S/S June 69

FM 6-161

DEPARTMENT OF THE ARMY FIELD MANUAL

RADAR SET

AN/MPQ-4A

HEADQUARTERS, DEPARTMENT OF THE ARMY

FEBRUARY 1965

AGO 7297A

FIELD MANUAL
No. 6-161

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *17 February 1965*

RADAR SET AN/MPQ-4A

			Paragraphs	Page
CHAPTER	1.	GENERAL	1-3	3
	2.	EQUIPMENT	4-6	4
	3.	PREPARATION FOR ACTION		
Section	I.	Emplacement and march order	7-9	7
	II.	Start-stop procedure	10-18	12
CHAPTER	4.	WEAPON AND IMPACT LOCATION		
Section	I.	Personnel	19, 20	29
	II.	Weapon location	21-25	29
	III.	Impact location	26-28	35
CHAPTER	5.	RADAR GUNNERY		
Section	I.	Registrations	29-36	37
	II.	Radar adjustment of fire	37-44	50
	III.	Radar survey	45, 46	55
CHAPTER	6.	MOVING TARGET DETECTION	47, 48	56
	7.	TACTICAL EMPLOYMENT AND POSITION REQUIREMENTS	49-53	57
	8.	SAFETY PRECAUTIONS	54-56	60
	9.	PROCEDURES FOR MINIMIZING THE EFFECTS OF JAMMING	57-61	61
	10.	DECONTAMINATION OF EQUIPMENT	62-64	63
	11.	TRAINING	65-70	64
	12.	DESTRUCTION OF EQUIPMENT	71-73	65
APPENDIX.		REFERENCES		66
INDEX				67

* This manual supersedes FM 6-161, 9 May 1961

CHAPTER 1

GENERAL

1. Purpose

This manual is a guide to personnel responsible for employing and operating radar set AN/MPQ-4A.

2. Scope

a. This manual covers the equipment and operating procedures to be used by sections employing radar set AN/MPQ-4A in accomplishing the missions of weapons location and radar gunnery, decontamination and destruction of equipment, safety precautions, and section training.

b. The material presented herein is applicable, without modification, to both nuclear and nonnuclear warfare.

c. 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 changes are recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded direct to the Commandant, United States Army Artillery and Missile School, Fort Sill, Okla.

3. References

Related publications are listed in the appendix.

CHAPTER 2

EQUIPMENT

4. Description

a. 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, 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. 1) and the power unit trailer (fig. 2).

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

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

d. The power unit PU-304/MPQ-4A (fig. 2) consists of a 1½-ton cargo trailer on which a power unit PU 107A/U is mounted. The power unit provides the 120/208-volt, 400-cycle, 3-phase power required for operation of the radar. The power unit trailer is also used to transport the operator's shelter, interconnecting cables, spare parts, control unit stand, and the seat support.

5. Performance Data

Pertinent performance data for the radar set are as follows:

a. Sector coverage: 445 mils.

b. Range:

(1) Maximum: 10,000 meters.

(2) Minimum: 170 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.

g. Weight: 6,000 pounds.

h. Mobility: comparable to that of a towed 155-mm howitzer.

6. Technical Characteristics

Technical characteristics of the radar are as follows:

a. Frequency: 16,000 megacycles (mc) (K_u band).

b. Pulse repetition frequency (PRF): 8,600 pulses per second (PPS).

c. Pulse width: 0.25 microsecond.

d. Peak transmitted power: 50,000 watts.

e. Intermediate frequency (IF): 30 megacycles.

f. Power requirement: 120/208-volt, 400-cycle, 3-phase, 5 kilowatt (kw).

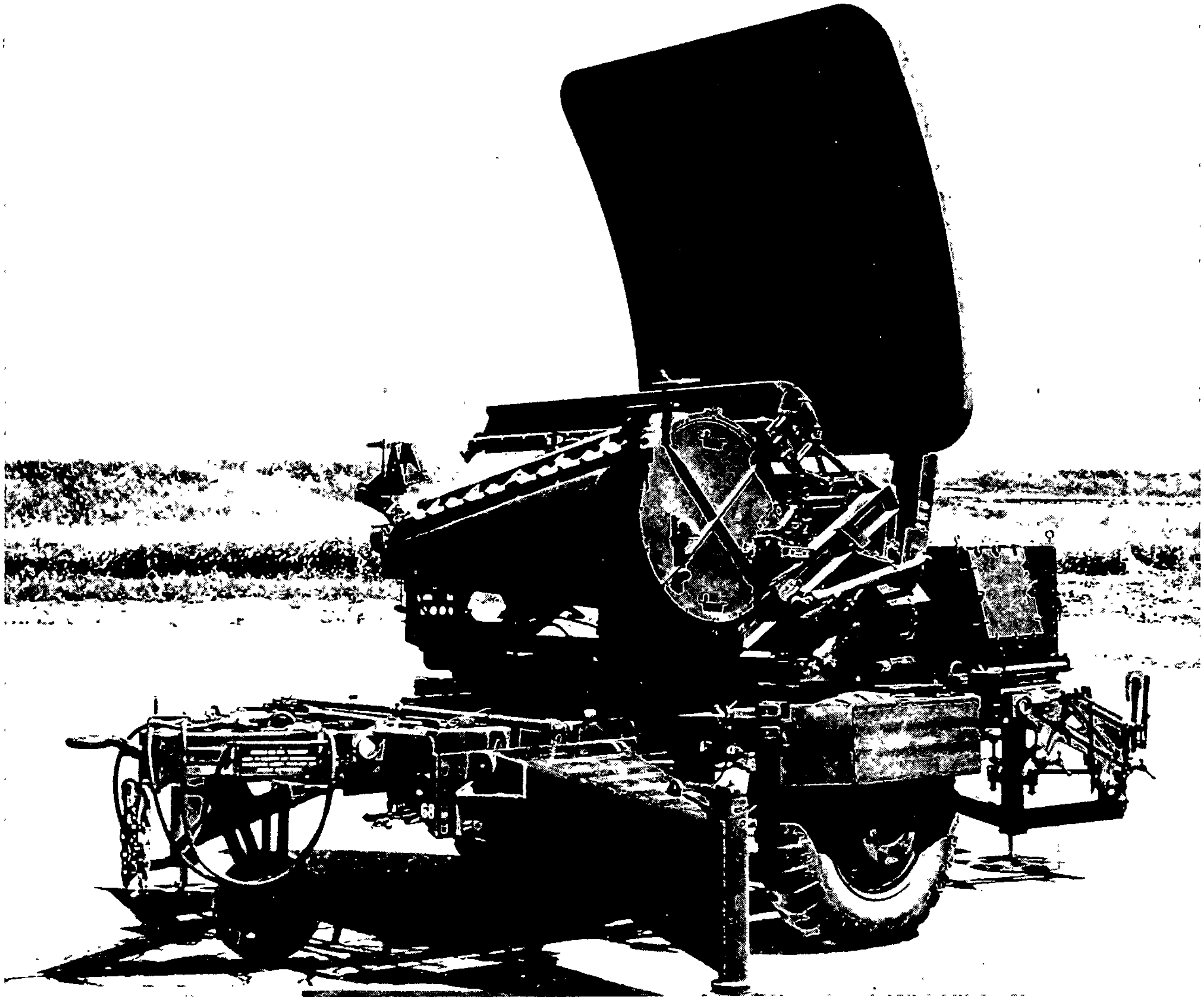

Figure 1. Radar trailer.

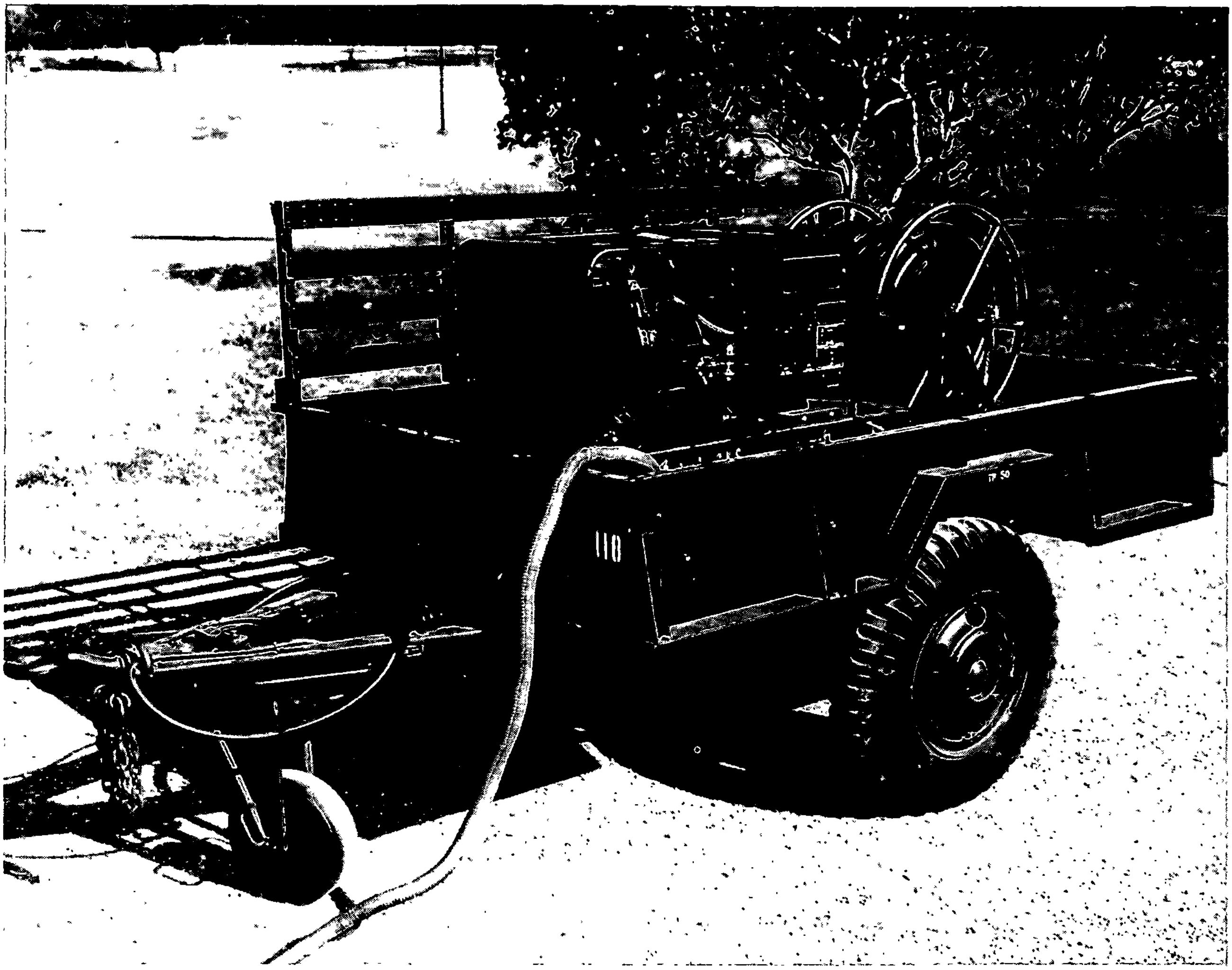

Figure 2. Power unit PU-304/MPQ-4A.

CHAPTER 3

PREPARATION FOR ACTION

Section I. EMPLACEMENT AND MARCH ORDER

7. Emplacement

a. Locate the radar trailer in a suitable position with the lunette pointing uphill. Set the trailer handbrakes.

b. 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 disconnected from the prime mover. This prevents the radar trailer from pitching backward.**

c. Loosen the lower transit locking screws (fig. 3), and release and lower the rear outrigger arm. Secure the rear outrigger arm using the front operational locking screws (fig. 4). Release the upper transit locking screws (fig. 3) and loosen the pivot screws. Rotate the outrigger arm to the upright position and secure it with the rear operational locking screws (fig. 4). Tighten the pivot screws.

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

e. Center the rear outrigger pad (fig. 4) directly under the jackscrew.

f. Lower the landing wheel and disconnect the radar trailer from the prime mover (fig. 5).

g. Lower the side outriggers and secure them with the locking screws (figs. 5 and 6).

h. Center the right and left outrigger pads under the jackscrews. Lower the jackscrews until they contact the outrigger pads.

i. Rotate both wheel fenders outward by disengaging the locking pins. Disengage the azimuth stowlock.

j. Release the reflector clamps (fig. 7) and pivot them clear of the reflector.

k. Raise the reflector. Secure it in position with the locking screws (fig. 8).

l. Remove the cover from the receiver-transmitter group.

m. Level the radar.

n. Open all vents.

o. Position the generator within 100 feet of the radar control-indicator. Set the handbrakes, lower the landing wheel and the support leg, and disconnect the prime mover.

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

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

q. Remove the cover from the control-indicator group.

r. Emplace the ground stake.

8. Installation of Operator's Shelter

Detailed procedures for the installation of the operator's shelter are contained in paragraph 45*b*, TM 11-5840-208-10. The general configuration is shown in figure 9.

9. March Order

a. Radar Trailer.

(1) Disassemble shelter in reverse order of that outlined in paragraph 45*b*, TM 11-5840-208-10.

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

(3) Engage the azimuth stowlock.

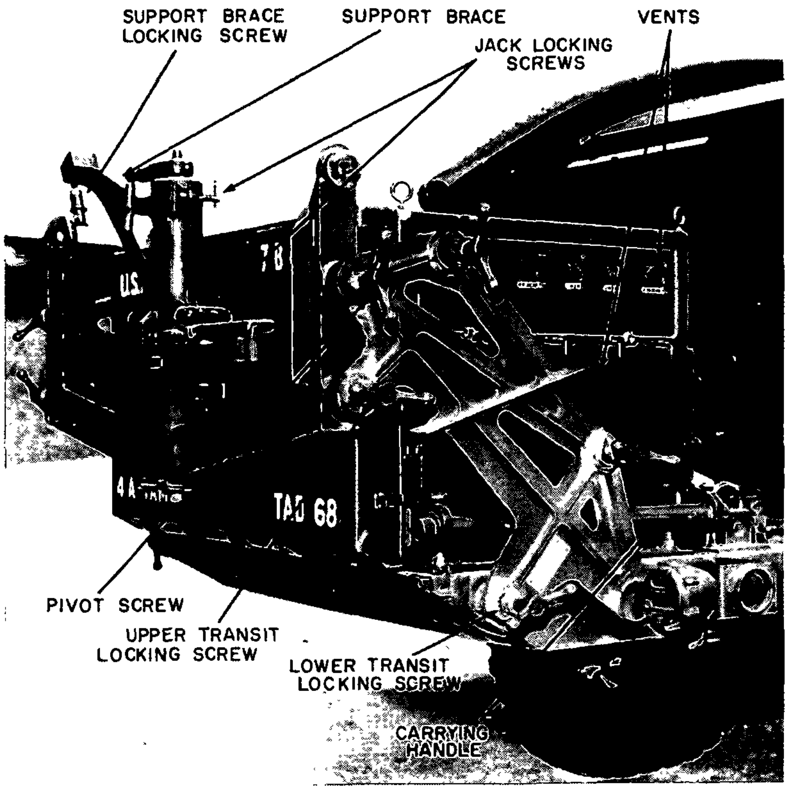

Figure 3. Rear outrigger arm in transit position.

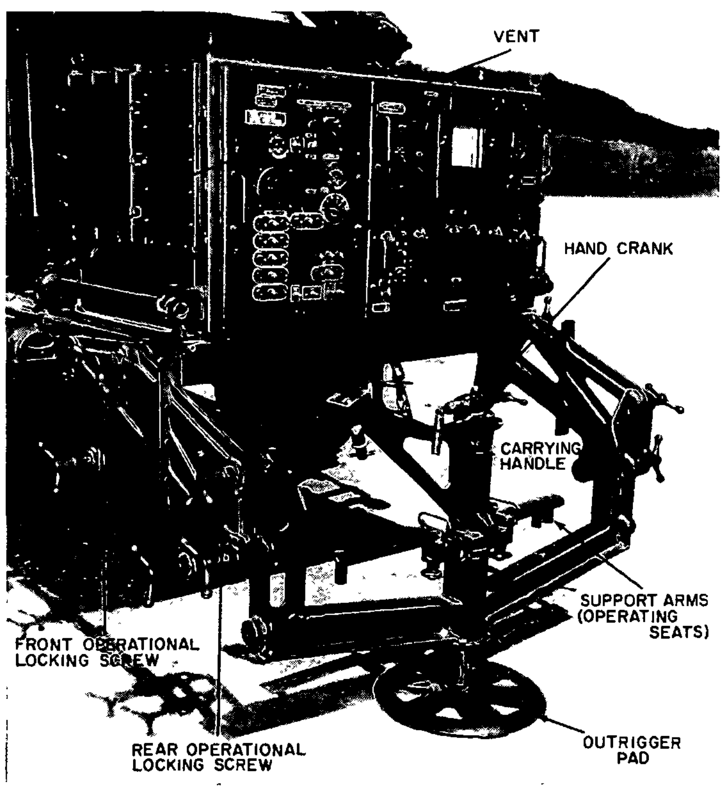

Figure 4. Rear outrigger arm in operational position.

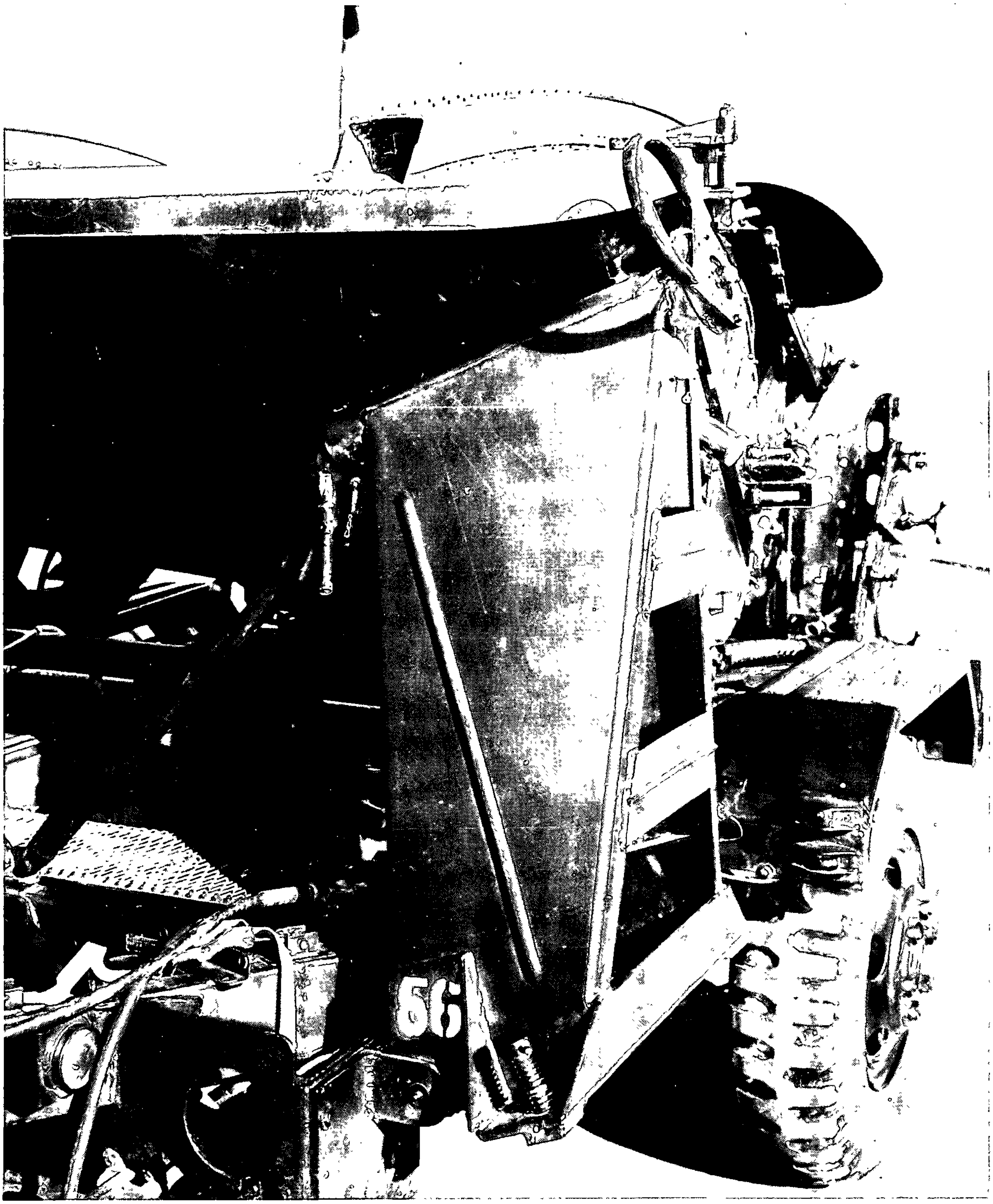

Figure 5. Radar trailer with side outrigger in transit position.

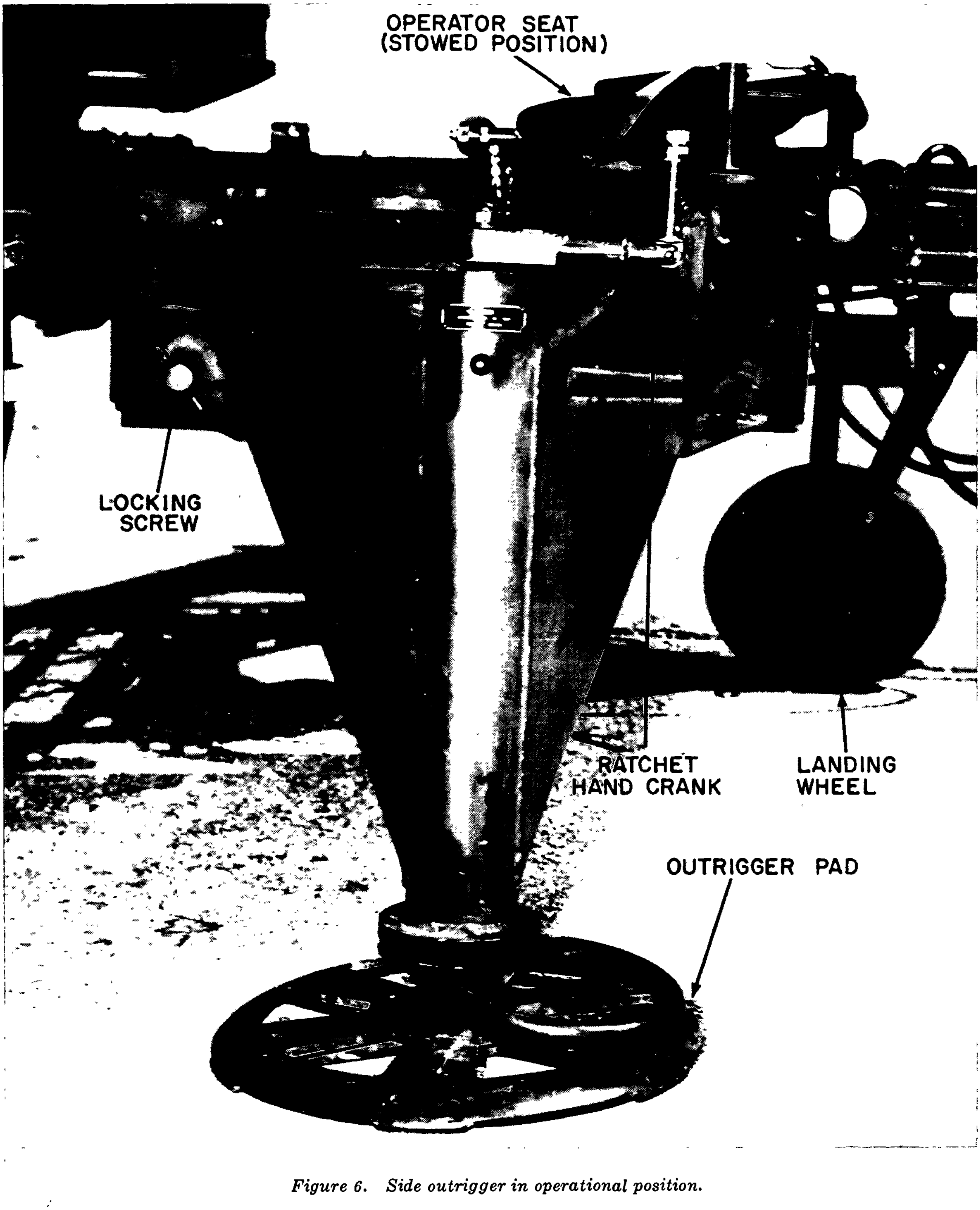

Figure 6. Side outrigger in operational position.

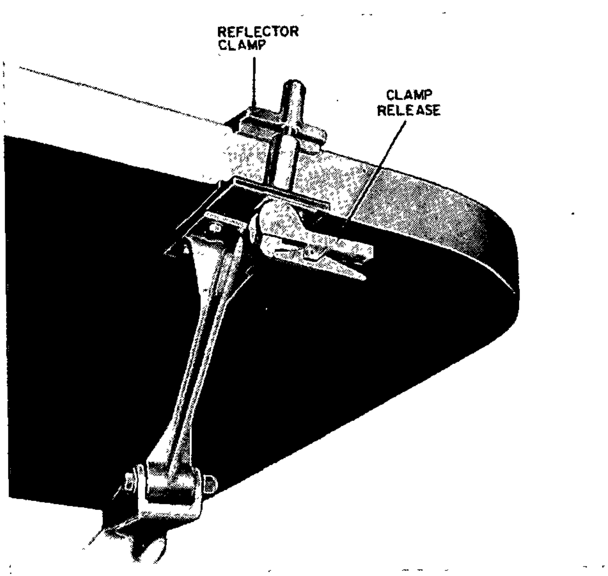

Figure 7. Reflector locking pads.

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

(5) Unlock reflector locking screws, lower reflector into the traveling position and secure with the reflector clamps.

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

(7) Release the pressure from all jacks and replace jack pads on traveling brackets.

(8) Release locking screws on side outriggers; raise and secure side outriggers to retaining post.

(9) Disconnect and reel in the cables.

(10) Connect radar to prime mover.

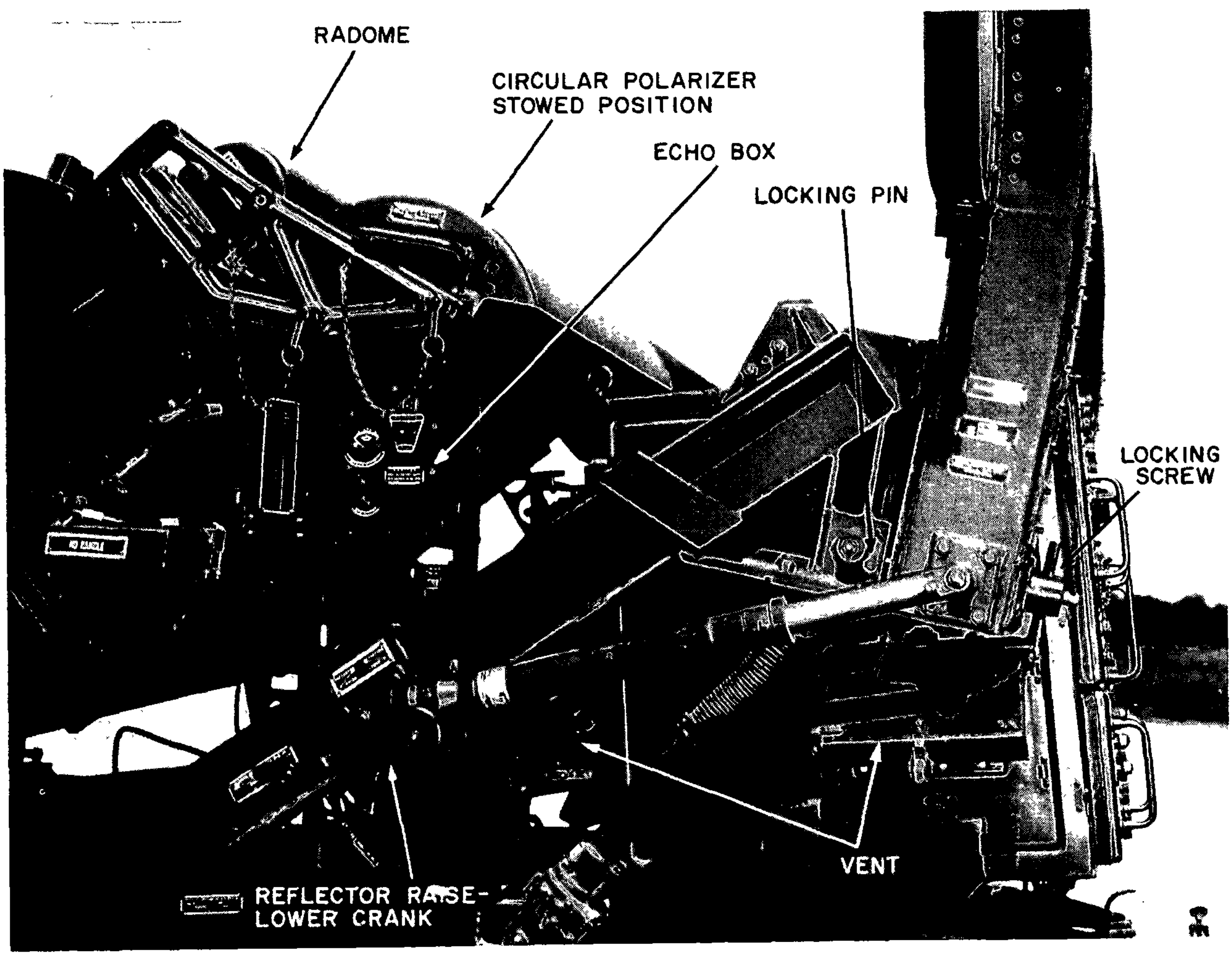

Figure 8. Partial side view of radar trailer.

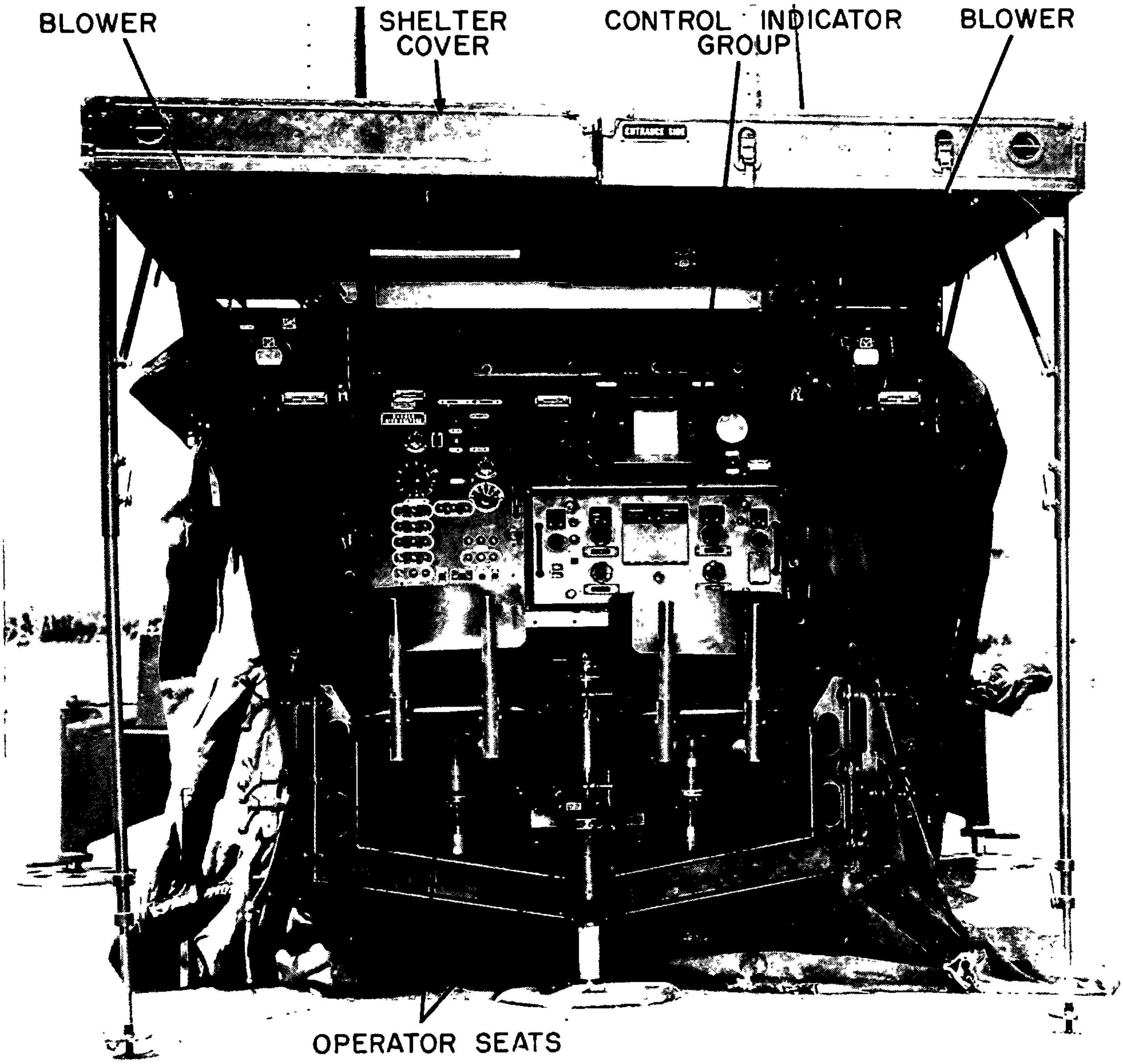

Figure 9. Control-indicator with shelter cover mounted.

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

b. Power Unit.

(1) Disconnect gas connecting hose from gas can.

(2) Disconnect exhaust extension and stow it in the generator trailer.

(3) Lower canvas and tie down.

(4) Connect power unit trailer to primer mover and raise the landing wheel.

(5) Raise rear jack stand of power unit trailer.

Section II. START-STOP PROCEDURES

10. Start Procedure

a. Power Unit.

(1) *Preoperation checks and adjustments.*

(*a*) Check coolant level.

(*b*) Check oil level.

(*c*) Check for coolant, oil, and fuel leaks.

(*d*) Check exhaust system (insure that the exhaust extension is installed).

(*e*) Connect fuel supply and place gasoline can on tailgate of the trailer. When the engine has started, place gasoline can on ground behind trailer to reduce fire hazard.

(*f*) Turn both circuit breakers to OFF (fig. 10).

(*g*) Insure that the Wye-Delta change board is connected properly. The Y symbol should be visible through the window in the change board door.

(*h*) Pull the throttle two-thirds of the way out.

(2) *Normal (electric) starting.*

(*a*) Turn the ignition switch to REMOTE (down) position.

(*b*) Move START-STOP switch to START position. (Release switch when engine starts.)

(3) *Manual (handcrank) starting.*

(*a*) Place START-STOP switch in the center position.

(*b*) Turn ignition switch to MANUAL (up) position.

(*c*) Pull out the manual choke. (Push it in when engine starts.)

(*d*) Handcrank the engine until it starts.

(*e*) Move the ignition switch to the REMOTE (down) position.

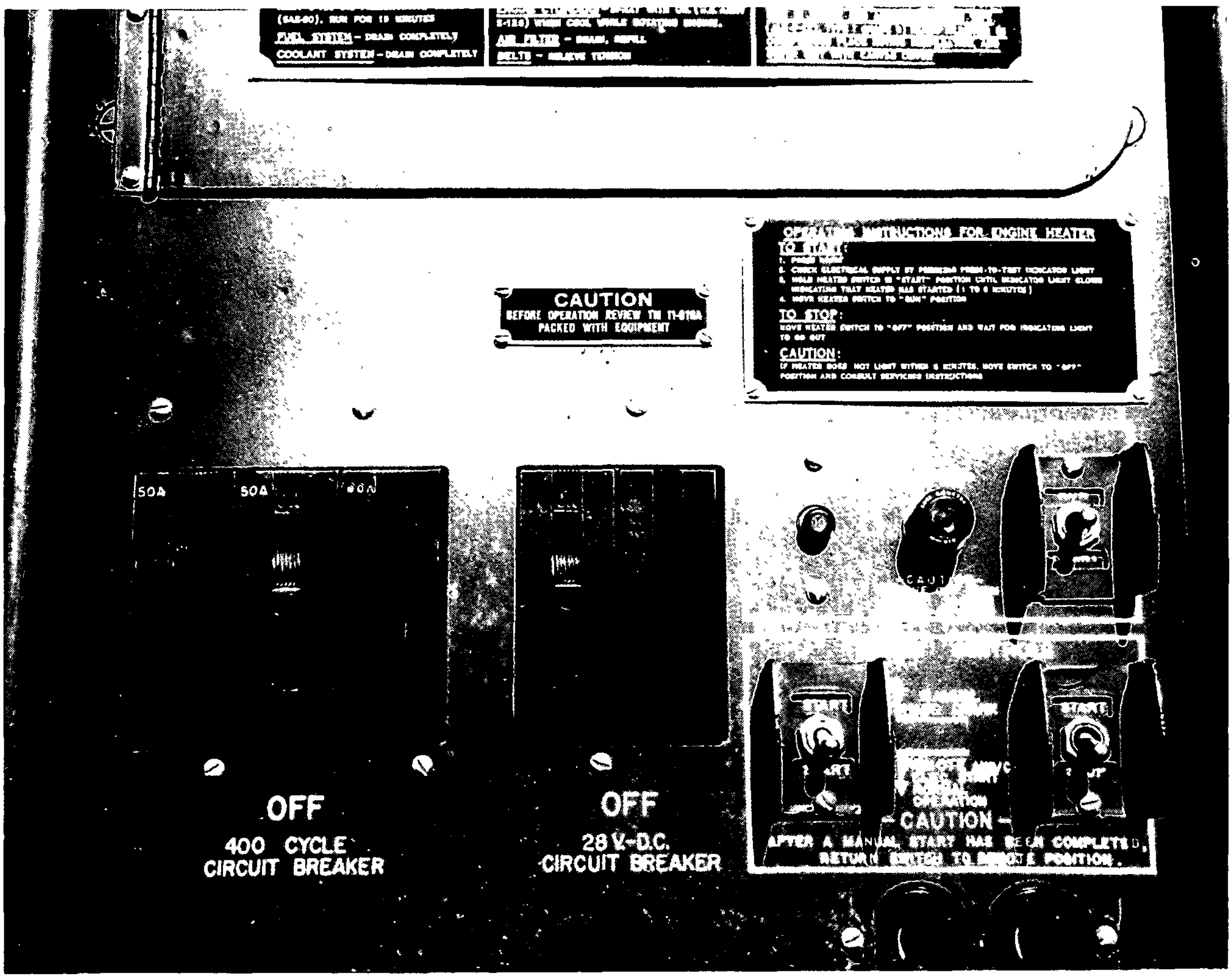

Figure 10. Power unit control panel.

(4) *Operation.* When engine temperature reaches 140°, push the throttle completely in, permitting the governor to take control of engine speed. The frequency meter should read 400 to 405 cycles and the voltmeter should read 120 to 126 volts. Do not turn on power until the radar has had preoperational checks.

Note. The 28-volt DC power generator is not used with the AN/MPQ-4A; therefore, that circuit breaker should be left in the OFF position.

After the load has been applied, recheck all meters for normal readings shown in (*a*) through (*f*) below. This check must be made frequently during operation of the equipment.

(*a*) Temperature: 165–185° F.

(*b*) AC voltmeter: 120–126 volts (see note below).

(*c*) Frequency meter: 400–405 cycles (see note below).

(*d*) Oil pressure: 20–30 pounds per square inch (psi).

(*e*) Battery charging ammeter: +0.5 to +5 amperes (may be more if battery is excessively discharged).

(*f*) AC ammeters (when radar is connected and transmitter on): 10 amperes on phases A and B, 20 amperes on phase C (approximate).

Note. While voltage in itself is not adjustable in this equipment, it is somewhat dependent on frequency. If either voltage or frequency is outside tolerances in (*b*) or (*c*) above, the governor setting must be adjusted by an engineer equipment mechanic. *DO NOT, under any circumstance, attempt to adjust either voltage or frequency by use of the manual throttle.*

b. Radar Set.

(1) *Preoperation checks and adjustments.*

(*a*) *Receiver-transmitter group.*

1. Set the AFC-MANUAL switch on the control-monitor to the AFC position (fig. 11).

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

(*b*) *Control-indicator group.*

1. Secure the control-power supply, indicator, and 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 (figs. 12 and 13), set the following switches in the positions indicated:

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

(*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.

(2) *Starting procedure.*

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

(*b*) On the control-power supply panel, turn the MAIN POWER switch to ON. The MAIN POWER ON & INTLK CLOSED indicator lamp will light and the TEST METER should indicate 27 volts.

(*c*) Check for operation of the system blowers. There are three blowers to be checked.

1. Check the blowers in the receiver-transmitter cabinet. To accomplish this, hold a piece of paper to the rear of the receiver-transmitter. If inrushing air draws the paper against the re-

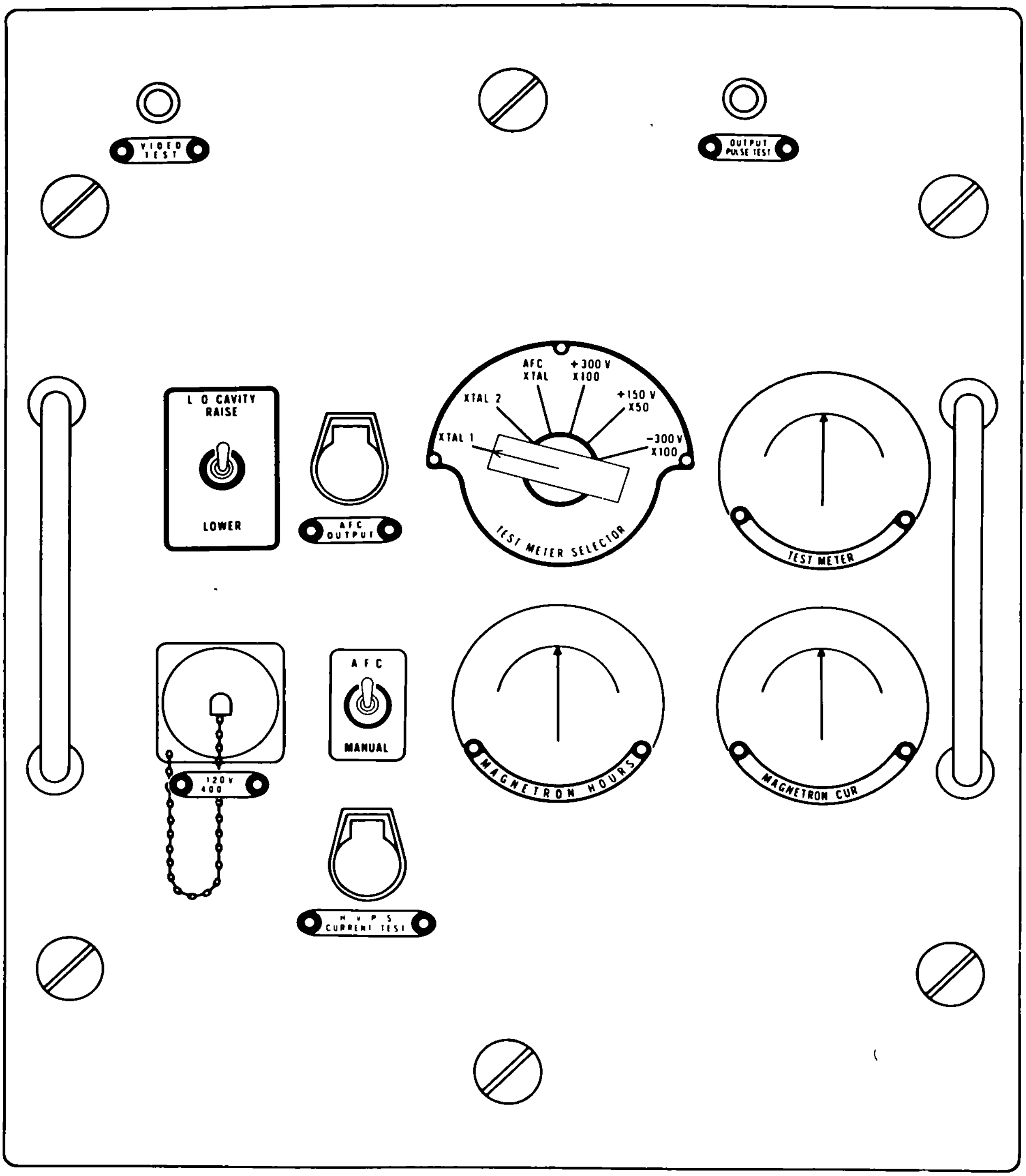

Figure 11. Control-monitor.

ceiver-transmitter compartment, the blower is operating. This procedure must be accomplished on both the left and right rear of the compartment to insure operation of both the main blower and the magnetron blower.

2. The control-indicator blower is operating if air is being discharged at the exhaust vent on the right side of the cabinet.

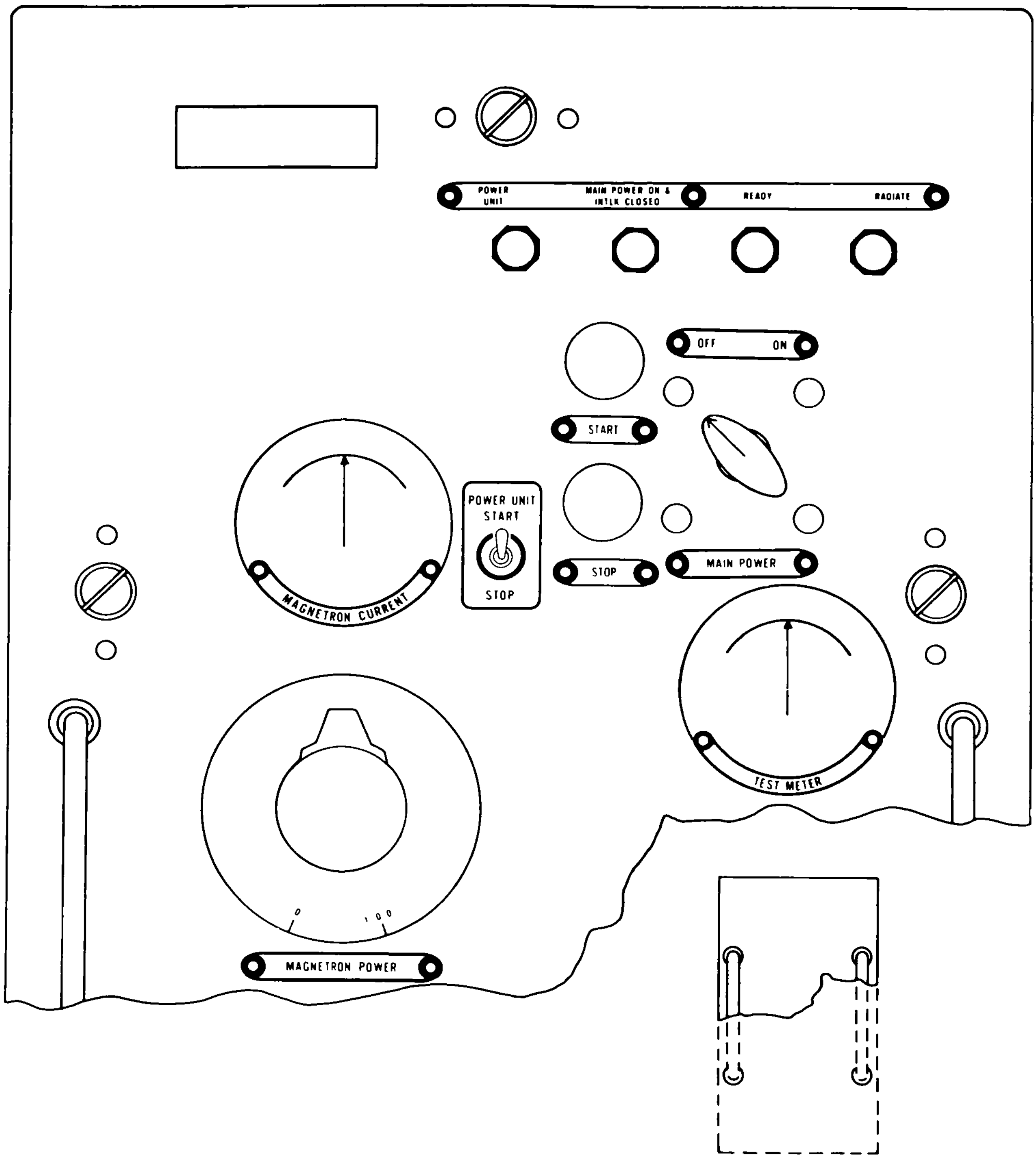

Figure 12. Control-power supply, upper half.

(*d*) While waiting for the 5-minute delay relay to close, perform the following checks and adjustments:

1. Thirty seconds after closing all drawers, rotate the TEST METER SELECTOR switches on the control-power supply and on the control-monitor through the positions listed below. The meter reading for each should be as indicated:

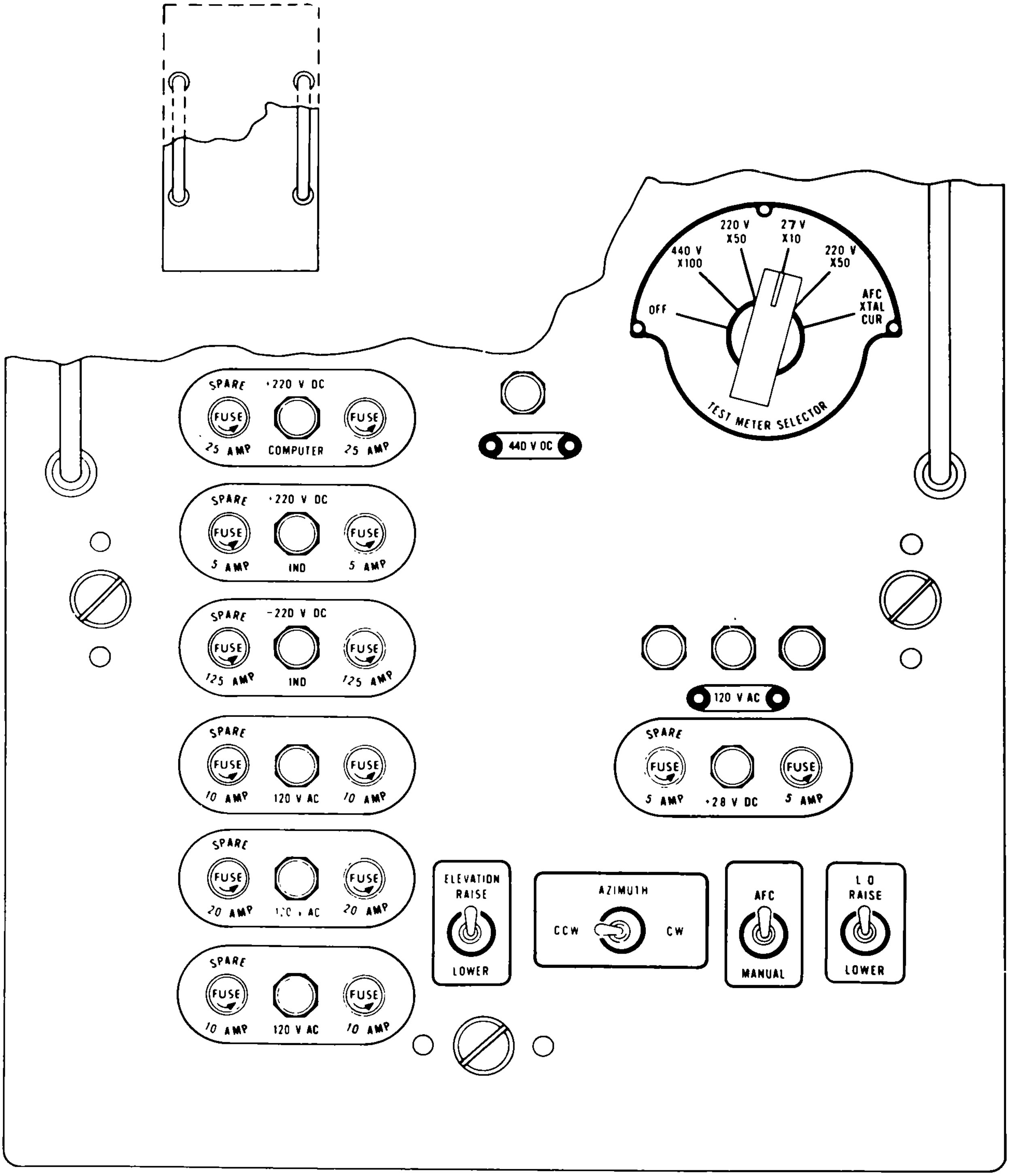

Figure 13. Control-power supply, lower half.

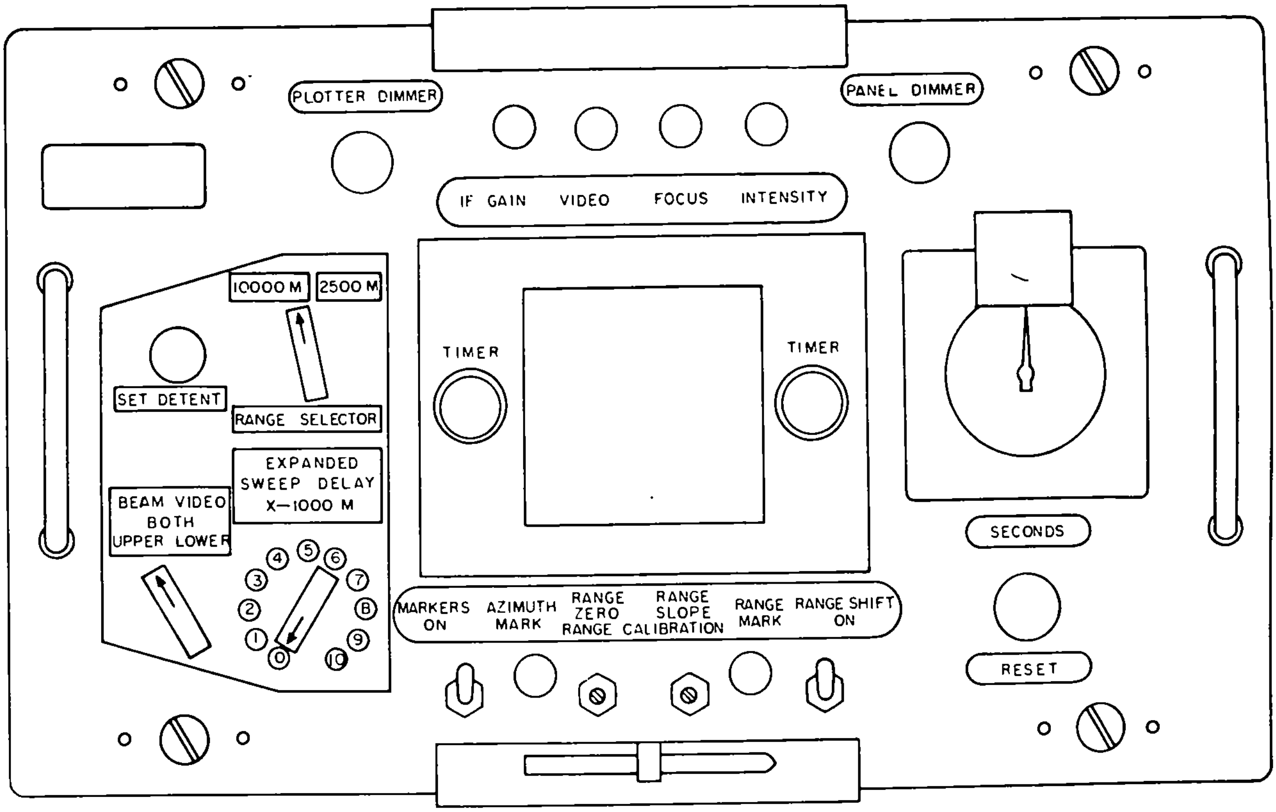

Figure 14. Azimuth and range indicator.

(a) At the control power supply:

Switch position	*Typical reading*
440 V	440 volts ± 5
220 V	220 volts ± 5
27 V	27 volts ± 2
−220 V	220 volts ± 5
AFC XTAL CUR	2.5 volts ± 0.5

Note. Return switch to AFC XTAL CUR position.

(b) At the control-monitor (fig. 11):

Switch position	*Typical reading*
XTAL 1	2.5 ± 0.5
XTAL 2	2.5 ± 0.5
AFC XTAL CUR	2.5 ± 0.5
+300	300 volts ± 5
+150V	150 volts ± 5
−300V	300 volts ± 5

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

3. Operate the ELEVATION switch. In the RAISE position, the reflector should tilt upward and the elevation counter should increase. 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 will light. Check to see that the dehydrator pressure gage reads approximately 12 psi and that the dry air indicator is blue.

(*f*) Adjust the MAGNETRON POWER variac to a position between 0 and 25. Press the START button. The RADIATE indicator lamp will light. Adjust the variac until the MAGNETRON CURRENT meter reads 22 ma (milliamperes).

(*g*) Set the VIDEO control (fig. 14) at maximum and the IF GAIN at minimum.

(*h*) With the RANGE SELECTOR switch in the 10000 M position, adjust the INTENSITY control until raster is just visible.

Note. Raster is a predetermined pattern of scanning lines which provides substantially uniform illumination of a cathode-ray tube.

(*i*) Move the RANGE SELECTOR switch to 2500 M position. If the intensity of the raster changes noticeably, have the mechanic adjust intensity balance.

(*j*) Adjust the FOCUS control for 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 ON. Range markers should appear on the B-scope at ranges of 2,000, 4,000, 6,000, 8,000, and 10,000 meters. If the markers do not appear, the most probable cause is improper tuning of the local oscillator.

(*p*) To tune the local oscillator—

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

2. If markers did not appear as described in (*o*) above, operate the LO switch on the control-power supply panel to the RAISE position until the markers appear. If no markers appear within 40 seconds, move the LO switch to the LOWER position. If markers have not appeared within 2 minutes, notify the radar mechanic.

3. When the range markers appear, operate the LO switch to the RAISE then to the LOWER position until maximum marker intensity is obtained. Return the AFC-MANUAL switch to the AFC position. Marker intensity should remain unchanged.

4. If a decrease in marker intensity occurs, the AFC circuit probably requires adjustment by the radar mechanic.

Note. There are two local oscillator frequencies that will cause the range markers to appear at full brilliance—one is 30 mc above the transmitter frequency, the other is 30 mc below. The lower frequency is correct and is the only frequency at which the AFC circuit will "lock in". Proper action of the automatic frequency control (AFC) circuit is indicated if the range marker intensity remains unchanged and the AFC XTAL CUR is steady when the AFC-MANUAL switch is placed in the AFC position. AFC XTAL CUR 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 operation, the TEST METER SELECTOR switch is placed 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 tuned to the wrong frequency. To correct this, place the AFC-MANUAL switch in MANUAL and operate the LO switch in LOWER until range markers reappear. Adjust the local oscillator for maximum intensity of range markers. Return the AFC-MANUAL switch to AFC. No change in marker intensity should occur.

11. Ringtime Check

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

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

b. Check the MAGNETRON CURRENT meter reading to assure a reading of 22 ma.

c. Set the indicator RANGE SELECTOR switch to the 10000 M position.

d. Turn the MARKERS switch to ON.

e. Tune the echo box (fig. 15) until a peak reading is obtained on the RELATIVE POWER meter.

f. Rotate the EXPANDED SWEEP DELAY until the bright band covers the area where the noise on the B-scope starts to build up.

g. Set the RANGE SELECTOR to the 2500 M position.

h. Adjust IF GAIN for maximum ringtime display.

i. With the LOWER BEAM RANGE control in the radar data computer control panel (fig. 16), place the range strobe over the point where the noise starts to build up.

j. Read the RANGE counter to obtain the ringtime distance. Minimum acceptable ringtime is 1200 meters.

k. Detune the echo box.

l. Return the RANGE SELECTOR switch to the 10000 M position.

Note. AFC operation can be checked using the ringtime display. Ringtime measured in AFC should not differ from ringtime measured in MANUAL by more than 50 meters.

12. Azimuth Collimation Check

The purpose of this check is to determine the angular separation between the optical axis and the center of scan. This check is performed as follows:

a. Determine the field correction in the following manner:

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

(2) Tune the echo box (fig. 15) for maximum deflection of the meter needle.

(3) Read the frequency of the transmitter from the dial above the echo box tuning knob.

(4) Apply this frequency to the chart on the inside of the echo box cover (fig. 17), interpolating if necessary. The figure obtained is called the *field correction.* Figure 18 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 2500 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.

Note. Use the azimuth handwheel on the frame of the radar to move the set in azimuth. If the AZIMUTH switch on the control-indicator is used to move the antenna by small amounts, the brake and some of the relays in the azimuth system could be damaged.

d. Set the DETENT switch in the AZIMUTH ORIENT position, and place the AZIMUTH and LOWER BEAM AZIMUTH controls 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, 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 reread the azimuth counter. The difference between the two readings should be numerically the same as the field correction.

13. 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 of little value when the set is to be used for weapon location; however, it is valuable for other applications, such as in a highburst registration. The checkpoint may be a fixed point of known elevation or 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.

Figure 15. Echo box.

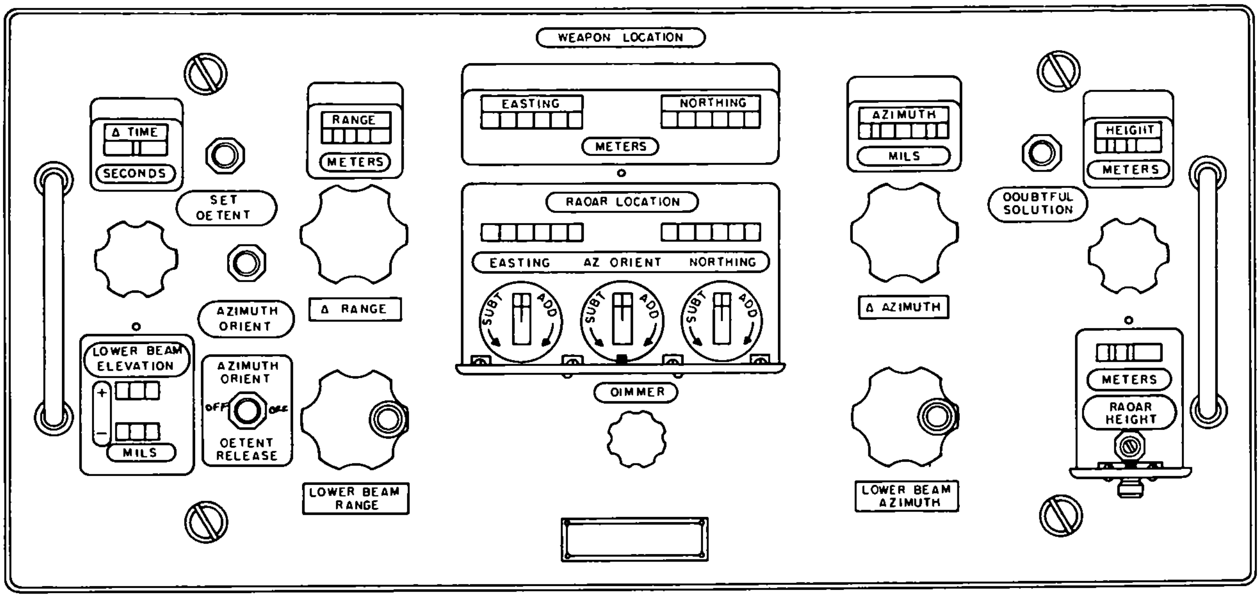

Figure 16. Radar data computer control panel.

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 17. Frequency correction chart.

c. Determine the correct elevation to the checkpoint from the elevation counter on the frame of the radar. Record for future reference any error greater than 1 mil.

14. Antenna Azimuth Orientation

The purpose of azimuth orientation is to obtain the correct reading on the radar azimuth counter.

a. Azimuth Orientation (Electrical Method).

(1) Place the RANGE SELECTOR switch to the 2500 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 shows up as a target on the B-scope.

(2) On the computer, set the DETENT switch to the OFF position, and place the Δ AZIMUTH control in 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 to reduce the size of the echo so that it can be more easily bisected.

(4) Hold the RADAR LOCATION AZ ORIENT switch in the ADD (or SUBT) position until the AZIMUTH counter reads the azimuth to the orienting point.

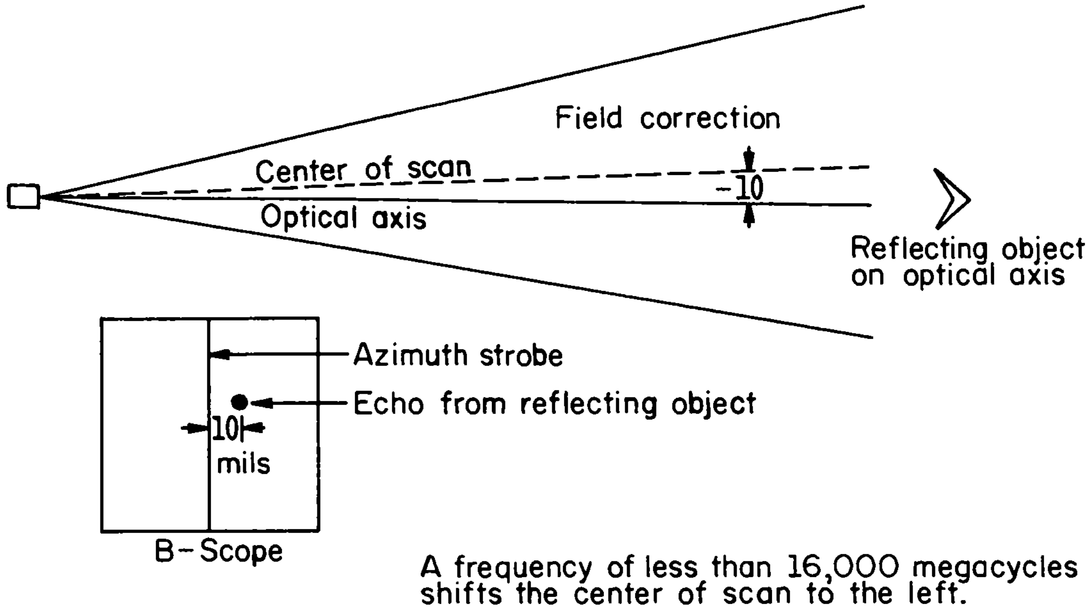

Figure 18. Collimation check.

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

(1) Position the antenna so that the orienting point is centered in the telescope. Set the azimuth to the orienting point on the azimuth counter located on the radar trailer frame.

(2) Set the DETENT switch to the AZIMUTH ORIENT position, and place ⊿ AZIMUTH and LOWER BEAM AZIMUTH controls in detent.

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

Example: If the field correction is positive:

Azimuth to the orienting point	1,653
Field correction	+4
Corrected orienting azimuth	1,657 mils

If the field correction is negative:

Azimuth to the orienting point	1,653
Field correction	—4
Corrected orienting azimuth	1,649 mils

(4) Hold the RADAR LOCATION AZ ORIENT switch in the ADD (or SUBT) position until the AZIMUTH counter reads the *corrected* orienting 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.

Note. If correct results were not obtained during azimuth collimation, call the radar mechanic. If no mechanic is available, the equipment may still be operated by applying the difference in azimuth between the orienting telescope and the B-scope. This difference should be applied in the same manner as the field correction obtained from the echo box.

15. Range Calibration

The purpose of range calibration is to aline the range circuits so that the correct range may be obtained from the range counter. Before range calibration is performed, power must be applied to the radar, the transmitter must be on, and the local oscillator must be tuned.

a. The procedure for performing range calibration using range markers is as follows:

(1) Turn the RANGE SHIFT switch to the OFF position.

(2) Set the DETENT switch to the OFF position and set the RANGE control in 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) Set the RANGE SELECTOR switch to the 2500 M position.

(5) Set the EXPANDED SWEEP DELAY switch to position 1.

(6) Set the MARKERS switch to the ON position.

Note. 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 switch to position 7.

(9) Set the range strobe to 8,000 meters.

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

(11) Since the RANGE ZERO and RANGE SLOPE controls interact, it will be necessary to recheck SLOPE at 8,000 meters after each change in ZERO at 2,000 meters and to recheck ZERO at 2,000 meters after each change in SLOPE at 8,000 meters.

b. If desired, range calibration may be checked by measuring the range to an electrical target with the radar set. This reading should agree with the survey data within 20 meters.

16. Computer Alinement Checks

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

a. Check the linearity between the antenna elevation counter and the computer LOWER BEAM ELEVATION counter in the following manner:

(1) Use the ELEVATION RAISE-LOWER switch to position the antenna in elevation so that the following readings are obtained on the LOWER BEAM ELEVATION: —100, —50, 0, 50, 100, 150, and 200 mils.

(2) Check to insure that the corresponding readings are obtained on the antenna elevation counter. If the readings are not within 2 mills of those on the LOWER BEAM ELEVATION counter, notify the radar mechanic.

b. Check the azimuth controls and the B-scope indicator as follows:

(1) Set the DETENT switch to OFF.

(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 strobe should move to the left.

(4) Set the DETENT switch to DETENT RELEASE and check to see that the two SET DETENT lights are on.

(5) Rotate the Δ AZIMUTH control clockwise. The AZIMUTH counter reading should *decrease* and the strobe should move to the right.

(6) Rotate the Δ AZIMUTH control counterclockwise. The AZIMUTH counter reading should *increase*, and the strobe should move to the left.

c. Check the range controls and the B-scope as follows:

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

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

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

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

(5) Move the DETENT switch to OFF and place Δ RANGE and Δ AZIMUTH in detent. The DETENT lights should go out.

d. Check the RADAR HEIGHT counter by rotating its adjustment screw. The counter reading should change, and the weapon HEIGHT counter reading should also change by the same amount.

e. Check the weapon HEIGHT counter by rotating the control knob; the reading should change only on the weapon HEIGHT counter.

f. Check the RADAR LOCATION and 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 readings should increase.

(3) Repeat the steps in (1) and (2) above with the RADAR LOCATION NORTHING switch and counter.

g. Check the linearity between the computer AZIMUTH counter reading and the movement of the azimuth strobe as follows:

(1) With the radar set radiating, find an electrical target on the B-scope.

(2) Set the computer DETENT switch to the OFF position and place the Δ RANGE and Δ AZIMUTH controls in detent.

(3) Rotate the LOWER BEAM AZIMUTH control until the azimuth strobe bisects the target on the B-scope. Note the reading on the AZIMUTH counter.

(4) Actuate the AZIMUTH switch in the CW (clockwise) or CCW (counterclockwise) position to move the antenna in azimuth and to move the position of the target on the B-scope.

(5) Rotate the LOWER BEAM AZIMUTH control until the strobe again bisects the target. The computer AZIMUTH counter should now read the same as it did before.

h. Check the Δ TIME counter by rotating its control knob clockwise to increase its reading and counterclockwise to decrease its reading.

i. After all of the components of the computer have been checked, check the accuracy of the computer.

(1) The accuracy check consists of a series of four problems which are set into the computer (fig. 19).

(2) Each day or each time the set is moved, the operator should perform the accuracy check and compare the output data obtained against the problem solution which will be provided by the radar mechanic. The error in easting or northing should not exceed 20 meters for any problem; or the sum of the errors in easting and northing should not exceed 36 meters for any problem.

(3) Before the operator performs the accuracy check, the computer drawer must be opened and the INTERLOCK SHORT switch must be closed (fig. 20). The reading on the BEAM SEPARATION dial (fig. 21) on the left side of computer drawer must read the same as that on the BEAM SEPARATION plate on the antenna.

(4) The operator will perform the accuracy check in the following manner:

(*a*) Set in the radar location data as follows:

1. Use the EASTING and NORTHING switch to set the EASTING and NORTHING counters to zero.

2. Set the RADAR HEIGHT counter to 300 meters.

(*b*) Set the radar on the proper angle of elevation.

(*c*) Set the DETENT switch to OFF.

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

(*e*) Set in the proper azimuth, using the AZIMUTH switch on the control-power supply and the com-

Radar set ser no ______ Date of alignment ________ Aligned by ________

Problem no	Lower beam azimuth	Elevation	Lower beam range	Upper beam azimuth	Upper beam range	Time	Weapon height	Output data	
								Easting	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 19. Computer accuracy check.

puter LOWER BEAM AZIMUTH control.

(*f*) Set in the proper lower beam range.

(*g*) Turn the TEST-NORMAL switch to TEST.

(*h*) Set the DETENT switch to DETENT RELEASE.

(*i*) Set in upper beam azimuth with the Δ AZIMUTH control.

(*j*) Set in upper beam range with the Δ RANGE control.

(*k*) Turn the TEST-NORMAL switch to NORMAL.

(*l*) Set in the time with the TIME knob.

(*m*) Set the weapon height into the computer.

(*n*) Check the WEAPON LOCATION EASTING and NORTHING against the problem solution provided by the radar mechanic.

(*o*) Repeat the steps in (*b*) through (*n*) above for the remaining problems. If the answer to any problem is out of tolerance, notify the mechanic.

17. Radar Location Data

On completion of the computer accuracy check, establish the grid reference of the radar by setting the true radar location into the computer in the following manner:

a. Use the RADAR LOCATION EASTING and NORTHING switches to set the grid reference of the radar site into the computer.

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

c. Normally, the reading on the weapon HEIGHT counter will then be the same as that on the RADAR HEIGHT counter.

18. Stop Procedure

a. Radar Set. The procedure for stopping the radar set is as follows:

(1) Reduce the MAGNETRON POWER variac to a position between 0 and 25.

(2) Press the STOP button on the control-power supply panel to turn the transmitter off.

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

(4) Turn the MAIN POWER switch to the OFF position. The READY indicator lamp and the MAIN POWER ON AND INTLK CLOSED indicator lamp will go out.

b. Power Unit. To stop the power unit, proceed as follows:

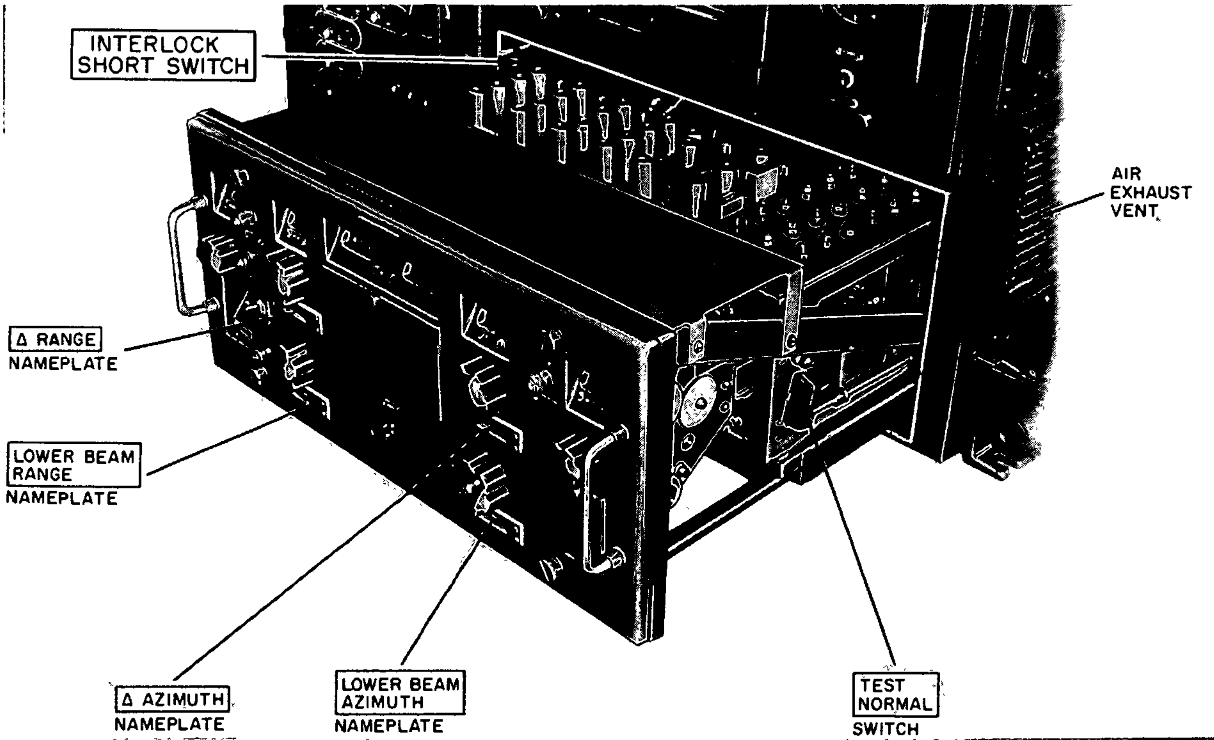

Figure 20. Partial view of radar data computer.

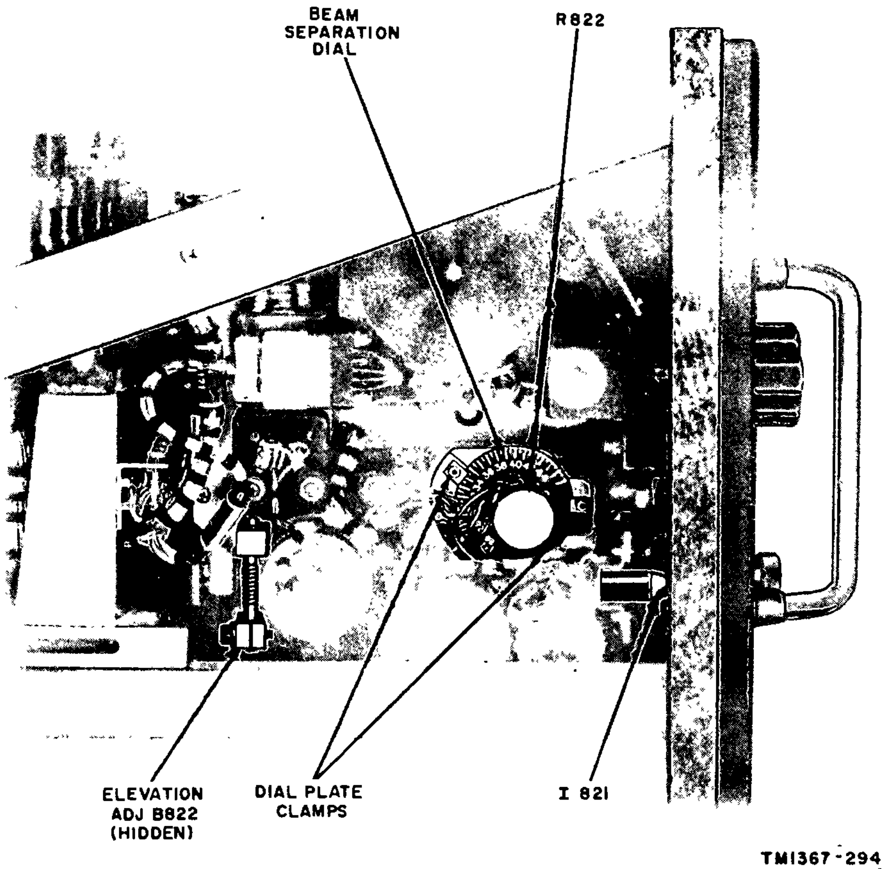

Figure 21. Beam separation dial on radar data computer.

(1) At the power unit, place the 400-CYCLE circuit breaker in the OFF position.

(2) Allow engine to run at idle speed for a few minutes.

(3) Hold the START-STOP switch to the STOP position.

(4) Perform the after-operation maintenance check.

CHAPTER 4

WEAPON AND IMPACT LOCATION

Section I. PERSONNEL

19. General

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.

20. Utilization of Personnel for Operation

a. For continuous operation, the section should be organized into two 3-man teams, excluding the chief of section and the radar mechanic, who are on call continuously.

b. The duties of the members of the three-man team are as follows:

(1) *The control unit operator* operates the radar and the computer, utilizing the controls on the control-indicator group.

(2) *The plotter* sets up the radar chart on a contour map, when available; determines altitude of the weapon locations; plots final locations; keeps the necessary records; and operates the communication equipment.

(3) *The generator operator* operates and maintains the generator, provides local security, and assists the chart operator during periods of intense enemy weapons activity.

c. To prevent fatigue and eyestrain, members of the team should alternate duties so that no one member serves as control unit operator more than 30 minutes at a time. When 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 comes on duty, since he will be working with two men who are familiar with the situation.

Section II. WEAPON LOCATION

21. General

The technique employed in locating mortars may be divided into two phases—detection and location. Both phases can be accomplished on the same projectile.

22. Detection

a. A sector of search will be assigned to the radar. This sector of search will normally be the zone of action of the supported unit and, as such, will vary with the tactical situation. The radar should be sited for maximum coverage of this 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). The sector of search may be so large, however, that the radar will be able to observe only a portion at any one time. In that event, the radar should observe one portion for a short period of time and then observe another portion, continuing 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. 22), the points at which the projectile intersects the two beams will be indicated by two bright spots (echoes) 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 marked with a grease pencil to show the exact location of the intersection points on the B-scope. The transparent cover is a reflection-type plotter. So designed that any mark made on the plotter will be reflected on the cathode-ray tube behind the transparent cover. This feature eliminates error due to parallax between the echo on the cathode-ray tube and the grease pencil mark on the plotter. Careful adjustment of the PLOTTER DIMMER control is neecssary to make the reflection clearly visible. The grease pencil marks are placed so that their reflection are the center of the echoes. These two operations, i.e., measuring elapsed time and marking the B-scope, constitute the detection phase of weapon location.

23. Operating Procedure

a. Move the AZIMUTH switch to the CW (clockwise) or CCW (counterclockwise) position to rotate the antenna to any 445-mil sector of the expected target area.

b. Move the ELEVATION switch to RAISE or LOWER to position the reflector so that the elevation angle is 10 mils above the highest point on the screening crest. At this point, ground clutter should decrease to a minimum.

Note. Use the telescope to determine the elevation angle to the top of the screening crest.

c. 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. 23). At the instant the first echo is seen on the B-scope, press either of the two TIMER buttons to start the SECONDS clock, and mark the presentation with a grease pencil. When the second echo appears, press either TIMER button again to stop the clock, and mark the second presentation with the grease pencil. The elapsed time between echoes will appear on the SECONDS clock.

Note. The RANGE SHIFT switch should be in the ON position. This will displace the video display of the upper and lower beams so that the two target echoes do not appear as one.

24. Computing Weapon Location

a. Place the DETENT switch in the OFF position and 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. 24).

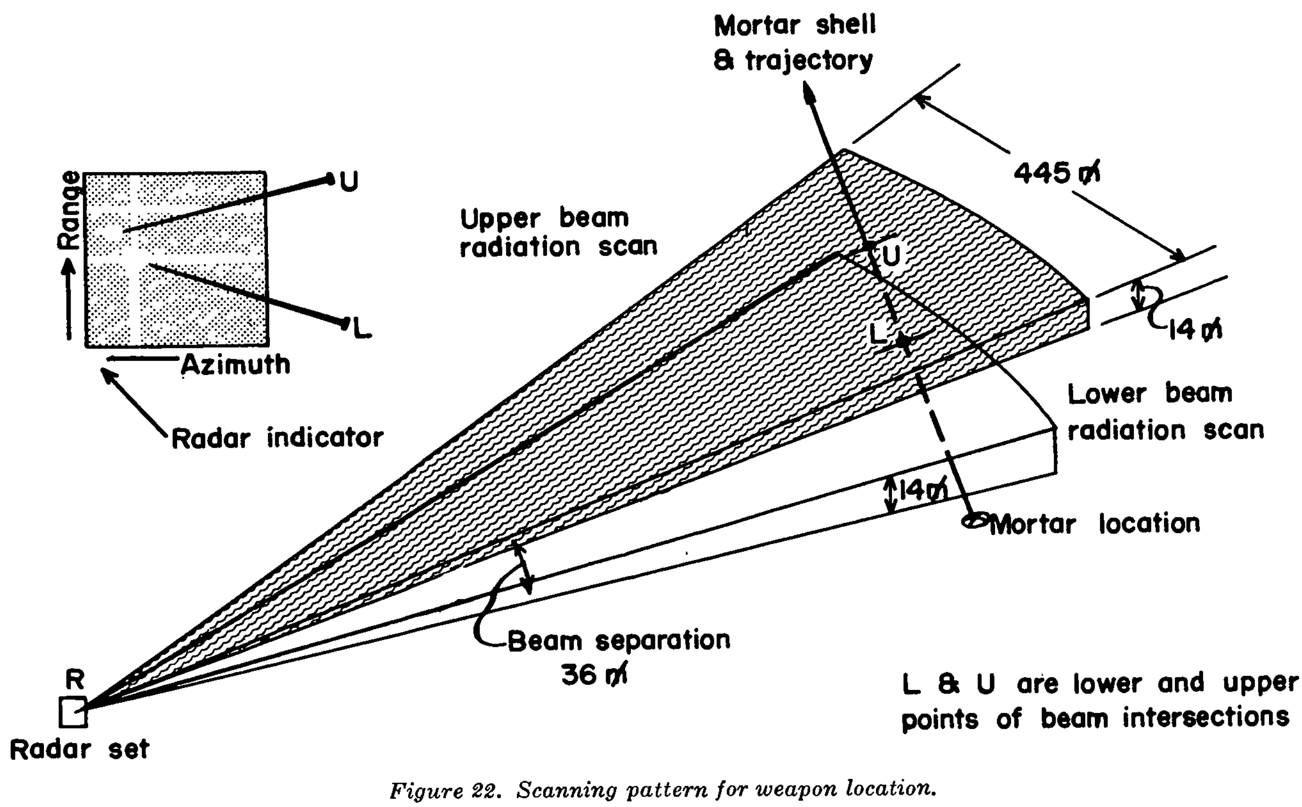

Figure 22. Scanning pattern for weapon location.

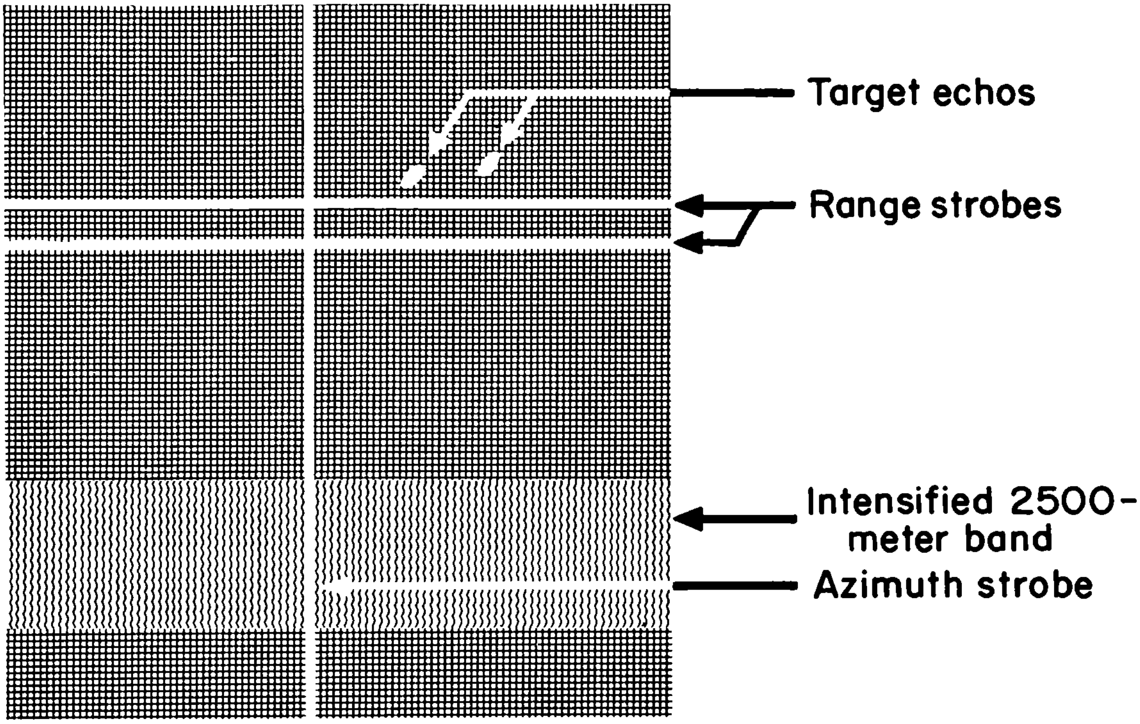

Figure 23. B-scope presentation (10,000-meter range sweep).

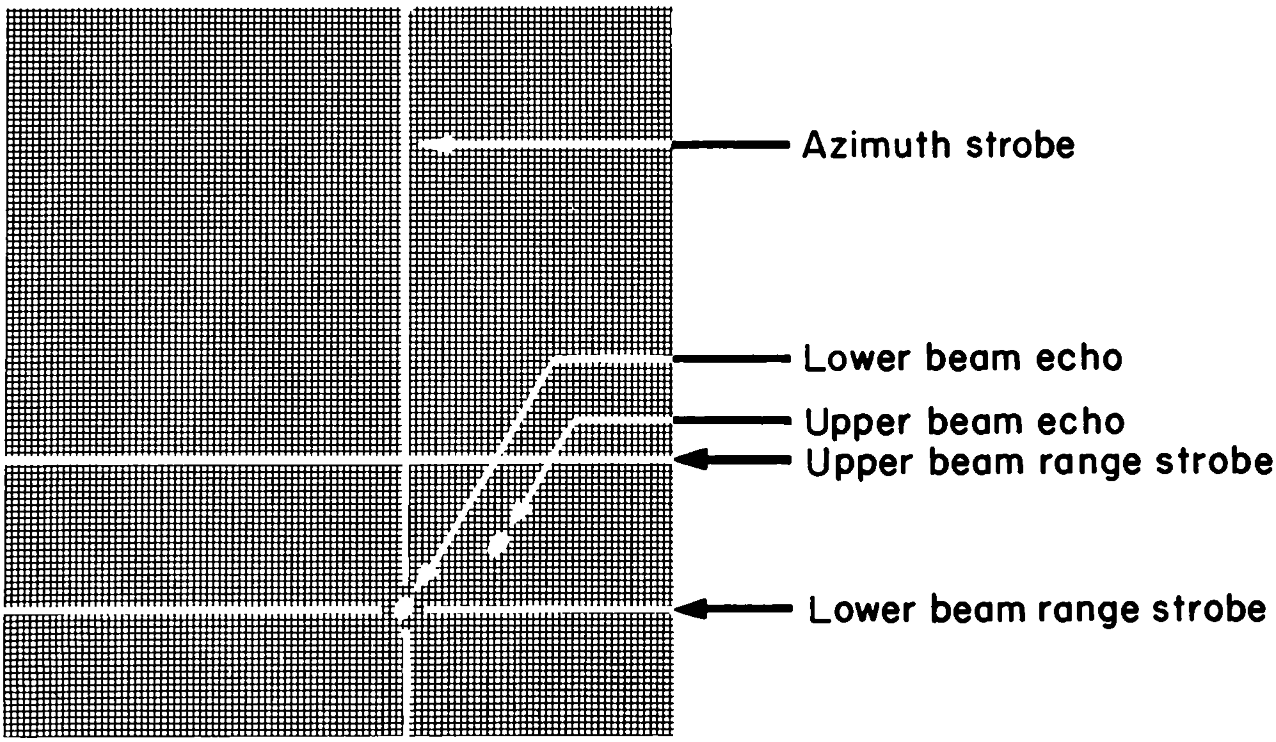

Figure 24. Strobing the lower echo (2,500-meter range presentation).

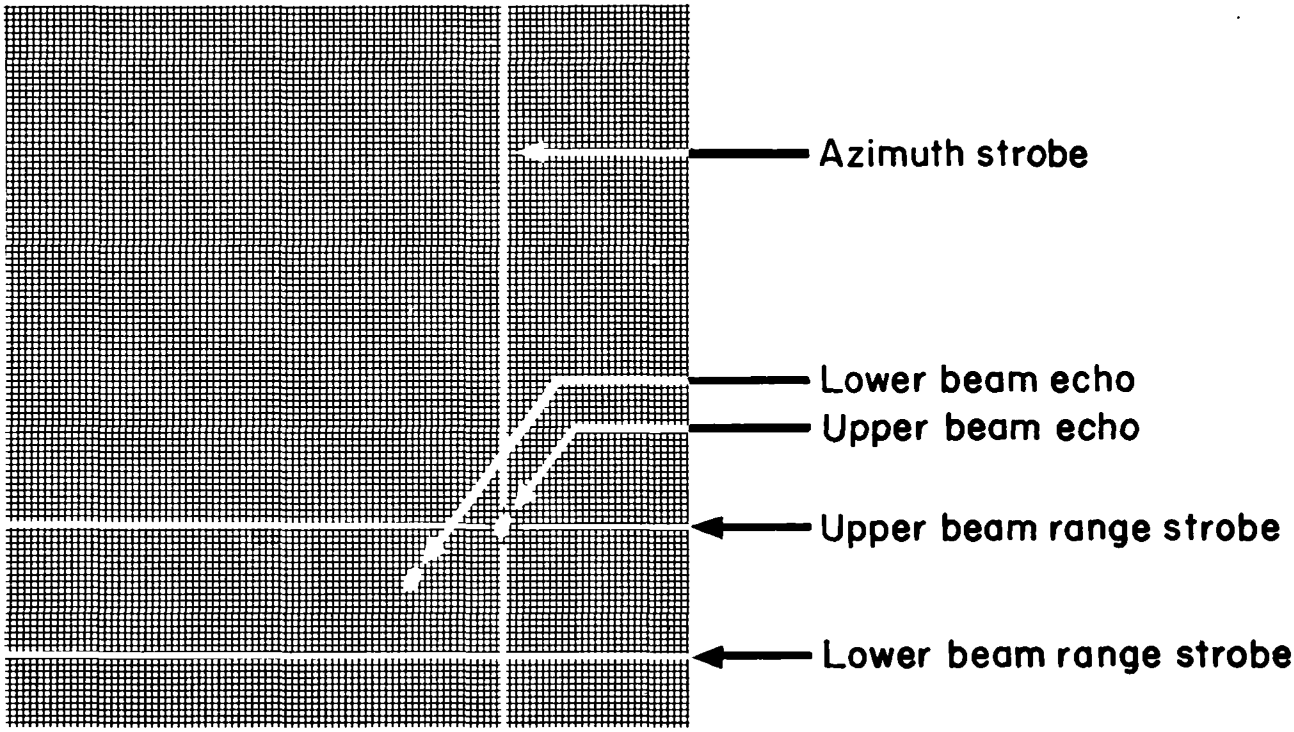

Figure 25. Strobing the upper echo (2,500-meter range presentation).

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 range strobe intersects the second (upper beam) mark on the B-scope (fig. 25).

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 on 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 weapon. The uncorrected polar coordinates of the weapon can be read from the RANGE and AZIMUTH counters.

25. 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 is different from that of the radar, set the altitude of the plotted point on the weapon HEIGHT counter. This action may change the weapon location coordinates. If a coordinate change greater than 10 meters occurs in either easting, northing, or both, the new weapon location should be replotted and its altitude determined. This procedure should be repeated until a coordinate change of less than 10 meters in easting, northing, or both occurs when the altitude is inserted.

b. Make certain that the DOUBTFUL SOLUTION indicator lamp is not on.

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, press the RESET switch to return the SECONDS clock to zero.

g. The radar equipment is now prepared for the next location or mission.

h. If the RANGE SELECTOR switch is in the 10,000 M position, set the EXPANDED SWEEP DELAY switch so that the bright band on the B-scope incloses the approximate position of the target. This is shown in figure 26. Turn the LOWER BEAM RANGE control on the computer 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 2,500 M position (fig. 27). (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. The operator should keep in mind that the Δ time factor becomes more important as the angle of elevation of the lower beam increases (fig. 28).

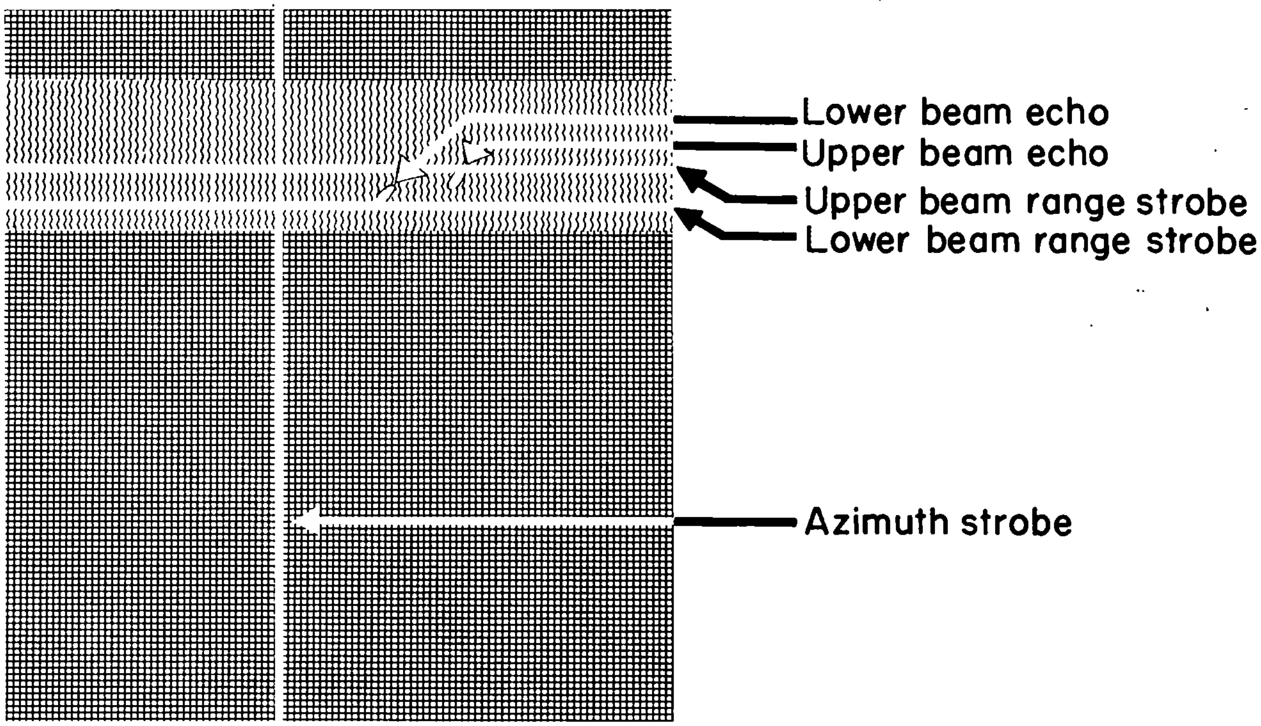

Figure 26. 2,500-meter bright band over the point where the echoes appeared.

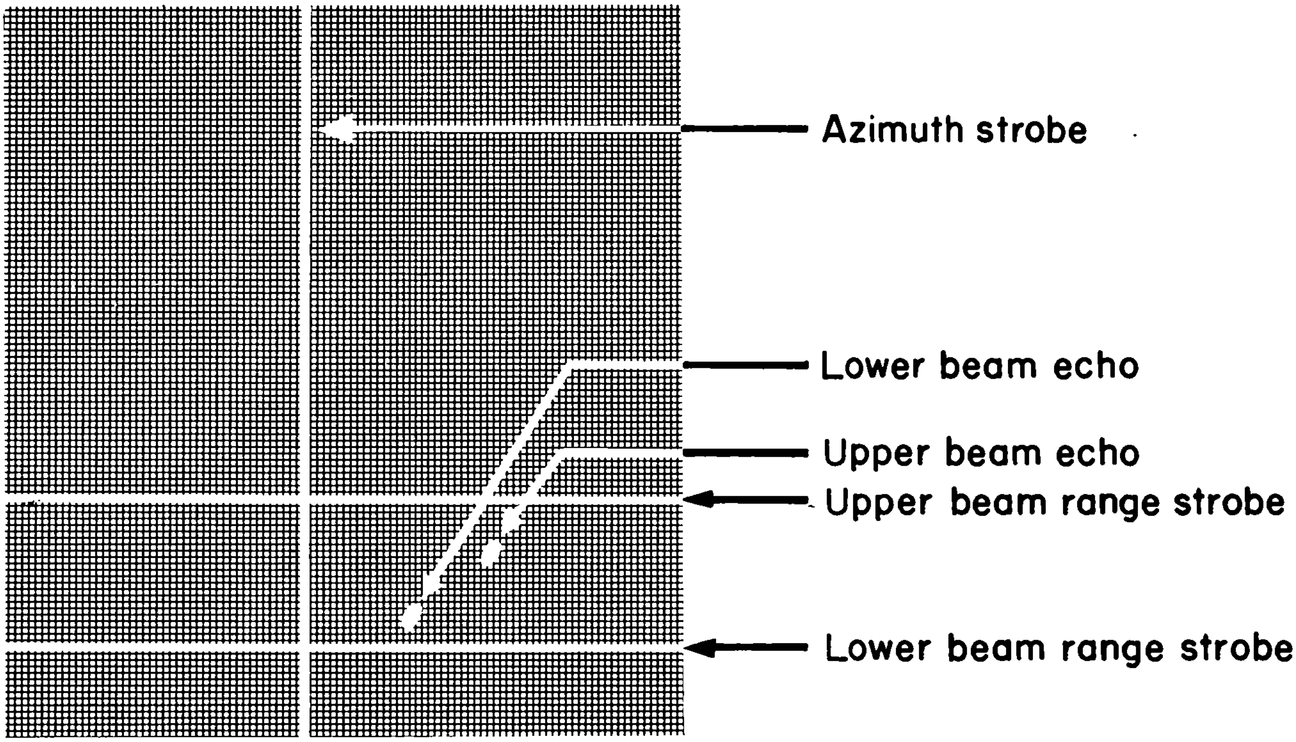

Figure 27. Echo presentation of a subsequent round with the 2,500-meter range sweep.

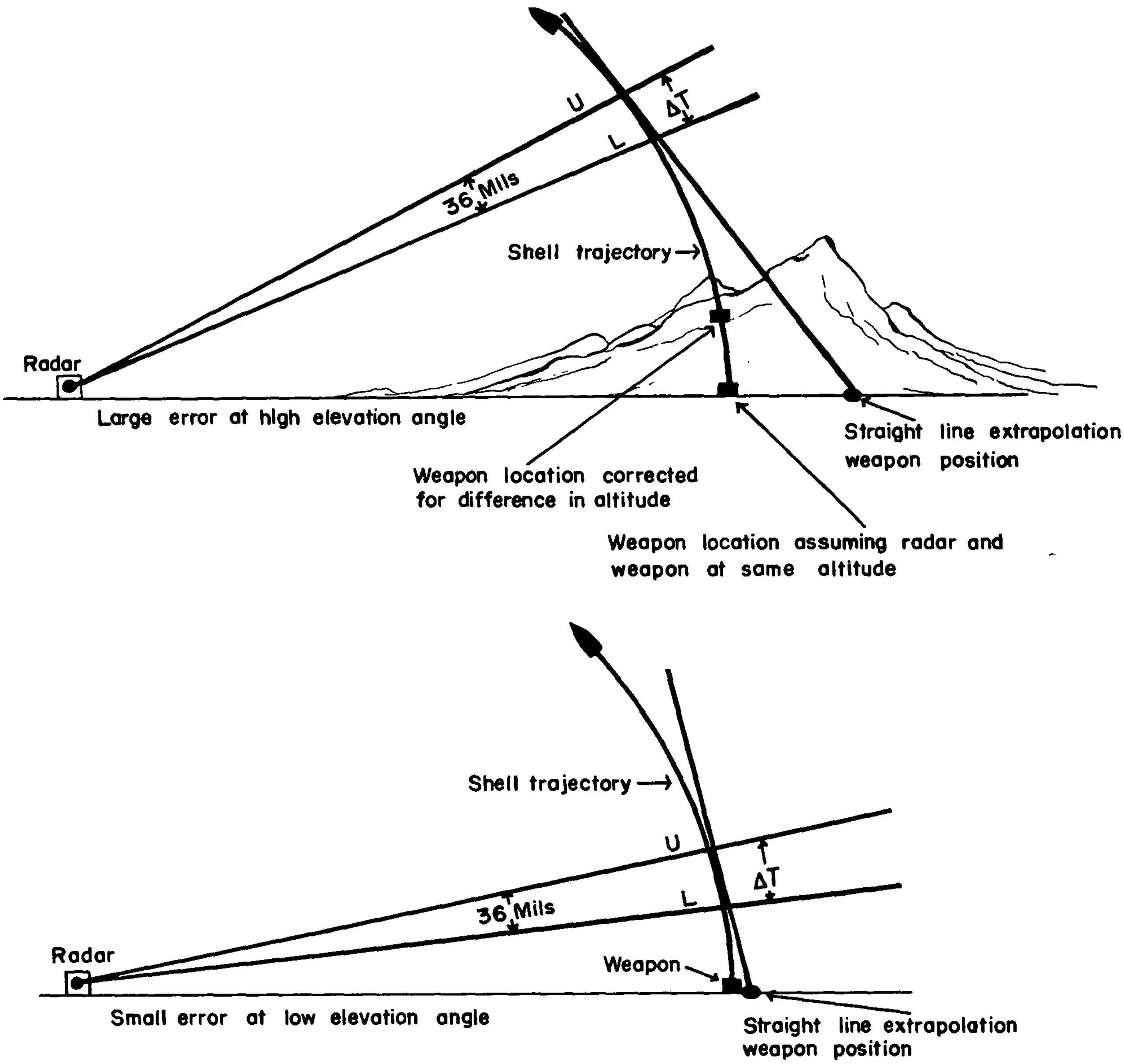

Figure 28. Effect on the weapon location of Δ time and differences in altitude corrections.

Section III. IMPACT LOCATION

26. General

Radar set AN/MPQ–4A may be used to compute the impact location of mortar and high-angle artillery rounds. The observed presentation will be identical with the scope pattern in figure 23 or 27, except that the projectile will be moving downward and the upper beam echo will appear on the B-scope first.

27. Computing 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 △ RANGE control until the upper range strobe intersects the first (upper beam) mark on the B-scope.

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

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

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

h. Correct the initial coordinates for altitude, using the procedure described in paragraph 25*a*.

i. Make sure that the DOUBTFUL SOLUTION indicator lamp is not lighted.

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

k. Place the DETENT switch in the OFF position.

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

m. On the indicator, press the RESET switch to return the SECONDS clock to zero.

n. The radar equipment is now prepared for the next location or mission.

28. Recording Form

DA Form 6–6 (Record of Sound, Flash, and Radar Locations) is used to record information pertaining to a weapon location. This form facilitates the recording and reporting of pertinent target information. It will be noted that the form does not provide spaces for recording azimuth and range to the enemy weapon. However, when the radar set AN/MPQ-4A is operated from an assumed grid, the azimuth and range to the target must be recorded. This azimuth and range will be used in determining corrected coordinates after survey control has been provided.

CHAPTER 5

RADAR GUNNERY

Section I. REGISTRATIONS

29. Purpose

a. A registration is fired by an artillery unit to determine corrections for nonstandard conditions. The firing tables, which are used in the fire direction center to determine the deflection fuze setting, and quadrant elevation to fire at a given point, were made for a set of standard conditions. These conditions were selected as a point of departure. They closely approximate the average conditions found in the North Temperate Zone of the earth. However, if these standard conditions do not exist at the time of firing, and they rarely do, a projectile fired with a certain charge and elevation will not burst at the range given in the firing table for that specific projectile.

b. In order to determine corrections, it is necessary to know where the rounds "did hit," when fired with a certain deflection, fuze setting, and quadrant. This "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 center-of-impact (CI) or high-burst (HB) registration is faster and more economical than a precision registration conducted by a ground observer. From six or less observed rounds fired in a high-burst registration, the FDC can determine corrections to firing data for deflection, fuze setting, and quadrant elevation. In a center-of-impact registration, the same number of rounds is used, but fuze quick is fired; therefore, the correction for fuze setting cannot be determined. 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.

30. Radar as the Observer

The AN/MPQ–4A radar section will often be required to observe HB and CI registrations. The radar section should be linked directly with the FDC at all times. The radar can complete a registration quickly, even during periods of visibility which would render ground observation ineffective.

31. Radar-Observed High-Burst Registration

a. A high-burst registration is fired with fuze time. The registration point must be selected at a point 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 expeditiously prepared by the FDC and sent to the radar. The radar section immediately plots the location of the registration point from the coordinates announced in the message to observer.

b. The message to observer is a standard message, consisting of six elements. It should be sent in the following sequence:

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

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

(3) *Coordinates.* The third element must always be sent. It specifies the military grid reference of the registration

point to the nearest 10 meters. It consists of the word COORDINATES, followed by the grid coordinates.

(4) *Minimum altitude.* This element consists of the phrase MINIMUM ALTITUDE, followed by the altitude in meters below which the registration point should not be selected. This altitude is computed in the FDC, normally by adding two height-of-burst probable errors to the altitude of the ground under the announced registration point.

(5) *Maximum altitude.* This element consists of the phrase MAXIMUM ALTITUDE, followed by the altitude in meters above which the registration point should not be selected. This altitude is computed in the FDC by multiplying the range from the gun to the registration point by a site of 50 mils, then adding this altitude to the altitude of the battery.

(6) *Report order.* This element consists of the order REPORT WHEN READY TO OBSERVE. It requires the radar section to inform the FDC when the section is ready to observe the registration.

c. The message to observe is received by the radar section and copied in the spaces provided on DA Form 2888, Radar Observed Center-of-Impact or High-Burst Registration, AN/MPQ-4A (fig. 32). DA Form 2888 may be requisitioned though normal supply channels.

d. The radar plotter determines the pointing azimuth and pointing range which are the azimuth and range from the radar to the announced registration point. The angle of elevation to the screening crest along the pointing azimuth is determined by observation through the telescope; then the pointing elevation is computed by adding 10 mils to that angle of elevation. The radar set is oriented on the pointing azimuth, range, and elevation. This information is recorded on DA Form 2888.

e. 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 registration point. Therefore, as soon as the radar plotter has computed the pointing data, he determines the altitude and transmits this information to the FDC. The altitude of the announced registration point for a high-burst registration is computed on DA Form 2888 and is determined in the following manner:

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

(2) Add this vertical interval to the altitude of the radar in meters. The sum is the altitude of the announced high-burst registration point.

(3) If this altitude is above the minimum altitude and below the maximum altitude given in the message to observer, the message ALTITUDE (so much) is sent to the FDC.

(4) If the altitude computed is above the maximum altitude, the FDC will be informed immediately. The FDC will make the decision to fire the altitude computed, move the registration point, or cancel the mission.

(5) If the computed altitude is below the minimum altitude, the minimum altitude will be used. In order to point the radar antenna at the minimum altitude, however, a new pointing elevation must be computed. This computation is made in the following manner:

(*a*) Subtract the altitude of the radar from the minimum altitude. The difference is the vertical angle.

(*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. When the radar section has completed all preparations to observe the registration, the message ALTITUDE (so much), REQUEST SPLASH, AT MY COMMAND, READY TO OBSERVE is sent to the FDC. This message informs the FDC of three things. First, it notifies the FDC that the radar section desires a splash warning. This warning is sent by the FDC 5 seconds before the round is due to burst. Second, it notifies the FDC that the radar section will control the fires of the firing battery; the term AT MY COMMAND means that the gun will fire at the command of the radar section. Third, it informs the FDC that the radar section has completed all preparations, and is ready to observe the registration.

g. When the radar section is notified that the battery is ready to fire, the radar plotter sends the command for the battery to fire the first round. When the battery has fired, the FDC reports ON THE WAY, OVER to the radar. Five seconds before the round is due to burst, the FDC transmits SPLASH, OVER. The radar plotter acknowledges this message by transmitting SPLASH, WAIT. When the radar section is ready for the battery to load another round, it sends the command REPEAT RANGE to the FDC. The first round fired in a high-burst registration is normally considered 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 RANGE is delayed until the antenna has been reoriented. For subsequent rounds, the command REPEAT RANGE may be transmitted immediately after the battery has announced ON THE WAY.

h. This procedure is continued until the radar section has observed and recorded on DA Form 2888 data for six usable rounds. The chief of section quickly checks the data for the six rounds to see if an error exists or if an obviously erratic round is contained in the six rounds observed. If the registration has been observed without error and if no erratic rounds exist, the radar section transmits the command END OF MISSION to the FDC. This informs the FDC that the radar section has enough information to determine the mean center of burst and that the base piece can be used for firing other missions.

i. As soon as the radar section has completed the computation of the registration point location, they send the information to the FDC in a registration report. This report is contained on the registration form.

32. Marking and Strobing High-Burst Registration Target Echoes

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, 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 will not be considered valid unless the initial echo appears as shown in figure 29. Adjustments of the pointing elevation must be continued until echoes such as these exist.

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 is marked and strobed as shown in figures 30 and 31.

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

33. Conduct of a High-Burst Registration

a. General. Before the radar set can be considered ready to observe a registration, it must be emplaced and checked using the most accurate procedures possible. A registration can be accurately observed only if the radar set has been leveled, collimated, oriented, and range calibrated. All procedures must be within prescribed tolerances.

b. Personnel. Four members of the radar section are needed to conduct a radar-observed high-burst registration. These members are listed below by the job titles which will be used in explaining the duties of each.

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

c. Sequence. When the radar section receives the message to observer, all members of the section start preparations immediately. In order to provide a detailed explanation of the duties of each member during the registration, the duties of each will be given for each of the five phases of the registration. These phases are as follows:

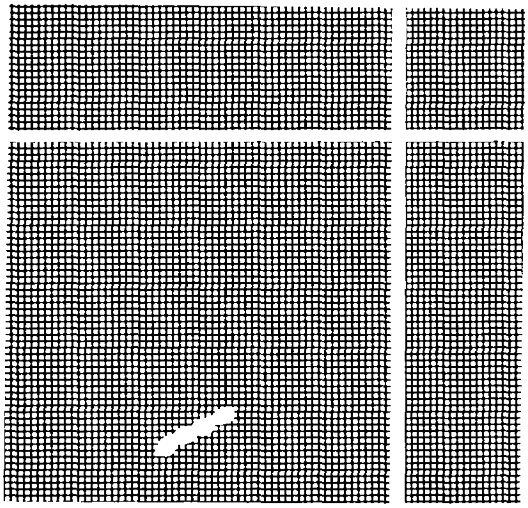

Figure 29. Projectile first entering the beam.

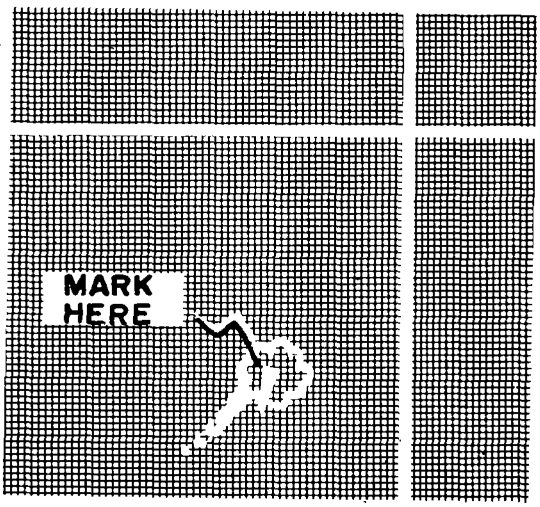

Figure 30. Projectile bursting in the beam.

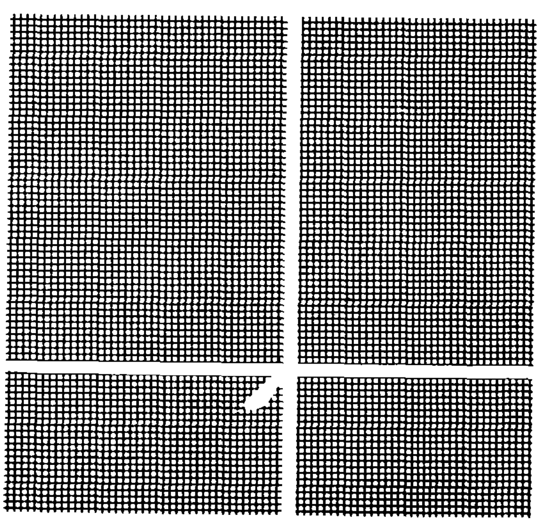

Figure 31. Strobing of marked burst.

(1) Preparation.
(2) Reorientation.
(3) Observation.
(4) Computation.
(5) Report.

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 in figure 32. The duties of personnel during the preparation phase are outlined in (1) through (4) below:

(1) The *radar plotter* performs the following duties in the order listed:

(*a*) Record the message to observer in step 1 of DA Form 2888 as shown in figure 32.

(*b*) Plot the coordinates given in the message to observe on the radar chart.

(*c*) Use the range-deflection protractor (RDP) to measure the azimuth and range to the announced registration point; then announce aloud the following data:
AZIMUTH 1634 (always read to the nearest mil).
RANGE 6110 (always read to the nearest 10 meters).

(*d*) Record the announced azimuth and range as the pointing azimuth and range in step 2, blocks 7 and 8, as the registration form.

(*e*) Record in block 9 the angle of elevation announced by the telescope observer. Add to this value the 10 mils already recorded in block 10, and record the sum, to the nearest mil in block 11 as the pointing elevation.

(*f*) Using the spaces provided in step 3 of the registration form, compute the altitude of the registration point.

(*g*) When all members of the radar section have reported ready, report to FDC: ALTITUDE (from step 3), AT MY COMMAND, REQUEST SPLASH, READY TO OBSERVE (step 4).

RADAR OBSERVED CENTER-OF-IMPACT OR HIGH-BURST REGISTRATION, AN/MPQ-4A
(FM 6-161)

SEE NOTES ON REVERSE

STEP 1: MESSAGE TO OBSERVER	STEP 2: INITIAL POINTING DATA	STEP 3: INITIAL REGISTRATION POINT ALTITUOE
1. OBSERVE *(Check applicable box)* ☒ HB ☐ CI	7. AZ *(Nearest 1 mil) (Note 1)* 1634 + 40 = 1674	12. RG *(8) (in thousands)* 6110
2. FOR *(Unit or call sign)* BANNER 9	8. RG *(Nearest 10 meters)* 6110	13. ELEV *(11)* 36.660 / 122.20 / 158.860 / + 26
3. AT COORDINATES 23456789	9. ELEV TO SC CR +16	14. VI *(12 x 13)* 159
4. MINIMUM ACCEPTABLE ALTITUDE 395	10. + 10 MIL	15. ALTITUOE *(RADAR)(Meters)* 326
5. MAXIMUM ACCEPTABLE ALTITUDE 592	11. ELEV *(Nearest 1 mil)(9 + 10)* +26 + 7 = 33	16. ALTITUDE *(RP)(14 + 15)* 521
6. REPORT WHEN READY TO OBSERVE		

STEP 4: REPORT TO FDC

ALTITUDE *(16)* ; AT MY COMMAND, REQUEST SPLASH, READY TO OBSERVE

STEP 5: RECOROING AND COMPUTATION

ROUND NO	FROM B SCOPE: RANGE	FROM B SCOPE: AZIMUTH	FROM TELESCOPE *(HIGH BURST ONLY)* AZIMUTH DEVIATION *(Note 3)*: LEFT (−)	RIGHT (+)	ELEVATION DEVIATION: BELOW (−)	ABOVE (+)
1	6300	1675		40		7
IF REQUIRED, AOJUST POINTING DATA AND CORRECT BLOCKS 7 AND 11 *(Note 2)*						
2	6280	1676		4	6	
3	6250	1672		5	5	
4	6340	1680		7		1
5	6320	1677	7		0	0
6	6290	1675		2	2	
~~7~~	~~6000~~	~~1650~~	~~25~~			~~19~~
8	6220	1680		5	6	
TOTAL	17.	18.	TOTAL LEFT (−)	TOTAL RIGHT (+)	TOTAL BELOW (−)	TOTAL ABOVE (+)

19. AZIMUTH DEVIATION = ALGEBRAIC TOTAL LEFT (−) AND RIGHT (+)	20. ELEVATION DEVIATION = ALBEBRAIC TOTAL BELOW (−) AND ABOVE (+)

23. REGISTRATION POINT RANGE	24. AZIMUTH OF CI	21.	22.
6 ⟌ 37700 (17) = 6283; 36 / 17 / 12 / 50 / 48 / 20 / 18	6 ⟌ (18)	[illegible] 3 = 16 / 6 (19)	[illegible] 3 = 18 / 6 (20)
		25. (21) + 3	27. (22) −3
		26. (7) 1674	28. (11) +33
		29. HB AZ *(Algebraically add 25 and 26)* 1677	30. HB ELEV *(Algebraically add 27 and 28)* +30

STEP 6: FINAL REGISTRATION POINT ALTITUOE	STEP 7: REPORT TO FDC
31. RP RG *(23)(In thousands)* 6.28	36. REPORT ON RADAR OBSERVED *(Check applicable box)* ☒ HB ☐ CI
32. HB *(Enter value block (30))* CI *(Enter value block (11))* +30	37. TIME OBSERVED 261500
	38. AZIMUTH *(CI (24) [illegible] (29)) (See Note 4)* 1677
33. VI *(31 x 32)* 188	39. RANGE *(23) (See Note 4)* 6280
34. ALTITUDE RADAR 362	40. ALTITUOE *(35)(See Note 4)* 550
35. ALTITUDE RP *(33 + 34)* 550	END OF MISSION

DA FORM 1 JAN 65 2888

1. Front

Figure 32. DA Form 2888 showing completed HB registration.

NOTES

NOTE 1: *(High Burst Only)* Telescope must be pointed at the pointing azimuth. To accomplish this, place radar set in azimuth orient. Apply *(add* or *subtract as necessary)* the field correction to the chart azimuth, and place this value on the azimuth counter. Place value of chart azimuth in Block 7.

NOTE 2: If the first burst deviation is more than 10 mils left, right, or above the center of the telescope, the pointing data must be changed to center the antenna on the first burst. Change the pointing data in the Step 2 block. If the first burst deviation is more than 5 mils below the center of the telescope, the FDC must be notified *(BURST TOO LOW, REQUEST SITE INCREASE)*. The antenna should not be depressed.

NOTE 3: *(High Burst Only)* If B–Scope azimuth disagrees with telescope azimuth in excess of ± 5 mils, either the operator or the observer has made an error in orientation or reading. The round is invalid and may not be used in computing the mean burst location.

NOTE 4: *(a)* The azimuth, range, the altitude reported to FDC must be computed independently by two crew members.

(b) If the FDC desires coordinates in addition to the azimuth, range, and altitude, the azimuth and range are inserted into the computer and polar plotted on the radar chart. The coordinates determined from the chart are sent to the FDC. The coordinates read from the computer easting and northing coordinate counters are used as a double check. The computer coordinates should agree with the polar plotted coordinates within 20 meters easting and 20 meters northing.

2. Back

Figure 32—Continued.

(2) The *control unit operator* performs the following duties in the order listed:

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

1. When the pointing azimuth is announced by the plotter, algebraically add the measured field correction to the pointing azimuth. The sum is the azimuth counter reading that must be set on the control unit in order to orient the telescope (the optical axis) on the pointing azimuth.

2. Move the telescope to the pointing azimuth by placing the DETENT switch in the AZIMUTH ORIENT position and setting the azimuth controls in detent. With the AZIMUTH switch, traverse the antenna until the COMPUTER counter indicates the computer counter setting.

Caution: **Fine adjustments are made by using the azimuth handwheel at the radar trailer. This prevents damage to the antenna drive motor.**

(*b*) Prepare the control unit for the registration in the following manner:

1. Place the DETENT switch in the OFF position and lock the upper beam controls.

2. Place the BEAM VIDEO switch in the LOWER position.

3. Place the RANGE SHIFT switch in the OFF position.

(3) The *telescope observer* performs the following duties in the order listed:

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

Note. The telescope is positioned on the pointing azimuth by rotating the antenna until the high burst chart azimuth appears on the radar trailer azimuth counter.

(*b*) After the telescope has been oriented on the pointing azimuth, measure the angle of elevation to the screening crest and report it to the radar plotter. To determine the elevation angle, set the elevation counter to zero and read the angle to the screening crest by using the telescope mounted on the radar trailer.

(4) The *recorder* performs the following duties in the order listed:

(*a*) Enter all known data on the registration form (fig. 32) and check the altitude computations made by the radar plotter. The registration form completed by the recorder serves to doublecheck the computations made by the radar plotter.

(*b*) Check the field correction at the echo box.

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

(*d*) Check the level of the set.

e. Reorientation. The reorientation phase begins when the radar section receives the message ON THE WAY for the first round in the mission. It ends when the antenna has been centered on, or is within 10 mils of, the burst produced by the first round. The objective of this phase is to center the telescope on the point where the majority of the bursts will occur. Duties of personnel during the reorientation phase are outlined in (1) through (4) below:

(1) The *telescope observer* performs the following duties in the order listed:

(*a*) Climb on the antenna pedestal and take a position to observe through the telescope.

(*b*) When SPLASH is received, look throughout the field of vision of the scope.

(*c*) When the burst appears, immediately sense the deviation in mils from the center of the telescope to the point of the burst.

Note. The observer will have his back turned toward the burst; therefore, care must be exercised to insure that sensings are correct.

(*d*) Report the deviation in mils to the recorder. If the deviation is more than 10 mils to the left or right or above the center of the telescope, the antenna must be moved to point the telescope at the burst. If the burst from the first round does not deviate more than 10 mils from the center of the telescope, reorientation will not be required, and the first round may be considered one of the six rounds for use in the registration.

(2) The *recorder* performs the following duties in the order listed:

(*a*) Record the announced azimuth and elevation deviation in the appropriate column in step 5 on the registration form.

(*b*) If reorientation is necessary, use the azimuth handwheel on the radar trailer to set the new pointing azimuth. If the burst was to the left, subtract the amount of the deviation from the reading on the azimuth counter, and move the antenna until the new pointing azimuth appears on the azimuth counter. If the burst was to the right, add the amount of the deviation to the pointing azimuth to obtain a new pointing azimuth, and move the antenna until the new pointing azimuth appears on the azimuth counter.

(*c*) After the new pointing azimuth is set, the recorder moves to the elevation counter. The elevation counter should reflect the new pointing elevation.

(*d*) Enter the new pointing azimuth and elevation on the registration form as required by step 5 (Note 2).

(3) The *radar plotter* performs the following duties in the order listed:

(*a*) Record in step 5 on the registration form the range announced by the control unit operator and the deviations reported by the telescope observer.

(*b*) Compute the new pointing azimuth and elevation are required by step 5 (Note 2) on the registration form.

(*c*) Announce the new pointing azimuth and elevation to the control unit operator.

(4) The *control unit operator* performs the following duties in the order listed:

(*a*) Watch for the appearance of the echo of the first round when SPLASH has been received.

(*b*) Mark and strobe the burst location.

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

(*d*) If a new pointing elevation has been computed by the radar plotter, place the new pointing elevation on the set by using the ELEVATION switch.

(5) During the reorientation phase, the antenna is never lowered. Initial data requires 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 deviation reported by the observer is more than 5 mils below the center of the telescope, the round will not be used for reorientation or computation of the registration. When a deviation of more than 5 mils below the center of the telescope is reported, the radar plotter notifies the FSC by transmitting ROUND TOO LOW, REQUEST SITE INCREASE.

(6) In the example registration mission recorded on the DA Form 2888 in figure 32, 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. These data are recorded on the form as shown in figure 32. The initial pointing data recorded in the step 2 block would be changed as shown. The control unit operator would set elevation +33 on the elevation counter, and the recorded would insure that the antenna elevation counter reads +33.

f. Observation. The observation phase begins when the reorientation phase is completed and ends when the data from six rounds have been recorded. The duties of personnel during the observation phase are outlined in (1) through (4) below:

(1) The *control unit operator* performs the following duties in the order listed:

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

(*b*) Mark and strobe the echo.

(*c*) Announce the range and elevation to the radar plotter.

(*d*) If the round is not observed, report LOST.

(*e*) If the round does not burst in the beam of the radar, it cannot be used in the registration. If the round does not burst in the beam, announce ABOVE BEAM or BELOW BEAM, as appropriate.

(2) The *telescope observer* performs the following duties in the order listed:

(*a*) Take a position to observe through the telescope when ON THE WAY is received.

Note. The observer must not stand in the beam any longer than is necessary, therefore he should kneel down out of the beam until ON THE WAY is received.

(*b*) Begin looking for the burst when SPLASH is received.

(*c*) When the burst appears, announce the azimuth deviation as LEFT or RIGHT (*so much*) and the elevation deviation as ABOVE or BELOW (*so much*).

(*d*) If the round is not observed, announce LOST.

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

(4) The *radar plotter* performs the following duties in the order listed:

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

(*b*) Record the deviations announced by the telescope observer.

(*c*) Apply the azimuth deviation announced by the telescope observer to the *pointing azimuth.* This computed azimuth and the azimuth announced by the control unit operator must agree within 5 mils. If they do not, the round is not considered in the registration, and an additional round must be fired.

(*d*) When it is determined by the senior radar operator (SRO) that six usable rounds have been observed and data recorded, send END OF MISSION to the FDC.

(5) The telescope observer and control unit operator have no further duties during the remainder of the high-burst registration.

g. Computation. The computation phase begins when the possibility of erratic rounds has been eliminated. During this phase, the plotter and recorder both perform the computations required. Each member works independently of the other. They compare results when the totals have been determined; when the final range, azimuth and elevation have been determined; when the altitude has been computed; and immediately before the report is rendered to the FDC. The computation of the registration point location is performed on the registration form in the following steps:

(1) The ranges reported from the B-scope 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 computation is continued.

(4) In a high-burst registration, the azimuth from the B-scope is not totaled. This azimuth is 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 (block 21), and elevation (block 22).

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

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

(8) The average elevation deviation is algebraically added to the final pointing elevation (block 11), using blocks 27 and 28. The result is the *HB EL* (block 30).

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

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

(11) 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. Report.

(1) When the computation made by the plotter and those made by the recorder have been compared and found to agree, the location of the registration point is transmitted to the FDC as polar coordinates. This report consists of the six following elements, transmitted in the order in which they are listed:

(*a*) REPORT ON RADAR-OBSERVED HIGH BURST. This element informs the FDC of the type of message to follow.

(*b*) TIME OBSERVED. This element 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 registration firing was completed.

(*c*) AZIMUTH. This element is the azimuth from the radar antenna to the registration point.

(*d*) RANGE. This element is the range from the radar antenna to the registration point.

(*e*) ALTITUDE. This is the computed altitude of the registration point.

(*f*) END OF MISSION. This informs the FDC that the report is complete and that the radar section is preparing for another mission.

(2) Both computers record the report to the FDC 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.

34. Radar-Observed Center-of-Impact Registration

a. A center-of-impact (CI) registration is fired with fuze quick. The radar cannot observe a burst on the ground; therefore, a point must be selected high enough in space so that the rounds can be observed by the radar. The registration point is the point where all rounds pass through the center of the lower beam. The use of the optical telescope is not required. All information is determined from strobing the point where each round passed through the center of the lower beam. The registration point location is computed and reported in a manner similar to that for a high-burst registration.

b. The radar section is alerted to observe a center-of-impact registration by a message to observer. The message to observer for a center-of-impact registration parallels that for the high burst, except that no minimum altitude is transmitted.

c. The procedures for determining pointing data and altitude are the same as those for a high-burst registration. If the computed altitude is above the maximum, the FDC will make the decision to fire the altitude computer, to move the registration point, or to cancel the mission.

d. In the center-of-impact registration there will be no requirement to reorient the radar, as the radar beam is sufficiently wide to insure detection of all rounds.

e. The center-of-impact registration also requires six usable rounds. The azimuth and range to each round will be determined by strobing the center of the target echo on the B-scope.

f. The registration point location will be sent to the FDC as it is in the high-burst registration.

35. Marking and Strobing Center-of-Impact Registration Target Echoes

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

b. The appearance of the echo for a center-of-impact registration is similar to that for a high-burst registration except that the round will not burst in the beam. The operator will see 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 halfway between the entry and exit points. This center point is the point to strobe for azimuth and range. This procedure is illustrated in figures 33 through 36.

36. Conduct of Center-of-Impact Registration

a. Preliminary checks and adjustment of the radar must be completed as in a high-burst registration.

b. Three members of the radar section are needed to conduct a center-of-impact registration. These are the—

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

c. When the radar message 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 center-of-impact registration is fired with fuze quick, the round cannot be observed through the telescope, so the observer cannot report the deviations of the round. The range and azimuth to each round are determined from the B-scope. When six valid rounds have been detected, their ranges and azimuths are averaged to find the range and azimuth to the registration point. The angle of elevation at which the rounds are observed is the pointing elevation. The duties of the crewmembers for a center-of-impact registration will be discussed in phases which parallel

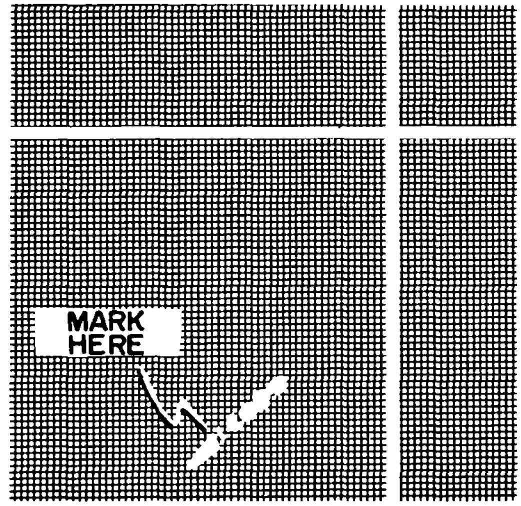

Figure 33. Marking where projectile enters the beam (CI).

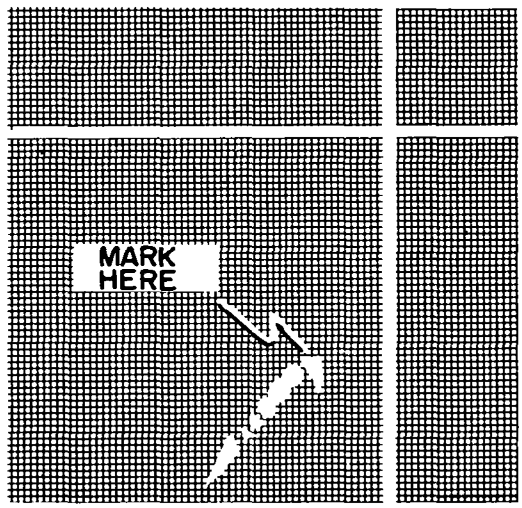

Figure 34. Marking where projectile leaves the beam (CI).

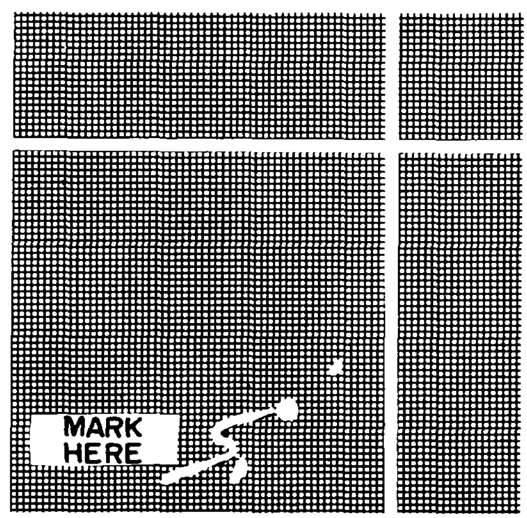

Figure 35. Marking the point where the projectile passed through the center of the beam.

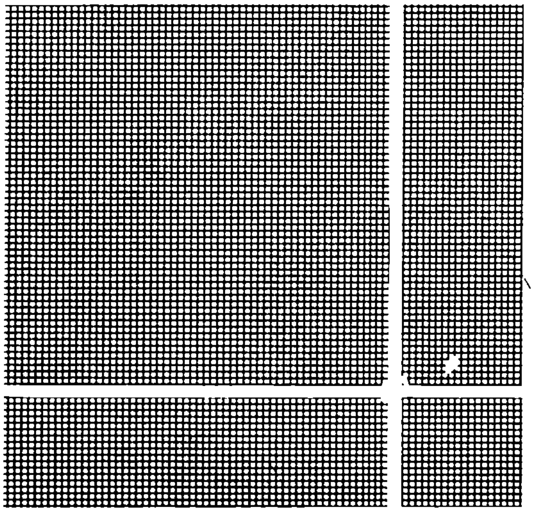

Figure 36. Strobing the midpoint.

those of a high-burst registration. Since the telescope is not used in a center-of-impact registration, there is no reorientation phase. Data recorded throughout all phases of the registration are illustrated in figure 37 on the completed DA Form 2888. The phases of the registration are as follows:

(1) Preparation.

(2) Observation.

(3) Computation.

(4) Report.

d. Preparation. The preparation phase begins when the radar section receives the messages to observer and ends when the radar section sends the ready report to the FDC. The duties of the crewmembers during the preparation are as follows:

(1) The *radar plotter* performs the following duties in the order listed:

(*a*) Record the message to observer on the registration form as shown in figure 37.

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

(*c*) Use the RDP to measure the azimuth and range to the announced registration point and announce—
AZIMUTH 624 (nearest mil).
RANGE 5410 (nearest 10 meters).

(*d*) Record the announced azimuth and range as the pointing azimuth and range in step 2, blocks 7 and 8, of the registration form.

(*e*) Record in block 9 the angle of elevation announced by the recorder. Add to this value the 10 mils already recorded in block 10, and record the sum in block 11 as the pointing elevation.

(*f*) Using the spaces provided in step 3 of the registration form, compute the altitude of the registration point.

(*g*) Compare this computed altitude with the maximum altitude given in the message to observer. If the computed altitude is above the maximum, inform the FDC.

(*h*) When all members of the radar section have reported ready, report AT MY COMMAND REQUEST SPLASH, READY TO OBSERVE to the FDC.

(2) The *control unit operator* performs the following duties in the order listed:

(*a*) Traverse the radar antenna to the vicinity of the pointing azimuth. To move the antenna to the approximate pointing azimuth, position the azimuth strobe in the center of the B-scope and rotate the antenna until the azimuth counter indicates the approximate pointing azimuth.

(*b*) When directed by the recorder use the ELEVATION switch to set in the pointing elevation.

(*c*) Prepare the control unit for the registration by—

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

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

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

(*d*) To orient the antenna in elevation during night registrations when the screening crest cannot be observed the telescope, elevate the antenna until the B-scope is free of all clutter; then depress the antenna

RADAR OBSERVED CENTER-OF-IMPACT OR HIGH-BURST REGISTRATION, AN/MPQ-4A
(FM 6-161)

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 ☒ CI	7. AZ *(Nearest 1 mil) (Note 1)* 624	12 RG *(8) (in thousands)* 5.410
2 FOR *(Unit or call sign)* BANNER 9	8 RG *(Nearest 10 meters)* 5410	13 ELEV *(11)* +32; 10.820 / 162.30 / 173.120
3 AT COORDINATES 23456789	9. ELEV TO SC CR +22	
4 MINIMUM ACCEPTABLE ALTITUDE ———	10 + 10 MIL	14 VI *(12 x 13)* 173
5. MAXIMUM ACCEPTABLE ALTITUDE 592	11. ELEV *(Nearest 1 mil)(9 + 10)* +32	15. ALTITUDE *(RADAR)(Meters)* 370
6. REPORT WHEN READY TO OBSERVE		16. ALTITUDE *(RP)(14 + 15)*

STEP 4: REPORT TO FDC

ALTITUDE *(16)* 543 ; AT MY COMMAND, REQUEST SPLASH; READY TO OBSERVE

STEP 5: RECORDING AND COMPUTATION

ROUND NO	FROM B SCOPE: RANGE	FROM B SCOPE: AZIMUTH	FROM TELESCOPE *(HIGH BURST ONLY)*: AZIMUTH DEVIATION *(Note 3)* LEFT (−)	AZIMUTH DEVIATION RIGHT (+)	ELEVATION DEVIATION BELOW (−)	ELEVATION DEVIATION ABOVE (+)
1	AN	ORIENTATION	ROUND	IS NOT	REQUIRED FOR	A CI
IF REQUIRED, ADJUST POINTING DATA AND CORRECT BLOCKS 7 AND 11 *(Note 2)*						
1	5120	600				
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 (+)

19. AZIMUTH DEVIATION = ALGEBRAIC TOTAL LEFT (−) AND RIGHT (+)

20 ELEVATION DEVIATION = ALGEBRAIC TOTAL BELOW (−) AND ABOVE (+)

23 REGISTRATION POINT RANGE	24 AZIMUTH OF CI	21	22
6 ⟌ 30390 (17) = 5065; 30 / 39 / 36 / 30 / 30	6 ⟌ 3629 (18) = 604.8 ≈ 605; 36 / 29 / 24 / 50 / 48	6 ⟌ ± (19)	6 ⟌ ± (20)
		25 (21)	27 (22)
		26 (7)	28 (11)
		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)* 5.060	36 REPORT ON RADAR OBSERVED *(Check applicable box)* ☐ HB ☒ CI
32. HB *(Enter value block (30))* CI *(Enter value block (11))* +32	37 TIME OBSERVED 261825
	38 AZIMUTH (CI (24) circled) HB (29)) *(See Note 4)* 605
33 VI *(31 x 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	END OF MISSION

DA FORM 1 JAN 65 2888

Figure 37. DA Form 2888 showing completed CI registration.

until clutter starts to appear, but not so low that it appears in the area where the center-of-impact registration is to be conducted. Enter in block 11 on the form the elevation indicated on the radar trailer elevation counter.

(3) The *recorder* performs the following duties in the order listed:

(*a*) Fill in all known data on the registration form and check the altitude computations made by the radar plotter. The registration form completed by the recorder will serve to doublecheck the computations made by the radar plotter.

(*b*) Direct the control unit operator to elevate the antenna until the center of the telescope reticle is approximately 10 mils above the screening crest. Having oriented the antenna in elevation, leave the telescope and read the elevation angle at the radar trailer. Apply any elevation corrections determined during the elevation orientation check, report the corrected elevation angle to the recorder, and enter this same value on the registration form.

e. Observation. The observation phase begins when the ready report has been sent to the FDC and ends when the data from six rounds have been recorded. The duties of personnel during the observation phase are as follows:

(1) The *control unit operator* performs the following duties in the order listed:

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

(*b*) Mark the point of entry when a round enters the beam.

(*c*) Mark the point of exist when the echo disappears.

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

(*e*) Strobe the center point and announce the range and azimuth to that point.

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

(2) Both the *radar plotter* and the *recorder* should record in step 5 range and azimuth announced by the control unit operator.

f. Computation. In the computation phase, the duties of both the recorder and the radar plotter are the same as those for high-burst registration, except that the azimuth read from the B-scope is used in determining the azimuth to the center-of-impact registration point, and the angle of elevation used in computing the altitude of the registration point is the pointing elevation.

g. Report. The report phase in the center-of-impact registration is similar to that in the high-burst registration.

Section II. RADAR ADJUSTMENT OF FIRE

37. General

a. The decision to fire or not to fire artillery and the choice of the method of attack on any target is 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 onto 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 both of the following conditions exist:

(1) No registration corrections are available.

(2) No survey exists and the target has been located by radar.

b. If the S3 decides to adjust on a target using radar as the observation agency, the radar crew must be able to rapidly and accurately perform the adjustment. 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.

38. Fire Adjustment Principles Pertinent to Radar

The goal of an adjustment is to move the center of burst of one or more rounds 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 FDC. Nor is it necessary for the FDC to know the location of the radar. Adjustment is begun by firing one round into the area in the vicinity of the target. When the location of the burst of the adjusting round is determined in relation to the radar, the radar crew computes the relative distance and direction to move the burst to the target center. This is the first principle of fire adjustment pertinent to a radar adjustment—move the burst to the target center. The second principle of adjustment is speed. Speed in adjustment procedures is improved by training and the use of standard terminology and procedures. The standard initial fire request, subsequent fire request, and adjustment techniques must be understood and used by the radar crew. The third principle of adjustment is to start the adjustment as close to the target as possible. This is done by using the best method available to determine the target location.

39. Target Location

To begin the adjustment as close to the target as possible, the most accurate means of target location should be used. The methods of target location available to the AN/MPQ–4A radar section are listed below in the order of preference.

a. Grid Coordinates. The AN/MPQ–4A should be used to adjust fire onto a point of known coordinates only when no visual observation means is available or when the target is in defilade and the firing unit has no registration corrections.

b. Polar Coordinates. Since polar coordinates can be read directly from the computer of the AN/MPQ–4A, this is the next preferred method of target location. However, the FDC must know the location of the radar in order for this method to be used. Polar coordinates consist of the azimuth and distance to the target in relation to the radar.

c. Shift From a Known Point. If no map is available and the FDC does not know the radar location, the next preferred method is a shift from a known point. The point selected as a known point must be one which has been plotted on the radar chart and on the firing chart at the FDC. A shift from a known point consists of a lateral shift from the known point and a shift in range along the OT (observer-target) line. The shift is announced as FROM (known point), LEFT (RIGHT) (so much), ADD (DROP) (so much). The shift may be determined by computation or from the target grid on the radar chart.

d. Mark Center of Sector. Mark center of sector is the most common method of target location employed by radar, since this is the fastest method that can be used to establish a known point when absolutely no survey control exists. In this procedure, the radar is pointed in the general direction of the target. A round is fired from a battery to the center of the target area. The radar locates the point of impact of the projectile, and that point is plotted on the radar chart as a point of known location. The point can then be used during radar adjustment of fire on future target locations.

40. Initial Fire Request

a. When radar is used to adjust fire, the radar section must determine and transmit the initial and subsequent fire requests to the FDC. The initial fire request 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 FDC. Subsequent fire requests are transmitted to obtain changes in the elements of the initial fire request necessary to move the bursts to the target center.

b. The initial fire request contains nine elements. These elements are listed in (1) through (9) below in the order in which they are used. For a detailed explanation of each element see FM 6–40.

(1) Identification of observer.
(2) Warning order.
(3) Azimuth and location of target.
(4) Nature of target.
(5) Classification of fire.
(6) Type of adjustment.
(7) Type of shell.

(8) Fuze action.
(9) Method of control.

c. The inherent characteristics of the AN/MPQ–4A require that some of the elements of the initial fire request be modified as compared to a visual observer's request. In the initial fire request for a radar mission, the term ONE GUN is always included in the type of adjustment. Since the AN/MPQ–4A can more accurately locate the point of origin or burst of a high-angle projectile, the AN/MPQ–4A radar section will always request HIGH ANGLE. Also, the radar section will request that the battery or FDC send a splash warning. This warning, consisting of the word SPLASH, is sent 5 seconds before the round is due to burst. The splash warning will not be sent unless it is requested; therefore, when it is desired, the fire request from the radar section must include REQUEST SPLASH. Any other particular requests or desires should be included at this point. For example, in a fire request from a radar section the type of adjustment element normally would include ONE GUN, HIGH ANGLE, REQUEST SPLASH. In sending the method of control, the supplementary method of control AT MY COMMAND may be used to direct the guns to fire only on command from the radar crew.

d. An example of a complete fire request, using the correct communication procedures and prowords, is as follows:

Radar: REPLOT 9, THIS IS SPLIT BEAM 4, FIRE MISSION, OVER.

FDC: SEND YOUR MISSION, OVER.

Radar: MARK CENTER OF SECTOR, AZIMUTH 6300, OVER.

FDC: MARK CENTER OF SECTOR, AZIMUTH 6300, OVER.

Radar: MORTAR FIRING, ONE GUN, HIGH ANGLE, REQUEST SPLASH, FUZE VT, AT MY COMMAND, WILL ADJUST, OVER.

FDC: MORTAR FIRING, ONE GUN, HIGH ANGLE, REQUEST SPLASH, FUZE VT, AT MY COMMAND, WILL ADJUST, WAIT—

41. Message to Observer

a. After the initial fire request has been received in the FDC and the S3 has made the decision to fire on the target, he will issue a fire order. This fire order consists of the necessay commands to start the production of firing data in the FDC. Certain elements of the fire order will be extracted by a computer in the FDC and sent to the radar section as a message to observer. This message to observer will always contain three elements and any modification to the radar section's initial fire request. The elements are as follows:

(1) *Batteries to fire for effect.* This element informs the radar section which firing batteries will fire for effect. This may be only one battery, but normally, at least a battalion will fire for effect on targets located by radar.

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

(3) *Concentration number.* The concentration number is the designation assigned to the target.

(4) *Modification.* This element includes any change to any element of the initial request sent by the radar section.

b. An example of a message to the observer is shown below. In this instance the S3 decided that shell white phosphorous, fuze quick, should be used instead of shell high explosive and fuze variable time as requested in the initial fire request.

FDC: BATTALION, ONE VOLLEY, SHELL WP, CONCENTRATION RQ502, OVER.

Radar: BATTALION, ONE VOLLEY, SHELL WP, CONCENTRATION RQ502, OVER.

42. Radar Considerations

a. For adjustments, as for any other mission which the radar may be assigned, the site should be selected so that the angle of elevation is at least 15 mils above the screening crest but does not exceed 40 mils. The radar should be emplaced, leveled, collimated, oriented by the best means available, and range calibrated.

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

43. Subsequent Fire Requests

After the first burst has been located by the radar, the radar section will transmit subsequent fire requests until the fire mission is completed. These requests include appropriate changes to elements previously transmitted and the necessary corrections for deviation and range. A subsequent fire request always includes either a correction for range or the phrases REPEAT RANGE, indicating that no correction in range is desired. Any other element of the initial fire request for which a change or correction is not desired is omitted in the subsequent fire request. The elements of the subsequent fire request are listed below in the order in which they are transmitted.

a. Change in Azimuth. This element is used when the azimuth from the radar to the target changes more than 100 mils since the radar will normally be adjusting on a stationary target, the probability of the azimuth changing is slight.

b. Correction for Deviation. The radar plotter measures the distance that the round hit to the left or right of the radar-target (RT) line and announces the correction in meters necessary to move the round to the line. The deviation correction is announced to the nearest 10 meters.

c. Correction for Range. A correction for range or the phrase REPEAT RANGE *must* be sent as part of the subsequent fire request. When the burst is moved to the RT line and is still short of the target, the correction is ADD, followed by the number of meters, to the nearest 10 meters, required to move the rounds to the target. If the round is over the target when it is moved to the RT line, the correction is DROP, followed by the number of meters necessary to move the burst to the target.

d. Change in Control. When the radar crew desires to change the method of control from WILL ADJUST to FIRE FOR EFFECT, it is sent in this element.

44. Procedure for Adjusting Fire With the AN/MPQ–4A

a. When a target location has been determined, the initial fire request is sent to the FDC. The radar plotter plots the target location on the radar chart (fig. 38). In the normal situation, where the radar and firing units are not on a common survey grid; the radar chart is set up with the radar located at map inspected coordinates or, if no map is available, at a grid intersection over a set of assumed coordinates and altitude.

b. The radar plotter places a target grid over the target location and orients the grid. The antenna is adjusted until it is pointing at the target. If a request is made to mark center of sector to locate the target, the antenna must be pointed in the general direction of the center of the sector.

c. 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 the correct pointing data placed on the 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, immediate steps must be taken. When the radar section is again ready to observe, it transmits the command REPEAT RANGE to the FDC. The command REPEAT RANGE informs the fire direction center that the radar section did not obtain data to make corrections and desires that another round be fired.

d. When the location of the burst has been determined, this location is plotted on the radar chart. The distance that the round bursts left or right and 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 FDC. These corrections are announced to the nearest 10 meters. The shift or correction RIGHT (so much), DROP (so much) is understood to mean meters, even though the term "meters" is not expressed.

e. Adjustment is continued until a burst location is made within 100 meters of the target (fig. 38). As a general rule, the adjustment phase ends when a burst falls within a radial distance of 100 meters of the target. The radar section then requests final corrections and FIRE FOR EFFECT.

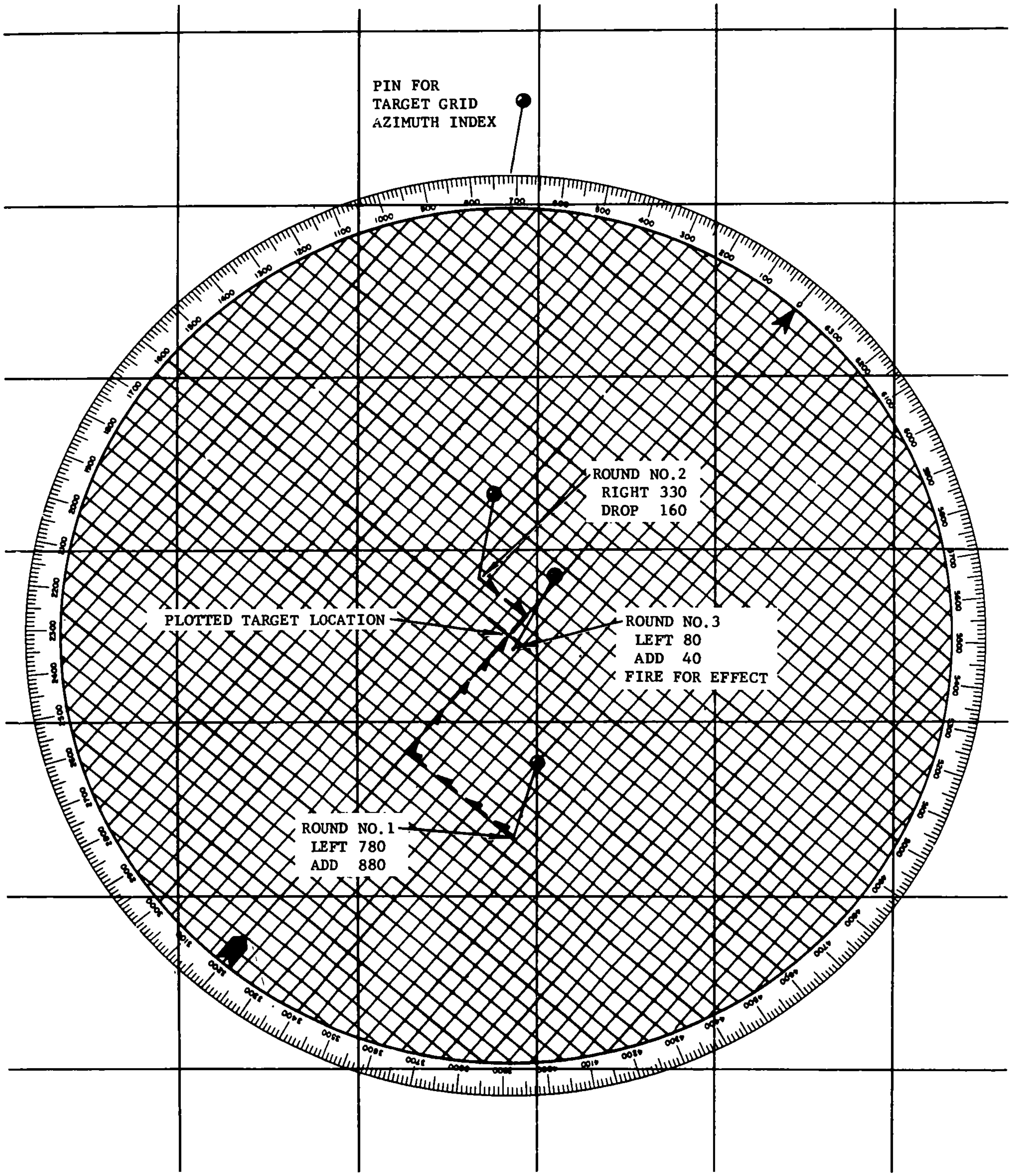

Figure 38. Use of target grid for determining radar fire adjustment corrections.

45. General

The likelihood of conflict in remote areas of the world places an increased requirement on the artillery to be able to fire using inaccurate maps or even without maps. The artillery must be able to deliver rapid and accurate fire in these 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 artillery firing units by combining the procedures employed in making a weapons location with those employed during a radar-observed high-burst registration.

46. Conduct of a Radar Survey

a. Emplacement of the Radar. To accomplish a survey mission, the radar should be emplaced near the center of the direct support battalion position area. The radar site should meet the normal positioning requirements for weapons location and radar gunnery applications. It should not be closer than 170 meters, the minimum range of the radar, to the base piece of any unit. Assumed coordinates and altitude are placed 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 so as to be over the battery being located. The base piece fires one round high angle. The location of the base piece is determined based on this one round.

c. Battery Altitude and Common Direction. The center battery fires a high-burst registration which can be observed from the radar site and from the battery center of each battery being provided survey. The executive officers observe the high burst with an aiming circle set up over the battery center and laid parallel to the battery. The battery executives of the flank batteries measure and record 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 officers orienting deflection and his recorded mean deflection to the high burst. The correction is opposite of 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 registration point 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 any error which occurred when the battery was initially laid. This error is determined by comparing the measured azimuth from each flank battery with azimuth between the radar-provided battery location and 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 altitudes of the batteries which observed the high burst.

CHAPTER 6

MOVING TARGET DETECTION

47. General

The radar set AN/MPQ–4A has a limited capability for detecting and locating moving ground targets. Because of the large number of battlefield surveillance radars available within the division, the AN/MPQ–4A is seldom used in the moving target detection role. When the AN/MPQ–4A is used for moving target detection, 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 in the 2500 M position with the EXPANDED SWEEP DELAY switch in the appropriate position to cover the area of interest. Pointing elevation is critical because of the narrow 14-mil beam.

48. Procedure

Preliminary procedures for preparing the radar set for moving target detection are identical to 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. Sequential plotting of target location on a contour map provides information as to the direction and speed of travel of a target. This information facilitates delivery of artillery fire on a predicted location of the target.

CHAPTER 7

TACTICAL EMPLOYMENT AND POSITION REQUIREMENTS

49. General

The tactical employment and position requirements for the radar set AN/MPQ–4A depend on the tactical mission assigned the radar section. Other technical and tactical factors that influence the operation of this equipment must also be considered. The suitability of a radar position can be determined only by the accomplishment of the assigned mission from that position.

50. Selection of Site

a. To insure complete coverage of the target area, coordination of the sectors of search for all radars is essential. The coordination of the sectors of search of all countermortar radars within the division is the responsibility of the division artillery S2. All tactical missions assigned to a radar section are determined by the direct support battalion commander. The battalion commander will designate the general position area within which the radar section may select positions.

b. The primary considerations governing the selection of the radar position area are—

(1) The integration of the radar zone of search with the zones of other units as directed by higher headquarters.

(2) The technical capabilities and limitations of the radar set.

c. The general position area designated should encompass an area sufficiently large to enable the field artillery radar technician or the chief of section to select the actual radar site, based on technical considerations affecting the operation of the radar. The radar position should be adjacent to one of the firing batteries. Such a position will simplify communications, facilitate survey and logistics, and enable the section to take advantage of any existing defensive perimeter. Depending on the mission, terrain, and situation, the radar position area should be located from 2,000 to 4,000 meters behind the forward edge of the battle area to give the radar section flexibility of action in both the offense and the defense.

d. The battalion commander also designates the sector (s) of search for the radar, if it has not been previously designated by higher authority. This sector of search will normally coincide with the zone of action of the supported unit.

e. After the general position area has been designated, the radar technician or chief of section will make a reconnaissance prior to making the actual selection of the 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*) Location of adjacent units.

(2) A ground reconnaissance is made after the map reconnaissance to facilitate occupation of the selected position. The ground reconnaissance is based on the tactical and technical consideration for the radar. It enables the radar technician (chief of section) to make decisions and issue orders concerning the following:

(*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*) Selection of alternate positions.

Note. The requirements in (*a*) through (*h*) above are not all-inclusive and they should be modified as dictated by the particular mission, situation, and terrain. The time available for reconnaissance generally is limited; therefore, the reconnaissance must be organized so that it can be accomplished as completely as possible in the time allotted.

51. 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 should include:

a. Communication. The communication requirements will vary, depending on the mission assigned to the radar section, but the site must permit the required communications to be established. Wire and/or radio are 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 must be emplaced in defilade to the enemy to afford personnel and equipment all possible protection from hostile fire.

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

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

f. Survey. The selection of a site near a firing battery or a known survey point will facilitate determination of the coordinates and altitude of the radar and the azimuth and elevation to a known point for orientation purposes. However, the minimum range of the radar (170 meters) must be considered if the radar is to be employed on a survey mission.

52. Technical Considerations

a. As a defense against electronic countermeasures, the radar should be placed behind a hill or ridge, called a screening crest. Angle of elevation to the screening crest should not exceed 15–40 mils.

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

(1) Maximum range of the radar.

(2) Sector of search.

53. Site Evaluation

a. After a radar site is occupied, a radar site evaluation diagram must be prepared and provided to the battalion S2 at the earliest practical time to facilitate the preparation of the target acquisition capabilities chart. Evaluation of the radar site is accomplished in order to determine the suitability of the radar site for the assigned mission and to inform higher echelons of the capabilities and limitations of the radar set in that site.

b. A site evaluation chart is a composite chart of both the screening crest profile and the clutter diagram, combined to depict all areas inadequately covered by the radar set. As additional time becomes available, the screening crest profile and clutter diagram are extended on both flanks of the sector of responsibility until the diagram includes all hostile areas in which projectiles can be detected. Site evaluation charts will be made in quantities established by unit SOP.

c. The screening crest profile is constructed by the senior radar operator, assisted by one man who observes through the optical telescope. Initially, the antenna is positioned at zero mils elevation and alined on either the right or left azimuth limit of the suspect sector. The observer reads the angle of elevation to the screening crest at this point, observing through the optical telescope. This procedure is continued at 100-mil azimuth intervals throughout the assigned sector. If the screening crest is very irregular, the width of the intervals must be reduced. The elevation readings are plotted on the screening crest profile portion of the site evaluation chart and the profile is drawn.

d. The clutter diagram is constructed in the following manner:

(1) Turn the transmitter on, set the BEAM VIDEO switch in the LOWER position, and place the RANGE SELECTOR switch in the 10000 M position.

(2) Elevate the antenna 10 mils above the highest angle of elevation to the screening crest within the assigned sector.

(3) If the sector is 445 mils or less, set the antenna on the azimuth of the center of sector. If the width of the assigned sector is greater than 445 mils, set the antenna on an azimuth 200 mils right of the left limit of the assigned sector, and traverse the antenna to the right at sufficient additional azimuth settings to cover the entire sector. In areas where the radar cannot observe, clutter (echoes from prominent terrain features) will appear on the B-scope.

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

(5) Plot these points on the clutter diagram portion of the site evaluation chart and connect the points for each patch of clutter by a solid line. Continue this process at elevation increments of 15 mils until all clutter has disappeared from the B-scope. Color code the area for each elevation for ease of interpretation.

CHAPTER 8

SAFETY PRECAUTIONS

54. 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.

55. 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 on the 120-volt AC line connections. *Extremely high voltages* in the amounts specified exist 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 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 transmitted 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 felt will vary with the individual and according to the time he is exposed.

(3) While observing through the optical telescope, an observer is not exposed to the radar beam. There is a minimum clearance of 55 centimeters between the eyepiece of the optical telescope and the lower half-power 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 telescope 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 will be required. For specific instructions, see TB SIG 225.

56. 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, First Aid for Soldiers.

CHAPTER 9

PROCEDURES FOR MINIMIZING THE EFFECTS OF JAMMING

57. Recognition of Jamming

The radar operator must learn to recognize the different forms of interference and to distinguish unintentional interference from interference caused by deliberate enemy jamming. Unintentional interference may result from the operation of nearby electrical equipment, or it may originate in the radar set 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 interference patterns remain on the scope after interference from all friendly sources has been eliminated. When the operator has observed the interference and determined that the interference is the result of enemy jamming, the next step is to take all possible action (para. 60–62) 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, this operator will be reacting just as the enemy wants him to do. Through training and practice, the operator can learn to distinguish unintentional interference from interference caused by enemy jamming and can take the necessary countermeasures.

58. 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 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 sector of the azimuth scanned by the radar being jammed. Depending on the type of transmission used, transmission jamming produces either strobe lines (extreme brightening of the weep) 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 not 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 other than active transmitters. Generally, this type of jamming is produced by reflecting items such as rope, chaff, and straw. These reflecting items, normally in the form of various types, shapes, and sizes of metallic strips and metallic coated papers, usually are dropped from aircraft. The purpose of these items 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 corner reflectors, metallic mesh, and stable, rotating, or oscillating dipoles. These types of window jamming devices are intended to produce strong false echoes which will obscure true target echoes or will "capture" tracking radars by causing the radar to lock on the false echoes. False echo interference may be called deception rather than jamming. All window jamming devices operate on the same principle—that of reflecting the transmitted pulse 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.

59. Location of Jamming Source

When interference is received and it appears to the radar operator that it is deliberate enemy jamming, he should report immediately to his superior the type of jammng received and the direction from which it is received. The operator also should keep a running record of information on the time, type, and direction of the jamming signal. Such information from two or more radar sites can provide data as to the exact location of the jammer and determine its movement if the jamming originates from a moving source. These 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 gun, missile, or aircraft. Jamming should be reported and recorded as long as the jamming indication is observed.

60. 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 of 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 continuous-wave jamming is strong enough to block the receiver completely, the GAIN control will not be effective in reducing the jamming effects.

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

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

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 through the Δ TIME will be inceased, the information obtained from the computer will still be of value.

61. Procedure for Operating Against Window Jamming

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

CHAPTER 10

DECONTAMINATION OF EQUIPMENT

62. General

Equipment which has been contaminated by chemical, biological, or radiological agents constitutes a danger to personnel. *Contamination* means the spreading of an injurious agent in any form and by any means. Persons, objects, of terrain may be contaminated. *Decontamination* is the process of making any contaminated place or object safe for unprotected personnel. This can be done by covering, removing, destroying, or changing into harmless substances the contaminating agent or agents. Generally, only that equipment contaminated by persistent agents needs to be decontaminated.

63. Decontamination for Chemical Agents

Decontaminate equipment contaminated by chemical agents in the following manner:

a. With rags, wipe off all visible contaminant from the AN/MPQ-4A radar set and power unit *exteriors*, apply DANC (decontamination agent, noncorrosive, M4), wipe with a gasoline-soaked rag, and then dry. If DANC is not available, scrub the contaminated area with soap and cool water. Remove all filters, soak them in gasoline, dry and recoat them with heavy oil, and then reinstall.

b. Do not use DANC on cables and rubber or plastic components.

64. Decontamination for Biological and Radiological Agents

a. General. After a contaminating attack, the recovery of equipment may be achieved either by waiting, to permit the decay of the contaminants, or by actively decontaminating the equipment, to reduce danger to a level where it is no longer a significant hazard to operating personnel. Decontamination may be either rough or detailed, depending on the urgency of the military situation. The procedure adopted will be a command decision.

b. Rough Decontamination. Rough decontamination will be performed when urgency is the main factor. The purpose of this type of decontamination is to reduce contamination sufficiently to permit personnel to work with, or close to, equipment for limited periods. Rough decontamination may be achieved by means of water or steam, if available. Soap or other detergent used in conjunction with water or steam will aid in decontamination. Care must be taken in the disposal of the water used since it, in turn, will have been contaminated.

c. Detailed Decontamination. Detailed decontamination, in which the emphasis is on thoroughness, will be carried out in rear areas and repair bases and will include procedures of surface decontamination, aging and sealing, and disposal.

CHAPTER 11

TRAINING

65. 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.

66. Objectives

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

67. Conduct of Training

a. Training will be 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 Schedules 6–10 and 6–156.

b. Individual training is conducted by noncommissioned officers as far 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 emphasized.

d. A record of the training received by each individual should be recorded on the progress card maintained by each chief of section for each man in his section. This card should reflect each period of instruction attended by the individual, tests taken, and remarks pertaining to the man's progress. Progress cards should be inspected frequently by the radar officer 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.

68. Standards To Be Attained

All personnel of a radar section must know the duties of other members of the section. Section personnel must be able to perform efficiently in all positions. This goal is attained by rotation of duties during training. A qualification test for AN/MPQ–4A radar operators is contained in FM 6–125.

69. Simulator, Radar Target Signal AN/TPA–7

Simulator, radar target signal AN/TPA–7 is a transportable training set designed for use with 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). Installation and operation of the simulator are described in TM 11–5840–287–12.

70. Training in Electronic Counter-Countermeasures

Radar trainer AN/ULT–T5 is a transportable, low-power radar transmitter primarily designed for use with any K_u-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 installation and operation of the radar trainer AN/ULT–T5 are contained in TM 11–6940–209–10.

CHAPTER 12

DESTRUCTION OF EQUIPMENT

71. 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 will be undertaken only upon authority delegated by a division or higher commander.

72. Principles

All sections will prepare plans for destroying their equipment in order to reduce the time required should destruction become necessary. The principles to apply in preparing these plans 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 are 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. Spare parts and accessories must be given the same priorities for destruction as the parts installed on the equipment.

73. Methods

To destroy equipment adequately and uniformly, all personnel of the unit must know the plan and priorities for destruction. For detailed information on destruction of the radar set AN/MPQ–4A, see TM 11–5840–208–10; on destruction of the power unit PU–107A/U, see TM 11–919; and on destruction of the vehicle, see the TM appropriate to the vehicle.

APPENDIX

REFERENCES

1. Field Manual (FM)

5–15	Field Fortifications.
5–20	Camouflage, Basic Principles and Field Camouflage.
5–25	Explosives and Demolitions.
6–20–1	Field Artillery Tactics.
6–20–2	Field Artillery Techniques.
6–40	Field Artillery Cannon Gunnery.
6–121	Artillery Target Acquisition.
6–125	Qualification Tests for Specialists, Field Artillery.
6–140	The Field Artillery Battery.
21–5	Military Training.
21–11	First Aid for Soldiers.
21–30	Military Symbols.
21–40	Small Unit Procedures in Chemical, Biological and Radiological Operations.
21–60	Visual Signals.
22–5	Drills and Ceremonies.
55–30	Motor Transportation Operations.

2. Technical Manual (TM)

3–220	Chemical, Biological, and Radiological (CBR) Decontamination.
9–1900	Ammunition, General.
9–2330–234–15	Operator, Organizational Field and Depot Maintenance Manual: Chassis, Trailer: 2½-ton, 2 wheel, M454.
	Radar Set AN/MPQ–4A
11–5840–208–10	—Operator's Manual.
11–5840–208–20	—Organizational Maintenance Manual.
11–5840–208–20P	—Organizational Maintenance Repair Parts and Special Tools List.
11–5840–208–30	—Field Maintenance, Third Echelon.
11–5840–208–30P	—Field Maintenance Repair Parts and Special Tools List.

3. Miscellaneous

AR 611–201	Manual of Enlisted Military Occupational Specialties.
AR 750–5	Organization, Policies and Responsibilities for Maintenance Operations.
ATP 6–100	Army Training Program for Field Artillery Units.
DA Form 2888	Radar Observed Center-of-Impact or High-Burst Registration, AN/MPQ–4A.
DA Form 468	Unsatisfactory Equipment Report.
DA Pam 310-series	Index of Military Publications.
TF 6–3096	Countermortar Radar AN/MPQ–4A—Part I—Operation.
TF 6–3185	Countermortar Radar AN/MPQ–4A, Preparation and Performance Checks.

INDEX

	Paragraphs	Page
Adjustments, preliminary	10	12
Antenna:		
Collimation, azimuth	12	20
Orientation, azimuth	12	20
Biological and radiological decontamination	64	63
Calibration, range	15	23
Center-of-impact registration	34	46
Checks, preoperation and performance	11	19
Collimation, azimuth, antenna	12	20
Computer of alinement check	16	24
Computing:		
Impact location	28	36
Weapon location	24	30
Conduct of:		
Registration		
Center-of-impact	36	47
High-burst	33	39
Training	65–70	64
Corrections for difference in altitudes	25	32
Data, radar, location	17	26
Decontamination:		
Chemical, biological, and radiological agents	63, 64	63
Equipment	62	63
Detection, weapon location	22	29
Destruction of equipment	71–73	65
Duties in:		
Emplacement	7	7
Impact location	26	35
March order	8	7
Weapon location	33	39
Electric shock	56	60
Elevation orientation check	13	20
Emplacement	7	7
Equipment, radar	4	4
Jamming	57–61	61
Location:		
General	19	29
Impact	26–28	35
Utilization of personnel	20	29
Weapon	21–25	29
March order	8	7
Normal stopping procedures	18	26
Orientation:		
Antenna azimuth and collimation	12, 14	20, 22
Elevation	13	20
Performance data	5	4
Position requirements, tactical employment and:		
Selection of site	50	57
Tactical considerations	51	58
Technical considerations	52	58
Preliminary adjustments	10	12
Preoperation and performance checks	10–16	12
Preparation of radar:		
High-burst registration	31	37
Center-of-impact registration	34	46
Procedure for operating against:		
Transmission jamming	60	62
Window jamming	61	62
Purpose	1	3
Radar:		
Adjustment of artillery fire	37–44	50
Gunnery	29–46	37
Location data	17	26
Selection of site	50	57
Survey	45, 46	55
Range calibration	15	23
Recognition of jamming	57	61
References	3, app	3, 66
Registration:		
Center-of-impact:		
Advantages and disadvantages	29	37
Conduct of	36	47
Preliminary procedure	34	46
Preparation of radar	36	47
High-burst:		
Advantages and disadvantages	29	37
Conduct of	33	39
General	31	37
Preliminary procedure	32	39
Preparation of radar	33	39
Purpose of	29	37
Safety precautions	54–56	60
Scope	2	3
Selection of site	50	57
Starting procedures, radar	10	12
Stopping procedure, radar	18	26
Tactical considerations in site selection	51	58
Technical characteristics	6	4
Technical considerations in site selection	52	58
Training:		
Conduct of	67	64
Objectives	66	64
Purpose and scope	65	64
Standards to be attained	68	64
Types of jamming	57	61
Utilization of personnel	20	29
Weapon and impact location	19–28	29

By Order of the Secretary of the Army: 3000015787

HAROLD K. JOHNSON,
General, United States Army,
Chief of Staff

Official:

J. C. LAMBERT,
Major General, United States Army,
The Adjutant General

Distribution:

Active Army:

DCSPER (2)
ACSI (2)
DCSLOG (2)
DCSOPS (2)
CAR (2)
CRD (1)
COA (1)
CINFO (1)
TIG (1)
TJAG (1)
CNGB (2)
CORC (2)
USACDCARTA (2)
USCONARC (5)
Armies (5)
Corps (3)
Corps Arty (3)
Div (2)
Div Arty (2)
USATC (2) except
USATC FA (5)
USMA (10)
Svc Colleges (2)
Br Svc Sch (2)
USASTC (2)
Units org under fol TOE:
(2 copies each)
6–156
6–166
6–186
6–216
6–346
6–356
6–366
6–376
6–386

NG: State AG (3); units—same as Active Army except allowance is one copy each.

USAR: Units—same as Active Army except allowance is two copies to each unit.

For explanation of abbreviation of abbreviations used, see AR 320–50.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1965—750-560

FM 6-161 RADAR SET AN/MPQ-4A—1965