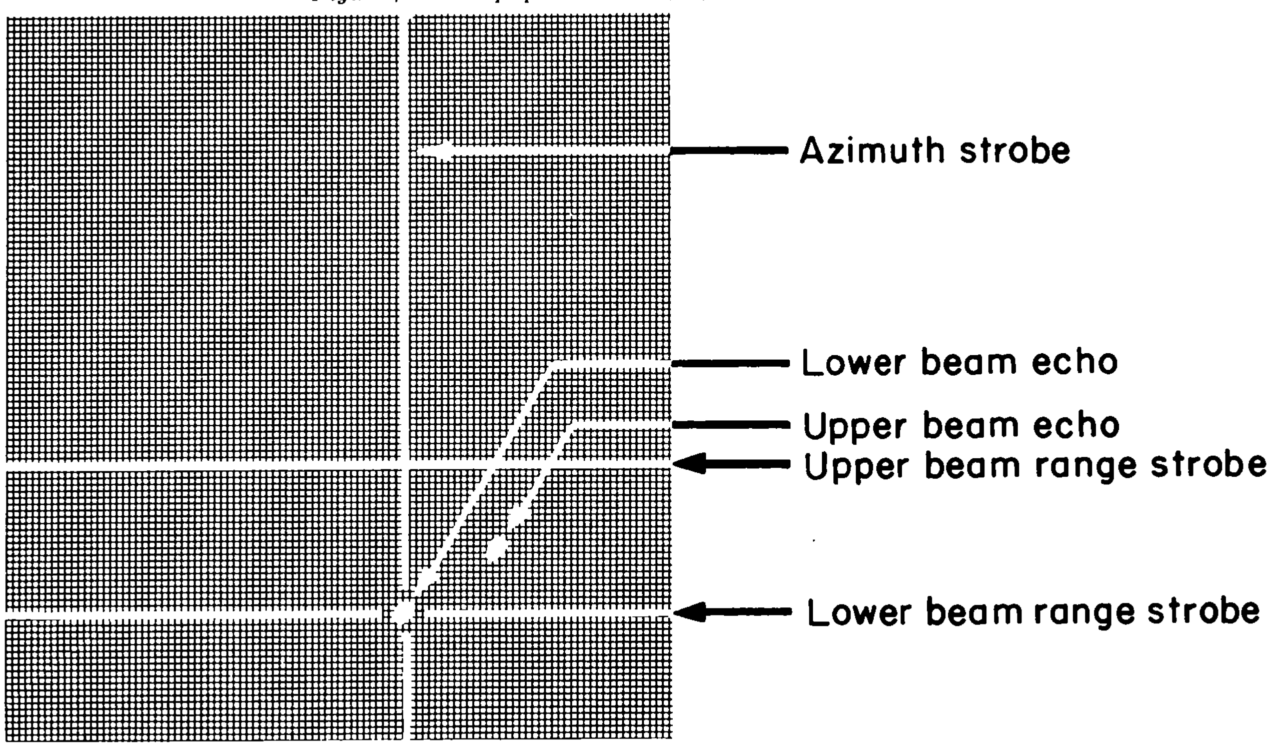


*Figure 4–3. Strobing the lower echo (3,750-meter range presentation).*

control on the computer panel to set the range strobes within the bright band. To expand the bright band over the entire area of the screen, turn the RANGE SELECTOR switch to the 3750 M position (fig 4–6). (When the approximate position is known, it will be possible for the operator to expand the sweep before the target appears on the B-scope). Note in figure 4–7 that the Δ

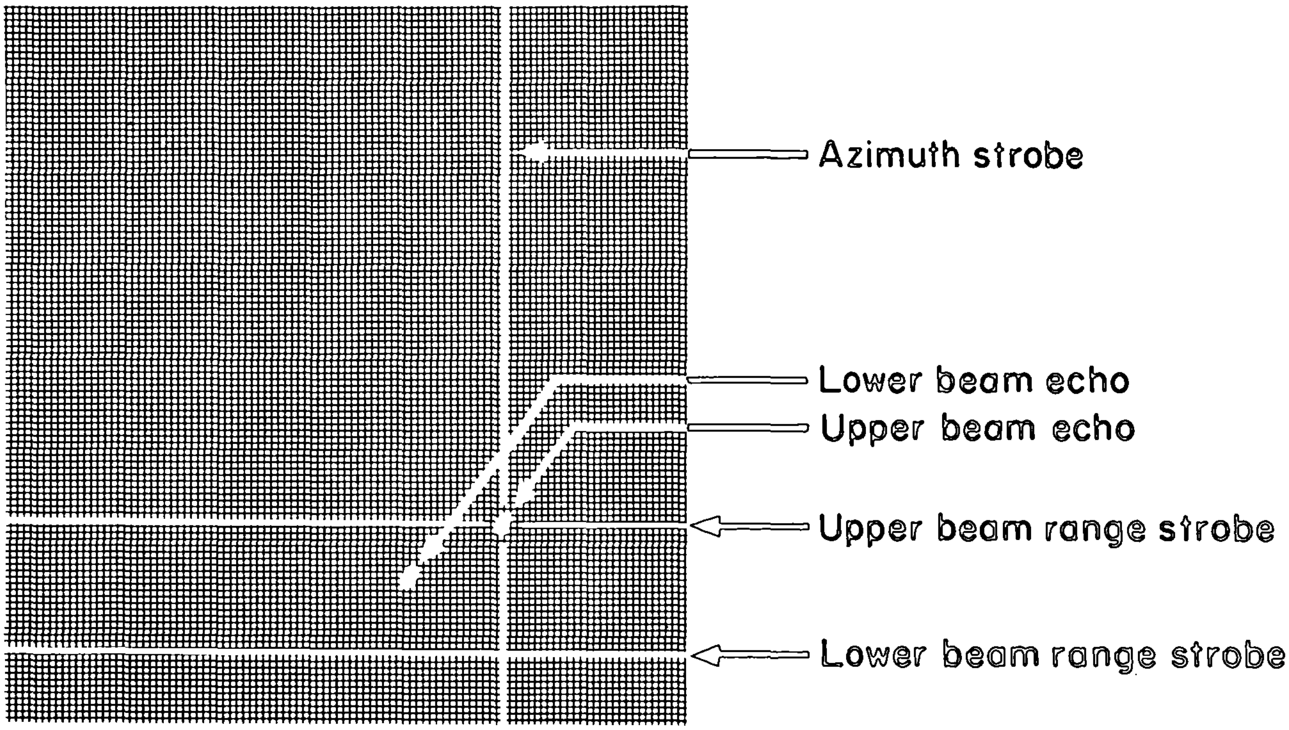


*Figure 4–4. Strobing the upper echo (3,750-meter range presentation.*

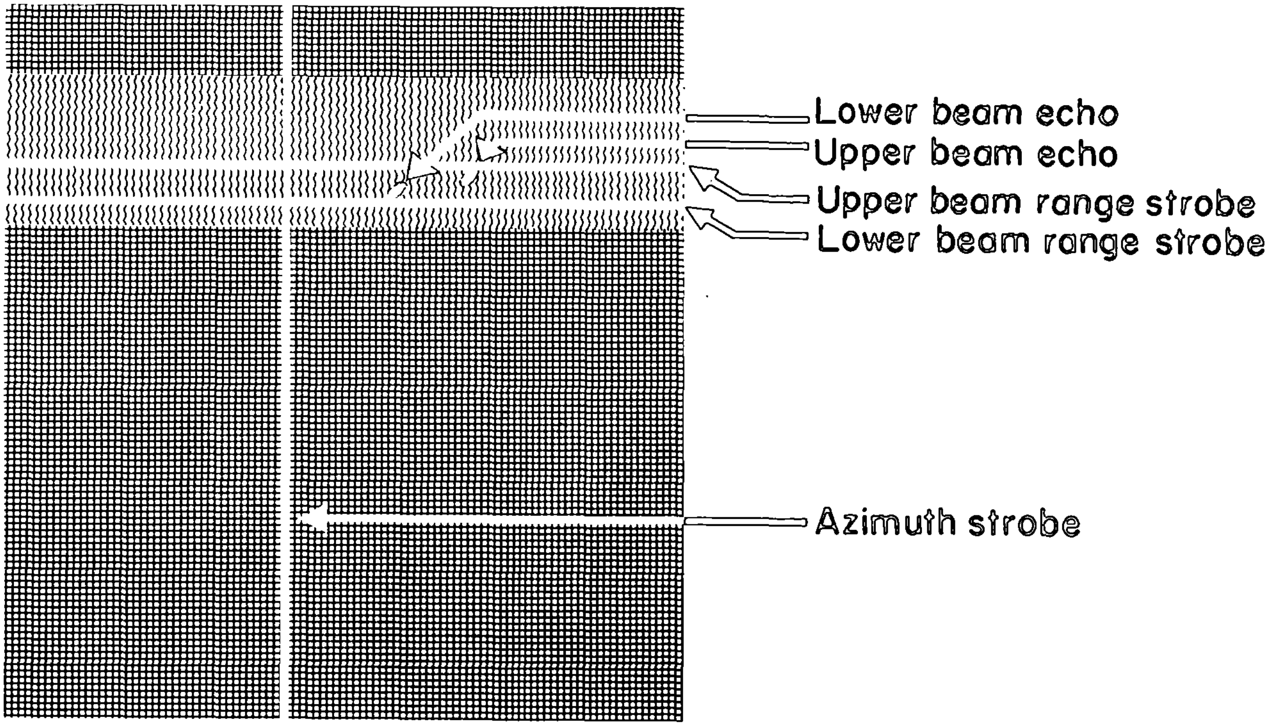


*Figure 4–5. 3,750-meters bright band over the point where the echoes appeared.*

time measurement becomes more important as the angle of elevation of the loser beam increases.

## 4–6. Single-Beam Extrapolation of a Low Angle Trajectory

*a.* In many cases the trajectory of a projectile

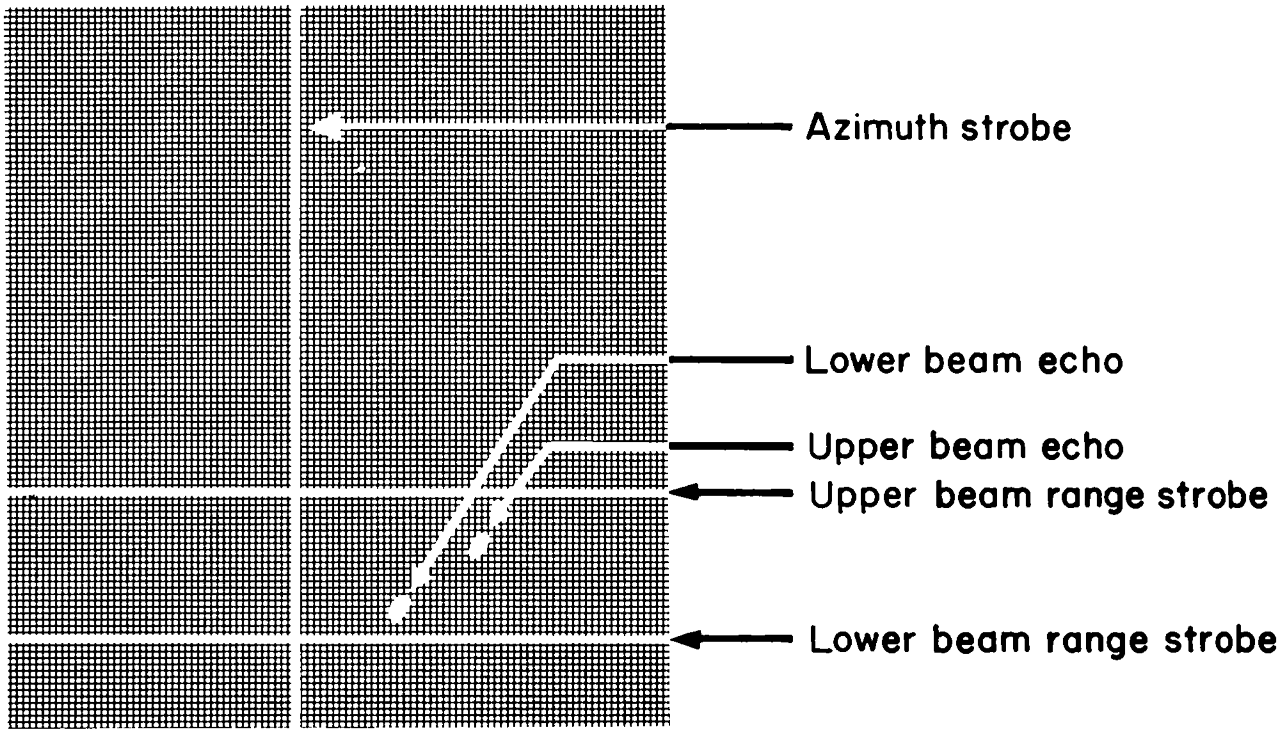


*Figure 4–6. Echo presentation of a subsequent round with 3,750-meter range presentation.*

is so shallow that the projectile passes through the lower beam but not through the upper beam, making dual beam locations impossible. Provision has been made in the radar set for the operator to select, after detection of the projectile, either the normal dual-beam extrapolation for high-angle trajectories or single-beam extrapolation for low-angle trajectories.

*b.* This selection is made by means of a SINGLE BEAM-DUAL BEAM switch mounted on the computer front panel (fig 4–8). When this switch is in the SINGLE BEAM position, the portion of the trajectory within the lower beam is substituted for the portion between beam centers as the trajectory sample used for computing the weapon location (fig 4–9). A projectile with a low-angle trajectory appears on the B-scope as a trace rather than as a spot. In single beam operation, the lower end of the projectile trace is used as though it were a lower beam intercept point, and the upper end of the projectile trace is used as though it were an upper beam intercept point. These two points determine the weapon position, or the point of impact of the projectile, in a manner similar to dual beam operation.

*c.* Procedures used for single beam operation are described in paragraph 4–9.

## 4–7. Operating Procedures

*a.* When the presentation characteristic of a low-angle projectile appears on the B-scope (fig 4–10), the operator—

(1) Marks each end of the lower beam presentation (fig 4–11).

(2) Sets the SINGLE BEAM-DUAL BEAM switch to SINGLE.

(3) Turns off the RANGE SHIFT.

(4) Strobes the mark representing the lower beam entry point (beginning of the presentation) using the lower beam handwheels (fig 4–12).

(5) Strobes the remaining mark using the Δ azimuth and Δ range handwheels (fig 4–13).

(6) Inserts the measured Δ time.

*Note.* If the Δ time has not been measured, an arbitrary Δ time 0.6 seconds should be inserted.

(7) Reads the weapon location from the coordinate counters.

(8) Compensates for the difference in altitude between the radar and weapon locations in the same manner as for dual-beam locations.

(9) Resets the SINGLE BEAM-DUAL BEAM switch to DUAL.

*b.* When performing single-beam locations the scanning elevation should not exceed +35 mils.

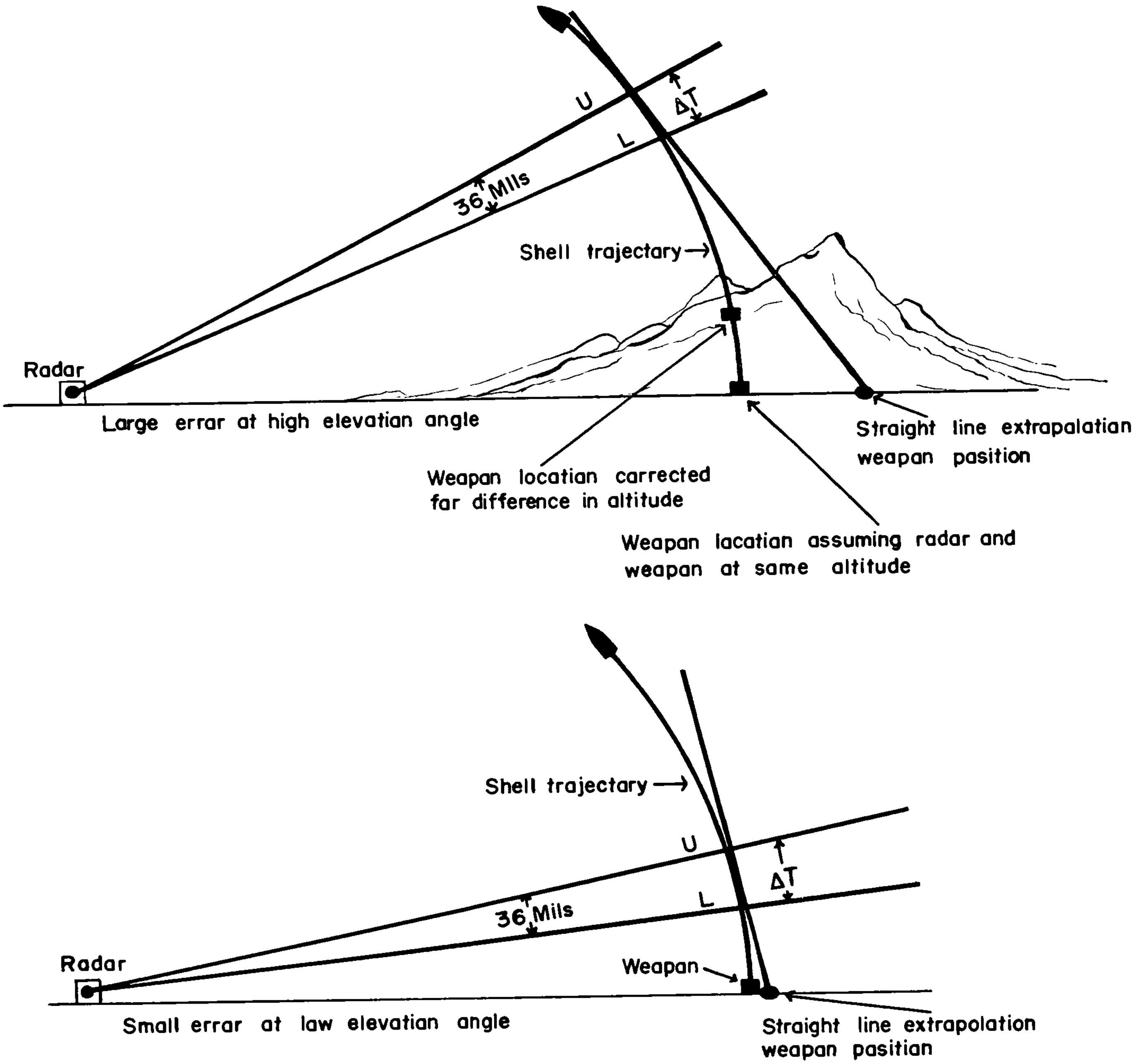


*Figure 4–7. Effects of Δ time and difference in altitude on the weapon location.*

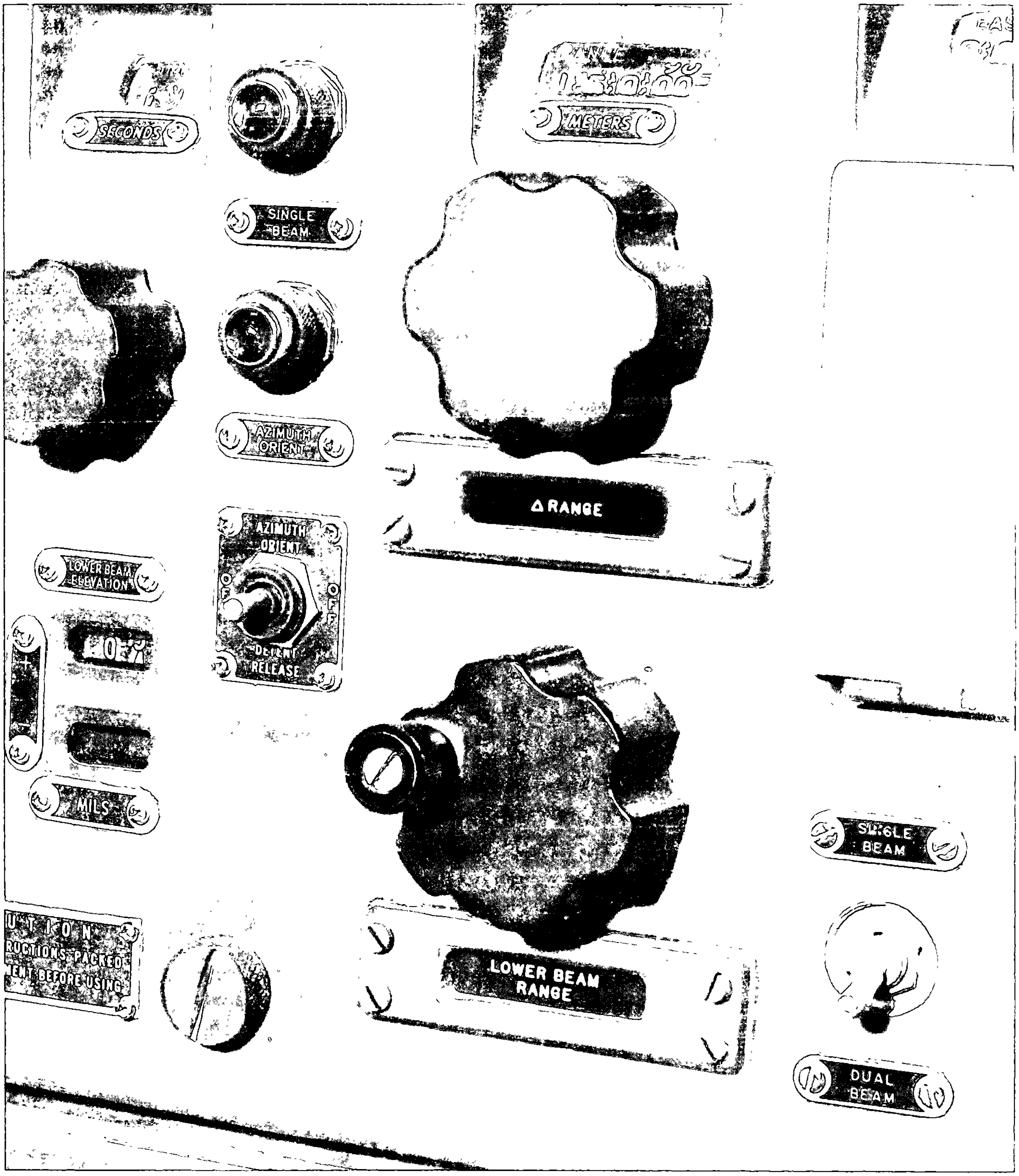


*Figure 4–8. Partial view of the radar data computer panel.*

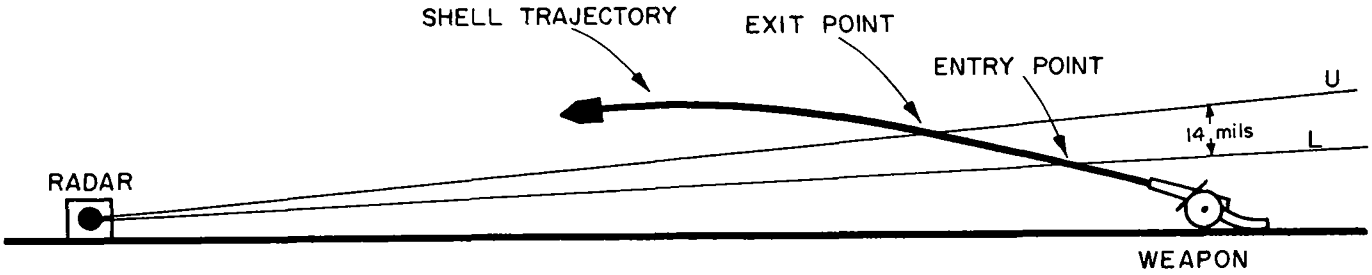


*Figure 4–9. Detection of a projectile traveling along a low-angle trajectory.*

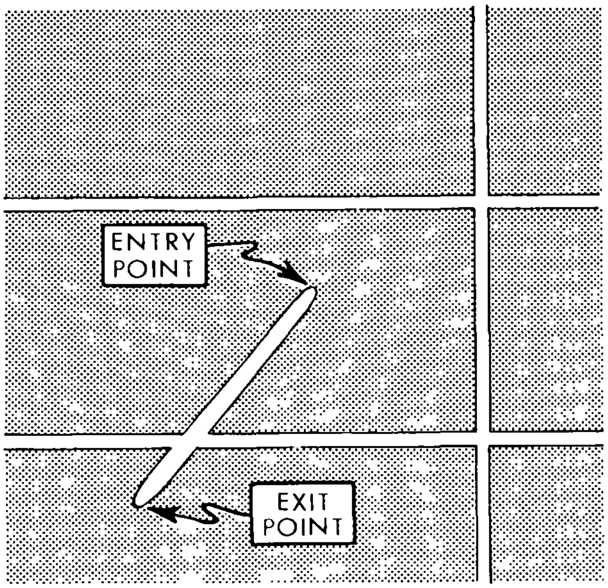


*Figure 4–10. B-scope presentation of a low-angle projectile.*

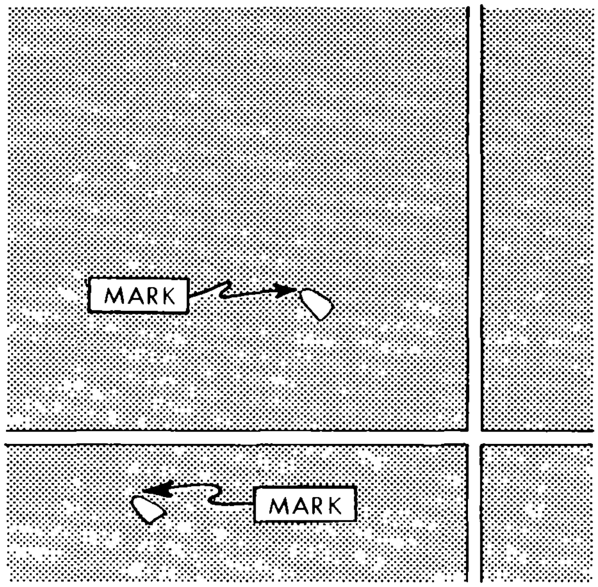


*Figure 4–11. B-scope presentation with entry and exit points marked SINGLE-DUAL switch set at SINGLE, and RANGE SHIFT off.*

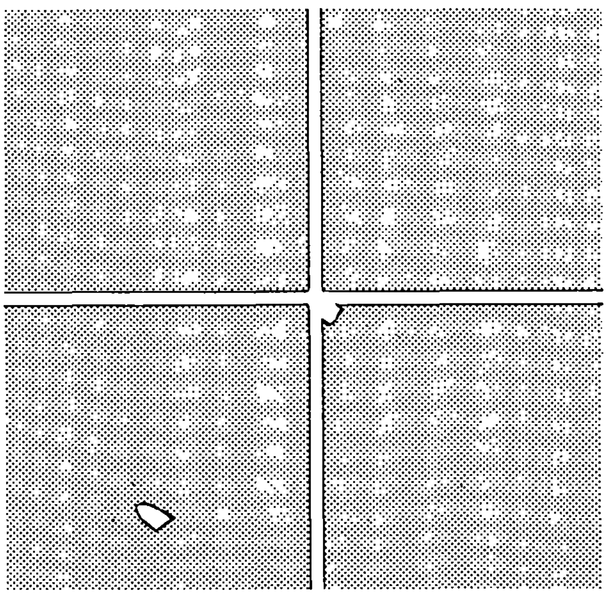

*Figure 4–12. Strobing the entry point.*

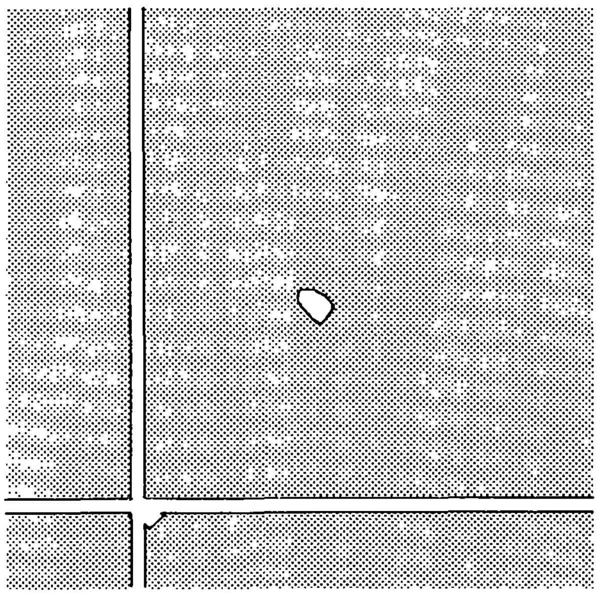

*Figure 4–13. Strobing the exit point.*

## Section II. IMPACT LOCATION

### 4–8. General

The radar set AN/MPQ–4A may be used to compute the impact location of a mortar or high-angle artillery round. The observed presentation will be identical with the scope pattern in figure 4–2 or 4–6 except that the projectile will be moving downward and, therefore, the upper beam echo will appear first on the B-scope.

### 4–9. Computing the Impact Location

*a.* Rotate the LOWER BEAM RANGE control until the lower range strobe intersects the second (lower beam) mark on the B-scope.

*b.* Rotate the LOWER BEAM AZIMUTH control until the azimuth strobe intersects the lower beam mark.

*c.* Set the DETENT switch to DETENT RELEASE.

*d.* Rotate the Δ RANGE control until the upper range strobe intersects the first (upper beam) mark on the B-scope.

*e.* Rotate the Δ AZIMUTH control until the azimuth strobe intersects the first (upper beam) mark.

*f.* Rotate the Δ TIME control until the time lapse between the two echoes appears on the Δ TIME counter.

*g.* Read the WEAPON LOCATION EASTING and NORTHING counters to obtain the uncorrected grid coordinates of the point of impact. The uncorrected polar coordinates of the point of impact can be read on the RANGE and AZIMUTH counters.

*h.* Correct the initial coordinates for altitude, using the procedure described in paragraph 4–5.

*i.* Make sure that the DOUBTFUL SOLUTION indicator lamp is off.

*j.* Read and record the final values on the WEAPON LOCATION EASTING and NORTHING counters for the location of the point of impact.

*k.* Place the DETENT switch on the OFF position.

*l.* Reset the Δ RANGE and Δ AZIMUTH controls to their detent positions.

*m.* On the indicator panel, press the RESET switch to return the SECONDS timer to zero. The radar equipment is now prepared for the next mission.

### 4–10. Recording Form

DA Form 4111 (Record of Sound, Flash, and Radar Locations) is used to record the information pertaining to a weapon location. This form facilitates the recording and reporting of pertinent target information. Spcaes are not provided on the form for recording the azimuth and range to the enemy weapon; however, the form must be modified to record this information when the radar set is surveyed on an assumed grid. The weapon coordinates can then be easily converted to the correct grid when the survey coordinates are provided.

# CHAPTER 5

# RADAR GUNNERY

## Section I. REGISTRATIONS

### 5–1. Purpose

*a.* The firing tables used by field artillery units are based on a set of standard conditions of weather (closely approximating the average weather conditions in the North Temperate Zone of the earth) and on a set of standard conditions of materiel. If all conditions of weather and materiel are standard and there are no errors in survey or in the firing chart, a projectile will achieve the standard range defined in the appropriate firing table and burst on the gun-target line. However, standard conditions of weather and materiel seldom exist simultaneously; therefore, a projectile rarely (if ever) hits the target when a weapon is fired with only standard firing table data. Nonstandard atmospheric conditions, nonstandard materiel, or errors in survey or in the firng chart may cuase inaccuracy in firing. The distance by which a projectile misses the target is caused by the combined effects of these errors. The total error and the corrections for it can be determined by registration.

*b.* In order to determine the corrections to compensate for nonstandard conditions, it is necessary to know where the rounds "did hit" when they were fired with a certain deflection, fuze setting, and quadrant elevation. The "did hit" location can be compared with the location where the rounds should have hit if all conditions had been standard. The difference between the "should hit" location and the "did hit" location can be converted to corrections by established procedures.

*c.* A mean-point-of-impact (MPI) or high-burst (HB) radar registration normally is faster and more economical than a precision registration conducted by a ground observer. From six usable observed rounds fired in a high-burst registration, the fire direction center (FDC) can determine the corrections to the firing data for deflection, fuze setting, and qudrant elevation. In a mean-point-of-impact registration, the same number of usable rounds in fired, but fuze quick is used; therefore, a correction for the fuze setting is not required. Normally, the FDC will fire a high-burst registration when fuze time is available and its use is anticipated for subsequent fire missions in the area.

### 5–2. Radar as the Observer

*a.* The AN/MPQ–4A radar section is often required to obeserve high-burst and mean-point-of-impact registrations. The radar section should have direct communications with the FDC at all times. The radar section can complete a registration quickly, even during periods of poor visibility when ground observation is ineffective.

*b.* The radar visibility diagram and the screening crest profile (para 7–5*b*) are used by the fire direction officer (FDO) to select a suitable location for the registration. Initially, using the visibility diagram, he selects an observable area within range of the radar; a suitable altitude can then be determined by checking the screening crest profile.

### 5–3. Radar-Observed High-Burst Registration

*a. General.* A high-burst registration is fired with fuze time. The high burst must be high enough in space that the burst can be observed through the optical telescope. The radar section is alerted to observe a high-burst registration by a "message to observer." This message must be prepared by the FDC and sent to the radar. The radar section immediately plots the coordinates announced in the message to observer.

*b. Message to Observer (Step 1, DA Form 2888, Figure 5–1).* The message to observer, which is a standard message, consists of five elements and should be transmitted to the radar section in the following sequence:

(1) *Warning order.* The first element must always be sent. It consists of the order OBSERVE HIGH BURST. This warning order informs the radar section of the type of registration to be fired and directs the radar crew to immediately begin preparations to observe.

(2) *Unit to fire.* The second element consists of the word FOR followed by the call sign or code name of the unit to fire. The second element may be omitted by SOP when it is unnecessary for the radar section to contact the battery that is to fire or to know the battery location.

(3) *Location.* The third element consists of the word GRID followed by the grid coordinates. It specifies the military grid reference (to the nearest 10 meters) to the point to which data are obtained. The third element must always be sent.

(4) *Minimum altitude.* Minimum Altitude, the fourth element, is omitted.

(5) *Altitude report.* The fifth element consists of the words REPORT ALTITUDE. It requires the radar section to report the altitude of the high burst to the FDC.

(6) *Report order.* The sixth element consists of the words REPORT WHEN READY TO OBSERVE.

*c. Use of DA Form 2888.* The message to observer received by the radar section is copied in step 1: Message to Observer, on DA Form 2888, Radar-Observed High-Burst or Mean-Point-Of-Impact (Datum Plane) Registration, (fig 5-1). DA Form 2888 is available through normal publications.

*d. Initial Pointing Data (Step 2, DA Form 2888, Figure 5-1).* The Radar Plotter determines the pointing azimuth and pointing range, which is the direction and distance from the radar to the announced location of the high burst. The angle of elevation to the screening crest along the pointing azimuth is determined by observation through the telescope (at 0 mils elevations) or from the screening crest profile. Pointing elevation is then computed by adding 10 mils to the angle of elevation to the screening crest. The minimum acceptable altitude is determined by plotting the announced registration point on a contour map, and adding 50 meters to the results. In cases where a map is not available, or assumed data is used, the FDC will determine the minimum acceptable altitude and report this to radar section.

*Note.* Fifty meters above the ground usually is a good height of burst for a high burst registration.

*e. Initial Registration Point Altitudes (step 3, DA Form 2888, Figure 5-1).* In order to complete the computations of firing data to send to the battery to fire, the FDC must know the altitude of the announced high burst. Therefore, as soon as the radar plotter has computed the pointing data, he determines the altitude and transmits it to the fire direction center. The altitude of the point selected for a high-burst registration is computed on ADA Form 2888 and is determined in the following manner:

(1) Multiply the pointing range (divide by 1,000 to the nearest 10 meters) by the pointing elevation. The product is the vertical interval between the radar and the high burst in meters. This step may be performed by simple multiplication in the space provided on the registration form.

(2) Add the vertical interval obtained in (1) above to the altitude of the radar in meters. The sum is the predicted altitude of the announced high-burst location.

(3) If the predicted altitude is above the minimum acceptable altitude computed for the registration, send the predicted altitude to the fire direction center.

(4) If the predicted altitude is below the MAP ALTITUDE plus 50 meters, use the MAP ALTITUDE plus 50 meters. However, a new pointing elevation must be computed to point the radar antenna at the minimum acceptable altitude. This computation is performed in the following manner:

(*a*) Algebraically subtract the altitude of the radar from the MAP ALTITUDE plus 50 meters. The difference is the vertical interval.

(*b*) Divide the vertical interval by the pointing range (divided by 1,000 to the nearest 10 meters). The result is the angle of elevation. This value rounded to the nearest mil is the new pointing elevation.

*f. Message to FDC.* When the radar section has completed all preparations to observe the registration, the message ALTITUDE (so much), AT MY COMMAND, READY TO OBSERVE is sent to the fire direction center (FDC). This message informs the FDC of three things. First, it notifies the FDC that the radar section will control the firing. The term AT MY COMMAND means that the weapon will fire at the command of the radar section. Second, it informs the FDC that the radar section is ready to observe the registration.

*g. Conduct of Fire.* When the radar section is notified that the weapon is ready to fire, the radar plotter sends the command to fire the first round. When the weapon has fired, the FDC transmits SHOT, OVER to the radar section. The radar plotter acknowledges the report by transmitting SHOT, OUT to the fire direction center. Five seconds before the round is due to burst, the FDC transmits SPLASH, OVER to

| RADAR OBSERVED HIGH-BURST OR MEAN-POINT-OF-IMPACT (DATUM PLANE) REGISTRATION<br>For use of this form, see FM 6–161; the proponent agency is TRADOC. | SEE NOTES ON REVERSE |
|---|---|

| STEP 1: MESSAGE TO OBSERVER | STEP 2: INITIAL POINTING DATA | STEP 3: INITIAL REGISTRATION POINT ALTITUDE |
|---|---|---|
| 1. OBSERVE (Check applicable box) ☒ HB ☐ MPI | 6. AZ (Nearest 1 mil) (Note 1) 1634 +40 = 1674 | 11 MAP ALTITUDE____+50 meters= |
| 2. FOR (Unit or call sign) Loud Thunder 18 | 7. RANGE (Nearest 10 meters) 6110 | 12. RANGE (7) (in thousands) 6.11 |
| 3. AT GRID 6400 3900 | 8. ELEV TO SC CR +16 | 13. ELEVATION (10) +26 |
| | 9. +10 MIL +10 | 14. VI (12 × 13) +159 |
| 4. REPORT ALTITUDE | 10. ELEV (Nearest 1mil) (8 + 9) +26+7= +33 | 15. ALTITUDE (RADAR) (Meters) 326 |
| 5. REPORT WHEN READY TO OBSERVE | | 16. ALTITUDE (RP) (14 + 15) 485 |

**STEP 4: REPORT TO FDC**

ALTITUDE (16 or 11 whichever is the greater) 485 ; AT MY COMMAND; REQUEST SPLASH; READY TO OBSERVE

**STEP 5: RECORDING AND COMPUTATION**

| ROUND NO. | FROM B SCOPE | | FROM TELESCOPE (HIGH BURST ONLY) | | | |
|---|---|---|---|---|---|---|
| | | | AZIMUTH DEVIATION (Note 3) | | ELEVATION DEVIATION | |
| | RANGE | AZIMUTH | LEFT ( – ) | RIGHT ( + ) | BELOW ( – ) | ABOVE ( + ) |
| 1 | 6300 | 1675 | | 40 | | 7 |
| IF REQUIRED, ADJUST POINTING DATA AND CORRECT BLOCKS 6 AND 10 (Note 2) | | | | | | |
| 2 | 6280 | 1676 | | 4 | 6 | |
| 3 | 6250 | 1672 | | 5 | 5 | |
| 4 | 6340 | 1680 | | 7 | | 1 |
| 5 | 6320 | 1677 | 7 | 2 | 0 | 0 |
| 6 | 6290 | 1675 | | | 2 | |
| 7 | 6000 | 1650 | 25 | | | 19 |
| 8 | 6220 | 1680 | | 5 | 6 | |
| TOTAL | 17. 37700 | 18. — | TOTAL LEFT ( – ) 7 | TOTAL RIGHT ( + ) 23 | TOTAL BELOW ( – ) 19 | TOTAL ABOVE ( + ) 1 |

| NOTE: AFTER SIX VALID ROUNDS REPORT "END OF MISSION" TO FDC | 19. AZIMUTH DEVIATION = ALGEBRAIC TOTAL LEFT ( – ) AND RIGHT ( + ) +16 | 20. ELEVATION DEVIATION = ALGEBRAIC TOTAL BELOW ( – ) AND ABOVE ( + ) –18 |
|---|---|---|

| 23. REGISTRATION POINT RANGE (Nearest 10 meters) | 24. AZIMUTH OF MPI (Nearest 1 mil) | | |
|---|---|---|---|
| 6283<br>6 ⟌ 37700 (17) | 6 ⟌ (18) | 21. ⊕+2.6<br>6 ⟌ +16. (19)<br>12<br>40 | 22. ⊖ –3<br>6 ⟌ –18 (20) |
| | | 25. (21) +3 | 27. (22) –3 |
| | | 26 (6) 1674 | 28. (10) +33 |
| | | 29. HB AZ (Algebraically add 25 and 26) 1677 | 30. HB ELEV (Algebraically add 27 and 28) +30 |

| STEP 6: FINAL REGISTRATION POINT ALTITUDE | | STEP 7: REPORT TO FDC |
|---|---|---|
| 31. RP RG (23) (In thousands) | 6.28 | 36. REPORT ON RADAR OBSERVED (Check applicable box) ☒ HB ☐ MPI |
| 32. HB (Enter value block (30)) MPI (Enter value block (10)) | +30 | 37. TIME OBSERVED 261500 |
| | | 38. AZIMUTH (MPI (24) HB (29)) (See note 4) 1677 |
| 33. VI (31 × 32) | +188 | 39. RANGE (23) (See note 4) 6280 |
| 34. ALTITUDE RADAR | 326 | 40. ALTITUDE (35) (See note 4) 514 |
| 35 ALTITUDE RP (33 + 34) | 514 | 41. GRID OF RP (Nearest 10 meters) 6422 3925 |

**DA** FORM 1 MAY 75 **2888** PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

*Figure 5–1. DA Form 2888 showing a completed high-burst registration.*

NOTES

NOTE 1 – *(High Burst Only)* The telescope must be pointed at the pointing azimuth. To accomplish this, place the DETENT switch in the AZIMUTH ORIENT position. Apply *(add or subtract as necessary)* the field correction to the chart azimuth. Then, move the antenna in the azimuth until the AZIMUTH counter indicates the corrected value. Record the chart azimuth in block 6.

NOTE 2 – If the burst from the first round appears above the horizon but is not seen on the B-scope, the pointing angle of elevation must be changed to cause the next round to burst in the radar beam. The antenna may also have to be moved in azimuth to cause the burst to appear in the center of the telescope. When the antenna is moved in either azimuth or elevation, the new pointing data must be entered in the appropriate block under step 2. If the first round bursts more than 5 mils below the center of the telescope, the FDC must be notified *(BURST TOO LOW, REQUEST ALTITUDE INCREASE).* The antenna should not be depressed.

NOTE 3 – *(High Burst Only)* If the B-scope azimuth disagrees with the telescope azimuth more than ± 10 mils, an error has been made in spotting, marking, or strobing the echo on the B-scope. Therefore, the data to the round will not be valid.

NOTE 4 – The average azimuth, range, and altitude must be computed independently by two crew members. Insert the average azimuth and range into the computer. Record the resulting grid coordinates in block 41, DA Form 2888. Polar plot the average range and azimuth on the radar chart and record the resulting grid coordinates. These two sets of coordinates should agree with each other within 20 meters in easting and 20 meters in northing.

*Figure 5–1—continued.*

the radar section. The radar plotter acknowledges this report by transmitting SPLASH, OUT to the fire direction center. When the radar section is ready for another raound, it sends the command REPEAT to the fire direction center. The first found fired in a high-burst registration normally is consisdered an orienting round, and the radar crew may have to reorient the antenna on the actual burst point of the round. If it is necessary to reorient the antenna, the command REPEAT is delayed until the antenna has been reoriented and until after the previous round is recorded. The antenna is then reoriented to the actual burst point of the round. This round is now considered a valid round with 0–0 error and the initial pointing data is changed to reflect the new pointing data.

*h. Criteria for Use of Rounds.* This procedure is continued until the radar section has observed and recorded on DA Form 2888 the data for six usable rounds. Usable rounds are those that do not burst over 50 meters from the rest of the rounds.

*i. Location of High-Burst.* The radar can provide the location of the high-burst either by grid coordinates and altitude; by direction, distance, and altitude from the radar to the high burst; by direction, distance, and altitude from the radar to the high burst; by direction, distance, and vertical angle to each round of the high burst. There is no difference in the accuracy of these three methods; however, the coordinates and altitude method is fastest because it does not require that the radar be plotted on the firing chart, and is the preferred method of reporting. After the registration has been observed and it has been determined that no erratic round has occurred. The radar section transmits END OF MISSION to the fire direction center.

## 5–4. Marking and Strobing Target Echoes for High-Burst Registration

*a.* The success of any radar-observed registration depends on the accuracy of the marking and strobing of the target echo on the B-scope.

In a high-burst registration, the range and azimuth are determined by strobing. Azimuth strobing provides a check on the azimuth deviations reported by the telescope observer.

*b.* A high-burst round is not considered valid unless the initial echo appears as shown in figure 5–3. Adjustments of the pointing elevation must be continued until the echoes appear.

*c.* The operator must know the point at which to strobe each round and how to mark the echoes to locate this point. The echo for a round fired in a high-burst registration first appears on the B-scope as shown in figure 5–2. It is then marked and strobed as shown in figure 5–3 and 5–4.

*Note.* In order to insure an accurate mark, the B-scope GAIN and INTENSITY controls must be properly adjusted.

## 5–5. Conduct of a High-Burst Registration

*a. General.* Before the radar set can be considered ready to observe a registration, it must be

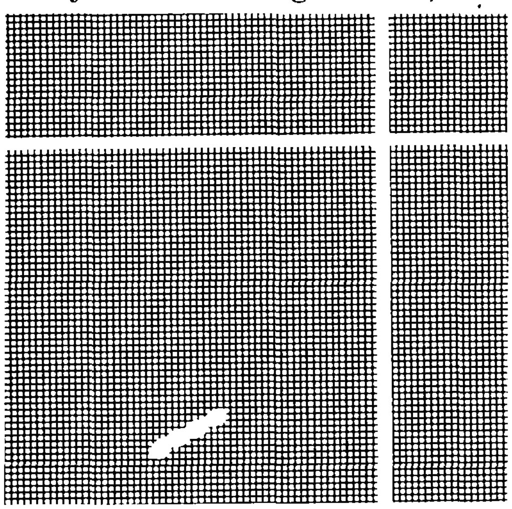

*Figure 5–2. Projectile first entering the beam (HB).*

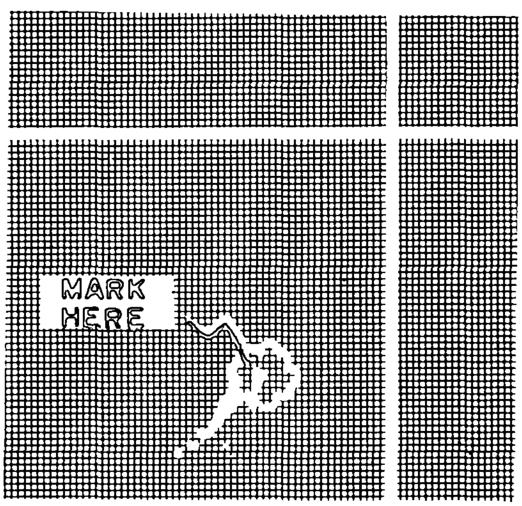


*Figure 5–3. Projectile bursting in the beam (HB).*

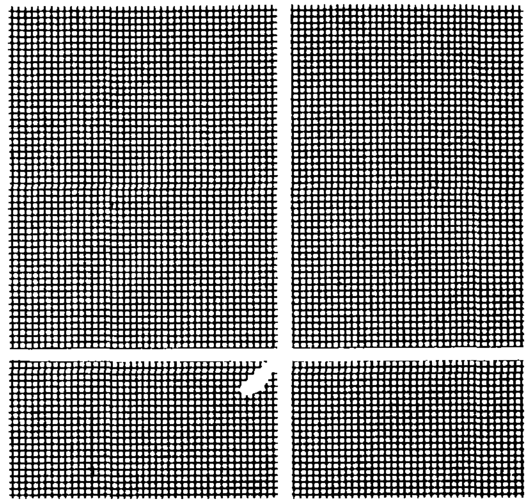

*Figure 5–4. Strobing a marked burst (HB).*

emplaced and checked by the most accurate procedures possible. A registration can be accurately observed only if the radar set has been leveled, collimated, oriented, and range calibrated and the accuracy of the computer has been verified. All performance checks must be within the prescribed tolerances.

*b. Personnel.* Four members of the radar section are needed to conduct a radar—observed high-burst registration. Their duty assignments are—

(1) Control unit operator.
(2) Radar plotter.
(3) Telescope observer.
(4) Recorder.

*c. Sequence.* When the radar section receives the message to observe, all members of the section start preparations immediately. A detailed explantation of the duties of each member is given for each of the following four phases of the registration:

(1) Preparation.
(2) Reorientation.
(3) Observation.
(4) Reporting.

*d. Preparation.* The preparation phase begins when the radar section receives the message to observer and ends when the section reports READY TO OBSERVE. An example problem used to explain the duties of personnel is shown on DA Form 2888 (fig 5–1). The notes on the reverse side of DA Form 2888 should be reviewed before proceeding. The duties of personnel during the preparation phase are outlined in (1) through (4) below.

(1) The radar plotter—

(*a*) Records the message to observer in step 1 on DA Form 2888 as shown in figure 5–1.

(*b*) Plots the coordinates given in the message to observer on the radar chart.

(*c*) Measure the azimuth and range to the announced highburst location and announces aloud the following data: AZIMUTH 1634 (always read to the nearest mil). RANGE 6110 (always read to the nearest 10 meters).

(*d*) Records the announced azimuth and range as the pointing azimuth and range is step 2, blocks 6 and 7, on the registration form.

(*e*) Records in block 8 the screening crest elevation at the pointing azimuth, as indicated on the screening crest profile. He adds to the angle of elevation the 10 mils already recorded in block 9 and records the sum, to the nearest mil, in block 10 as the pointing elevation.

*Note.* At this point block 10 indicates only the sum of the screening crest plus 10 mils; i.e., 26 mils. The additional 7 mils indicated in block 11 on the form is the deviation, which will not become known until after the registration begins.

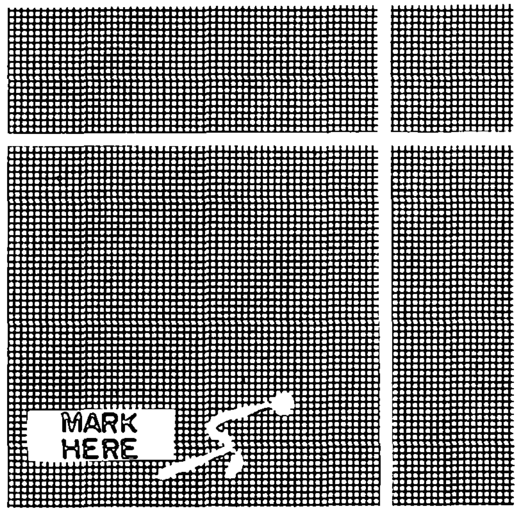


*Figure 5–7. Marking the point where the projectile passed through the center of the beam (MPI).*

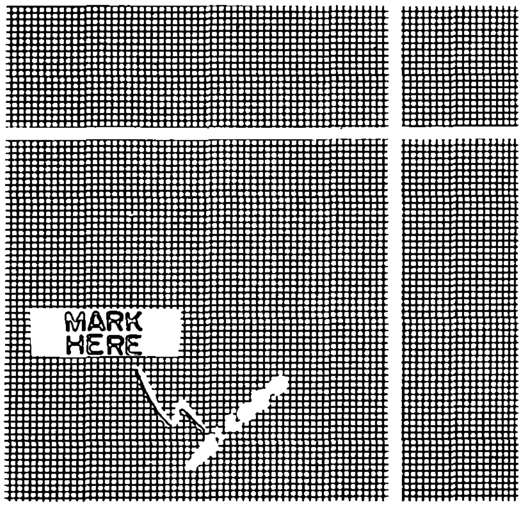


*Figure 5–5. Marking the point where the projectile enters the beam (MPI).*

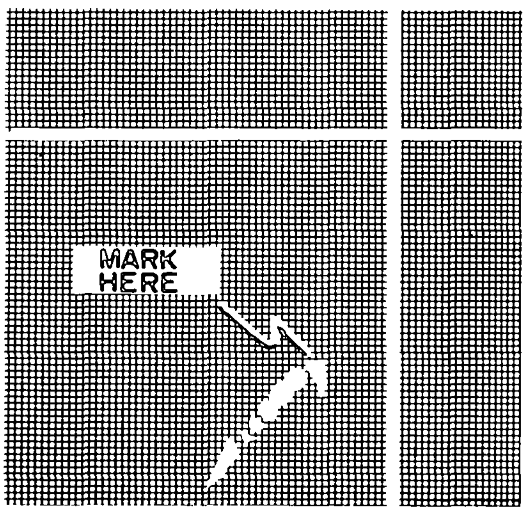


*Figure 5–6. Marking the point where the projectile leaves the beam (MPI).*

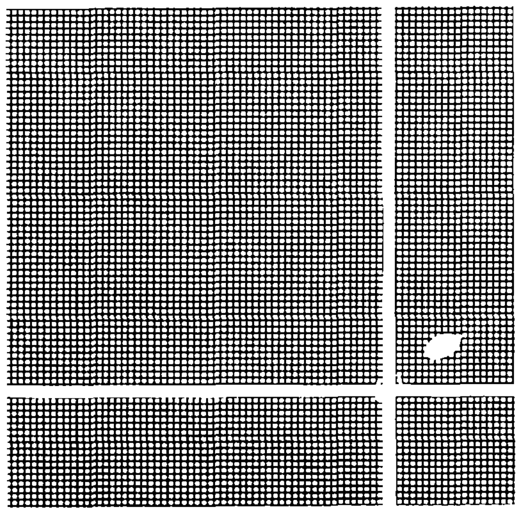

*Figure 5–8. Strobing the midpoint.*

(*f*) In the blocks for step 3 on the registration form, computes the altitude of the high burst.

(*g*) After all members of the radar section have reported ready, reports to FDC (step 4): ALTITUDE (from block 16), AT MY COMMAND, REQUEST SPLASH, READY TO OBSERVE.

(2) The control unit operator—

(*a*) Orients the radar optical axis (telescope) on the pointing azimuth in the following manner:

*1.* When the pointing azimuth is announced by the plotter, adds or subtracts the measured field correction to the pointing azimuth. The sum is the AZIMUTH counter reading that must be set on the computer panel in order to orient the telescope (the optical axis) on the pointing azimuth.

*2.* Moves the telescope to the pointing azimuth by placing the DETENT switch in the AZIMUTH ORIENT position and setting the azimuth control in detent. Using the AZIMUTH switch on the control-power supply panel, traverses the antenna until the AZIMUTH counter on the computer panel indicates the value of the chart azimuth with the field correction algebraically added.

*Note.* If the antenna azimuth counter is operable and the orienting azimuth was inserted during antenna orientation, the telescope is positioned on the pointing azimuth by rotating the antenna until the high-burst chart azimuth appears on the antenna azimuth counter on the radar frame.

***Caution:*** **Fine adjustments are made with the azimuth handwheel on the radar trailer frame to prevent damage to the azimuth brake.**

(*b*) Prepares the computer and indicator panels by—

*1.* Placing the DETENT switch in the OFF position and locking the upper beams controls.

*2.* Placing the BEAM VIDEO selector switch in the LOWER position.

*3.* Placing the RANGE SHIFT switch in the OFF position.

*4.* Placing the RANGE SELECTOR switch in the 3750 M position.

*5.* Placing the EXPANDED SWEEP DELAY switch to the appropriate position. The expected range to the burst should be near the center of the 3750-meter scope.

(3) The telescope observer—

(*a*) Assists the control unit operator in orienting the telescope on the pointing azimuth by rotating the azimuth handwheel on the radar trailer frame to make the fine adjustments in azimuth.

(*b*) Determines that the announced pointing elevation is at least 10 mils above the screening crest at the pointing azimuth by using the telescope mounted on the radar trailer.

(4) The *recorder*—

(*a*) Enters all known data on the registration form (fig 5–1) and checks the altitude computation performed by the radar plotter. The registration form completed by the recorder can be used to doublecheck the computations of the radar plotter.

(*b*) Checks the field correction at the echo box, and announces the amount of the field correction to the control unit operator.

(*c*) Insures that the correct reading is set on the elevation counter at the radar trailer when the antenna is set on the pointing elevation.

(*d*) Checks the level of the radar set.

*e. Reorientation.* The reorientation phase begins when the radar section receives the message SHOT for the first round in the mission. It ends when the deviations of the burst can be read from the telescope and the burst of the projectile appears and is marked on the B-scope (fig 5–3). The duties of personnel during the reorientation phase are outlined in (1) through (4) below:

(1) The telescope observer—

(*a*) Takes a position to observe through the telescope.

(*b*) Looks for the burst through the scope when SPLASH is received.

(*c*) Immediately spots the deviation in mils from the center of the telescope to the point of the burst when the burst appears.

*Note.* The observer cannot stand behind the telescope, but must stand to the side. Threfore, care must be taken to insure that spotting is correct.

(*d*) Reports the deviation in mils to the recorder and insures that the recorder and the radar plotter announce the azimuth and elevation deviations and record them in the appropriate columns in step 5 on their DA Forms 2888.

*Note.* If the burst is more than 40 mils left or right of the center of the telescope or 10 mils above the center of the telescope the antenna is repositioned to center the telescope at the point where the first round burst. He uses the azimuth handwheel on the radar trailer to set the new pointing azimuth announced by the recorder.

(2) The recorder—

(*a*) Records and announces the azimuth and elevation deviations for each round in the appropriate columns in step 5 on the registration form.

(*b*) Calculates the new pointing azimuth and pointing angle of elevation required to cause the round to burst in the beam, if the burst from the first round does not appear on the B-scope as shown in figure 5–3. If the burst was to the left of the center of the telescope, he subtracts the amount of the deviation reported by the telescope observer from the pointing azimuth to obtain a new pointing azimuth. If the burst was to the right of the center of the telescope, he adds the amount of the deviation reported by the telescope observer to the pointing azimuth to obtain a new pointing azimuth. If the burst was more than 5 mils below the center of the telescope, he reports to the radar plotter that nex round must be raised in altitude.

(*c*) Moves to the radar data computer panel when the new pointing azimuth and pointing angle of elevation have been set. He insures that the new pointing azimuth appears on the AZIMUTH counter and that the new pointing elevation appears on the ELEVATION-DEPRESSION counter.

(*d*) Enters the new pointing azimuth and elevation on the registration form.

(*e*) If reorientation was accomplished, the azimuth and elevation deviations to the initial round become zero and the round should be considered usable for computations.

(3) The radar plotter records in step 5 on the registration form the range and azimuth announced by the control unit operator and the azimuth and elevation deviations reported by the telescope observer.

(4) The control unit operator—

(*a*) Watches for the appearance of the echo on the B-scope of the first round when SPLASH is received.

(*b*) Marks and strobes the burst location.

(*c*) Announces the azimuth and range to the radar plotter.

(*d*) Corrects the elevation of the antenna to the new pointing elevation announced by the recorder if the burst of the projectile does not appear on the B-scope.

(5) During the reorientation phase, the antenna is never lowered. The initial data required setting the elevation at 10 mils above the screening crest. If the antenna is lowered, the beam may be blocked by the screening crest. If the first angle of elevation reported by the recorder is more than 5 mils below the initial pointing elevation, the round will not be used for reorientation or reporting. When the angle of elevation reported is more than 5 mils below the initial pointing elevation, the radar plotter notifies the FDC by transmitting BURST TOO LOW, REQUEST ALTITUDE INCREASE.

(6) In the registration recorded on DA Form 2888 (fig 5–1) the telescope deviations reported by the observer were RIGHT 40, ABOVE 7. The data reported by the control unit operator from the B-scope were RANGE 6300, AZIMUTH 1675. The initial pointing data recorded in step 2 were changed as shown in figure 5–1.

*f. Observation.* The observation phase begins when the reorientation phase has been completed and ends when END OF MISSION is announced. The duties of personnel during the observation phase are described in (10 through (4) below.

(1) The control unit operator—

(*a*) Watches the B-scope for the appearance of the echo as SPLASH is received for each round.

(*b*) Marks and strobes the echo.

(*c*) Announces the range and azimuth to the radar plotter.

(*d*) Reports LOST if the round is not observed. If the round does not burst in the beam of the radar, it cannot be used in registration.

(2) The telescope observer—

(*a*) Takes a position to observe through the telescope when SHOT is received.

*Note.* The observer must not stand erect in the radar beam. He should kneel down away from the beam and not raise his head above the level of the telescope because of the radiation hazard.

(*b*) Looks for the burst through the telescope when SPLASH is received.

(*c*) Announces the azimuth deviation as LEFT or RIGHT (so much) and the elevation deviation as ABOVE or below (so much) when the burst appears.

(*d*) Announces LOST if he does not observe the round.

(3) The *recorder* records on the registration form the azimuth and elevation deviations announced by the telescope observer and insures the the information is received by the radar plotter.

(4) *The radar plotter*—

(*a*) Records the range and azimuth announced by the control unit operator.

(*b*) Records the azimuth and elevation deviations announced by the recorder.

(*c*) Compares the azimuth announced by the recorder to the azimuth announced by the control unit operator. The two azimuths must agree within ± 10 mils. If they do not agree, he checks to determine if an error has been made. If necessary, he requires an additional round to be fired. The radar officer or the chief of section will determine when the data have been recorded for six usable rounds.

(5) When the data have been recorded for six usable rounds, END OF MISSION is transmitted to the fire direction center.

*g. Computation.* The computation phase begins when the possibility of erratic rounds has been liminated. During this phase, both the plotter and recorder perform the computation required. Each member works independently of the other. Then they compare results when the totals are determined; when the final range, azimuth, and elevation are determined; when the altitude is computed; and immediately before the report is sent to the fire direction center. The high-burst location is computed on the DA Form 2888 as follows:

*Note.* Round 7 was deleted as eratic because it differed significatnly in range from other rounds.

(1) The ranges from the RANGE counter on the computer panel are added, and the total is recorded in block 17.

(2) The azimuth and elevation deviations are totaled (blocks 19 and 20).

(3) The totals obtained by the plotter are compared with those obtained by the recorder. If the totals do not agree, the error must be found before the computation is continued.

(4) In a high-burst registration, the azimuths from the AZIMUTH counter on the computer panel are not totaled. These azimuths are used only during the observation phase for comparison with the azimuth computed from the telescope observer's deviations.

(5) The totals are divided by the number of usable rounds to determine the average range (block 23), the average azimuth deviation (flock 21), and the average elevation deviation (block 22).

(6) The average range is the *range to the high burst* (block 31).

(7) The average deviation is algebraically added to the final pointing azimuth (block 7), using blocks 25 and 26. The result is the high-burst azimuth (block 29).

(8) The average range and azimuth are plotted on the radar chart and also placed in the radar chart and also placed in the radar set computer. If the coordinates obtained do not agree within 20 meters, they must be recomputed and replotted.

(9) The average elevation deviation is algebraically added to the final pointing elevation (block 10), using blocks 27 and 28. The results is the high-burst elevation (block 30).

(10) The high-burst range, azimuth, and elevation obtained by the plotter are compared with those obtained by the recorder. If the values do not agree, the work is recomputed until the error is corrected.

(11) The high-burst altitude is computed by miltiplying the high-burst elevation (block 30) by the high-burst range (block 23) in the thousands and adding the product to the altitude of the radar as shown in step 6 on the registration form.

(12) The high-burst altitude (block 35) computed by the plotter is checked with that computed by the recorder. If the values do not agree, the work is recomputed until the error is found.

*h. Reporting.*

(1) When the computations made by the plotter and those made by the recorder have been compared and found to agree, the location of the high-burst is transmitted to the FDC as grid or polar plot coordinates. This report consists of the following six elements, transmitted in the order in which are listed:

(*a*) REPORT ON RADAR-OBSERVED HIGH BURST—Informs the FDC of the type of message to follow.

(*b*) TIME OBSERVED—Provides the FDC and the radar section with a message number for future reference to the registration. It is the approximate time at which the firing was completed.

(*c*) DIRECTION—The azimuth from the radar antenna to the high-burst location.

(*b*) DISTANCE—The range from the radar antenna to the high-burst location.

(*e*) ALTITUDE—The computed altitude of the high-burst location.

(*f*) GRID—The grid coordinates of the high-burst location.

*Note.* When grid coordinates are reported the direction and distance may be omitted.

(2) Both computers record the report to the FDC in step 7 on the registration form. The radar plotter transmits the message to the FDC. The recorder listens as it is transmitted to insure that no errors are made.

## 5–6. Radar-Observed Mean-Point-of-Impact Registration

*a.* A mean-point-of-impact (MPI) registration is fired with fuze quick. However, the projectiles may not be observed at impact, because the radar will normally be sited behind a mask. The registrations will be observed at a selected datum plane (SDP). A datum plane is a plane in space through which all rounds pass that are fired during the conduct of the MPI registration. It may be explained to be an imaginary hilltop or a mound of dirt on which the rounds actually impact. The selected datam plane is the plane where all rounds in the registration pass through the center of thw lower beam. The use of the optical telescope is not required. All information is determined by strobing the point where each round passed through the center of the lower beam.

*b.* The radar section is alerted to observe a mean-point-of-impact registaration by a message to observer. The message to observer for a mean-point-of-impact registration is the same as that for a high-burst registration.

*c.* The procedures for determining the pointing data are the same as those for a high-burst registration.

*d.* Under step 3 on the registration form, compute the altitude of the selected datum plane (SDP).

*e.* When performing mean-point-of-impact registrations the radar antenna need not be reoriented, since the radar beam is wide enough to cover the registration point.

*f.* Performance of a mean-point-of-impact registratin requires six usable rounds. Range and azimuth to each round is determined by strobing the center of the target echo on the B-strobe.

*g.* The results of a mean-point-of-impact registration are sent to FDC.

## 5–7. Marking and Strobing Target Echoes for Mean-Point-of-Impact Registration

*a.* The accuracy of the mean-point-of-impact registration depends to a great extent on the procedure used in marking and strobing the echo on the B-scope. In the mean-point-of-impact registration, the azimuth and range are obtained from the B-scope.

*b.* The appearance of the echo for a mean-point-of-impact registration is similar to that for a high-burst registration, except that the round does not burst in the beam. The operator sees only a trace of light as the round passes through the lower beam. He marks the point of entry, follows the round until it disappears, and marks the point of exit. After marking the entry and exit points, the operator must interpolate and mark a point half-way between the entry and exit points. This center point is strobed for azimuth and range. The procedure is illustrated in figure 5–5 through 5–8.

## 5–8. Conduct of Mean-Point-of-Impact Registration

*a.* Preliminary checks and adjustments of the radar must be performed as they are for a high-burst registration.

*b.* Three members of the radar section are needed to conduct a mean-point-of-impact registration. They are the—

(1) Control unit operator.
(2) Readar plotter.
(3) Recorder.

*c.* When the radar section receives the message to observer, the procedures to be followed and the duties of the crew members are similar to those for a high-burst registration. Since the mean-point-of-impact registration is fired with fuze quick, the rounds cannot by observed through the telescope; therefore, the observer cannot report the deviations of the rounds. The range and azimuth to each round are determined form the B-scope. When six usable rounds have been detected, their ranges and azimuths are averaged to find the range and azimuth to the mean-point-of-impact. The angle of elevation at which the rounds are observed is the pointing elevation. The duties of the crew members for a mean-point-of-impact registration will be discussed in phases near those of a high-burst registration. Since the telescope is not used in a mean-point-of-impact registration, there is no reorientation phase. The data recorded throughout all phases of the registration are illustrated on the completed DA Form 2888 in figure 5–9. The phase of the registration are as follows:

(1) Preparation.
(2) Observation.
(3) Computation.
(4) Reporting.

*d. Preparation Phase.* The preparation phase begins with the radar section receives the message to observer and ends when the radar section reports READY TO OBSERVE. The duties of the crew members during the preparation phase are as follows:

(1) *The radar plotter—*

(*a*) Records the message to observer on the DA Form 2888 as shown in figure 5–9.

(*b*) Plots on the radar chart the coordinates given in the message to observer.

(*c*) Measure the azimuth and range to the announced mean-point-of-impact and announces aloud the following data: AZIMUTH 624 (always read to the nearest Mil). RANGE 5410 (always read to the nearest 10 meters).

(*d*) Records the announced azimuth and range as the pointing azimuth and range in step 2, blocks 6 and 7 on DA Form 2888.

(*e*) Records in block 8 the angle of elevation to the screening crest announced by the recorder in block 9 and records the sum, to the nearest mil, in block 10 as the pointing elevation.

(*f*) Use the range (in thousands) and the pointing elevation to compute the altitude of the selected datum plane. (Step 3 DA Form 2888.)

(*g*) After all members of the radar section have reported ready, reports to the FDC (step 4) altitude (from block 16), AT MY COMMAND, READY TO OBSERVE.

(2) *The control unit operator—*

(*a*) Traverses the radar antenna to the vicinity of the pointing azimuth. To move the antenna to the approzimate pointing azimuth, he positions the azimuth strobe in the center of the B-scope and rotates the antenna until the AZIMUTH counter on the computer panel indicates the approximate pointing azimuth.

(*b*) When directed by the recorder, places the antenna at the pointing elevation with the ELEVATION switch on the control-power supply panel.

(*c*) Prepares the computer and indicator panels by—

*1.* Placing the DETENT switch in the OFF position and locking the upper beam controls.

*2.* Placing the BEAM VIDEO slector switch in the LOWER position.

*3.* Placing the RANGE SHIFT switch in the OFF position.

(*d*) To orient the antenna in elevation during a night registration, when no screening crest profile has been prepared or when the screening crest cannot be observed through the telescope, elevates the antenna until the B-scope is free of all clutter. Then, he depresses the antenna until clutter starts to appear, but not so low that it appears in the area where the mean-point-of-impact registration will be conducted. He enters in block 10 on the registration form the elevation indicated on the ELEVATION-DEPRESSION counter on the radar trailer.

(3) *The recorder—*

(*a*) Enters all known data on DA Form 2888 and checks the computations performed by the radar plotter. DA Form 2888 completed by the recorder can be used to doublecheck the computations of the radar plotter.

(*b*) Directs the control unit operator to elevate the antenna until the center of the telescope is approximately 10 mils above the screening crest. When the antenna is oreinted in elevation he reads the elevation indicated on the elevation counter at the radar trailer. He then applies any elevation corrections determined during the elevation orientation check, reports the corrected elevation to the recorder, and enters the value on DA Form 2888.

*e. Observation Phase.* The observation phase begins when the radar section reports READY TO OBSERVE and ends when the data from six usable rounds have been recorded. The duties of personnel during the observation phase are as follows:

(1) *The control unit operator—*

(*a*) Watches the B-scope for the appearance of the echo as SPLASH is received for each round.

(*b*) Marks the point of entry where the round enters the beam.

(*c*) Marks the point of exit where the round leaves the beam (the echo disappears).

(*d*) Interpolates to find the point where the round passed through the center of the beam.

(*e*) Strobes the center point and announces the range and azimuth as indicated on the RANGE and AZIMUTH counters on the computer panel, to the radar plotter and the recorder.

(*f*) If the round is not observed, reports LOST.

(2) Both the radar plotter and the recorder whould record in step 5 on DA Form 2888 the ranges and azimuths announced by the control unit operator.

*f. Computation Phase.* In the computation phase, the duties of both the recorder and the radar plotter are the same as those for the high-burst registration, except that the azimuth read from the AZIMUTH counter on the computer panel is used in determining the azimuth the mean-point-of-impact, and the angle of elevation used in computing the altitude of the mean-point-of-impact is the pointing elevation.

*g. Reporting Phase.* The reporting phase in the mean-point-of-registration is similar to that in the high-burst registration.

## Section II. RADAR ADJUSTMENT OF FIRE

### 5–9. General

*a.* The decisions to fire or not to fire artillery and the choice of the method of attack on any target are made by the S3 of the firing unit. If the initial target location is accurate, first-round fire for effect may be delivered on the target. However, if the initial target location is doubtful, an observation agency must be used to adjust the fire on the target. Radar may be used as the observation agency during the adjustment phase of a fire mission. Normally, radar will be used as the observation agency only when no visual observation means is available and when one or more of the following conditions exist:

(1) No registration corrections are available.

(2) No survey exists.

(3) The target has been located by radar.

*b.* If the S3 decises to adjust on a target by using radar as the observation agency, the radar crew must be able to perform the adjustment rapidly and accurately. Speed, consistent with accuracy, is essential. The more time required for the adjustment, the more time the enemy will have to dig in or run.

## 5–10. Fire Adjustment Principles Pertinent to Radar

The goal of an adjustment is to move the burst of one round to the center of the target or target area. It is not necessary for the radar crew to know the location of the firing unit or the fire direction center. Nor is it necessary for the fire direction center to knoow the location of the radar. The adjustment is begun by firing one round into the area of the target. When the location of the burst of the adjusting round is determined, the radar crew computes the correction necessary to move the burst to the target center. The first principle of radar fire adjustment is to move the burst to the target center. The second principle of fire adjustment is speed. Speed in adjustment is improved by training and by the use of standard terms and procedures. The standard call for fire, the subsequent corrections, and the adjustment techniques must be correctly understood and used by the radar crew.

## 5–11. Target Location Information

To increase the accuracy of the radar in acquiring the first round fire, the target location information furnished by the S3 to the radar section must be as accurate and usable as possible. The methods of describing the target location and their order of preference are as follows:

*a. Grid Coordinates.* These provide the most accurate data to the radar section and since they are based on a common grid system there is no problem in understanding just exactly where the point is.

*b. Shift From a Known Point.* This method can be used when no survey control exists and the firing unit and the radar are not on a common grid, but do have common Known Points on their charts. This method allows the FDC to locate the target in relation to one of these Known Points.

*c. Mark Center of Sector.* When the firing unit and the radar have no common Known Points on their charts and no survey control exists in the area this method is used to place a Known Point on both charts. The firing unit fires a round into an area that they can visually observe at the same time the radar section locates this round with the radar. This location now serves as a common Known Point on both charts.

## 5–12. Call for Fire

*a.* When radar is used to adjust fire, the radar section must determine and transmit the call for fire and the subsequent correction to the fire direction center. The call for fire is transmitted in a standard message format, using standard terminology, and contains the information required by the FDC for the preparation of fire commands. The information is transmitted in the order in which it will be used in the fire direction center. Subsequent corrections are transmitted to obtain changes in the elements of the call for fire necessary to move the bursts to the target center.

*b.* The call for fire contains six elements. These elements are listed in (1) through (6) below in the order in which they are used. For a detailed explanation of each element, see FM 6–40.

(1) Observer identification.

(2) Warning order.

(3) Locationof target.

(4) Description of target.

(5) Method of engagement.

(6) Method of fire and control.

*c.* The characteristics of the AN/MPQ–4A radar require that some elements of the call for fire include information not normally included by a ground observer. Specifically, since the AN/MPQ–4A can more accurately locate the point of origin or burst of a single projectile fired at a high angle of elevation, the call for fire will include the terms ONE GUN and HIGH ANGLE in the method of engagement elements. When the radar section wishes to control the time of firing, AT MY COMMAND is included in the method of fire and control element.

*d.* An example of a complete call for fire using the correct communication procedures is as follows:

Radar: BAR BELL 18, THIS IS SPLIT BEAM 14, FIRE MISSION, OVER

FDC: SPLIT BEAM 14, THIS IS BAR BELL 18, FIRE MISSION, OUT.

Radar: GRID 273337, DIRECTION 6400, OVER.

FDC: GRID 273337, DIRECTION 6400. OUT.

Radar: MORTAR FIRING, ONE GUN,

HIGH ANGLE, AT MY COMMAND, ADJUST FIRE, OVER.

FDC: MOTOR FIRING, ONE GUN, HIGH ANGLE, AT MY COMMAND, ADJUST FIRE, OUT.

### 5–13. Message to Observer

*a.* After the call for fire has been received, the fire direction officer issues a fire order. This fire order consists of the necessary commands for the FDC to start the production of firing data. Certain elements of the fire order are extracted by a computer in the FDC and sent to the radar section as a message to observer. This message to observer always contains four elements and any modivication to the radar section's call for fire. The elements are as follows:

(1) *Batteries to fire for effect.* The first element informs the radar section which batteries will fire for effect.

(2) *Adjusting battery.* The second element informs the radar section which battery will conduct the adjustment.

(3) *Rounds in fire for effect.* The third element informs the radar section of the number of rounds that will be fired by each tube during fire for effect.

(4) *Target number.* The fourth element is the designtation assigned to the target.

(5) *Modification.* A modification is any change to any element in the radar section's call for fire.

*b.* As an example, the standard call for fire implied shell high explosive and fuze quick. However, the S3 decided that shell white phosphorious, fuze quick, would be used. The message to observer sent to the radar section is:

FDC: BATTALION, BRAVO, WP, ONE ROUND, TARGET RQ5020, OVER.

Radar: BATTALION, BRAVO, WP, ONE ROUND, TARGET RQ5020, OUT.

### 5–14. Radar Considerations.

*a.* For adjustments, as for any other mission which the radar may be assigend, the site should be selected so that the angle of elevation to the screening crest is at least 15 mils but not more than 40 mils. The radar should be emplaced, leveled, collimated, and oriented by the best means available. Range calibration and the accuracy of the computer should be vertified.

*b.* A radar chart may be used in conducting a radar adjustment. If the radar location cannot be determined by survey or by map inspection, a grid intersection is selected as the radar position and is assigned arbitrary coordinates and altitude. The shift necessary to move the burst to the target may be computed or may be determined form the target grid. See FM 6–40 for a discussion of the target grid.

### 5–15. Subsequent Corrections

*a.* After the first burst has been located by the radar, the radar section transmits subsequent corrections until the fire mission is completed. The corrections include appropriate changes to elements previously transmitted and the necessary corrections for deviation and range. A subsequent correction includes either a correction for deviation or range, or both, or the term REPEAT in which case no subsequent corrections are made. The term REPEAT is also used to indicate that the observer desire to repeat FIRE FOR EFFECT with or without correction to any of the elements, i.e., ADD 50, REPEAT. Any other element of the call for fire for which a change or correction is not desired is omitted in the subsequent correction.

*b.* Change in control. When the radar crew desires to change the method of control from adjust fire to fire for effect, FIRE FOR EFFECT is sent as part of the subsequent correction.

### 5–16. Procedure for Adjusting Fire

*a.* When the radar section is prepared to start the adjustment mission, the call for fire is sent to the fire direction center. The radar plotter plots the target location on the radar chart. In a situation where the radar and firing units are not on a common survey grid, the radar chart is set up with the radar plotted at map inspection coordinates or, if no map is available, at a grid intersection with assumed coordinates and altitude.

*b. Grid Coordinate Comparison Method.* The adjustment is performed by sending a direction of 6400 mils to the fire direction center. The antenna is moved in azimuth and elevation (screening crest plus 10 mil along the radar target line) until it is pointing at the target. The radar plotter sends a request for ONE ROUND, HIGH ANGLE, AT MY COMMAND to the fire direction center.

(1) When the battery is ready to fire the round, the message BATTERY READY is transmitted to the radar section. When the radar section is raady for the first round to be fired, the command FIRE is sent to the guns. If the first round is not located by the radar, the

| RADAR OBSERVED HIGH-BURST OR MEAN-POINT-OF-IMPACT (DATUM PLANE) REGISTRATION<br>For use of this form, see FM 6–161: the proponent agency is TRADOC. | SEE NOTES ON REVERSE |
|---|---|

| STEP 1 MESSAGE TO OBSERVER | STEP 2 INITIAL POINTING DATA | STEP 3 INITIAL REGISTRATION POINT ALTITUDE |
|---|---|---|
| 1. OBSERVE (Check applicable box) ☐ HB ☒ MPI | 6 AZ (Nearest 1 mil) (Note 1) 624 | 11. MAP ALTITUDE ____+50 meters= |
| 2 FOR (Unit or call sign) Loud Thunder 28 | 7 RANGE (Nearest 10 meters) 5410 | 12 RANGE (7) (in thousands) |
| 3 AT GRID 5230 4860 | 8. ELEV TO SC CR +22 | 13 ELEVATION (10) |
| | 9. +10 MIL +10 | 14 VI (12 × 13) |
| 4 REPORT ALTITUDE | 10. ELEV (Nearest 1mil) (8 + 9) +32 | 15 ALTITUDE (RADAR) (Meters) |
| 5 REPORT WHEN READY TO OBSERVE | | 16. ALTITUDE (RP) (14 + 15) |

STEP 4 REPORT TO FDC

ALTITUDE (16 or 11 whichever is the greater)

, AT MY COMMAND; REQUEST SPLASH; READY TO OBSERVE

STEP 5: RECORDING AND COMPUTATION

| ROUND NO | FROM B SCOPE | | FROM TELESCOPE (HIGH BURST ONLY) | | | |
|---|---|---|---|---|---|---|
| | | | AZIMUTH DEVIATION (Note 3) | | ELEVATION DEVIATION | |
| | RANGE | AZIMUTH | LEFT ( – ) | RIGHT ( + ) | BELOW ( – ) | ABOVE ( + ) |
| 1 | 5120 | 600 | | | | |
| IF REQUIRED, ADJUST POINTING DATA AND CORRECT BLOCKS 6 AND 10 (Note 2) | | | | | | |
| 2 | 5010 | 609 | | | | |
| 3 | 5100 | 602 | | | | |
| 4 | 5050 | 605 | | | | |
| 5 | 5090 | 603 | | | | |
| 6 | 5020 | 610 | | | | |
| | | | | | | |
| | | | | | | |
| TOTAL | 17 30390 | 18 3629 | TOTAL LEFT ( – ) | TOTAL RIGHT ( + ) | TOTAL BELOW ( – ) | TOTAL ABOVE ( + ) |

| NOTE: AFTER SIX VALID ROUNDS REPORT "END OF MISSION" TO FDC | 19 AZIMUTH DEVIATION = ALGEBRAIC TOTAL LEFT ( – ) AND RIGHT ( + ) | 20 ELEVATION DEVIATION = ALGEBRAIC TOTAL BELOW ( – ) AND ABOVE ( + ) |
|---|---|---|

| 23 REGISTRATION POINT RANGE (Nearest 10 meters) | 24 AZIMUTH OF MPI (Nearest 1 mil) | 21 | 22 |
|---|---|---|---|
| 5065<br>6 ⟌ 30390 (17) | 604.8 = 605<br>6 ⟌ 3629 (18) | ± 6 ⟌ (19) | ± 6 ⟌ (20) |
| | | 25 (21) | 27 (22) |
| | | 26 (6) | 28. (10) |
| | | 29 HB AZ (Algebraically add 25 and 26) | 30 HB ELEV (Algebraically add 27 and 28) |

| STEP 6. FINAL REGISTRATION POINT ALTITUDE | | STEP 7: REPORT TO FDC | |
|---|---|---|---|
| 31. RP RG (23) (In thousands) | 5.06 | 36. REPORT ON RADAR OBSERVED (Check applicable box) ☐ HB ☒ MPI | |
| 32. HB (Enter value block (30)) MPI (Enter value block (10)) | +32 | 37 TIME OBSERVED | 261825 |
| | | 38. AZIMUTH (MPI (24) HB (29)) (See note 4) | 605 |
| 33 VI (31 × 32) | +162 | 39. RANGE (23) (See note 4) | 5060 |
| 34. ALTITUDE RADAR | 370 | 40 ALTITUDE (35) (See note 4) | 532 |
| 35. ALTITUDE RP (33 + 34) | 532 | 41. GRID OF RP (Nearest 10 meters) | 5180 4830 |

DA FORM 1 MAY 75 2888 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

*Figure 5–9. DA Form 2888 showing a completed MPI registration.*

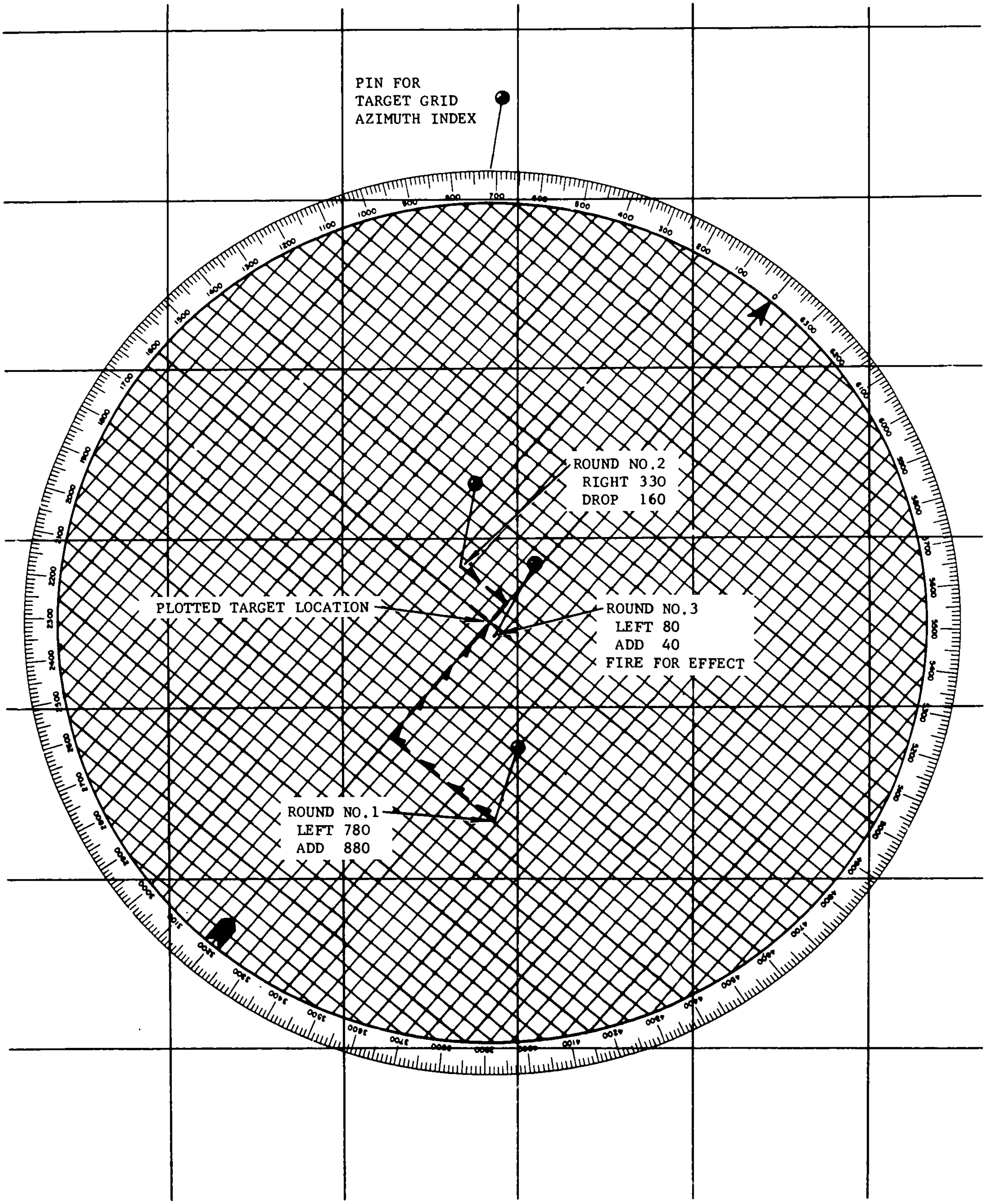


*Figure 5-10. Use of target grid for determining radar fire adjustment corrections.*

radar section must quickly check to verify that no error has been made in orientation or computation. When the radar section is again ready to observe, the plotter transmits the command UNOBSERVED, REPEAT to the fire direction center. The command UNOBSERVED, REPEAT informs the dire direction center that radar section did not obtain data for corrections and desires that another round be fired at the same location.

(2) When the location of the burst has been determined, it is compared to the target location grid coordinates. The difference in easting (dE) is the lateral shift and the difference in northing (dN) is the range shift.

EXAMPLE:

| | | |
|---|---|---|
| Grid coordinates of target | 27300 | 33700 |
| Grid coordinates of burst | 27100 | 33500 |
| RIGHT | 200 ADD 200 | |

This shift, to move the burst to the target, is sent to the fire direction center. Right 200 ADD 200. These corrections are announced to the nearest 10 meters. The shift (or correction) Right (Left) (so much), Add (Drop) (so much) is understood to mean meters, even though the word "meters" is not expressed.

(3) The adjustment is continued until a round bursts within 100 meters of the target in deviation and range. The radar section then sends final corrections and requests "Fire For Effect," for example: RIGHT 50, ADD 90, FIRE FOR EFFECT.

*c. Target Grid Method*

(1) The radar plotter places the target grid (fig 5–10) over the target location and orients the grid. The antenna is adjusted until it is pointing at the target. If a request has been made to mark the center of sector, the antanna must be pointed in the general direction of the center of the sector.

(2) When the battery is ready to fire the round, the message BATTERY IS READY is transmitted to the radar section. When the radar section has placed the correct pointing data on the radar set and is ready for the first round, the radar section sends the command FIRE to the guns. If the first round is not located by the radar, the radar section must quickly check the orientation of the radar set and verfify that no error has been made in orientation or computation. When the radar section is again ready to observe, it transmits the command REPEAT to the fire direction center. The command REPEAT informs the fire direction center that the radar section did not obtain data for corrections and desires another round be fired at the same location.

(3) When the location of the burst has been determined, it is plotted on the radar chart. The distance that the round bursts to the left or right, over or short of the target (center of the target grid) is read directly from the target grid. The shift necessary to move the next burst to the target is sent to the fire direction center. These corrections are announced to the nearest 10 meters. The shift (or correction) RIGHT (LEFT) (so much, ADD (DROP) (so much) is understood to mean meters, even though the word "meters" is not expressed. The adjustment is continued as stated in the grid comparison method.

## Section III. RADAR SURVEY

### 5–17. General

The possibility of conflict in remote areas of the world places an increased requirement on the artillery to be able to conduct fire on a target with data obtained from inaccurate maps or even without maps. The artillery must be able to deliver rapid and accurate fire in remote areas, often without survey control or adequate time to complete an observed firing chart. The AN/MPQ–4A radar can be used to provide hasty survey control between the radar position and the artillery firing units by combining the procedures for marking a weapon location with those for observing a high burst registration.

### 5–18. Conduct of a Radar Survey

*a. Emplacement of the Radar.* To conduct a survey mission, the radar should be emplaced near the center of the direct support battalion position area; however, it should not be closer than 1,000 meters to the weapons to be surveyed. (If a weapon is closer than 1,000 meters to the radar, a short survey traverse provides more reliable data.) The radar site should meet the normal positioning requirements for weapon location and radar gunnery applications. Assumed coordinates and altitudes are set into the radar set computer.

*b. Battery Coordinates.* The coordinates of each battery center, relative to the radar, are determined by the radar section, using standard weapon location techniques. The radar beam is positioned over the battery being located. The base piece fires one round at high angle, and the location of the base piece is determined form data based on this one round.

*c. Battery Altitude and Common Direction.* The center battery fires a high-burst registration which can be observed form the radar site and from the battery center of each battery being provided survey. Each battery executive officer observes the high-burst with an aiming circle set up over the battery center and laid parallel to the guns. The battery executive officers of the flank batteries measure and record the deflection and the vertical angle to the high burst. The executive officers compute the mean deflection and vertical angle to the high burst. The registration deflection effect is the difference between the registering executive officer's orienting deflection and his recorded mean deflection to the high burst. The correction is opposite the effect. The radar section provides the coordinates and altitude of the high burst, both of which are relative to the assumed altitude and coordinates set into the radar computer. The location of the high burst is plotted on the firing chart. The deflection indexes for the flank batteries are constructed at a value equal to the deflection correction modified by an error which occurred when the battery was initially laid. This error is determined by comparing the measured azimuth from each flank battery with the azimuth between the radar-provided battery location and the high-burst location. The center battery deflection index is constructed at the adjusted deflection to the high-burst. The vertical angle measured from each battery is converted to a vertical interval, using the radar chart range, and applied to the high-burst altitude. This procedure provides the altitude of each battery which observed the high burst.

# CHAPTER 6

# MOVING TARGET DETECTION

## 6–1. General

The radar set AN/MPQ–4A has a limited capability for detecting and locating moving ground targets. Beacause of the large number of battlefield surveillance radars available within the dividion, the AN/MPQ–4A is seldom used in the moving target detection role. When the AN/MPQ–4A is used for moving target detection a line of sight must exist between the radar set and the area of interest. Only the lower beam is used. The RANGE SELECTOR switch is placed in the 3750 M position with the EXPANDED SWEEP DELAY switch in the correct position to cover the area of interest. The pointing elevation is critical because of the narrow 14-mil beam.

## 6–2. Procedure

The preliminary procedures for preparing the radar set for moving target detection are identical with those for weapon location. Moving targets are detected as moving echoes on the B-scope. A moving target is located by strobing the echo in azimuth and range. Plotting the changing locations of a target on a contour map provides its direction and speed of travel. This information eases the delivery of artillery fire on the predicted location of the target.

# CHAPTER 7

# TACTICAL EMPLOYMENT AND POSITION REQUIREMENTS

## 7–1. Tactical Missions

*a.* Some considerations affecting the mission assigned to the AN/MPQ–4A radar section are—

(1) Mission of the supported force.

(2) Tactics and employment techniques of the enemy artillery.

(3) The amount and type of weapons in the enemy force and the degree to which they are active.

(4) The capabilities and limitations of the AN/MPQ–4A radar and other available target acquisition systems.

*b.* After considering the above factors the commander will assign one or more of the following missions and assign sector(s) of search.

(1) Location of enemy mortars.

(2) Location of enemy artillery.

(3) Location of moving targets.

(4) Radar Gunnery.

*c.* Since the radar section cannot perform missions (1) and (2) above concurrently, the normal practice is to assign a primary mission of either locating hostile mortars or artillery and a secondary mission of radar gunnery. Because of the inherent limited capability for the location of moving targets, this mission is seldom assigned.

## 7–2. Selection of Site

*a.* Coordination of search areas for all radars is essential to insure complete coverage of the target area. Within the Division, this coordination is performed by the Division Artillery S2. When operating as a part of a Corps force, further coordination of division artillery sites and the Target Acquisition Battery sites in the division zone is performed by the Target Acquisition Battalion S3. The Radar visibility diagram (para 7–5*b*,*f*, *g*), which is forwarded through channels, facilitates the coordination of all target acquisition activities.

*b.* After the tactical mission is assigned the battalion commander (division artillery units) or battery commander (Tgt Acq Bn) designates a general position area within which the radar section may select a position. This general position area should encompass an area large enough that the field artillery platoon leader, radar technician or chief of section may select the actual radar site, based on the technical considerations affecting the operation of the radar.

*c.* If possible, the radar position should be adjacent to the center battery of a firing battalion to simplify communications, facilitate survey and logistics, and enable the section to take advantage of any existing defensive perimeter. Depending upon the mission, terrain, and situation, the radar position area should be located from 2,000 to 4,000 meters behind the FEBA to give the radar section flexibility of action in the offense and defense.

*d.* After the general position area has been designated, the radar technician or chief of section will make a reconnaissance before selecting the actual radar position. If time permits, this reconnaissance will be divided into two phases—a map reconnaissance and a ground reconnaissance.

(1) The map reconnaissance is made to determine, but is not limited to, the following:

(*a*) Possible sites available.

(*b*) Routes into and out of the area.

(*c*) Identifying landmarks.

(*d*) Locations of adjacent units.

(2) A ground reconnaissance is made after the map reconnaissance to aid in occupation of the selected position. The ground reconnaissance is based on the tactical and technical consideration for the radar as modified by dictates of the particular mission, situation, and terrain. Since the time available for reconnaissance is generally limited, the reconnaissance must be organized so that it can be accomplished as completely as possible in the time allotted. It must be detailed enough to allow the radar technician or chief of section to make decisions and issue orders concerning—

(*a*) The exact location of the radar.

(*b*) The location of the radar operations center.

(*c*) The location of the generator.

(*d*) The location of the truck park.

(*e*) Routes into and out of the area.

(*f*) Searching and marking the area for mines.

(*g*) Local security, to include camouflage and defense against air and ground attack.

(*h*) The selection of alternate positions.

## 7–3. Tactical Considerations

The tactical considerations in selecting a radar site are similar to those considered in choosing a position for a field artillery firing battery. Normally, these considerations include communications, concealment, cover, routes of approach, security, and survey.

*a. Communication.* The communication requirements vary with the mission assigned to the radar section, but the site must permit the required communications to be established. Wire and/or radio are the normal means of communication for the radar section.

*b. Concealment.* In selecting a site for the radar, advantage must be taken of natural concealment, such as trees and shrubs.

*c. Cover.* The radar should be emplaced in defilade to the enemy to give personnel and equipment all possible protection from hostile fire.

*d. Routes of Approach.* The site selected for the radar should have more than one route of approach that will allow occupation of the site without being observed by the enemy. Road conditions, overhead clearances, bridges, and stream fords must be considered.

*e. Physical Security.* If possible, the radar site should be selected within the defense perimeter of another unit to ease the local security requirements for the radar section.

*f. Electronic Security (ELSEC).* This pertains to protective measures applied to intentional electromagnetic radiations of communications equipment and systems to prevent the interception, analysis, or exploitation of those radiations by foreign intelligence collection efforts. ELSEC is an important aspect of OPSEC and tactical cover and deception. Chapter 5, Electronic Security, of FM 32–5, and FM 32–6 cover the functions and techniques of ELSEC in detail.

*g. Operational Security (OPSEC).* This includes all actions necessary and appropriate to deny the enemy information concerning planned, on-going, or completed operations.

*h. Survey.* The selection of a site near a firing battery or a known survey point aids in the determination of the coordinates and altitude of the radar and the azimuth and elevation to a known point for orientation purposes.

## 7–4. Technical Considerations

*a.* Echoes are frequently received from objects outside the main lobe of the radar beam. These echoes can cause clutter to appear on the radar scope and obscure actual target returns. Ideally, the radar is positioned in shallow defilade so the objects which cause the clutter are masked by a hill or ridge. This mask is called a screening crest. The clutter (caused by the mask itself) appears at close range, where it will not interfere with the detection of desired targets. A screening crest is not essential with intercept-type radars like the AN/MPQ–4A. If the radar is emplaced behind a screening crest, the crest should be in friendly territory and within 1,000 meters of the radar, since the area between the radar and the screening crest will be obscured by clutter and therefore cannot be used for detection of weapons. It is desirable that the radar scan at an elevation of 50 mils or less; therefore, the elevation to the screening crest should not exceed 40 mils. A screening crest is also useful as a defense against electronic countermeasures.

*b.* Other technical considerations that should be considered in selecting the radar site are the—

(1) Maximum range of the radar (15,000 meters)

(2) Sector coverage (445 mils).

## 7–5. Site Evaluation

*a.* Since most sites selected represent a compromise between what is desired and what is available, it is likely that there will be blind spots of significant size in the radar's assigned area of responsibility. It is necessary that the battalion S2 and Tgt Acq Bn S3 have a diagram showing the sectors being searched, and significant blind spots within these areas. With this information, the S2 can prepare the radar portion of his target acquisition capabilities chart, and provide other means of coverage for the blind spots if available and desirable.

*b.* The radar visibility diagram (fig 7–3) is an overlay showing the boundaries (azimuth and range) of the sectors (normally not to exceed three) actually being searched and all areas within these sectors which cannot be observed. Sectors of search are overlapped so that sector centers are 400 mils apart. Sectors adjacent to those actually being searched may also be included when time permits or if required by unit SOP. One copy of the diagram is retained by the radar section for use by radar operator; the number of copies forwarded to higher headquarters for further distribution will be established by the unit SOP (construction of the diagram is discussed in *f* below).

*c.* The radar section also prepares a screening crest profile (fig 7–1) for use by the radar operator in choosing a scanning elevation or the elevation to be used for radar-observed registrations. Elevations for profile may be determined with an aiming circle during the ground reconnaissance or with the orienting telescope of the radar set after occupation of the site. In either case, the instrument is set at zero elevation and the elevation to the screening crest is read directly from the reticle. Screening crest elevations are normally measured every 100 mils throughout the sectors being searched. If the screening crest is very irregular, the interval between readings must be reduced. The elevation readings are plotted at the azimuth at which they were determined, as shown in (fig 7–1).

*d.* While measuring screening crest elevations, the section should measure the elevations of hill masses that can be seen above the screening crest and then construct a skyline profile as shown in figure 7–2. These hill masses can be expected to produce clutter, and they may completely obscure observation of the areas beyond them. This information is not used in the preparation of the screening crest profile, but it is useful in preparing the visibility diagram.

*e.* Clutter in each sector to be included in the visibility diagram is observed at various elevations, starting 10 mils above the lowest point in the screening crest within that sector and moving up in 5-mil increments until the most favorable operating elevation has been determined. Generally, it is desirable to scan at an elevation as close to the elevation of the screening crest as possible; however, lower scanning elevations usually cause more clutter. The selected elevation will normally be the lowest elevation at which an acceptable amount of clutter is observed. In any case, the elevation must be at least 10 mils above the screening crest and low enough to enable the radar to perform its assigned mission. During these observations, the IF GAIN control should be set at the normal operating level; if it is anticipated that the circular polarizer will be used at this site, the polarizer should be in the operating position.

*f.* The visibility diagram (fig 7–3) is prepared in the following manner:

(1) Place a sheet of tracing paper over the appropriate map and draw in the register marks and the boundaries (range and azimuth) of the sectors being searched. Do not include marks and boundaries within 1,000 meters of the radar. Identify each sector by placing a letter along the edge of the sector nearest the radar.

(2) Set the antenna azimuth at the center of one of the sectors, and set the antenna elevation at the elevation chosen for that sector (*e* above).

(3) Place the RANGE SELECTOR switch in the 15000 M position, the BEAM VIDEO switch in the BOTH position, and the RANGE SHIFT switch at OFF. Place the detent switch at OFF and the Δ RANGE and Δ AZIMUTH controls in detent.

(4) Using the LOWER BEAM RANGE and LOWER BEAM AZIMUTH controls, measure the range and azimuth to several points around each patch of clutter.

(5) Plot these points on the visibility diagram and connect the points for each patch of clutter with a solid line. Shade the areas within these solid lines to indicate that targets in these areas cannot be observed (fig 7–3).

(6) Using a map and the observations made during measurement of the screening crest profile, identify the terrain feature which causes the clutter. Determine whether the area beyond the patch of clutter is also obscured. For example, note in figure 7–2 that the hill at azimuth 5250 extends approximately 60 mils above the screening crest. A scanning elevation of 35 mils was selected for this sector, which causes all returns from objects behind that hill to be cut off. Shade this area to indicate that targets in the area cannot be observed.

(7) Draw a dotted arc in each sector to indicate the maximum range at which 81 mm mortars can be located by the radar. This range varies with the scanning elevation of the radar and with the type of ammunition, charge, and elevation being fired by the mortar. The following ranges are considered representative for the elevations indicated:

| Scanning elevation | Maximum effective detection range |
|---|---|
| 35 mils | 10,000 meters |
| 40 mils | 9,400 meters |
| 50 mils | 8,400 meters |
| 60 mils | 7,500 meters |
| 70 mils | 6,800 meters |
| 80 mils | 6,300 meters |

(8) Repeat the procedure in (1) through (7) above for each sector included in the visibility diagram.

*g.* The visibility diagram overlay must include the following marginal information:

(1) Security classification.
(2) Date and time.
(3) Map reference.
  Sheet name.
  Sheet number.
  Map series number.
  Scale.
(4) Prepared by
  Name and rank
  Organization
(5) Additional information
  Scanning elevation for each sector
  Explanation of dotted line indicating maximum detection range for 81-mm mortar (when used).

# TYPICAL SCREENING CREST PROFILE

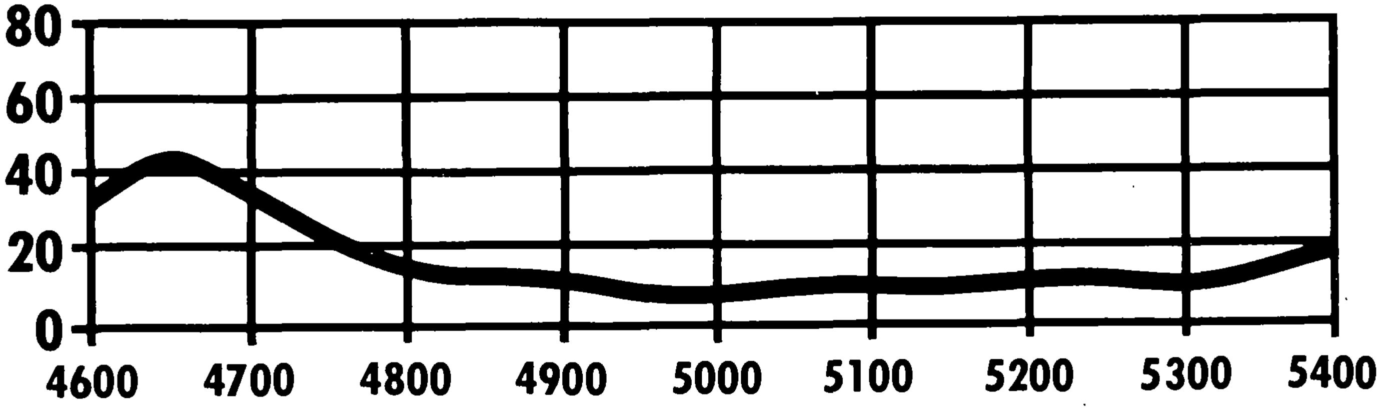


*Figure 7–1. Typical screening crest profile.*

# SKYLINE PROFILE SEEN ABOVE SCREENING CREST

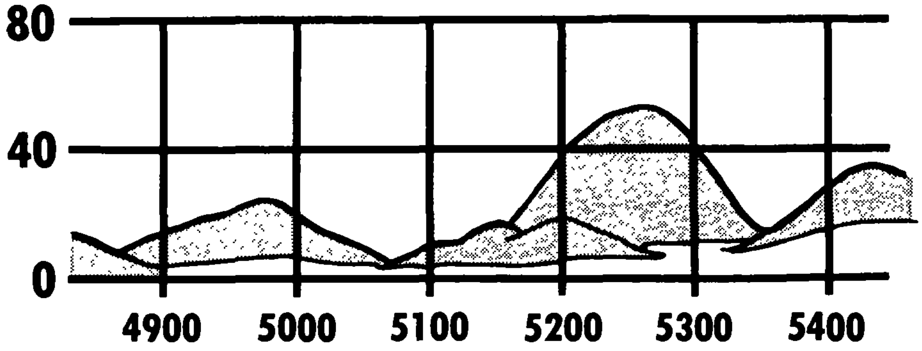


*Figure 7–2. Skyline profile seen above screening crest.*

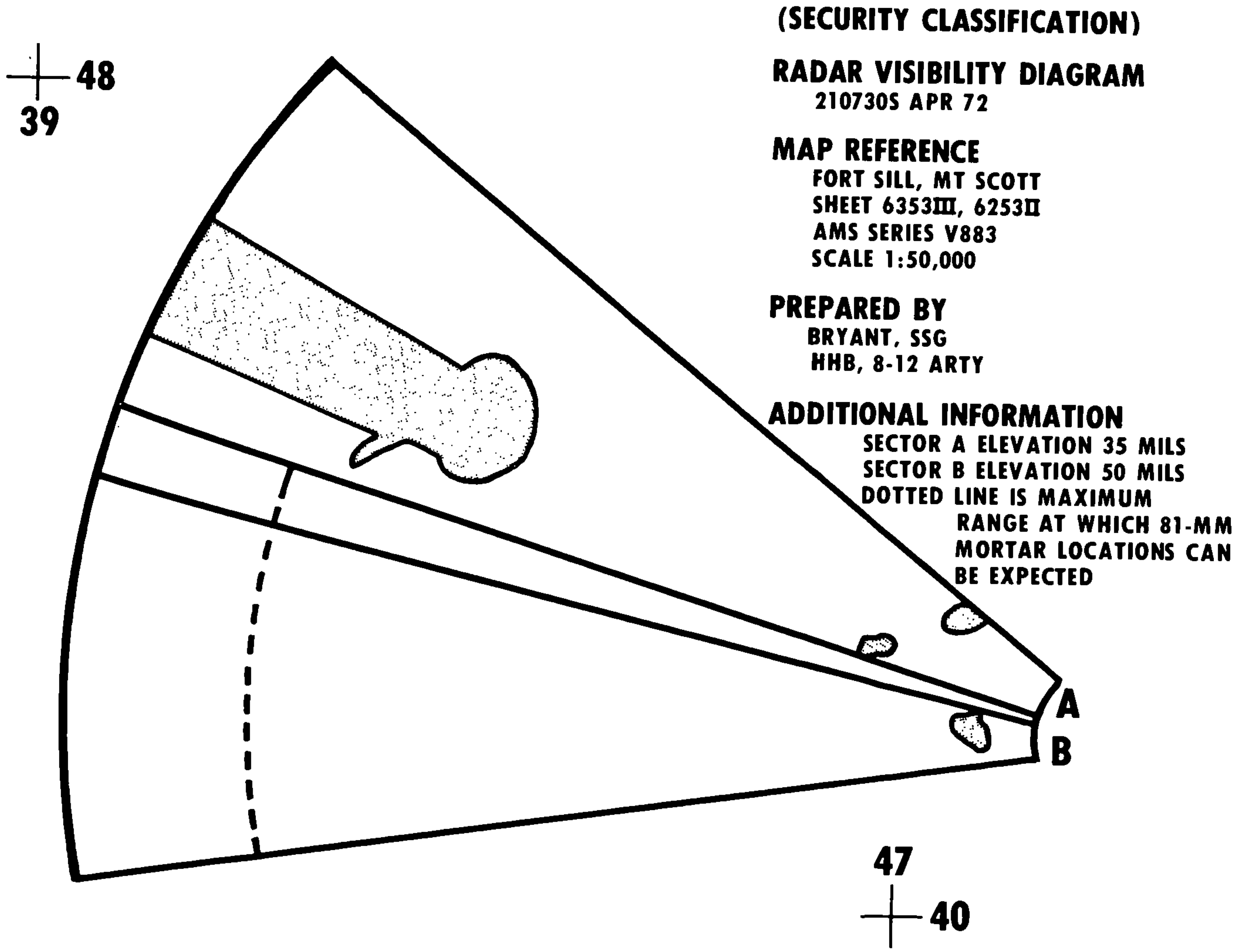


*Figure 7–3. Typical radar visibility diagram.*

# CHAPTER 8

# SAFETY PRECAUTIONS

## 8-1. Principles

Using personnel will not perform maintenance or inspections on the radar equipment beyond those functions specifically authorized in this manual and in the appropriate technical manual.

## 8-2. Precautions

*a.* Dangerous voltage is used in the operation of the radar equipment. Personnel must exercise caution when working on or near the 440-volt plate and power supply circuits, or the 120-volt AC line connections. Personnel must be familiar with warning notices contained in C 9, TM 11-5840-208-10. *Extremely high voltage* exists in the amounts specified in the following units:

| | |
|---|---|
| Duplexer tube assembly | 700 volts |
| Power supply PP-1588/MPQ-4A | 700 volts |
| Indicator, azimuth and range IP-375/MPQ-4A | 14,000 volts |
| Modulator and transmitter | 26,000 volts |

*b.* Do not refuel the power unit and do not handle or leave open gasoline containers in the vicinity of the radar set while the radar transmitter is on.

*c.* Radio-frequency energy transmitter by the radar set can produce damaging effects on body tissue.

(1) It can cause eye cataracts, headaches, testicular damage, and skin injury. Such harm can occur to personnel who are exposed to radiation of 10 milliwatts per square centimeter for a period of 10 minutes or longer.

(2) The power radiated by the radar AN/MPQ-4A is sufficient to cause the effects listed in (1) above when the individual is between the half-power points of the radar beam out to a distance of approximately 15 meters from the reflector. The effects will vary with the individual and length of time he is exposed.

(3) An observer is not exposed to the radar beam while he is observing through the optical telescope. There is a minimum clearance of 55 centimeters between the eyepiece of the optical telescope and the lower half point of the beam. There is a danger, however, that an operator standing erect by the optical telescope may expose his head to radiation above the safety level. During a high-burst registration the observer should be cautioned to keep his head down near the eyepiece of the telescope.

*d.* Radioactive material is contained in type OB2 WA and type 6560 tubes. These tubes are potentially dangerous when broken. If handling personnel are cut by the broken tube, emergency medical attention is required. For specific instructions, see TB 43-0116.

## 8-3. Electric Shock

Electric shock accidents can cause breathing to cease. A casualty may recover if artificial respiration is applied promptly and efficiently. The principles and procedures for the treatment of electric shock are described in FM 21-11.

# CHAPTER 9

# PROCEDURES FOR MINIMIZING THE EFFECTS OF JAMMING

## 9–1. Recognition of Jamming

The radar operator must learn to recognize the different forms of interference and to distinguish unintentional interference from deliberate interference caused by enemy jamming. Unintentional interference may result from the operation of nearby electrical equipment, or it may originate in the radar itself. This interference will, at times, produce patterns on the radar scope similar to the patterns caused by enemy jamming. Interference caused by enemy jamming is indicated when an interference pattern remains on the scope after the interference from all friendly sources has been eliminated. When the operator has observed the interference and determined that it is the result of enemy jamming, the next step is to take all possible action (para 9–3 through 9–5) to minimize the effects of the jamming and to continue operation. If, because of enemy jamming, an untrained operator shuts down his set with the mistaken idea that the set is defective, he will be reacting just as the enemy want him to. Through training and practice, the operator can learn to distinguish unintentional interference from the interference caused by enemy jamming and can take the necessary countermeasures.

## 9–2. Types of Jamming

Jamming is divided into two general categories—transmission jamming, which is produced by a transmitter radiating a modulated or an unmodulated radio-frequency signal, and reflective jamming, which is produced by reflecting devices and is intended to produce false targets or to obscure actual target signals on the radar scope.

*a. Transmission Jamming.* Transmission jamming usually has a directional characteristic; that is, the jamming indication normally is limited to a particular portion of the sector scanned by the radar being jammed. Depending on the type of transmission used, transmission jamming produces either strobe lines (extreme brightening or the sweep) or sector blanking (complete blanking of all indications) in the direction from which the jamming is being received. However, if the jamming signal is extremely strong, transmission jamming can completely saturate the radar scope, and the direction from which the jamming is being received cannot be determined. From the counter countermeasure viewpoint; it is important to note the direction of the jamming indication, when the jamming does have discernible directional characteristics, so that the jammer can be located and steps can be taken to reduce its effectiveness.

*b. Reflective Jamming.* Reflective jamming is produced by means of other than active transmitters. Generally, reflective jamming is produced by reflecting items, such as rope, chaff, and straw. These reflecting items, usually in the form of various types, shapes, and sizes of metallic strips and metallic coated papers, are dropped from aircraft. The purpose of reflective jamming is to create false echoes or to produce large echoes, with the intention of shadowing or obscuring target signals from actual aircraft or missiles. Reflective jamming also is produced by window jamming devices, such as corner reflectors, metallic mesh, and strobe, rotating or osculating dispoles. These types of window jamming devices are intended to produce strong false echoes which will obscure the true target echoes. False echo interference may be called deception instead of jamming. All window jamming devices operate on the same principle—that of reflecting the pulse transmitted from a radar set. Only by intensive training and experience can a radar operator learn to distinguish between true target echoes and echoes produced by window jamming devices.

## 9–3. Location of Jamming Source

When interference is received and it appears to the radar operator that it is deliberate enemy jamming, he should immediately report to his superior the type of jamming received and the direction from which it is received. The operator also should keep a record of the time, type, and direction of the jamming signal. Information from two or more radar sites may provide data to establish the exact location of the jammer and may determine its movement if the jamming originates from a moving source. This data can be used as a guide in resiting the radar equipment, or they may be used to produce fire direction data to place the site of the jammer under active fire with guns, missiles or aircraft. Jamming should be reported and recorded as long as the jamming indication is observed. All suspected or confirmed instances of jamming and interference should be reported in accordance with AR 105–3.

## 9–4. Procedure for Operation Against Transmission Jamming

After the type and direction of the jamming have been determined, the following procedures should be used by the AN/MPQ–4A radar operator to reduce the effectiveness of the jammer:

*a. Gain Control.* In continuous-wave jamming, a type of electronic jamming, a gain setting less than that used for normal operation is usually most effective. A reduced gain setting prevents overloading the receiver and allows the target echo to be seen through the jamming signal. The GAIN control should be varied over its entire range to find the setting at which the target echo is best seen. When continous-wave jamming is strong enough to block the receiver completely, the GAIN control will not effectively reduce the jamming effects.

*b. Local Oscillator.* Varying the local oscillator tuning a small amount may help to reduce the effects of continuous-wave jamming if the jamming signal is confined to a narrow frequency band. Modulated jamming, however, usually produces a signal of sufficient bandwidth to make varying the local oscillator ineffective as an antijamming measure.

*c. Siting.* The AN/MPQ–4A radar is difficult to jam unless a *line-of-sight* condition exists between the jammer and the radar. Therefore, it is important that the radar be located in defilade.

*d. Antenna Elevation.* If jamming occurs only when the jammer is in the main lobe of the radar, some relief may be obtained by increasing the vertical angle of the antenna. Even though the Δ time will be increased, the information obtained from the computer will still be of value.

## 9–5. Procedure for Operating Against Window Jamming

To counter window jamming, adjust the INTENSITY, FOCUS, AND IF GAIN controls for maximum definition. Window jamming indications usually appear as many closely spaced targets (clutter). Good definition helps to separate the true target echoes from the jamming echoes and make it easier to follow the movement of the target indication through the random movement of the jamming echoes on the scope.

# CHAPTER 10

# DECONTAMINATION OF EQUIPMENT

## 10–1. General

*a.* This chapter discusses briefly the subject of decontamination of equipment. In order to understand precisely how to perform these operations, the radar section should become thoroughly familiar with the procedures outlined in TM 3–220, TM 3–225, and FM 21–40.

*b.* Equipment which has been contaminated by chemical, biological, or radiological (CBR) agents must be decontaminated to reduce the hazard to personnel. Decontamination can be done by covering, removing, destroying, or changing into harmless substances the contaminating material. Personnel performing CBR decontamination should wear the mask and their normal clothing buttoned at the neck and tied at the wrists and ankles with string (trousers bloused). For added protection, personnel may wear any other protective items that are available.

## 10–2. Chemical Decontamination

The best method of decontaminating radar equipment is to use hot air. The next best method is aeration or weathering. The metal parts exposed to blister and V-agents may be decontaminated with DS2, which is an excellent decontaminant for radar equipment. It is also readily available to the radar section. Electrical devices which contain electron tubes or other heat-producing elements are normally decontaminated by the heat given off during operation.

## 10–3. Biological Decontamination

A decontaminant for destroying or removing contamination should be effective against a variety of biological agents. Items currently available are natural and chemical decontaminants. Most decontaminants and procedures for chemical decontamination are effective for biological decontamination. Natural decontamination by rain, wind, and sunlight will destroy most biological agents on the exterior of equipment within a day. Ethylene oxide or carbonide may be used to decontaminate the interior of the equipment.

## 10–4. Radiological Decontamination

Decontaminants which have good cleansing characteristics are normally used for radiological decontamination, because the contaminants for fallout are usually finely divided particles which adhere closely to materials and tend to settle into pores and crevices. In most military situations, radiological contaminants are satisfactorily removed by flushing with water, by the use of steam and by brushing. The use of DS2 for chemical decontamination of equipment will also remove most radiological contamination. When speed is not an important factor, aging is the most desirable method, since it will make laborious decontamination work unnecessary.

# CHAPTER 11

# TRAINING

## 11-1. Purpose and Scope

The purpose of this chapter is to present the requirements for training the personnel of a radar section in the performance of their duties. It includes general information on the conduct of training.

## 11-2. Objectives

The objectives are to train radar crewmen rapidly in their individual duties and, through drill, to weld them into an effective, coordinated team that is capable of functioning efficiently and quickly in combat. Maximum efficiency is attained through frequent drills.

## 11-3. Conduct of Training

*a.* Training is conducted in accordance with the principles set forth in FM 21-5. The goal of training should be the attainment of the standards set forth in AR 611-201 and Army Subject Schedule 6-10.

*b.* Individual training is conducted by noncommissioned officers as practicable. Officers are responsible for preparing training plans, for conducting unit training, and for supervising and testing individual training.

*c.* Throughout training, the application of prior instruction to current training must be stressed.

*d.* A record of the training received by each individual should be entered on a progress card maintained by his chief of section. This card should reflect each period of instruction attended by the individual, the tests taken, and remarks concerning his progress. Progress cards should be inspected frequently by the radar unit commander to make sure that they are being kept properly and to determine the status of training. *Requiring the chief of section to keep these records emphasizes his responsibility for his section.*

*e.* The necessity for developing leadership and initiative in noncommissioned officers must be emphasized constantly throughout training.

## 11-4. Standards To Be Attained

Each member of a radar section must know the duties of the other members of the section. Section personnel must be able to perform efficiently in all positions. This goal is atained by rotating the duties during training. The qualification test for AN/MPQ-4A radar crewmen are given in chapter 13.

## 11-5. Simulator, Radar Target Signal AN/TPA-7

The simulator, radar target signal AN/TPA-7, is a transportable trainer set designed for use with the radar set AN/MPQ-4A. This simulator generates electronic signals that duplicate actual projectile echoes on the radar B-scope. Electronic countermeasures (ECM) and atmospheric interference can also be simulated. To use this simulator, modification kit 40019264 must be applied to the radar set in accordance with the appropriate modification work order (MWO). The installation and operation of the simulator are described in TM 11-5840-287-12.

## 11-6. Training in Electronic Counter-Countermeasures

Radar trainer AN/ULT-T5 is a transportable, low-power radar transmitter designed primarily for use with any K-band radar set for training radar operators in antijamming techniques. The selected jamming signal is displayed on the scope of the radar simultaneously with the target signal. Instructions for installing and operating the radar trainer AN/ULT-T5 are contained in TM 11-6940-209-10.

# CHAPTER 12

# DESTRUCTION OF EQUIPMENT

## 12–1. General

*a.* Tactical situations may arise in which it will be necessary to abandon equipment in the combat zone. In such a situation all abandoned equipment must be destroyed to prevent its use by the enemy.

*b.* The destruction of equipment subject to capture or abandonment in the combat zone be undertaken *only* upon authority delegated by a division or higher commander.

## 12–2. Principles

Each radar section will prepare a plan for destroying its equipment in order to reduce the time required if destruction becomes necessary. The principles to apply to preparing the plan are as follows:

*a.* Plans for destruction of equipment must be adequate, uniform, and easily carried out in the field.

*b.* Destruction must be as complete as the available time, equipment, and personnel will permit. Since complete destruction requires considerable time, priorities must be established so that the more essential parts will be destroyed first.

*c.* The same essential parts must be destroyed on all like units to prevent the enemy from constructing a complete unit from damaged ones.

*d.* Repair parts and accessories must be given the same priorities for destruction as the parts installed on the equipment.

## 12–3. Methods

To destroy equipment adequately and uniformly, all personnel of the unit must know the plan and priorities for destruction. For detailed information on the destruction of radar set AN/MPQ–4, see TM 11–5840–208–10; on the destruction of power unit PU–304C/MPQ–4, see TM 5–6115–450–15; and TM 750–244–2 on procedures for destruction of electronics material to prevent enemy use; and on the destruction of the vehicle, see applicable vehicle manual.

# CHAPTER 13

# QUALIFICATION TESTS FOR AN/MPQ-4A RADAR SPECIALISTS

## 13-1. Purpose and Scope

This chapter describes the test to be given in the qualification of AN/MPQ-4A radar specialists. Tests based on these outlines are designed to measure a radar crewman's skill in the emplacement and operation of the radar set AN/MPQ-4A. Tests are designed to determine the relative proficiency of an individual crewman in his performance of the duties of a radar specialist and are not intended for use in determining the relative proficiency of batteries or higher units. These tests are designed to serve as an incentive for the individual radar crewman to expand his knowledge to cover all duties in the radar section, thereby increasing his value to the unit.

## 13-2. Preparation of Tests

The tests will be prepared under the direction of the battalion/battery commander and should reflect the following:

*a.* Tests should be standardized so that the difference between the test scores of any two individuals will be a valid measurement of the differences in their skills.

*b.* Each radar crewman is a prospective candidate and copies of the tests should be available upon his request.

## 13-3. Organization of Tests

The qualification tests are organized to follow a logical sequence of events. They include the nomenclature of the radar set AN/MPQ-4A, selection of site and emplacement, operation of the radar set, evaluation of site map reading and use of plotting equipment, weapon and impact location, and radar gunnery. The test should be conducted in the sequence in which they are presented in this manual.

## 13-4. Administration of Tests

*a.* Because of differences in equipment, some modification may be necessary in administration of the tests to some units. Modification of the tests should be accompanied by a reevaluation of the weighting system.

*b.* The battery commander is responsible for testing the personnel within his battery. Generally, the tests will be administered as follows:

(1) An officer, warrant officer, or enlisted man who is fully qualified and experienced in the subject covered by the tests will be detailed as the examiner to administer the tests.

(2) Each section of the qualification test may be administered over a period of time, which should be standardized throughout the unit.

(3) A single test, once started, will be conducted from start to finish without interruption.

(4) The candidate will receive no unauthorized assistance. Assistance will be furnished to the candidate as required for each test. If a candidate fails any test because of the examiner or any assistant, the test will be disregarded and the candidate will be given another test on the same subject.

(5) Times are not prescribed for each test because of the differing requirements in units and the varying effects of weather on the test. However, the examiner should assess appropriate penalties when excessive time is taken to complete a portion of a test. The responsible officer must decide what constitutes excessive time prior to the administration of the tests, according to the conditions existing at that time.

(6) The examiner will explain to the candidate the scope of the test and will indicate the men who will act as his assistants. The examiner will critique the candidate's performance at the completion of the test and turn the tentative scope in the battery commander. The battery commander will compute the final score and forward the test score to the battalion S3.

## 13-5. Qualification Scores

A total maximum score of 100 is possible on completion of the tests. The minimum scores required for qualification of expert, first class specialist, and second class specialist are as follows:

| *Individual classification* | *Points* |
|---|---|
| Expert | 90–100 |
| First class specialist | 80–89 |
| Second class specialist | 70–79 |

## 13–6. Outline of Tests

| Paragraph | Subject | Number of tests | Points each | Maximum credit |
|---|---|---|---|---|
| 13–7 | Nomenclature of radar set AN/MPQ–4A | 1 | 3 | 3 |
| 13–8 | Selection of site and emplacement | 1 | 12 | 12 |
| 13–9 | Operation of radar set AN/MPQ–4A | 10 | -- | 40 |
| | Test 1 | (1) | 5 | (5) |
| | Test 1 | (1) | 7 | (7) |
| | Test 3 | (1) | 4 | (4) |
| | Test 4 | (1) | 2 | (2) |
| | Test 5 | (1) | 3 | (3) |
| | Test 6 | (1) | 2 | (2) |
| | Test 7 | (1) | 3 | (3) |
| | Test 8 | (1) | 10 | (10) |
| | Test 9 | (1) | 2 | (2) |
| | Test 10 | (1) | 2 | (2) |
| 13–10 | Evaluation of site | 1 | 7 | 7 |
| 13–11 | Map reading and use of plotting equipment | 1 | 6 | 6 |
| 13–12 | Weapon and impact locations | 3 | 6 | 18 |
| 13–13 | Radar gunnery | 2 | 7 | 14 |
| | Total | 19 | -- | 100 |

## 13–7. Nomenclature of Radar Set AN/MPQ–4A

*a. Scope of Test.* The candidate will be required to locate, name, and/or state the purpose of various parts of the radar set AN/MPQ–4A.

*b. Special Instructions.* The nomenclature printed on the part, which the candidate is to be questioned, will be covered with masking tape or similar material.

*c. Outline of Test.*

| Examiner commands | Action of candidate |
|---|---|
| LOCATE, NAME, AND/OR STATE THE PURPOSE OF THE PARTS NAMED. (The examiner will select 20 items from the below):<br>Antenna group OA–1258/MPQ–4A and all its components.<br>Telescope M62A2F and amount, telescope.<br>Control-indicator group and all its components.<br>Dehydrator.<br>Receiver-transmitter group and all its components.<br>Power cable reel.<br>Remote cable reel.<br>Electrical equipment shelter and components.<br>Control-indicator stand.<br>Power cable.<br>Remote control cable.<br>Pedestal control cable. | Locates, names and/or states the purpose of each part designated. |

*d. Penalties.*

(1) A penalty of 0.25 point for each error in nomenclature or statement of purpose and for each failure to locate the specified part.

(2) If the total penalties exceed 3 points, no credit will be awarded.

*e. Credit.* Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 13–6.

## 13–8. Selection of Radar Site and Emplacement

*a. Scope of Test.* The candidate will be required to select a radar site and explain how he would emplace the set.

*b. Special Instructions.*

(1) The examiner will prepare a situation map of the area showing the following elements of an assumed situation:

(*a*) The location of established survey control in the area.

(*b*) The location of friendly units adjacent to the area in which the radar set is to be sited.

(*c*) The general area designated for selecting a site.

(*d*) The suspected area of enemy activity.

(2) When assessing penalties, the examiner must bear in mind that any selected position is a compromise.

(3) The following equipment should be furnished:

(*a*) Aiming circle.

(*b*) Binoculars.

(*c*) Map of area with all pertinent information.

(*d*) Plotting equipment.

(*e*) Compass.

(4) The mission of locating a mortar should be assigned to the candidate.

*c. Outline of Test.*

| Examiner commands | Action of candidate |
|---|---|
| SELECT A RADAR SITE AND EXPLAIN HOW YOU WOULD EMPLACE THE RADAR SET. | Selects a radar site within the designated area, as prescribed in paragraphs 7-1 through 7-5, and explains how he would emplace the set. |

*d. Penalties.* Cut a maximum of—

(1) Four points for failure to select a position for which the terrain will provide electrical screening to minimize ground clutter and, at the same time, provide an acceptable screening angle of elevation (15 to 40 mils for radar gunnery).

(2) Two points for failure to select a position which provides ready access, cover, and concealment.

(3) One point for failure to consider the proximity of survey control.

(4) One point for failure to consider the proximity of friendly units.

(5) Four points for improper explanation of emplacement.

*e. Credit.* Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 13–6.

## 13–9. Operation of Radar Set AN/MPQ–4A

*a. Scope of Tests.* The candidate will be required to demonstrate his knowledge on all phases of operation of the radar set except for weapon location and radar gunnery.

*b. Special Instructions.* The examiner must insure that the radar set used by the candidate is in good working order prior to the test and that the computer has been correctly alined.

*c. Outline of Tests.*

| Test number | Examiner commands— | Action of candidate |
|---|---|---|
| 1 | PERFORM PRELIMINARY ADJUSTMENTS | Performs the preliminary adjustments of the following equipment, as described in paragraphs 3–4 and 3–5:<br>a. Receiver-transmitter group.<br>b. Control-indicator group.<br>c. Antenna group.<br>d. Interlock circuits.<br>e. Vents. |
| 2 | PLACE THIS SET IN OPERATION | Puts the set in operation by using the starting procedures, as outlined in paragraphs 3–6 and 3–7. |
| 3 | PERFORM THE FOLLOWING CHECKS AND ENTER THE RESULTS IN THE RADAR LOG.<br>a. Ringtime check.<br>b. AFC operation check. (The local oscillator must be properly tuned before the ringtime and AFC operation checks are performed). | Performs the ringtime check and the AFC check, as outlined in paragraph 3–8. |
| 4 | RANGE CALIBRATE THIS SET BY USING THE RANGE MAKERS. | Performs the procedure for range calibration, as outlined in paragraph 3–12. |
| 5 | ORIENT THE ANTENNA IN AZIMUTH, USING THE ELECTRICAL METHOD AND PERFORM THE AZIMUTH COLLIMATION CHECK. (The examiner will furnish the candidate a good electrical target at a known azimuth). | Performs the required procedures, as described in paragraph 3–9 and 3–10*a*. |
| 6 | ORIENT THE ANTENNA, USING THE OPTICAL METHOD. | Performs the required action, as outlined in paragraph 3–10*b*. |
| 7 | CHECK THE ALINEMENT OF THE ORIENTING TELESCOPE WITH THE ELEVATION DIALS. | Performs the elevation orientation check, as outlined in paragraph 3–11. |
| 8 | PERFORM THE COMPUTER ALINEMENT CHECK (The computer must be properly alined prior to this test). | Performs the computer alinement check, as described in paragraph 3–13. |
| 9 | SET THE ACTUAL RADAR LOCATION INTO THE COMPUTER. | Performs the required action, as outlined in paragraph 3–14. |
| 10 | PLACE THIS RADAR SET OUT OF OPERATION BY USING NORMAL STOPPING PROCEDURES. | Performs the normal stopping procedures, as described in paragraph 3–15 and3–16. |

*d. Penalties.*

(1) *Test 1.* A penalty of 1 point for failure to—

(*a*) Set the AFC–MANUAL switch on the control-monitor panel to the AFC position.

(*b*) Set the three control-power supply controls to their proper positions. (A penalty of 1 point for each of the three settings. Maximum cut is 1 point.)

(*c*) Set the azimuth and range indicator controls to the proper positions. (A penalty of 1 point for each of the nine settings. Maximum cut is 1 point.)

(*d*) Check to make sure that the azimuth stowlock is out, the azimuth handwheel is all the way out, and the fenders are down (No partial credit).

(*e*) Close all interlocks and open all vents. (No partial credit)

(2) *Test 2.* A penalty of 1 point for failure to—

(*a*) Check the power unit for proper voltage and frequency.

(*b*) Check the operation of the system blowers. (A penalty of 1 point for failure to check each of the three blowers.)

(*c*) Rotate the TEST METER SELECTOR switch and check the reading on both the control power supply panel and the control-monitor panel.

(*d*) Verify the proper movement of the antenna in azimuth and elevation.

(*e*) Check the dehydrator for proper air pressure and dry air.

(*f*) Adjust the magnetron current to 18 after the transmitter has been turned on.

(*g*) Tune the local oscillator, if necessary.

(3) *Test 3.* A penalty of 2 points for failure to—

(*a*) Perform the ringtime check properly.

(*b*) Perform the AFC check properly.

(4) *Test 4.* A penalty of 0.5 points for failure to—

(*a*) Turn the RANGE SHIFT switch off.

(*b*) Set the range at 2,000 meters using the LOW BEAM RANGE control.

(*c*) Set the RANGE SELECTOR switch to the 3750 M position and the EXPANDED SWEEP DELAY switch to position 0.

(*d*) Properly adjust and check the RANGE ZERO and RANGE SLOPE adjustments.

(5) *Test 5.* A penalty of 1 point for—

(*a*) Failure to use the LOWER BEAM AZIMUTH control to place the azimuth strobe over the target.

(*b*) Failure to adjust the IF GAIN control to reduce the size of the echo so that it may be easily bisected.

(*c*) Each error in collimation.

(6) *Test 6.* A penalty of 1 pont for each error or failure to follow the proper procedure.

(7) *Test 7.* A penalty of 1 point for each failure to—

(*a*) Check the level of the radar set before centering the reticle on the checkpoint.

(*b*) Record errors greater than 1 mil.

(*c*) Know why the elevation orientation check is useful.

(8) *Test 8.* A penalty of 1 point for each failure to —

(*a*) Check the linearity between the antenna ELEVATION-DEPRESSION counter and the computer LOWER BEAM ELEVATION counter at seven elevations from −100 to + 200 mils.

(*b*) Check the Δ AZIMUTH and LOWER BEAM AZIMUTH controls with the AZIMUTH counter and the range strobes.

(*c*) Check the Δ RANGE and LOWER BEAM RANGE controls with the RANGE counter and the range strobes.

(*d*) Check both the RADAR HEIGHTS counter and the weapon HEIGHT counter for proper operation.

(*e*) Check the RADAR LOCATION and WEAPON LOCATION counters by using the RADAR LOCATION EASTING and NORTHING switches.

(*f*) Check the linearity between the computer AZIMUTH counter and the movement of the azimuth strobe.

(*g*) Check the Δ TIME counter for proper operation.

(*h*) Know where the four computer accuracy check problems are located (in the computer compartment and in the logbook).

(*i*) Know the tolerances for the check results (not greater than 20 meters in easting or northing, with the sum of error not greater than 36 meters).

(*j*) Perform the required steps in sequence.

(9) *Test 9.* A penalty of 2 points for failure to know how to set the radar location into the computer.

(10) *Test 10.* A penalty of 2 points for failure to perform the normal stopping procedures.

*e. Credit.* Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 13–6.

## 13–10. Evaluation of Site

*a. Scope of Test.* The candidate will be required to evaluate the previously selected radar site by constructing the screening crest profile, a skyline profile, and coverage diagrams.

*b. Special Instructions.*

(1) The following equipment will be made available to the candidate:

(*a*) One radar set AN/MPQ–4A.

(*b*) One radar site evaluation chart.

(2) The examiner will insure that the radar set is adjusted correctly and operating properly.

(3) Two assistants will be available to operate the set.

*c. Outline of Test.*

| Examiner commands— | Action of candidate |
|---|---|
| CONSTRUCT RADAR SITE EVALUATION CHART. | Constructs the radar site evaluation chart, as prescribed in paragraph 7-5. |

*d. Penalties.* The candidate will be graded on the neatness, accuracy, and quality of his radar site evaluation chart. Penalties will be made accordingly.

*e.* Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 13-6.

## 13-11. Map Reading and Use of Plotting Equipment

*a. Scope of Test.* The candidate will be required to construct a grid sheet and plot the known friendly and enemy positions.

*b. Special Instructions.*

(1) The following equipment will be made available to the candidate:

(*a*) One mapboard.
(*b*) One grid sheet.
(*c*) One range deflection protractor.
(*d*) One coordinate scale.
(*e*) One plotting scale.
(*f*) One protractor.
(*g*) One 4H and one 6H pencil.
(*h*) Red, blue, and green hard lead pencils.
(*i*) Four map pins.
(*j*) One contour map of the area.

(2) The examiner will provide the candidate with the known friendly and enemy positions. The candidate will be given the grid coordinates and polar coordinates to plot. In at least one case, the candidate will determine the height of the position from a contour map. The radar azimuth indexes will be constructed.

*c. Outline of Test.*

| Examiner commands— | Action of candidate |
|---|---|
| PLOT ALL KNOWN LOCATIONS ON GRID SHEET. (The locations and designations of adjacent units and enemy positions will be given to the candidate. Information may be in the form of polar coordinates and grid references. The candidate will have a map of the area for determining all additional information, such as heights of locations, labeling of lower left hand corner of grid sheet, etc.). | Constructs a grid sheet, as prescribed in FM 6-40, paragraphs 16-1 through 16-12. |

*d. Penalties.*

(1) A penalty of 0.6 points for the incorrect—

(a) Labeling of the grid sheet.
(*b*) Establishment of the indexes.
(*c*) Labeling of a known location.
(*d*) Use or reading of the range-deflection protractor.
(*e*) Use or reading of the coordinate scale.
(*f*) Use or reading of the plotting scale.
(*g*) Use of map pins.
(*h*) Use of 4H or 6H pencil.
(*i*) Use of colored pencils.
(*j*) Use of height from the contour map.

(2) No credit will be allowed if penalties exceed 6 points.

*e. Credit.* Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 13-6.

## 13-12. Weapon and Impact Locations

*a. Scope of Tests.* The candidate will be required to act as the radar operator and the chart operator in a series of three tests on detection and location of mortars.

*b. Special Instructions.*

(1) A radar set AN/MPQ-4A with the necessary equipment will be emplaced in a favorable position for detecting projectiles fired from a mortar and for locating the weapon and impact locations.

(2) A qualified operator will be made available to assist in operating the set.

(3) The examiner will make the necessary arrangements to provide the mortar with sufficient ammunition to conduct the tests. He will establish communication between the weapon and the radar site.

*c. Outline of Test.*

| Test number | Examiner commands | Action of candidate |
|---|---|---|
| 1 | SCAN ASSIGNED SECTOR FOR PROJECTILES. (Examiner will have a maximum of five rounds fired at approximately 1 minute intervals). | Scans the assigned sector, detects the projectiles, and performs the procedures outlined in paragraph 4-4 and 4-5. |
| 2 | COMPUTE THE WEAPON LOCATION. | Computes the weapon location as prescribed in paragraphs 4-6, 4-7. |
| 3 | COMPUTE THE IMPACT POINT OF THIS ROUND. | Computes the impact point as prescribed in paragraph 4-9. |

*d. Penalties.* Penalties will be made as follows:

(1) *Test 1.* For failure to—

(*a*) Adjust the radar so that it scans the proper sector in azimuth, a penalty of 4 points.

(*b*) Set the elevation about 10 mils above the highest point of the screening crest in the sector, a penalty of 2 points.

(*c*) Detect the projectile echo on the ascending leg of the trajectory, a penalty of 1 point for each projectile echo missed.

(2) *Test 2.* For failure to—

(*a*) Strobe the echoes in proper sequence, a penalty of 1 point.

(*b*) Place the DETENT switch in DETENT RELEASE position, a penalty of 2 points.

(*c*) Use the TIMER switch properly, a penalty of 1 point.

(*d*) Set the Δ TIME into the computer, a penalty of 3 points.

(*e*) Plot the location on the map to determine the altitude, a penalty of 2 points.

(*f*) Insert the altitude into the computer if the difference exceeds 20 meters, a penalty of 3 points.

(*g*) Place Δ RANGE and Δ AZIMUTH controls in detent after the final location has been made a penalty of 1 point.

(3) *Test 3.* For failure to—

(*a*) Aline the antenna on the proper azimuth for impact location, a penalty of 4 points.

(*b*) Strobe the lower beam echo before the upper beam echo, a penalty of 4 points.

(*c*) Use the Δ TIME, a penalty of 2 points.

(*d*) Plot the location on the map and determine the difference in altitude, a penalty of 2 points.

(*e*) Place Δ RANGE and Δ AZIMUTH controls in detent after the final location has been made, a penalty of 1 point.

*e. Credit.* Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 13–6.

## 13–13. Radar Gunnery

*a. Scope of Tests.* The candidate will be required to determine the grid or polar coordinates and the altitudes of a high-burst and a mean-point-of-impact registration.

*b. Special Instructions.*

(1) The following equipment will be made available to the candidate:

(*a*) Two DA Form 2888 for use with the AN/MPQ–4A radar set.

(*b*) One sketch of the reticle in the orienting telescope with six rounds representing high burst placed at random around the center of the reticle. The range deviation for each round will be listed adjacent to the reticle sketch.

(*c*) One grid sheet.

(*d*) Necessary plotting equipment.

(2) During the test on high-burst registration, the candidate will use one DA Form 2888. He will determine and record the pointing data and the deviations indicated on the sketch of the telescope reticle. He will then compute the average range, elevation, and azimuth to the center of burst and determine the grid coordinates and altitude of the high-burst location.

(3) During the test on mean-point-of-impact registration, the candidate will use one DA Form 2888. He will determine and record the pointing data. The range and azimuth for each round will be given to the candidate, and he will enter this information on the form. He will then compute the average range and azimuth to the center of burst and determine the grid coordinates and altitude of the mean-point-of-impact registration point.

(4) The examiner will use the standard procedures, as shown in paragraphs 5–3 and 5–6, initiate tests 1 and 2 for the high-burst and the mean-point-of-impact registration.

*c. Outline of Tests.*

| Test number | Examiner commands— | Action of candidate |
|---|---|---|
| 1*a*. | CONDUCT RADAR-OBSERVED HIGH-REGISTRATION, REPORT WHEN READY. (The following information will be made available to the candidate: location of the radar, screening crest angle, field correction, unit to fire, high-burst location, and minimum altitude). | Conducts radar-observed served high-burst registration as prescribed in paragraph 5–3 through 5–5. |
| *b*. | DETERMINE THE GRID COORDINATES AND ALTITUDE TO THE HIGH-BURST LOCATION AND RECORD THE DATA IN STEP SEVEN OF DA Form 2888. | |
| 2*a*. | CONDUCT RADAR-OBSERVED MEAN-POINT-OF IMPACT Registration. REPORT. WHEN READY. (The following information will be made available to the candidate: unit to fire, location of mean-point-of-impact registration point, location of the radar, and the screening crest angle). | Conduct radar-observed mean-point-of-impact registration as outlined in paragraphs 5–6 through 5–8. |
| *b*. | DETERMINE THE GRID COORDINATES AND ALTITUDE TO THE MEAN-POINT-OF-IMPACT REGISTRATION POINT AND RECORD THE DATA IN STEP SEVEN OF DA FORM 2888. | |

*d. Penalties.* Penalties will be made as follows:

(1) For each mistake in determining the pointing data, a penalty of 2 points.

(2) For each mistake in filling in the form, a penalty of 1 point.

(3) For inability to determine the range and azimuth to the registration point or high-burst location, a penalty of 4 points.

(4) For inability to determine the data to be sent to the fire direction center, a penalty of 3 points.

*e. Credit.* Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 13–6.

# APPENDIX A

# REFERENCES

## 1. Army Regulations (AR)

| | |
|---|---|
| (C) 105–2 | Electronic Counter Countermeasures (ECCM) (Including Electronic Warfare Susceptibility and Vulnerability) (U). |
| (C) 105–3/AFR 55–3 | Report Meaconing, Intrusion, Jamming, and Interference of Electromagnetic Systems (U). |
| (C) 105–87 | Electronic Warfare (U). |
| 310–25 | Dictionary of United States Army Terms. |
| (C) 530–1 | Operational Security (OPSEC) (U). |
| (C) 530–3 | Electronic Security (ELSEC) (U). |
| 611–201 | Enlisted Career Management Fields and Military Occupational Specialties. |
| 750–1 | Army Materiel Maintenance Concepts and Policies. |

## 2. Field Manual (FM)

| | |
|---|---|
| 5–15 | Field Fortifications. |
| 5–20 | Camouflage. |
| 5–25 | Explosives and Demolitions. |
| 6–2 | Field Artillery Survey. |
| 6–20 | Field Artillery Tactics and Operations. |
| 6–40 | Field Artillery Cannon Gunnery. |

Field Artillery Cannon Gunnery.

| | |
|---|---|
| 6–121 | Field Artillery Target Acquisition. |
| 6–140 | Field Artillery Organizations. |
| 21–5 | Military Training Management. |
| 21–11 | First Aid for Soldiers. |
| 21–26 | Map Reading. |
| 21–30 | Military Symbols. |
| 21–40 | Chemical, Biological, Radiological and Nuclear Defense. |
| 21–60 | Visual Signals. |
| 22–5 | Drill and Ceremonies. |
| (C) 31–40 | Tactical Cover and Deception (U). |
| (C) 32–5 | Signal Security (SIGSEC) (U). |
| 32–6 | SIGSEC Techniques. |
| (C) 32–20 | Electronic Warfare (U). |
| 55–30 | Army Motor Transport Operations. |

## 3. Technical Manuals (TM)

| | |
|---|---|
| 3–220 | Chemical, Biological, and Radiological (CBR) Decontamination. |
| 5–2805–204–14 | Organizational, DS and GS Maintenance Manual: Engine, Gasoline, Military Standard Models. |
| 5–6115–365–15 | Organizational, DS, GS, and Depot Maintenance Manual, Including Repair Parts Generator Sets, Gasoline and Diesel Engine Driven, Trailer Mounted. |
| 5–6115–450–15 | Operator, Organizational, DS, GS, and Depot Maintenance Manual: Generator Set Gasoline Engine: 10–KW, AC, 120/240–V. Single Phase; 120/208–V, 3-Phase, 400-Hertz, Skid-Mounted (Less Engine) (Military Design Model MEP–023A). |

| | |
|---|---|
| 9–1300–20 | Ammunition, General. |
| 9–1375–200 | Demolition Materials. |
| 9–2330–234–15 | Operator's organizational, Direct Support and General Support Maintenance Manual (including Repair Parts and Special Tools List): Chassis, Trailer: 2½-Ton, 2-Wheel, M454 (2330–709–5847). |
| 11–5840–208–ESC | Equipment serviceability criteria for Radar Set AN/MPQ–4A. |
| 11–5840–208–10 | Operator's Manual: Radar Set AN/MPQ–4A. |
| 11–5840–208–20 | Organizational Maintenance Manual: Radar Set AN/MPQ–4A. |
| 11–5840–208–30 | DA Maintenance Manual: Radar Set AN/MPQ–4A. |
| 11–5840–287–12 | Operator and Organizational Maintenance Manual: Simulator, Radar Target Signal AN/TPA–7. |
| 11–6940–209–10 | Operator's Manual: Radar trainer AN/ULT–T5. |
| 38–750 | Army Maintenance Management Systems (TAMMS). |
| 55–450–11 | Air Transportation of Supplies and Equipment: Helicopter External Loads Rigged with Aerial Delivery Equipment. |
| 750–244–2 | Procedures for destruction of electronics material to prevent enemy use (Electronics Command). |

## 4. Table of Organization and Equipment (TOE)

| | |
|---|---|
| 6–116 | Headquarters, Headquarters and Service Battery, Field Artillery Battalion, 105-mm, Towed, Separate Light Infantry Brigade. |
| 6–156 | Headquarters and Headquarters Battery, Field Artillery Battalion, 105-mm, Towed, Infantry Division. |
| 6–186 | Headquarters and Headquarters Battery, Field Artillery Battalion, 105-mm, Towed, Separate Infantry Brigade. |
| 6–216 | Headquarters, Headquarters and Service Battery, Field Artillery Battalion (105-mm towed), Airborne Division or Headquarters, Headquarters and Service Battery, Field Artillery Battalion, 105-mm, Towed, Separate Airborne Brigade. |
| 6–366 | Headquarters and Headquarters Battery, Field Artillery Battalion, 155-mm, Self-Propelled, Armored Division or Headquarters and Headquarters Battery, Field Artillery Battalion, 155-mm, Self-Propelled, Infantry Division (Mechanized). |
| 6–376 | Headquarters and Headquarters Battery, Field Artillery Battalion, 155-mm, Self-Propelled, Separate Armored Brigade or Headquarters and Headquarters Battery, Field Artillery Battalion, 155-mm, Self-Propelled, Separate Infantry Brigade (Mechanized). |
| 6–577 | Field Artillery Target Acquisition Battery. |

## 5. Miscellaneous

| | |
|---|---|
| ASubj-Scd 6–10 | Field Artillery Radar Operations. |
| ATP 6–100 | Field Artillary Cannon Units. |
| ATT 6–155 | Field Artillery Battalion, Light or Medium, Towed or Self-Propelled. |
| DA Form 2888 | Radar Observed High-Burst or Mean-Point-of-Impact (Datum Plane) Registration, AN/MPQ–4A. |
| DA Form 2407 | Maintenance Request. |
| DA Pam 108–1 | Index of Army Motion Pictures and Related Audio-Visual Aids. |
| DA Pam 310-series | Index of Military Publications. |
| TB 43–0116 | Identification of Radioactive Items in the Army Supply System. |
| TC 30–1 | Tactical Cover and Deception. |
| TC 32–6 | Signal Security (SIGSEC). |
| TF 6–3096 | Countermortar Radar AN/MPQ–4A (22 min). |

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By Order of the Secretary of the Army:

FRED C. WEYAND
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*Chief of Staff*

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*Major General, United States Army*
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