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DEPARTMENT OF THE ARMY FIELD MANUAL

COUNTERBATTERY RADAR SET AN/MPQ-10A

HEADQUARTERS, DEPARTMENT OF THE ARMY
OCTOBER 1969

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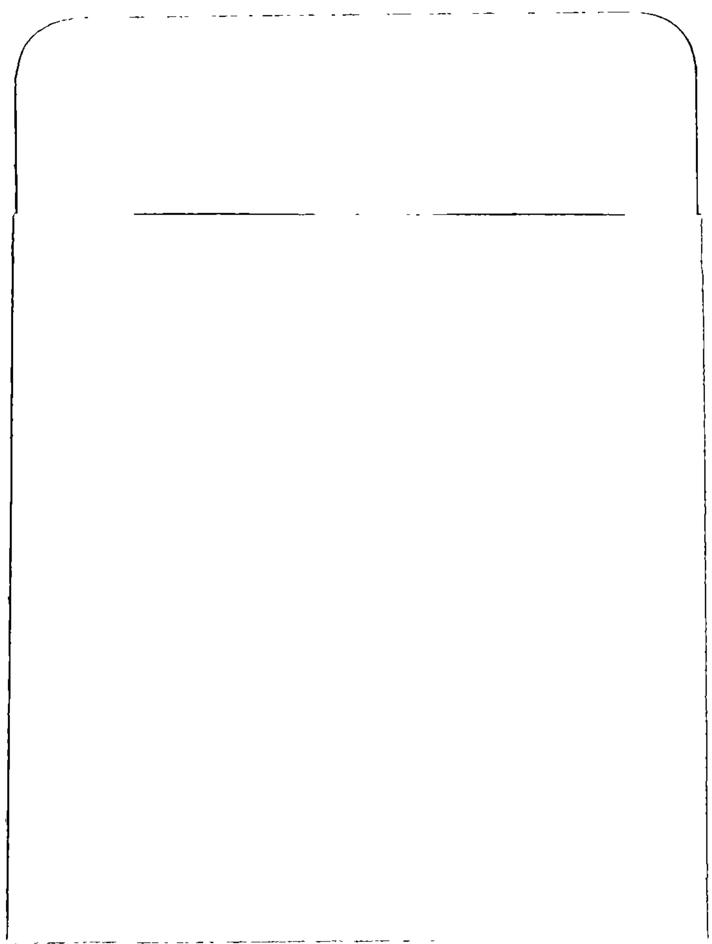


FIELD MANUAL No. 6–160

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *3 October, 1969*

COUNTERBATTERY RADAR SET AN/MPQ–10A

*This manual supersedes FM 6–160, 3 January 1956.

CHAPTER 1

GENERAL

1. Purpose

This manual is a guide for the employment of field artillery radar sections equipped with the counterbattery radar set AN/MPQ–10A.

2. Scope

a. This manual covers preparation for action of the counterbattery radar set AN/MPQ–10A and its associated equipment; techniques of operation in weapons location, radar gunnery, moving target detection, and position fixing and vectoring of aircraft; principles of employment; safety procedures; electronic counter-countermeasures; decontamination; training; destruction of equipment; and qualification tests for radar specialists.

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 change is recommended. Reasons will be provided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028 (Recommended Changes to Publications) and forwarded direct to the U.S. Army Field Artillery School, ATTN: AKPSIAS–PL–FM, Fort Sill, Oklahoma 73503.

CHAPTER 2

EQUIPMENT

3. General

a. The counterbattery radar set AN/MPQ-10A (fig. 1) is a mobile, pulse-modulated, tracking radar used to locate artillery.

b. The major components of the radar set are the tracker mount (fig. 2) and the radar set control unit (fig. 3).

c. The allied equipment used with the radar set are the recorder RD-54/TP (fig. 4) and the power unit PU-619M (fig. 5). The power unit 619M consists of two SF-10-MD air cooled, 10 KW, 60-hertz 3-phase, 120/208 volt generators mounted on a 1½-ton trailer, M103A.

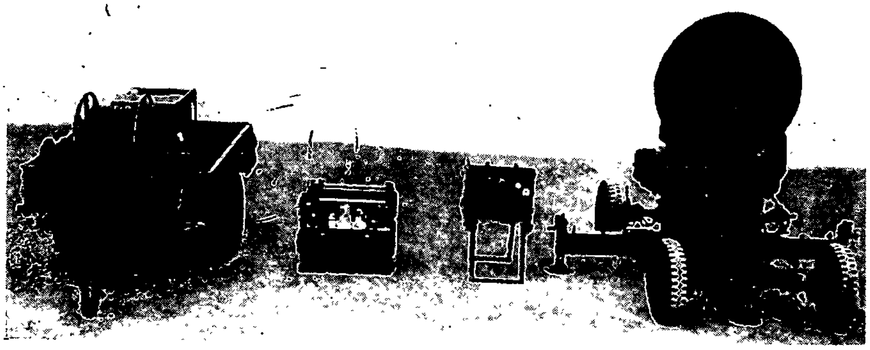


Figure 1. Counterbattery radar set AN/MPQ-10A, major components, and allied equipment.

4. Technical Characteristics

a. General.

Power input ....115v, 60 Hz, 3 phase ac 6 kw max.
Range ....20,000 yd max, 500 yd min.
Range accuracy ....20 yd probable error.
Elevation coverage:
Lower limit ....−125 mils.
Upper limit ....+1,540 mils.
Azimuth coverage .....6,400 mils, continuous.
Azimuth or elevation accuracy ....1.5 mils probable error.
Sector scan width .....200 to 800 mils, adjustable.
Automatic tracking rates:
Elevation ....250 mils per second max.
Azimuth ....350 mils per second max.
Slant range ....1,000 yd per second max.
Manual tracking rates:
Elevation ....650 mils per second max.
Azimuth ....850 mils per second max.
Slant range ......2500 yd per second max.
Sector scanning rate ....800-mil cycle in 3.5 seconds.
Resolution:
Azimuth ....90 mils.
Elevation ....90 mils.

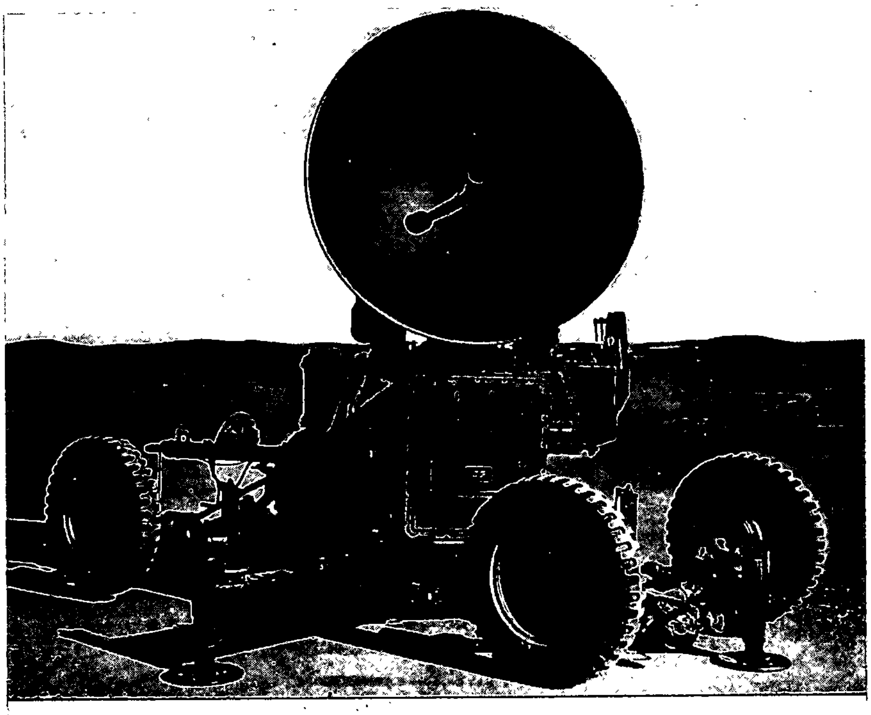
b. R-F System.

Antenna rotation .....3,600 rpm (automatic tracking).
Antenna ....Dipole
Reflection ....68 ¾ in parabolic reflection
Type of feed ....⅞ in coaxial lines
Beam width ....azimuth half power 5° elevation half power 5° (without conical scan)

c. Transmitting System.

Frequency ....2,700 to 2,860 MHz (S-band).
Pulse rate ....1,100 pulses per second (nominal)
Pulse width ....0.8 microsecond.
R-F source ....Type 2J31 to 2J34 magnetron
Peak power ....200 kw
Average power ....180 watts

d. Receiving System.



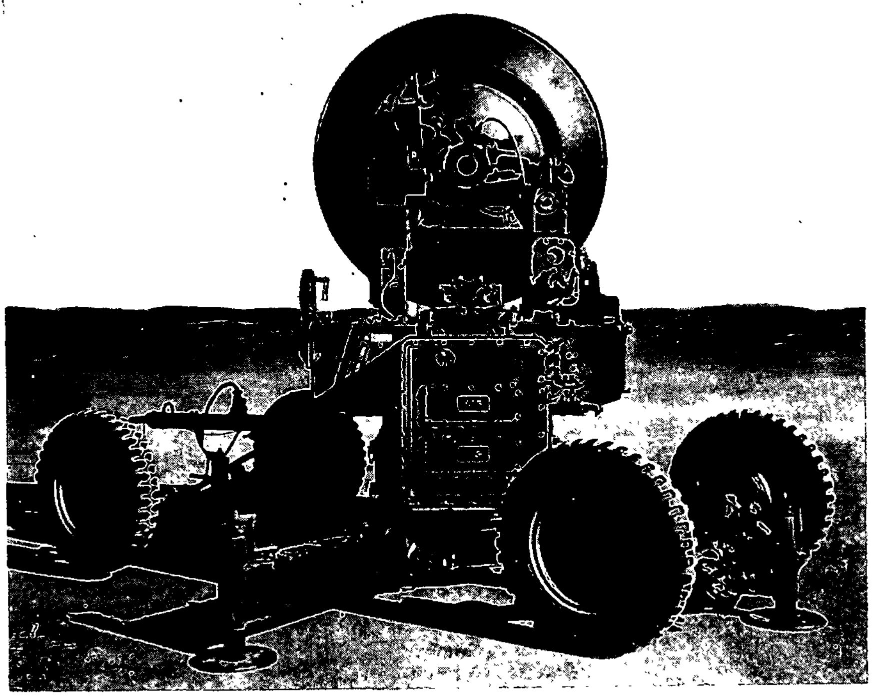


Figure 2. The tracker mount.

e. Presentation System.

Indicators ---- ------B scope (7 in); 0–10,000 yd and 0–20,000 yd ranges; J-scope (3 in); 2,000 yd range; dial indication of range, azimuth, and elevation.

f. Power Supply System.

Power unit required .Power unit PU–619M; two gasoline engine-driven generators, SF–10–MD.

Fuel consumption -----2.2 gal per hr.

g. Cabling System.

Control cable ---------Electrical special purpose cable assembly CX–1912/U (150 ft) connects the radar set control unit to the tracker mount. When not in use, this cable is stored on the control cable reel, which is mounted on the generator trailer.

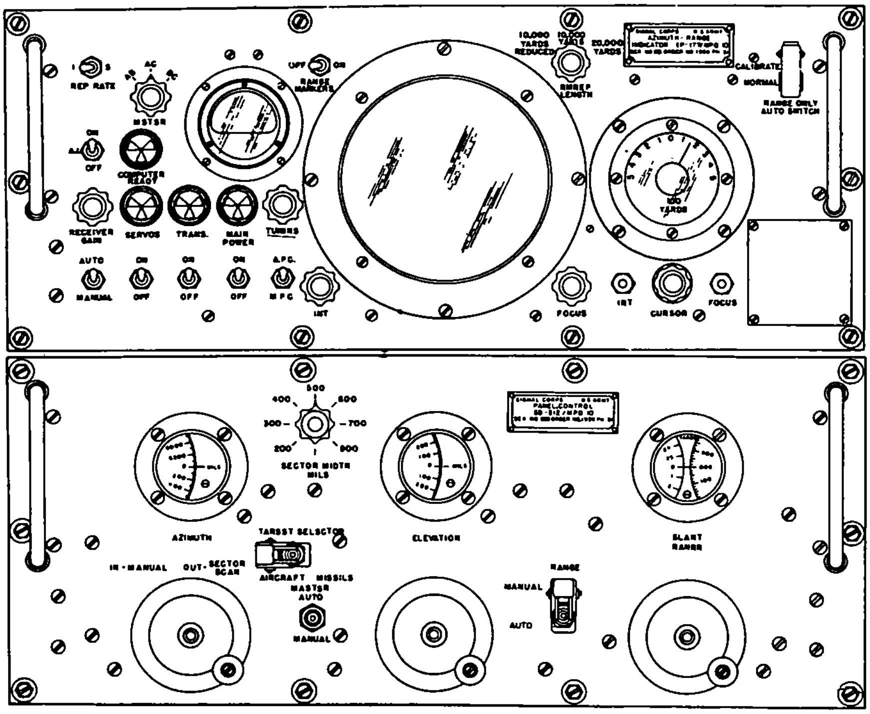


Figure 3. The radar set control unit.

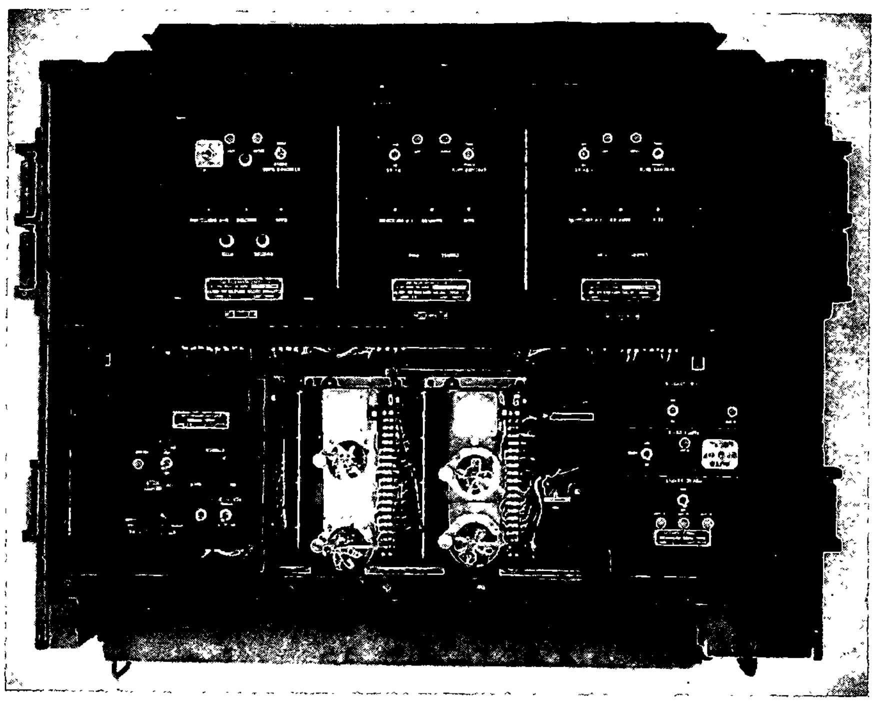


Figure 4. Recorder RD-54/TP.

Power cable .... Electrical power cable assembly CX-1863/MPQ-10 (150 ft) connects the tracker mount to the power unit. When not in use, this cable is stored on power cable reel which is mounted

Power cable continued. on the generator trailer. CX-1863/MPQ-10 is compatible with the old power unit (PU-26A) as well as the new power unit (PU-619M).

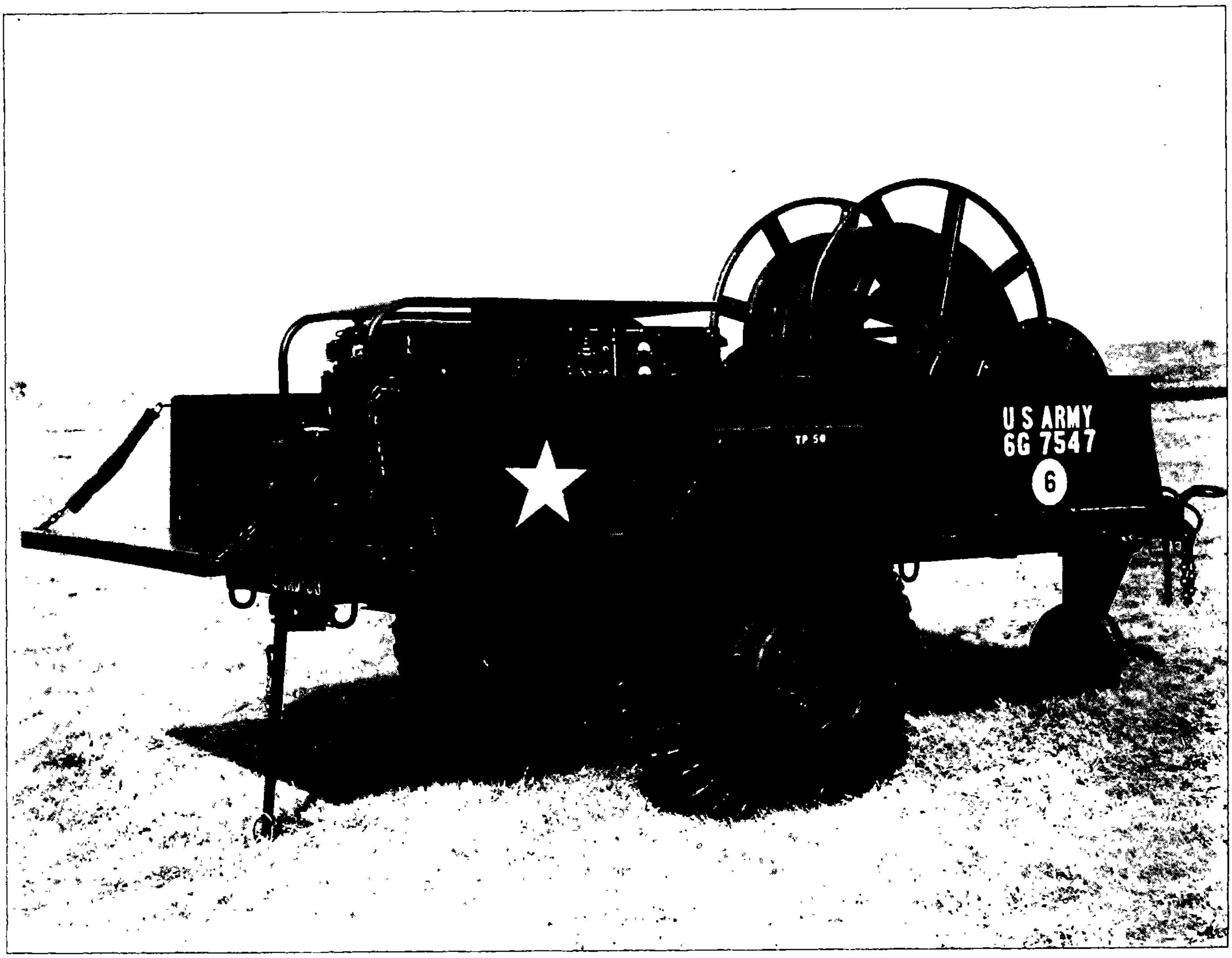


Figure 5. Power unit PU619M (Two SF–10–MD generators mounted on M103A trailer).

CHAPTER 3

PREPARATION FOR ACTION

Section I. EMPLACEMENT AND MARCH ORDER

5. Emplacement

a. Emplacing the Radar Tracker Mount. The senior radar operator (SRO) guides the tracker mount prime mover onto the radar site to insure that the tracker mount is centered over the radar ground stake. He then supervises the radar crew in performing the following operations:

(1) Lock the rear wheel handbrakes. Secure the safety chain and insert the jumper cable into the dummy socket. Uncouple the tracker mount from the prime mover.

(2) Unlock the outriggers by rotating the outrigger eccentric hinge levers toward the rear of the carriage until they contact the lever stops. Swing the outriggers into the open position and lock them in place by returning the outrigger eccentric hinge levers to their original positions. Remove the jack pads from the outriggers and attach them to the jacks.

(3) Disengage the azimuth stow lock and rotate the antenna 800 mils counterclockwise.

(4) Lock the drawbar, steering link, and front axle yoke into one rigid lever.

Data cable	Supplied with the azimuth-elevation-range recorder RD-54/TP (225 ft) and is used to transmit all power, control, and signal data from the AN/MPQ-10 tracker mount to the recorder RD-54/TP.
Test cable	Enclosed in the rear of the recorder RD-54/TP and supplied to connect any of the servoamplifiers to the recorder when the servoamplifier is removed for repair. This cable serves no other function.

Caution: **To prevent injury to personnel and damage to the equipment, at least five crewmen are required to lower and raise the front axle.**

Warning: **The crewman operating the front compensating spring lock must exercise great care to prevent injury to his fingers and hand when the lock handle is released. All personnel must occupy positions which insure that the jack pads cannot drop on their feet as the carriage is being lowered.**

(5) Attach a rope with a tensile strength of at least 2,000 pounds to the drawbar lunette. While four crewmen maintain tension on the rope, the SRO releases the stearing lock and swings it forward out of its recess in front of the chassis swivel.

(6) With the rope still under tension, the SRO positions himself in front of the right front axle with his feet clear of the front jack pad and axle. He then leans over the right tie rod and unbuckles the safety strap that secures the front end compensating spring handle. Next, he grasps the safety latch handle, being careful not to permit his fingers to be caught by the handle when it is released, and unlocks the front axle by unlatching and lifting the front lock handle.

(7) As the drawbar is raised to an angle of about 30° the crewman lifting the drawbar moves quickly to the rope. The five crewman lower the front axle as gently as possible to prevent damage to the equipment. The SRO insures that the front jack handle and the steering lock clear the steering yoke as the axle is being lowered. The front end is properly emplaced when the axle has dropped to its lowest limit.

(8) While the drawbar is held in a vertical position, the SRO locks the axle by returning the compensating spring lock handle to its original position. If the lock handle will not rotate to the locked position, move the drawbar up and down until the latch locks. Then buckle the safety strap that secures the lock handle. Remove the drawbar locking pin and fold the drawbar forward to rest on the raised steering lock link.

Caution: **Do not force the lock handles because breakage of parts may result. Hold the**

drawbar and lowering bars securely until the lock handles are locked.

(9) Lower the front jack and apply pressure so the jack can act as a brake. Make sure the other jacks are not extended. Release the rear wheel handbrakes.

(10) Lock the lowering levers to the rear axle by rotating them forward and engaging the locking pins. Then remove the two wheel-lowering bars from their brackets and insert the pointed ends of the bars in the sockets of the rear wheel-lowering levers. Push the bars inward until the detents in the levers lock them in place.

***Caution:* Keep the safety straps fastened at all times unless the front and rear chassis compensating spring lock handles are being used to unlock the axles. Never unlock the rear axles unless four crewmen are present to hold the lowering bars. The bars must be held securely while the locks are being released.**

(11) Two crewmen occupy positions between the wheels and in front of the rear axle with one on the left side and the other on the right side. Two more crewmen occupy corresponding positions behind the rear axle with one on the left side and the other on the right side. Unbuckle the safety strap that secures the rear axle compensating spring lock handle and release the lock. Lower the rear axle.

***Warning:* All personnel must occupy safe positions so that the jack pads cannot drop on their feet while the carriage is being lowered. To prevent injury to personnel, lower the carriage to the lowest position possible in order to reduce the likelihood of unexpected movement of the carriage when the chassis compensating spring lock handles are released in preparation for raising the carriage to the traveling position. The front and rear axles can be locked in several positions.**

(12) Relock the axle by returning the lock handle to its original position and buckle the safety strap that secures it. Return the lowering bars to the carrying rack; then unlock the lowering levers from the rear axle and rest them on their supports.

b. Leveling the Radar Tracker Mount.

(1) The SRO directs the four jack operators to lower and apply pressure to each of the jacks. He then directs that each jack be turned an equal amount until the wheels are off the ground.

(2) The tracker mount is leveled from front to rear and then from side to side. The SRO directs that the jack on the low end of the tracker mount be raised. (The bubble in the level vial will be on the high side.) The side jacks are turned one-half as many turns as the front and rear jacks. (Example: The SRO commands FRONT JACK FOUR TURNS CLOCKWISE. The front jack operator turns his jack four turns clockwise and the side jack operators turn their jacks two turns clockwise.)

***Warning:* Each time a jack handle is moved, it must be returned to the down position and locked in one of the slots on the rim of the jack assembly. If the handle is not locked, the weight of the radar on the jack may cause the jack handle to spin rapidly and injure the jack operator.**

(3) After the tracker mount has been leveled from front to rear, the SRO directs that the jack on the low side of the carriage be raised. (The bubble in the level vial will be on the high side.) When one side is raised, the other side is lowered an equal amount. *Example:* If the right side is raised one turn, the left side is lowered one turn.) Changes are continued until the carriage is level from side to side.

(4) The SRO rotates the tracker mount 3,200 mils to check for errors. If any error exists, split the deviation and, using the appropriate jack, bring the bubble halfway to center.

(5) Lock all four jack handles in the down position in one of the slots on the rim of the jack assembly.

c. Emplacing the Generator, Control Unit, and Recorder and Cabling the Radar System.

(1) The generator is positioned on level ground within the 150-foot power cable length from the tracker mount. Set the trailer handbrakes and uncouple the generator trailer from the truck. Lower and lock the landing wheel of the generator trailer. Drop the safety support at the rear of the trailer to prevent the trailer from turning over. Roll up and fasten the trailer end canvas to permit ventilation around the generator. Make certain that the ground where the exhaust pipe will lie is free of fire hazards and that the exhaust pipe is clear of the generator canvas.

(2) The radar set control unit and the recorder RD–54/TP can be mounted together in a van or emplaced on reasonably level ground. The radar set control unit must be emplaced within the 150 foot length of the control cable from the tracker mount. The recorder RD–54/TP must be emplaced within the 225 foot length of the data cable from the tracker mount.

(3) Extend the control cable to its full length. The two connectors are identical and one end is connected to the tracker mount and the other is connected to the radar set control unit.

(4) The male end of the power cable is connected to the generator and the female end is connected to the tracker mount.

(5) The male end of the recorder cable is connected to the tracker mount and the female end is connected to the recorder.

(6) Insure that all connections are tight. Avoid crossthreading when connecting the cables.

d. Opening the Blower Intake and Exhaust Ports. The intake ports and exhaust ports can be opened any time before power is applied to the equipment. The ports are located as follows:

(1) Base units—one intake, one exhaust.

(2) Main frame—two intakes, two exhausts.

(3) Range computer—two intakes, two exhausts.

(4) Radar modulator—one intake, two exhausts.

(5) Control unit—two intakes, one exhaust.

6. March Order

a. After the power unit has been shut off, close all intake and exhaust ports and replace the covers on the recorder and the radar set control unit.

b. Disconnect the cables and rewind them on their reels. In winding the control cable, start with the center of the cable on the reel so that the two ends will be on the outside.

c. To raise the radar tracker mount—

(1) Raise all jacks except the front jack.

(2) Place the jack pads on the outriggers.

(3) Lock the lowering levers to the rear axle and place the lowering bars in the lowering levers. Push the bars inward until the detents in the levers lock them in place.

(4) Release the rear wheel brakes and rotate the antenna until it points 800 mils to the left of the traveling position.

(5) Two crewmen occupy positions between the wheels and in front of the rear axle with one on the left side and the other on the right side. Two more crewmen occupy corresponding positions behind the rear axle with one on the left side and the other on the right side. Unbuckle the safety strap that secures the rear axle compensating spring lock handle and release the lock.

Note. Wheels must have pressure to operate compensating lock.

(6) When the lock is released, raise the rear axle to the traveling position, using the lowering bars as handles.

Caution: **All personnel must occupy positions which insure that the jack pads cannot drop on their feet. The crewmen on the lowering bars must exercise great caution to prevent sudden movement of the tracker mount while raising the rear axle.**

(7) Lock the axle by returning the lock handle to its original position and buckle the safety strap to secure the lock handle and return the lowering bars to the carrying rack. Lock the rear wheel handbrakes.

(8) Raise the drawbar and insert the drawbar pin into the horizontal holes in the side of the drawbar. Insert the drawbar steering link pin into the vertical holes near the steering yokes.

(9) The SRO unbuckles and releases the front compensating spring lock handle. The five crewmen pull on the rope to apply pressure on the drawbar assembly. When the lock has been opened, the front axle is raised to the traveling position. As the drawbar is pulled forward, the SRO locks the compensating spring lock and secures the steering lock.

(10) The SRO removes the drawbar pin and the drawbar steering link pin and inserts them in their retaining holes.

(11) Swing the outriggers to the traveling position and lock them in place with the outrigger eccentric hinge levers.

(12) Rotate the antenna to the traveling position and engage the azimuth stowlock. Return the antenna to zero mils elevation.

(13) The SRO guides the prime mover back to the tracker mount while the crewmen hold and guide the drawbar until the lunette and pintle mate. Connect the safety chain and jumper cable and insert the cotter pin in the pintle.

(14) Release the rear handbrakes on the tracker mount.

d. March Ordering the Generator. To march order the generator—

(1) Close and secure the end canvas. Raise and lock the safety support at the rear of the trailer.

(2) The SRO guides the prime mover to the generator trailer while the crewmen hold and guide the drawbar until the lunette and pintle mate.

(3) Connect the safety chains and jumper cable and insert the cotter pin in the pintle.

(4) Raise and lock the landing wheel. Release the handbrakes.

7. Preoperational Checks

a. Power Unit PU–619/M.

(1) Perform the daily preventive maintenance service (TM 5–6115–275–12).

(2) Place the three-way fuel valve in the SET FUEL SUPPLY or AUX FUEL SUPPLY position, depending on the source of fuel.

(3) See that the unit is properly grounded.

(4) Insure that the load lines are properly connected to terminals L 1, L 2, and L 0 (TM 5–6115–275–12).

(5) Insure that the phase switch is in the 120, 3 PH position (TM 5–6115–275–12).

b. Radar Set. Before applying power to the radar set, set the controls on the radar set control unit and the tracker mount as follows:

(1) *Radar set control unit.*

(*a*) MAIN POWER ON-OFF switch .... OFF.

(*b*) SERVOS ON-OFF switch .... OFF.

(*c*) AJ ON-OFF switch. OFF.

(*d*) TARGET SELECTOR AIRCRAFT-MISSILE switch .... MISSILE.

(*e*) REP RATE 1–2 switch .... 1.

(*f*) RANGE MARKERS ON-OFF switch .... OFF.

(*g*) RANGE ONLY AUTO CALIBRATE-NORMAL switch .... NORMAL.

(*h*) AZIMUTH handwheel .... IN.

(*i*) MASTER AUTO-MANUAL switch .... MANUAL.

(*j*) RANGE MANUAL-AUTO switch .... AUTO.

(*k*) TUNING AFC-MFC switch .... AFC.

(*l*) RECEIVER GAIN AUTO-MANUAL switch .... MANUAL

(2) *Tracker mount.*

(*a*) ANTENNA RELEASED-NORMAL switch ... NORMAL.

(*b*) OVER-VOLT CKT switch .... NORMAL.

(*c*) EMERGENCY switch .... ON.

c. Recorder RD–54/TP. Before applying power, set the controls on the recorder as follows:

(1) *Power distribution panel.*

(*a*) 115V AC SUPPLY ON-OFF switch .... OFF.

(*b*) PAPER DRIVE MOTOR ON-OFF switch ...... OFF.

(*c*) PAPER DRIVE AUTO-OFF-LOCAL switch .. OFF.

(*d*) 115V AC SERVICE ON-OFF switch .... OFF.

(2) *Control panel.*

(*a*) PAPER DRIVE AUTOMATIC-MANUAL switch .... Not used.

(*b*) HEIGHT FEET switch .... MPQ–10 7500.

(*c*) DIMMER DIM-BRIGHT control .... Midposition.

(*d*) PANEL LIGHTS ON-OFF switch .... OFF.

(3) *Servoamplifier panel.*

(*a*) 115V AC ON-OFF switch .... OFF.

(*b*) SYNCHRO DATA SINGLE-DUAL switch .... Height to SINGLE Range to DUAL Azimuth to DUAL.

(*c*) C–F SWITCHING control .... Counterclockwise.

(*d*) GAIN control ..... Counterclockwise.

(*e*) DAMPING control . Counterclockwise.

8. Starting

a. Power Unit PU–619M with Generator Set SF–10–MD.

(1) *Electrical starting.*

(*a*) Place the circuit breaker in the OFF position.

(*b*) Place the REMOTE-LOCAL switch in the LOCAL position.

(*c*) Place the EMER STOP-RUN switch in the NORMAL position.

(*d*) Turn the VOLT ADJ knob fully *counterclockwise.*

(*e*) Set the VOLT SEL switch for the desired output.

(*f*) Set the CURRENT SEL switch for the desired output.

(*g*) Press the START-STOP switch to the START position and release when the engine starts.

Note. When power is applied to the radar, the voltage must be readjusted to 115 volts on the lowest phase, as measured on the radar set control unit of the radar.

(2) *Manual starting.*

(*a*) Place the EMER STOP-RUN switch to the EMER RUN position.

(*b*) Place the REMOTE-LOCAL switch in the LOCAL position.

(*c*) Wrap the starter rope on the pully and pull with quick steady motion.

(*d*) When the engine reaches operating pressure, place the EMER STOP-RUN switch in the NORMAL position and at same time press the START-STOP switch to the START position and release.

(3) *Operating instructions.*

(*a*) Observe the engine oil pressure indicator for the proper oil pressure (30 to 40 PSIG).

(*b*) Observe the battery charging meter for proper operation.

(*c*) Check the FREQUENCY meter for the proper reading. If the meter does not indicate 60 cycles, the engine governor must be adjusted.

Note. The generator mechanic will make this adjustment.

(*d*) Check the generator output voltage.

Note. The generator output voltage is controlled by VOLT ADJ knob on the front panel.

(*e*) When the set is adjusted to the proper levels, place the circuit breaker in the ON position.

b. Radar set.

(1) *Starting procedure.* To start the radar set—

(*a*) Turn the MAIN POWER switch to the ON position. The white MAIN POWER lamp should glow. The B-scope and J-scope should light in approximately 1 minute.

(*b*) Readjust the line voltage so that the lowest phase on the control unit voltmeter is 115 volts.

(*c*) Check the J-scope for sweep and range mark. Check the B-scope for fast gate and sweep in the 20,000 YARDS, 10,000 YARDS, and 10,000 YARDS REDUCED positions of the SWEEP LENGTH switch.

***Caution:* The next step can cause the tracker mount to slew rapidly to a new position. Take precautions to prevent injury to personnel and damage to the equipment.**

(*d*) Turn the SERVOS switch to the ON position. The yellow SERVOS lamp should glow. Turn the SLANT RANGE handwheel clockwise, then counterclockwise. The SLANT RANGE dial reading should increase, then decrease; and the fast gate on the B-scope should move up, then down.

(*e*) Turn the AZIMUTH handwheel clockwise, then counterclockwise. The antenna assembly should turn to the right then to the left. The AZIMUTH dial reading should increase, then decrease. Turn the ELEVATION handwheel clockwise, then counterclockwise. The antenna elevation should increase, then decrease; and the ELEVATION dial reading should increase, then decrease.

(*f*) Pull out on the AZIMUTH handwheel. The antenna assembly should scan a sector centered on the azimuth shown on the SECTOR WIDTH MILS control. Check the AZIMUTH dial to insure that the sector width is the same as that indicated on the SECTOR WIDTH MILS control.

(*g*) Push in the AZIMUTH handwheel.

(*h*) After the MAIN POWER switch has been on for at least 5 minutes, set the TRANS switch to ON. The red TRANS lamp should glow. Readjust the line voltage to 115 volts, at the lowest phase, if necessary.

(*i*) Place the ANTENNA RELEASED-NORMAL switch in the RELEASED position. Check the meters on the modulator and the meter panel. If the readings are not within the specified limits given below, call the radar mechanic.

1. Modulator. The meter readings on the modulator should be as follows:

(a) AC volts meter .... 115 (± 5 volts).

(b) HIGH VOLT meter ....5.8 (±0.2 kv).

(c) RECT CURRENT meter ....100 (± 10 ma).

(d) MAG CURRENT meter ....22 (±2 ma).

2. Meter panel. The readings for the positions of the switches of the XTAL current meter and the DC voltsmeter are as follows:

(a) *XTAL CURRENT meter.*

(*1*) RCVR position .... 0.5 (±0.1 ma).

(*2*) AFC SW position (XTAL CURRENT switch in AFC 1 or AFC 2 position) .... 0.6 (±0.2 ma).

(b) *DC VOLTS meter.*

(*1*) +400 position .... 400 (±50 volts).

(*2*) +300 position .... 300 (±5 volts).

(*3*) +250 position .... 250 (± 10 volts).

(*4*) +200 position .... 200 (±5 volts).

(*5*) +150 position .... 150 (±5 volts).

(*6*) −300 position .... 300 (±5 volts).

(*7*) SEL RECT position .... 140 (±10 volts).

(*j*) Place the ANTENNA RELEASED-NORMAL switch in the NORMAL position.

(2) *Scope intensity and focus adjustments.*

(*a*) *B-scope.* To adjust the B-scope—

1. Set the RECEIVER GAIN switch on the control unit to the MANUAL position.

2. Turn the B-scope INT control and the RECEIVER GAIN control fully counterclockwise.

3. Pull out the AZIMUTH handwheel on the control panel.

4. Turn the B-scope INT control clockwise until the B-scope trace is just visible.

5. Push in the AZIMUTH handwheel.

6. Adjust the B-scope FOCUS control for the finest possible resolution of the trace and the range mark.

(*b*) *J-scope.* To adjust the J-scope—

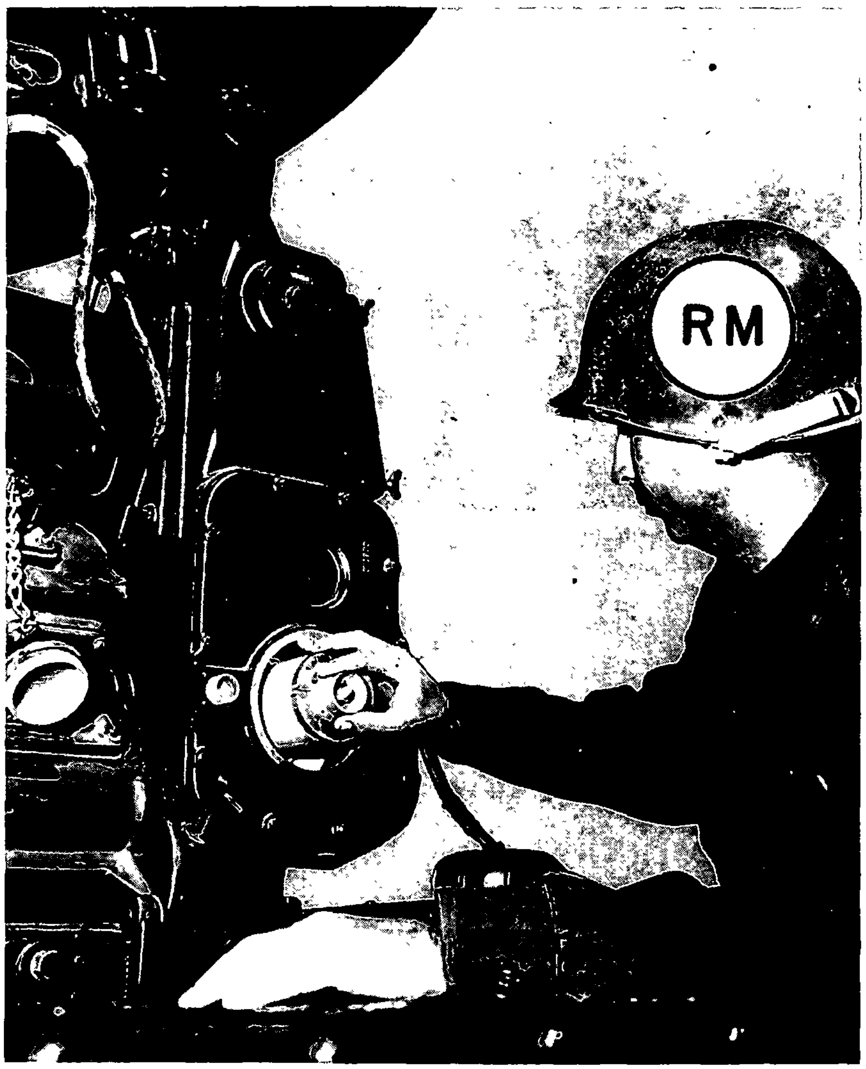


Figure 6. Tuning the echo box.

1. Adjust the J-scope INT control with the screwdriver so that the J-scope sweep is clearly visible and the brightened portion at the top of the J-scope (the range gate) is clearly differentiated from the remainder of the sweep.

2. Adjust the J-scope FOCUS control with a screwdriver so that the J-scope sweep is defined sharply.

3. Turn the RECEIVER GAIN control clockwise until noise (grass) is clearly displayed on the J-scope.

(3) *Receiver tuning.* To tune the receivers—

(*a*) Allow the radar to warm up (transmitter on for approximately 10 minutes).

(*b*) Elevate the antenna to approximately 1,400 mils.

(*c*) Place the ANTENNA RELEASED-NORMAL switch in the RELEASED position. (Performed by someone other than the control unit operator.)

(*d*) Adjust the echo box tuning control (fig. 6) for maximum deflection of the meter needle.

(*e*) Place the AFC–MFC switch in the MFC position. With the TUNING control and the RECEIVER GAIN control, adjust for maximum ringtime display.

(*f*) With the SLANT RANGE handwheel, set the B-scope range marker to the top of the bright ringtime display (fig. 7). Measure the ringtime by placing the edge of the display at the "12 o'clock" position on the J-scope and note the reading on the SLANT RANGE dial (fig. 8). Ringtime should not be less than 5,200 yards.

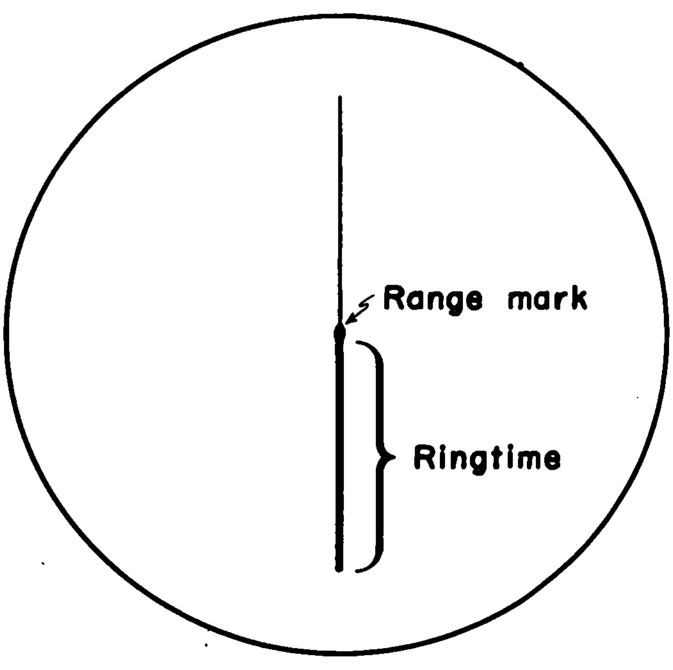


Figure 7. B-scope ringtime presentation.

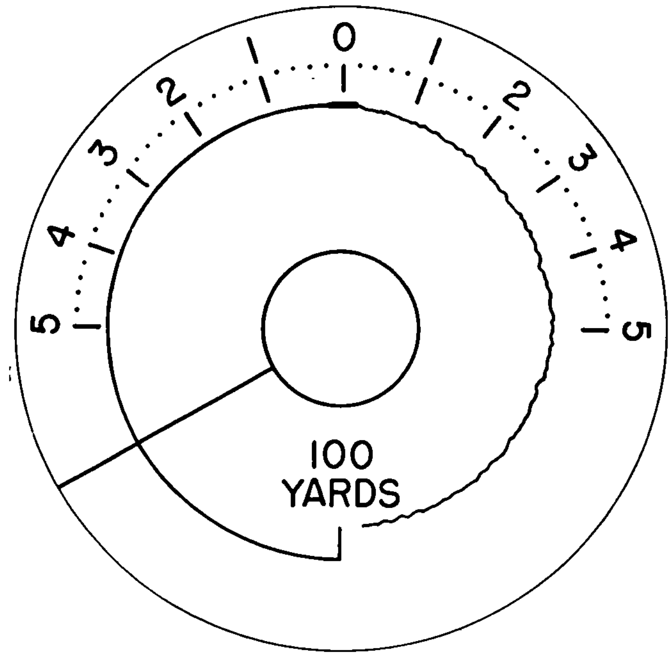


Figure 8. J-scope ringtime presentation.

(*g*) Place the RECEIVER GAIN toggle switch in the AUTO position. Remeasure the ringtime by placing the leading edge of the display at the "12 o'clock" position on the J-scope and noting the reading on the SLANT RANGE dial. Ringtime should decrease not more than 150 yards. Return the RECEIVER GAIN toggle switch in the MANUAL position.

(*h*) Place the AFC–MFC switch in the AFC position. Remeasure the ringtime by placing the leading edge of the display at the "12 o'clock" position on the J-scope and noting the reading on the SLANT RANGE dial. If there is a difference of more than ±50 yards, the radar mechanic must make necessary adjustments.

(*i*) Detune the echo box by turning the tuning control eight full turns counterclockwise. Replace the cover.

(*j*) If it should be necessary to operate in the MFC position, frequent tuning will be required. This tuning is accomplished by selecting a fixed echo and gating it on the J-scope. Turn the RECEIVER GAIN control counterclockwise until the echo is barely visible and adjust the TUNING control for maximum display of the return signal.

(*k*) Return the ANTENNA RELEASED-NORMAL switch to the NORMAL position. Place the antenna in sector scan and adjust the intensity and receiver gain for optimum target discrimination.

(4) *Altitude converter checks.* To check the altitude converter—

(*a*) Return the ANTENNA RELEASED-NORMAL switch to the RELEASED position.

(*b*) Check the readings on the HOR RG and ALT dials of the altitude converter when the ELEV and SLANT RANGE dials are placed in each of the combined settings shown in table 1. The maximum difference between the readings on the HOR RG and ALT dials and the expected readings shown in table 1 for each combined setting should not exceed 30 yards. If the difference exceeds 30 yards, have the mechanic adjust the set.

Table 1. Expected Altitude Converter Readings for Four Selected Control Panel Settings

Control panel settings		Expected altitude converter readings	
Elevation dial (mils)	Slant range dial (yards)	Hor RG dial (yards)	Alt dial (yards)
533	2,000	1,732	1,000
533	10,000	8,660	5,000
800	10,000	7,070	7,070
800	2,000	1,414	1,414

c. Recorder RD–54/TP. To start the recorder—

(1) Place the 115V AC SUPPLY switch on the power distribution panel to the ON position.

(2) Set the PANEL LIGHTS switch on the control panel to the ON position and rotate the DIMMER control to the intensity level desired for the plotting surface lighting.

Note. Lower the antenna in elevation and reduce the slant range so that the height stylus carriage will not travel off the scale and cause an overload on the servomotor.

(3) On each of the three servo-amplifiers turn the 115V AC SUPPLY switch to the ON position. If the indicator or illuminating lights on the power distribution panel do not illuminate, check the fuses on the panel. If the bottom indicator on an electronic control amplifier panel does not light, check the fuse on the panel. If replacing a fuse does not correct the trouble, notify the radar mechanic.

(4) Place the HEIGHT FEET switch on the control panel in the desired position.

9. Stopping

a. Recorder RD–54/TP. To stop the recorder—

(1) On each of the three servoamplifiers turn the 115V AC SUPPLY switch to the OFF position.

(2) Turn the 115V AC SUPPLY switch on the power distribution panel to the OFF position.

(3) Set the PAPER DRIVE AUTO-OFF-LOCAL switch to the OFF position.

b. Radar Set. To stop the radar set—

(1) Set the SERVOS switch to the OFF position.

(2) Set the TRANS switch to the OFF position.

(3) Set the MAIN POWER switch to the OFF position.

(4) Reset all switches to their normal preoperational settings.

c. Generator SF–10–MD.

(1) To stop the generator SF–10–MD in normal circumstances—

(*a*) Remove the load by placing the circuit breaker in the OFF position.

(*b*) Press the START-STOP switch to the STOP position and release.

(*c*) Close the fuel selector valve.

(2) To stop the generator SF–10–MD in emergency circumstances place the EMERGENCY STOP-RUN switch in the EMERGENCY STOP position.

Section III. COLLIMATION

10. General

The radar orienting telescope is used for orienting the radar on a known azimuth and elevation. The orienting telescope is collimated so that the line of sight of the optical telescope is parallel to the electrical axis of the radar beam. When this collimation has been performed a target will be centered in the telescope when the radar is automatically tracking that target. For collimation, the radar antenna should be elevated sufficiently to eliminate ground clutter, and the SLANT RANGE dial reading should exceed 1,000 yards. This operation is performed prior to orientation. Under normal conditions, the orienting telescope will remain collimated; however, collimation should be checked once each week and after each move. To check collimation, the object being tracked is observed through the orienting telescope by a crewman standing on the range computer. The object normally will appear to move in

Figure 9. Correcting for elevation deviation.

a circular pattern around the center of the telescope reticle. If the radius of any part of the circular pattern exceeds 10 mils from the pattern center, the radar mechanic should adjust the tracking circuits before proceeding with collimation. If the center of the circular pattern is not at the center of the telescope reticle, collimation is required. The AIRCRAFT MISSILE switch is placed in the AIRCRAFT position during the collimation check.

11. Types of Targets Used For Collimation

The radar is collimated while it is automatically tracking an airborne target. This target can be either a fixed-wing aircraft or a corner reflector suspended from a balloon. Corrections for deviations should be made while the radar is tracking the target for the mean of the deviations. If the reticle is not clearly visible, the telescope may be illuminated by adjusting the reticle control located on the right trunnion.

12. Corrections For Elevation Deviations

If corrections for deviation in elevation are necessary, they can be made by rotating the elevation screw (fig. 9), located on the right side of the telescope with a screwdriver. The screw should be rotated until the target appears on the center horizontal crosshair (fig 10). This adjustment moves the telescope (or optical axis) into alinement with the electrical axis of the radar beam.

Note. One full turn of the screw will change the elevation 50 mils.

13. Corrections For Azimuth Deviations

If corrections for deviations in azimuth are necessary, the radar mechanic should make the adjustment as follows. The adjustment is performed by loosening the two jamnuts located on either side of the spinner motor housing and turning the hexagonal head bolts, simultaneously loosening one and tightening the other until the

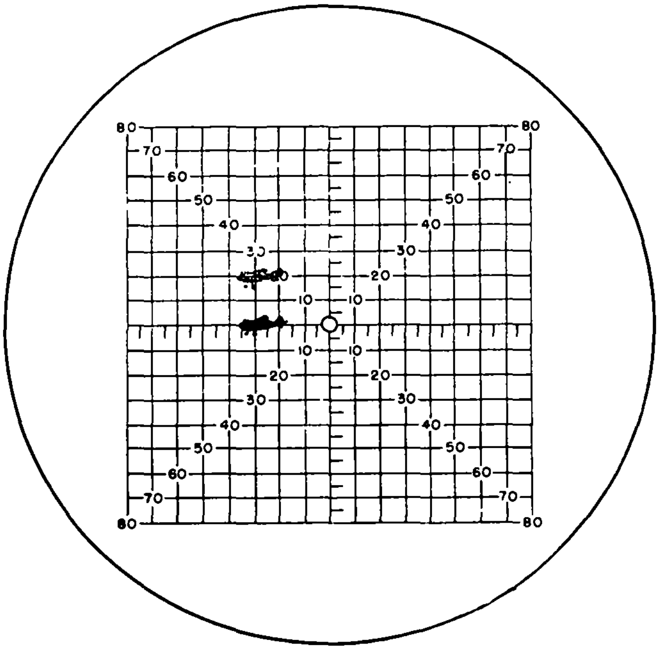


Figure 10. View through telescope during collimation after correction for elevation deviation.

target is centered in the reticle (fig. 11). After the target has been centered, both bolts are tightened until they are snug. The jamnuts are then tightened. A check should be made to verify that the target has remained centered in the reticle.

14. Procedure

Three men are required to collimate the radar; one operates the radar set control unit, one observes through the telescope and one relays commands from the telescope observer to the control unit operator. When the target echo appears on the J-scope, the radar set control unit operator gates the target, places the MASTER AUTO-MANUAL switch in the AUTO position, and announces ON TARGET. The telescope observer notes the deviations and makes corrections.

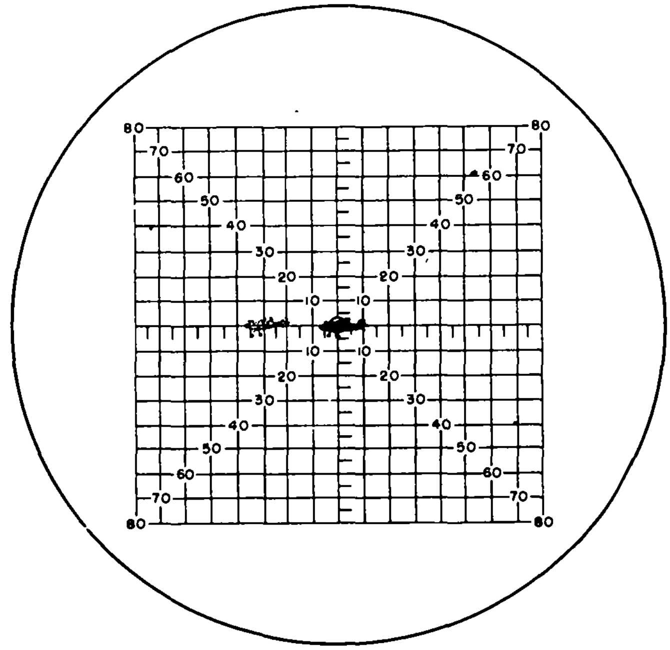


Figure 11. View through telescope after all collimation corrections.

Section IV. ORIENTATION

15. General

To provide accurate azimuth and elevation data, a radar set must be properly oriented on a known azimuth and elevation. The radar set must be oriented in azimuth upon occupation of a new position. Since elevation is the vertical angle, with the vertex at radar, between the horizontal plane and the axis of the radar beam, elevation orientation need only be checked in each new position to assure that vibration during the road march has not disturbed the antenna alinement.

16. Description

Orientation is the procedure employed to adjust the azimuth and elevation dials to present accurately the known azimuth and elevation at which the antenna is pointed. Azimuth orientation and the checking of elevation orientation are operator functions. The actual elevation orientation is performed by the radar mechanic. The two methods of orienting the radar are described below.

a. Survey. A visible distant point at least 1,000 meters from the radar can be used as an orienting point. Accurate azimuth and elevation data to this point can be obtained from survey. If neither survey data nor an aiming circle are available, approximate azimuth orientation data can be obtained by measuring the azimuth on a contour map. Elevation orientation can be completed only when survey data become available.

b. Aiming Circle. When the aiming circle is used to orient the radar, it is set up at a minimum of 150 meters from the radar, and the grid azimuth is measured from the aiming circle to the radar telescope. The azimuth from the radar to the aiming circle is computed by adding or subtracting 3,200 mils from the measured azimuth. With this azimuth set on the AZIMUTH dial, the radar is oriented on the aiming circle telescope.

17. Azimuth Orientation

a. Preliminaries.

(1) Level the radar set.

(2) Check collimation.

(3) Place the ANTENNA RELEASED-NORMAL switch in the RELEASED position.

b. Survey Method. To orient the radar set with survey data—

(1) Move the main frame assembly in azimuth until the azimuth to the orienting point appears on the AZIMUTH dial.

(2) Disengage the AZIMUTH ORIENTATION CLUTCH.

(3) Move the main frame assembly until the orienting point is centered vertically and horizontally in the orienting telescope reticle.

(4) Engage the AZIMUTH ORIENTATION CLUTCH.

(5) Read the elevation dial. The elevation should be within 1 mil of the surveyed angle of elevation to the orienting point.

(6) Rotate the main frame assembly clockwise about 100 mils and then return it to the orienting azimuth with the last motion counterclockwise. The orienting point should be within 1 mil of the vertical crosshair.

(7) Repeat (6) above, starting with a counterclockwise motion.

(8) Place the ANTENNA RELEASED-NORMAL switch in the NORMAL position.

c. Aiming Circle Method. To orient the radar set with the aiming circle—

(1) Set up and level the aiming circle at least 150 meters from the radar set and the power unit. (The transmitter should be off when the magnetic needle on the aiming circle is being used.)

(2) Move the antenna until the head of the aiming circle is centered in the reticle of the orienting telescope. Measure the grid azimuth and the angle of elevation from the aiming circle to the perforations in front of the orienting telescope on the radar.

(3) Determine the azimuth from the radar to the aiming circle by adding or subtracting 3,200 mils from the grid azimuth maesured with the aiming circle. Determine the angle of elevation from the radar to the aiming circle by changing the sign of the angle of elevation from the aiming circle to the radar.

(4) The aiming circle is now considered the orienting point, and the remainder of the procedure is the same as that for the survey method.

Section V. RANGE CALIBRATION

18. General

a. In order to obtain accurate horizontal range measurements with the radar set, it must be range calibrated. Range calibration consists of adjusting the radar set so that it indicates the true slant range to a selected target.

b. Range calibration of the radar should be checked each day and each time that the radar is moved. For a rapid check, the range marker method can be used.

19. Procedure

After the radar set has been emplaced, the normal performance checks are made, and the set is collimated and oriented. The range to a fixed target must be known.

a. Fixed Target Method. To calibrate the range by the fixed target method—

(1) Point the antenna towards the fixed target in azimuth and elevation and turn the SLANT RANGE handwheel on the radar set control unit until the target echo appears at the 12 o'clock position on the J-scope. If the target is visible, check to insure that the antenna is pointing at the correct target by looking through the orienting telescope.

(2) Reduce the size of the target echo until it is just barely visible by adjusting the RECEIVER GAIN control. Then maximize the target echo on the J-scope by making slight adjustments with the AZIMUTH and ELEVATION handwheels on the radar set control unit.

(3) Set the RECEIVER GAIN switch to AUTO and lock on the target echo in range by placing the RANGE ONLY AUTO switch in the CALIBRATE position.

(4) The range indicated on the SLANT RANGE dial should agree with the known range to the fixed target within 15 meters.

(5) Return the RANGE ONLY AUTO switch to the NORMAL position.

b. Range Marker Method. To calibrate the range by the range marker method—

(1) Clear the J-scope of all video by elevating the antenna to eliminate ground clutter.

(2) Place the RANGE MARKERS switch in the ON position and the RECEIVER GAIN switch in the AUTO position.

(3) Turn the SLANT RANGE handwheel on the radar set control unit until the second range marker is at the 12 o'clock position on the J-scope.

(4) Place the RANGE ONLY AUTO switch in the CALIBRATE position and read the range indicated on the SLANT RANGE dial on the radar set control unit.

(5) Repeat (3) and (4) above to determine the range to the seventh range marker. Determine the interval between these two range markers and divide by five.

(6) Repeat (3), (4), and (5) above to determine the average interval between successive range markers from the 32nd to the 37th range marker.

(7) Determine the average marker interval by adding the two intervals and dividing the sum by two.

(8) The range to any of the range markers can now be determined by multiplying the number of the marker by the average interval. Lock onto this marker by placing the RANGE ONLY AUTO switch in the CALIBRATE position. The reading on the SLANT RANGE dial should agree with the computed range within 15 yards.

(9) Turn the RANGE MARKERS switch to the OFF position. Turn the RECEIVER GAIN toggle switch to the MANUAL position.

Section VI. SYNCHRONIZATION AND CALIBRATION OF RECORDER RD–54/TP

20. General

a. Synchronization is the process of making the recorded range, azimuth, and height data of the recorder RD–54/TP coincide with the range, azimuth, and height data transmitted from the radar. The process of synchronization also includes the adjustment of the GAIN DAMPING and CF switching controls of the servoamplifiers of the recorder RD–54/TP. The synchronization procedure also serves as a system check for radar performance and should be performed each time the radar is moved to a new position. The radar should be leveled, oriented, and collimated prior to synchronization.

b. The recorder RD–54/TP is synchronized at one particular range, azimuth, and height. Since the radar set and the recorder RD–54/TP are required to track targets at different ranges, azimuths, and heights, calibration runs are necessary to insure that accurate data are being recorded on the plots produced by the recorder RD–54/TP.

c. Calibration is the process of determining corrections to compensate for nonlinear operation of the radar throughout its operating limits. These corrections are noted on the plot-reading scale and applied to the plots produced by the recorder RD–54/TP.

21. Synchronization of Recorder RD–54/TP

a. Range Synchronization.

(1) *Radar preliminaries.* To prepare the radar—

(*a*) Turn the ANTENNA RELEASED-NORMAL switch on the tracker mount to the RELEASED position.

(*b*) Set the ELEV dial on the tracker mount at zero mils with the last motion downward.

(*c*) Set the SLANT RANGE YDS dial on the radar set control unit at 3,000 yards. If the slant range at the tracker mount does not read 3,000 yards, notify the mechanic.

(*d*) Read the HOR RG dial at the tracker mount; it should read 3,000 ±10 yards.

(2) *Recorder RD–54/TP preliminaries.*

(*a*) Turn the 115V AC SUPPLY switch on the power distribution panel to the ON position.

(*b*) Turn the PAPER DRIVE AUTO-OFF-LOCAL switch to the OFF position.

(*c*) Turn the PAPER DRIVE MOTOR ON-OFF switch to the ON position.

(*d*) Turn the 115V AC ON-OFF switches on the height, range, and azimuth panels of the servoamplifier to the ON position.

(3) *Range synchronization procedure.*

(*a*) Turn the range GAIN control clockwise until the stylus carriage begins to jitter rapidly.

(*b*) Adjust the range DAMPING control until the stylus stops jittering.

Note. Tension can be felt at the range stylus carriage when properly adjusted. An over-adjustment will cause the range stylus carriage to be sluggish and result in inaccurate target locations.

(*c*) Place the range amplifier SYNCHRO DATA switch in the SINGLE position.

(*d*) Unlock and adjust the coarse (top) synchro until the stylus carriage indicator is directly under the 3,000 yard graduation on the stylus frame cover. Lock the coarse synchro.

(*e*) Put the range amplifier SYNCHRO DATA switch in the DUAL position.

(*f*) Unlock and adjust the fine (lower) synchro until the stylus carriage indicator is directly under the 3,000-yard graduation on the stylus frame cover. Lock the fine synchro.

(*g*) Note the GAIN control setting and turn the GAIN control fully counterclockwise.

(*h*) Displace the range stylus carriage 150 to 200 yards, as measured on the stylus frame cover range scale.

(*i*) Adjust the C–F SWITCHING control until the green light goes out and the red light comes on. Add one-eight of a turn clockwise.

(*j*) Return the GAIN control to the setting noted in (*g*) above. The red light should go out, the green light should come on, and the stylus should return to the 3,000 yard graduation on the stylus frame cover scale.

(*k*) Place the PAPER DRIVE AUTO-OFF-LOCAL switch in the LOCAL position. Drive sufficient paper through the recorder to read the range with the plot-reading scale.

(*l*) Read the range with the plot-reading scale. If the range is not 3,000 yards, readjust the fine synchro to eliminate the error. Repeat the process of adjusting and measuring until the error is eliminated.

b. Azimuth Synchronization.

(1) *Radar preliminaries.* To prepare the radar—

(*a*) Round off the azimuth to the center of the sector of search to the nearest 100 mils.

(*b*) Move the main frame assembly to the 100 mil mark that represents the azimuth to the center of sector.

(2) *Recorder RD–54/TP preliminaries.* To prepare the recorder follow the same procedure used for range synchronization in *a*(2) above.

(3) *Azimuth synchronization procedure.* To synchronize the azimuth—

(*a*) Turn the azimuth GAIN control clockwise until the stylus carriage begins to jitter rapidly.

(*b*) Adjust the azimuth DAMPING control until the azimuth stylus stops jittering.

Note. Tension can be felt at the azimuth stylus carriage when it is properly adjusted. An over-adjustment will cause the azimuth stylus carriage to be sluggish and result in inaccurate target locations.

(*c*) Place the azimuth amplifier SYNCHRO DATA switch to the SINGLE position.

(*d*) Unlock and adjust the coarse (top) synchro until the stylus carriage indicator is directly under the 1,600 mils mark on the azimuth scale of the stylus frame cover. Lock the coarse synchro.

(*e*) Put the azimuth amplifier SYNCHRO DATA switch in the DUAL position.

(*f*) Unlock and adjust the fine (lower) synchro until the stylus carriage indicator is directly under the 1,600-mil mark on the azimuth scale of the stylus frame cover. Lock the fine synchro.

(*g*) Note the GAIN control setting and turn the GAIN control counterclockwise.

(*h*) Displace the azimuth stylus carriage between 10 and 20 mils as measured on the stylus frame cover azimuth scale.

(*i*) Adjust the C–F SWITCHING control until the green light goes out and the red light comes on. Add one-eighth of a turn clockwise.

(*j*) Return the GAIN control to the setting noted in (*g*) above. The red light should go out, the green light should come on, and the stylus should return to the 1,600-mil graduation on the stylus frame cover.

(*k*) Place the PAPER DRIVE AUTO-OFF-LOCAL switch in the LOCAL position and drive sufficient paper through the recorder to read the azimuth with the plot-reading scale.

(*l*) Read the azimuth with the plot-reading scale. If the azimuth reading is not exactly 1,600 mils, readjust the fine synchro to eliminate the error. Repeat the process of adjusting and measuring until the error is eliminated.

c. Height Synchronization.

(1) *Radar preliminaries.* To prepare the radar—

(*a*) Turn the SLANT RANGE handwheel until the SLANT RANGE dial on radar set control unit reads 3,000 yards.

(*b*) Set the antenna by hand to an elevation of 346 mils with the last motion downward.

(*c*) The altitude dial on the tracker mount should read 1,000 yards. If the reading is not exactly 1,000 yards, elevate the antenna until the altitude dial does read 1,000 yards. If, after this adjustment, the elevation dial reading is not within 2 mils of 346 mils notify the radar repairman.

(2) *Recorder RD 54/TP preliminaries.* To prepare the recorder RD54/TP, in the MPQ10 7,500 position. Turn the SYNCHRO-DATA switch to the SINGLE position.

(3) *Height synchronization procedure.* To synchronize the height—

(*a*) Displace the stylus carriage and adjust the GAIN control until the stylus carriage returns to its original position with positive action. This positive action can be checked by trying to move the carriage by hand. The torque should be sufficient to prevent the carriage from moving unless excessive pressure is exerted.

(*b*) Adjust the DAMPING control to remove any excessive jitter that may occur. If no jitter occurs, adjust the damping control to midpoint.

Note. Tension can be felt at the height stylus carriage when properly adjusted. An over-adjustment will cause the height stylus carriage to be sluggish and will result in inaccurate target location.

(*c*) Unlock the lower height synchro and adjust it until the stylus carriage indicator is directly under the 3,000- foot graduation of the 7,500-foot scale of the stylus frame cover height scale.

(*d*) Place the PAPER DRIVE AUTO-OFF-LOCAL switch in the LOCAL position. Drive sufficient paper through the recorder to read the height with the plot-reading scale.

(*e*) If necessary, readjust the lower height synchro until it reads exactly 3,000 feet on the plot-reading scale. Lock the lower synchro.

(*f*) Set the HEIGHT FEET switch to the MPQ10 30,000 position. The stylus carriage indicator should move from 3,000 on the 7,500-foot scale to exactly 3,000 on the 30,000-foot scale. If not, an adjustment must be made by the radar mechanic.

22. Calibration of the Recorder RD–54/TP

a. Height Calibration.

(1) *Radar preliminaries.* To prepare the radar—

(*a*) Set the antenna by hand to an elevation of 346 mils with the last motion downward.

(*b*) Set the SLANT RANGE dial on the radar set control unit to 700 yards.

(2) *Recorder RD 54/TP preliminaries.* To prepare the recorder RD 54/TP—

(*a*) Set the HEIGHT FEET switch to the MPQ10, 7,500 position.

(*b*) Set the PAPER DRIVE AUTO-OFF-LOCAL switch to the OFF position.

(3) *Height calibration procedure.* To calibrate the height—

(*a*) Slowly turn the SLANT RANGE handwheel until the SLANT RANGE dial indicates 1,000 yards, with the last motion increasing. Announce "Mark".

(*b*) Place the PAPER DRIVE AUTO OFF LOCAL switch on the recorder in the LOCAL position driving approximately 1 inch of paper through the recorder. When completed announce "Move."

(*c*) Repeat (*a*) above at 3,000 yards; then, repeat (*b*) above.

(*d*) Repeat (*a*) above at 5,000 yards; then, repeat (*b*) above.

(*e*) Repeat (*a*) above at 7,000 yards; then, repeat (*b*) above.

(*f*) Move the SLANT RANGE handwheel until the SLANT RANGE dial indicates 7,500 yards and, with the last motion decreasing, repeat the entire procedure at 7,000 at 5,000, 3,000, and 1,000 yards.

(*g*) Remove the paper from the recorder RD54/TP, and, using the plot-reading scale, read and record the height for each ((*c*), (*d*), and (*e*) above), increasing and decreasing.

(*h*) If the deviation between any two successive readings is greater than 30 feet, notify the radar repairman.

(*i*) Zero height is determined for an increasing height by algebraically subtracting 1,000 from the first reading of the group of increasing height readings. For a decreasing height, algebraically subtract 1,000 from the last reading of the group of decreasing height readings.

(*j*) Mark the plot-reading scale in the lower left corner with the zero heights, using a red grease pencil for increasing height and a blue grease pencil for decreasing height.

b. Range Calibration.

(1) *Radar preliminaries.* To prepare the radar—

(*a*) Set the antenna to zero mils elevation.

(*b*) Set the SLANT RANGE dial on the radar set control unit to 700 yards.

(2) *Recorder preliminaries.* To prepare the recorder, set the PAPER DRIVE AUTO-OFF-LOCAL switch to the OFF position.

(3) *Range calibration procedure.* To calibrate the range—

(*a*) Start with a range reading of 1,000 yards, and using steps of 2,000 yards, proceed in the same manner as for height calibration in *a* above.

(*b*) Remove the paper from the recorder RD54/TP, and, using the plot-reading scale, read and record the range for each step.

(*c*) At each level, the recorded ranged should not differ from the correct value by more than 20 yards. These differences (errors) are averaged and rounded off to the nearest 10 yards. The average error is converted to a correction by changing the sign. Separate corrections are determined for the increasing and decreasing ranges.

(*d*) Record the corrections at the top center of the plot-reading scale, with a red grease pencil for increasing corrections and a blue grease pencil for decreasing corrections.

(*e*) If an error greater than 20 yards is found in (*b*) above, recalibrate the range at 1,000-yard intervals. If an error greater than 20 yards still exists after recalibration, notify the radar repairman and carry separate corrections for each of the intervals on the plot-reading scale.

c. Azimuth Calibration.

(1) *Radar preliminaries.* To prepare the radar, turn the tracker mount by hand to the 100-mil mark representing the azimuth to the center of the sector.

(2) *Recorder RD54/TP preliminaries.* To prepare the recorder RD54/TP, set the PAPER DRIVE AUTO-OFF-LOCAL switch to the LOCAL position, driving approximately 1 inch of paper through the recorder RD54/TP.

(3) Azimuth calibration procedure. To calibrate the azimuth—

(*a*) Move the tracker mount by hand and increase the azimuth approximately 100 mils; then return to the 100-mil mark selection in (1) above with the last motion decreasing.

(*b*) Set the PAPER DRIVE AUTO-OFF-LOCAL switch to the LOCAL position and drive approximately 1 inch of paper through the recorder.

(*c*) Decrease the azimuth approximately 100 mils and move the tracker mount back to the 100-mil mark selected in (1) above, with the last motion increasing.

(*d*) Set the PAPER DRIVE AUTO-OFF LOCAL switch to the LOCAL position and drive approximately 1 inch of paper through the recorder.

(*e*) Pull the paper out of the recorder RD54/TP and note the differences that occur between the radar data and the recorder data. Change the signs and record the increasing corrections, with a red grease pencil, and the decreasing corrections with a blue grease pencil on the plot-reading scale. These corrections should not exceed 1 mil for increasing or decreasing checks.

d. Paper Speed Check for the Recorder RD 54/TP. To check the paper speed of the recorder RD54/TP—

(1) Set the PAPER DRIVE AUTO-OFF-LOCAL switch to the LOCAL position.

Note. Check the generator output frequency for 60 Hz before proceeding with this check.

(2) Lift one stylus off the paper.

(3) At a predetermined time, drop the stylus on the paper.

(4) About 50 seconds later, lift the stylus enough to make a break in the trace.

(5) At exactly 60 seconds from the first time the stylus was dropped, drop it again.

(6) Remove the paper from the recorder RD54/TP. The distance from the start of the trace to the point where it started when the stylus was dropped the second time should be 22½ inches. This measurement can be made with the plot-reading scale by using the distance from the base line to the tick mark on the side of the plot-reading scale. If the measurement is not within one-sixteenth of an inch, call the radar repairman to make the necessary adjustments.

CHAPTER 4

WEAPONS LOCATION

Section I. GENERAL

23. General

Enemy mortar and artillery emplacements usually are in defilade to friendly radar sets. This prevents the radar operator from detecting or tracking the projectile at the instant it leaves the muzzle. The radar is always emplaced behind a screening crest, which normally prevents the radar from tracking the projectile to its burst. Since the radar begins tracking the projectile sometime after it leaves the muzzle and tracks it to a point somewhere before the burst, the plot produced by the recorder RD–54/TP does not include the exact location of the weapon or the burst. The location of the weapon or the burst must be determined by extending the plotted trace. The trace is extended to the left for a weapon location and to the right for a burst location. To interpret and to extrapolate the data from a plot, the radar personnel must know how the height, range, azimuth, and base line traces are produced and understand the theory and characteristics of each trace.

24. Personnel Required For Weapon Location

a. The radar section must be organized for continuous operation. For efficient operation, a minimum of three personnel are required—the radar set control unit operator, the RD54/TP operator/plot reader, and the radar plotter/recorder. These personnel must also operate the generator and the communication equipment.

b. To prevent eyestrain, the radar set control unit operator should be relieved approximately every 30 minutes.

25. Duties During Operation

The individual duties of the personnel on duty during operation should be such that each person is able to perform his job as well as possible in the shortest time. The duties of the personnel during radar operation are described below.

a. Radar Set Control Unit Operator. The radar set control unit operator must constantly observe the B-scope to detect enemy weapons activity. He should be thoroughly familiar with the clutter and should have a site evaluation chart available for his immediate use. A knowledge of the tactical situation will enable him to evaluate the activity produced on the B-scope. When a round is detected, he should announce the pickup data (azimuth, range, and elevation). He must exercise good judgment about the length of time to remain on a pickup point without tracking a round. He must track the rounds and assist in improving the pickup data to obtain better plots.

b. RD–54/TP Operator/Plot Reader. The RD–54/TP operator/plot reader must continually check the recorder RD–54/TP for proper operation. He also checks the calibration corrections during slack periods and checks the paper speed periodically. He insures that each of the four styluses is marking properly and records the time and pickup data on each plot. When the plot is produced, he removes it from the recorder RD–54/TP, analyzes it, and extends the traces. He reads the range and azimuth and announces them to the radar plotter/recorder; then he rereads the plot to apply any significant difference in altitude between the radar and weapon location. He has the primary responsibility *for the improvement of pickup data.* He also determines the *accuracy of the location.*

c. Radar Plotter-Recorder. The radar plotter/recorder prepares the radar chart, contour map, and situation overlay and keeps them up to date. When the RD–54/TP operator/plot reader announces the range and azimuth from a plot, the plotter plots these data on a contour map and determines the difference in altitude between the radar position and the weapon location. This difference is announced to the RD–54/TP operator/plot reader, and the process is continued until the readings are within tolerance (20 feet on the 7,500-foot scale, 50 feet on the 30,000-foot scale). The radar plotter then records the weapon coordinates and altitude. He records all data on DA Form 6–6 and *immediately* reports *all* locations to the battery processing center. He operates the communication equipment within the radar plot processing center and, during slack periods, checks the generator.

26. Estimation of Accuracy

The plot reader bases his estimates of accuracy on the appearance of the plot and the method used for locating and orienting the radar.

a. Appearance of the Plot. The more of the ascending portion of the trajectory that is tracked, the more accurate the location, because the extension of the trace is not as long and more of the trace is available for analysis. Also, a variation of paper speed will affect the accuracy of the plot. Any variation or oscillation in the trace will also have a detrimental effect on the accuracy of the location.

b. Location of the Radar. When the radar has been located and oriented with data obtained from a survey party, the error is considered to be nonexistent. However, if the radar has been located and oriented with data determined by map inspection or graphical three-point resection, the error will vary from 20 to 100 meters, according to the method used and the state of training of the radar crew. The effects of both the appearance of the plot and the method of radar location should be considered by the plot reader. If the location is based on the average of several plots, the accuracy will be greater than that of any one plot. The overall estimate of accuracy is developed through experience by the radar crew.

27. DA Form 6–6

a. The form for keeping records of weapon locations is DA Form 6–6. (Record of Sound, Flash, and Radar Locations).

b. To use DA Form 6–6, the radar plotter/recorder fills in the heading to include the period of time a particular sheet encompasses, the sheet number, and the number of sheets in the series. The data entered in columns L through U are described in (1) through (10) below.

RECORD OF SOUND, FLASH, AND RADAR LOCATIONS
(FM 6-122)

PERIOD COVERED:	FROM TIME	FROM DATE	TO TIME	TO DATE	SHEET NUMBER	NUMBER OF SHEETS
	0001	2 AUG 64	2400	2 AUG 64	1	1

L FROM (File Nr)	M GRID REFERENCE AND HEIGHT: E AND N	M GRID REFERENCE AND HEIGHT: H	M ACCURACY: METERS	M ACCURACY: NR PLOTS	N MEANS OF LOCATING	O TIMES ACTIVE (From - To)	P NATURE OF TARGET	Q REMARKS (Area Shelled, Etc)	R TIME REPORTED TO ARTY CP	S MISSION FIRED BY	T NUMBER OF ROUNDS	U CONC. NR
1	27260 34240	428	0-400	1	R	0710 0725	High angle	Unknown	0720	2/13th	18	AB 432
2	24185 34585	415	0-600	1	R	0730	Low angle	Unknown	0737	2/13th	30	AB 205
3	25830 32330	402	0-400	1	R	0735 0740	High angle	Unknown	0745	2/13th	16	AB 311
4	28890 32660	411	0-400	1	R	0755 0820	Low angle	Unknown	0802	2/13th	22	AB 98

DA FORM 1 SEP 55 6–6 EDITION OF 1 OCT 53 WILL BE USED UNTIL EXHAUSTED [illegible]

Figure 12. DA Form 6–6.

(1) *Column L*—The file number designated by the initiating unit. Locations are numbered consecutively starting with number 1.

(2) *Column M*—The grid reference and height of the final location of the weapon. The recorder operator also enters his estimate of accuracy and the number of plots on which it is based.

(3) *Column N*—The means of locating the weapon. The letter "R" indicates that the location was made by radar.

(4) *Column O*—The time the enemy weapon was firing.

(5) *Column P*—The nature of the target is estimated by the recorder operator and is designated as high or low angle.

(6) *Column Q*—Remarks, such as the area shelled, normally will be entered as unknown. In some instances a higher headquarters may request that the radar operator extrapolate the burst end of the plot to determine where the enemy fire was placed.

(7) *Column R*—The time the locating was reported to the higher artillery command post.

(8) *Column S*—The designation of the unit which fired on the enemy location.

(9) *Column T*—The number of rounds fired on the enemy location.

(10) *Column U*—The target number entered by the radar section is designated by the unit firing the counterfire.

c. If the radar operator starts tracking subsequent rounds from the same hostile weapon after the first location is reported, the first location is held and an average of all the rounds is reported as the location.

28. Procedure For Weapon Location

The same technique is employed in locating enemy mortars and artillery. This technique is divided into three distinct phases of operation—detection, tracking, and location.

a. Detection.

(1) The sector of search assigned to the radar will vary in width from 200 to 800 mils depending on the situation. The transmitted radar beam is approximately 100 mils in width. In order to cover the assigned sector of search, the radar set control unit operator places the radar in sector scan by setting the sector scan limits with the SECTOR WIDTH MILS control and pulling out the AZIMUTH handwheel. This causes the radar to sector scan; i.e., to move back and forth across the sector at the minimum scanning elevation and to place a blanket of radio energy over the assigned sector.

(2) When a weapon fires and the projectile enters this blanket of radio energy, the returned echo causes a bright spot to appear on the detection or B-scope of the radar set control unit. When this bright spot (target echo) appears, the radar set control unit operator stops the radar from sector scanning by pushing in the AZIMUTH handwheel. He then positions the sweep (trace) through the target echo on the B-scope (fig. 13) by rotating the AZIMUTH handwheel and turns the SLANT RANGE handwheel until the range gate is positioned at the point where the echo appeared (fig. 14). At this time, the radar is positioned in both range and azimuth at the point in space through which the projectile passed. The azimuth, elevation, and slant range to that point can be determined from the radar set control unit dials. The radar set control unit operator directs his attention to the J-scope and prepares to begin the tracking phase.

b. Tracking. When the next round is fired from the same weapon, even if there has been a considerable change in firing data, the projectile will again enter the stationary radar beam and cause a target echo to be returned to the radar. The echo will appear as a hump on the tracking or J-scope. By turning the SLANT RANGE handwheel, the radar set control unit operator moves the hump (target echo) to the 12 o'clock position on the scope (fig. 15). At that instant, the

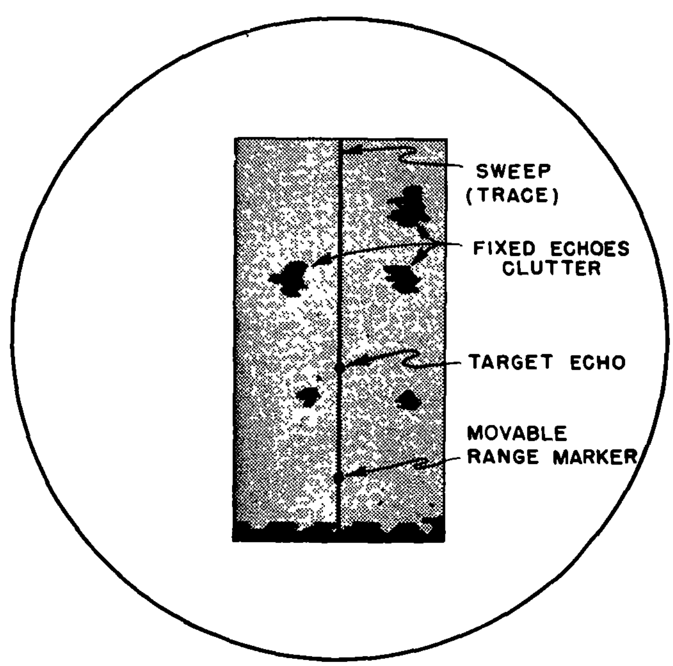


Figure 13. B-scope sweep positioned through target echo.

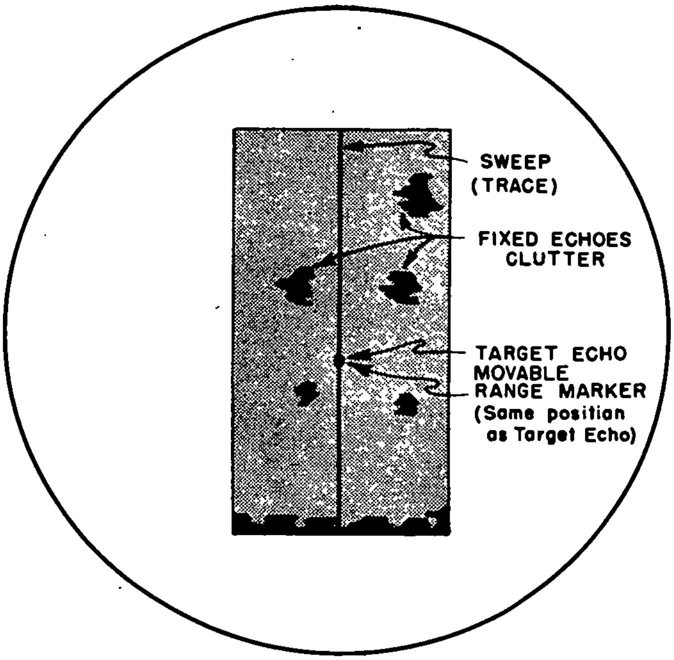


Figure 14. B-scope range gate positioned on target echo.

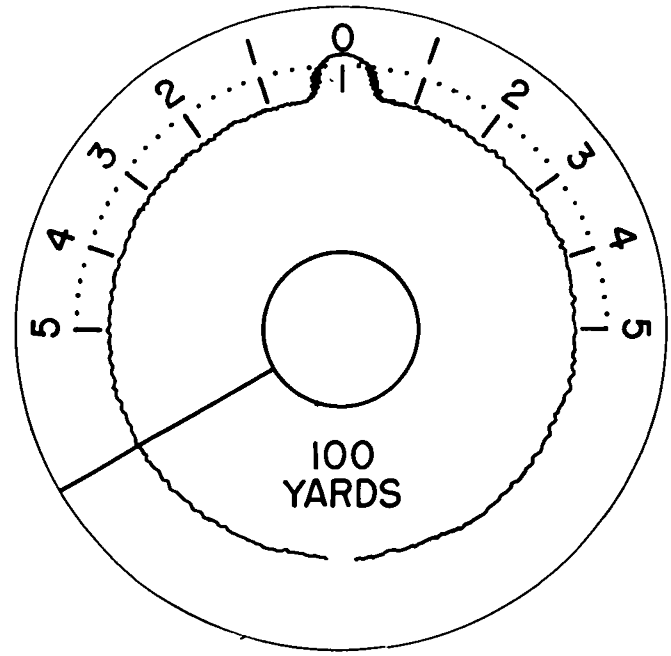


Figure 15. J-scope target presentation.

operator places the MASTER AUTO-MANUAL switch in the AUTO position to cause the radar to automatically track the projectile in range, azimuth, and elevation. When the elevation of the descending portion of the trajectory reaches that of the screening crest, the radar set control unit operator places the MASTER AUTO-MANUAL switch in the MANUAL position. This action concludes the tracking phase and returns the radar beam to its original pickup point.

c. Location. While the radar is automatically tracking the projectile, it is continuously measuring the slant range, the azimuth, and the elevation angle from the radar to the projectile in flight. The slant range and the elevation angle are converted to horizontal range and height by the altitude converter. These data are transmitted by cable to the recorder RD–54/TP in the form of horizontal range in yards, azimuth in mils, and height in feet. The recorder RD–54/TP graphically plots these data as traces on paper. It is necessary to extend these traces back to their origin to determine the location of the weapon. If the radar could start tracking the projectile the instant that it leaves the muzzle, the problem of locating the weapon would be minimized; however, this is not the case. The radar starts tracking the projectile sometime after it leaves the muzzle and tracks it to some point before the burst. The parabolic template (fig. 16) is used to extend these traces (fig. 33), and the plot-reading scale (fig. 16) is used to determine the range and azimuth to the weapon. The polar coordinates are plotted on a contour map, and the weapon is located as described in paragraph 48.

Section II. RECORDER RD–54/TP

29. General

a. General. The recorder RD–54/TP is an electromechanical device that simultaneously records, on paper, a graphic representation of the height, horizontal range, and azimuth data transmitted from the radar set. The radar set is aimed at a general area where a projectile is expected. After the round has been fired, the radar set picks up the projectile in flight. By the time that the projectile is picked up by the radar set, it has traveled a portion of its flight. As the remaining flight of the projectile is being tracked, the signal data supplied by the synchro generators in the radar set are fed directly to the recorder. The RD–54/TP plots the height, the horizontal range, and the azimuth to the projectile as these data are received from the radar set. The horizontal range and azimuth to the point of origin or the point of impact of the projectile is extrapolated from the plot by means of a plastic parabolic template and a tricalibrated scale called a plot-reading scale.

b. Major Assemblies. The major assemblies of the recorder are the—

(1) Control amplifiers.

(2) Recorder assembly.

(3) Console Assembly.

c. Electronic Control Amplifiers. Each channel (height, horizontal range, and azimuth) of recorder RD–54/TP contains a servoamplifier. The function of the amplifier is to amplify the error voltage generated in the synchro control transformer of a particular channel. The amplified error voltage is then used to control the associated servomotor, positioning the stylus carriage.

d. Recorder Assembly. The recorder assembly is the main functional or operating part of recorder RD–54/TP. Through its three servo loops, the electrical signal data are transformed into mechanical shaft movement. By means of a system of pulleys and wire rope, this shaft movement drives three stylus carriage assemblies over the plotting paper. Each channel of the recorder assembly contains a servo unit, hereinafter called a servo gearbox assembly. Mounted directly upon each servo gearbox assembly are its associated control transformers and servomotor. A paper drive motor, a paper drive gearbox, and a system of rollers feed the plotting paper beneath the four styluses at a speed of 22½ inches per minute. The styluses, in continuous contact with the plotting paper, trace lines on the paper which are graphic representations of the height, the horizontal range, and the azimuth to a projectile throughout its tracked flight versus time.

e. Console Assembly. The console assembly forms the main housing and protective member of the equipment. It is specially designed to accommodate the servoamplifiers and the recorder assembly mechanism. Shock mounts at the bottom of the console absorb the vibrations caused by rough handling. Lifting and carrying handles facilitate movement of the equipment from one location to another. Various access panels provide the means of operating and servicing the equipment while maintaining the maximum amount of protection possible under field conditions.

30. Parabolic Templates and Plot-Reading Scale

Supplied with the recorder RD–54/TP equipment are two parabolic templates and a plot-reading scale (fig. 16). One template corresponds to the 7,500-foot height scale and the other to the 30,000-foot height scale. Interpolation of a parabolic height trace requires the use of the applicable parabolic template, depending on the preselected height scale. Horizontal range (in yards) and azimuth (in mils) can be determined with the plot-reading scale.

31. Cabling Connections

One cable assembly is used to connect recorder RD–54/TP to the other equipment. This cable, called the data cable, carries all power and signal data to the recorder from the tracking radar set. A plug (P701) at one end of the data cable is connected to a receptacle (J504) on the console. The other end of the cable is connected to the radar set (fig. 17).

32. Installation For Paper Roll

The procedure for installing a roll of paper in the recorder assembly (fig. 18) is as follows:

a. Loosen the captive nuts which hold the front paper roll cover to the recorder housing and lift it open. Similarly, open the paper well cover.

b. Carefully raise the stylus frame assembly to expose the backing plate.

c. Trip the paper well clutch stop and, at the same time, move the paper well clutch handle to the left.

d. Remove the empty paper roll core.

e. Lay the new paper roll in the paper well housing with the coated side up. Feed from the top of the roll.

f. Using the paper roll lift, raise the roll into position directly between the two paper holders. Engage the paper holders with the core of the paper roll. Move the clutch handle back to its locked position.

g. Unroll a sufficient length of paper from the roll to allow at least 1 foot to overlap the front end of the recorder assembly (fig. 19).

h. Draw the paper over the rear paper roller, the platen, and the front paper roller.

i. Aline the drive holes in the paper with the front and rear pinwheels. If the drive holes in the paper and the front and rear pinwheels will not mesh, loosen the setscrews in the two pinwheels (one on the right front and one on the right rear). Position the pinwheels until the paper drive pins fit correctly into the drive holes of the paper. (During this adjustment, keep the paper taut against the paper roll to avoid bunch-

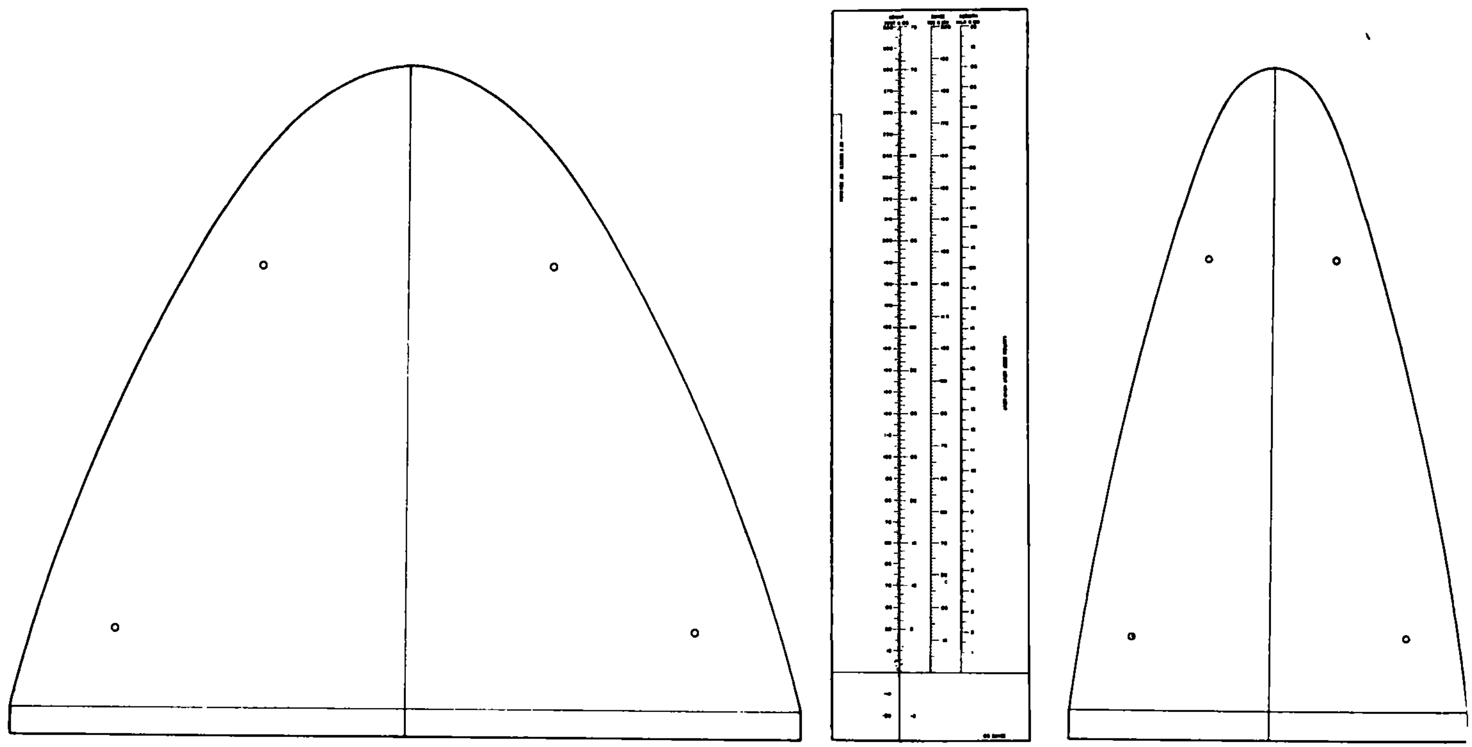


Figure 16. Parabolic templates and plot-reading scale.

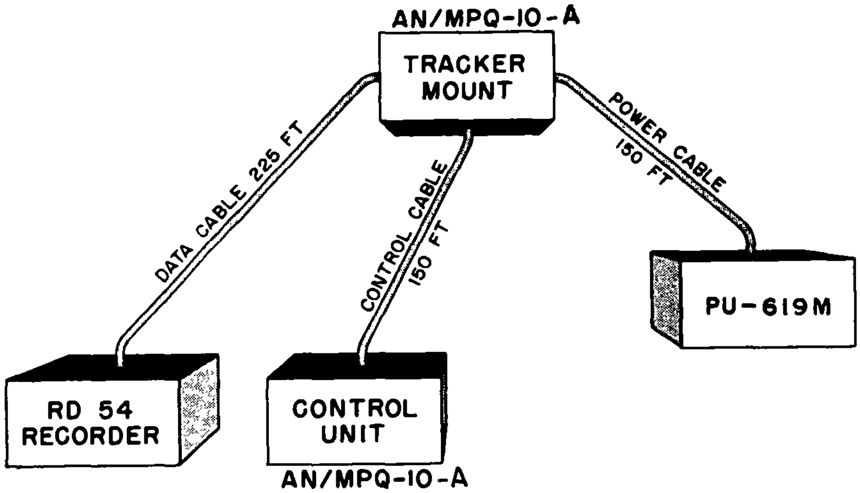


Figure 17. AN/MPQ–10A radar section cable system.

ing and wrinkling. Be sure that the pins on both sides of both rollers are engaged.) Tighten the setscrews.

j. Carefully close the stylus frame assembly.

k. Close the paper well and front paper roll covers. Secure these covers in place by tightening the captive screws.

l. Place the PAPER DRIVE LOCAL switch in the LOCAL position and drive sufficient paper through the recorder to check the operation of the paper drive.

33. Stylus Pressure Adjustment

If the trace produced by the stylus on the plotting paper is too light and the two knurled nuts have been adjusted to their limits, the stylus pressure may be adjusted. To adjust the stylus pressure—

a. Open the stylus cover and raise the stylus frame assembly. The stylus carriage is now accessible.

b. Remove the two plain knurled nuts; this action will allow the stylus and the helical compres-

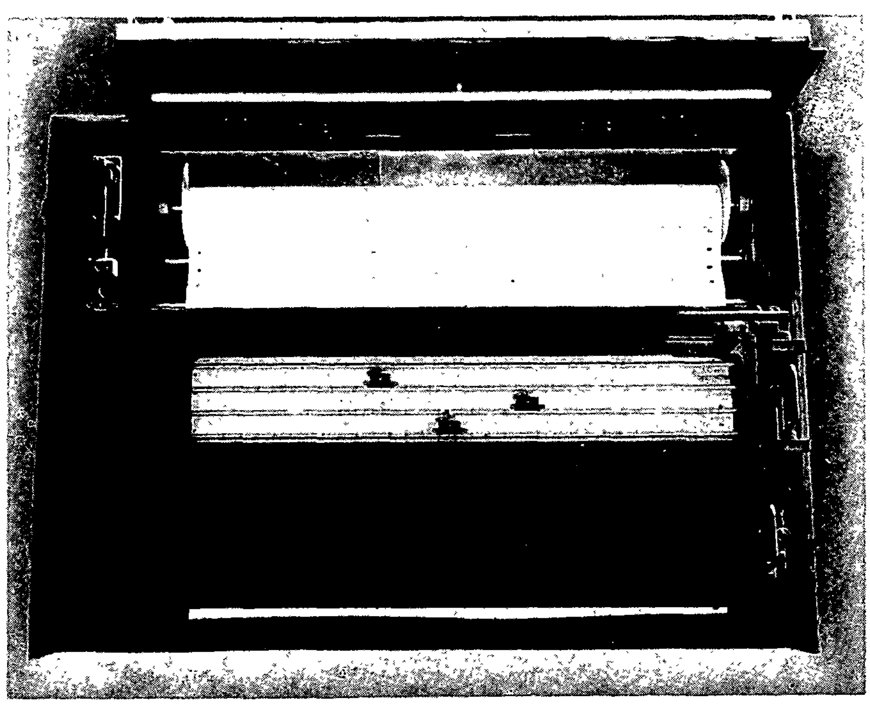


Figure 18. Recorder RD–54/TP, top view.

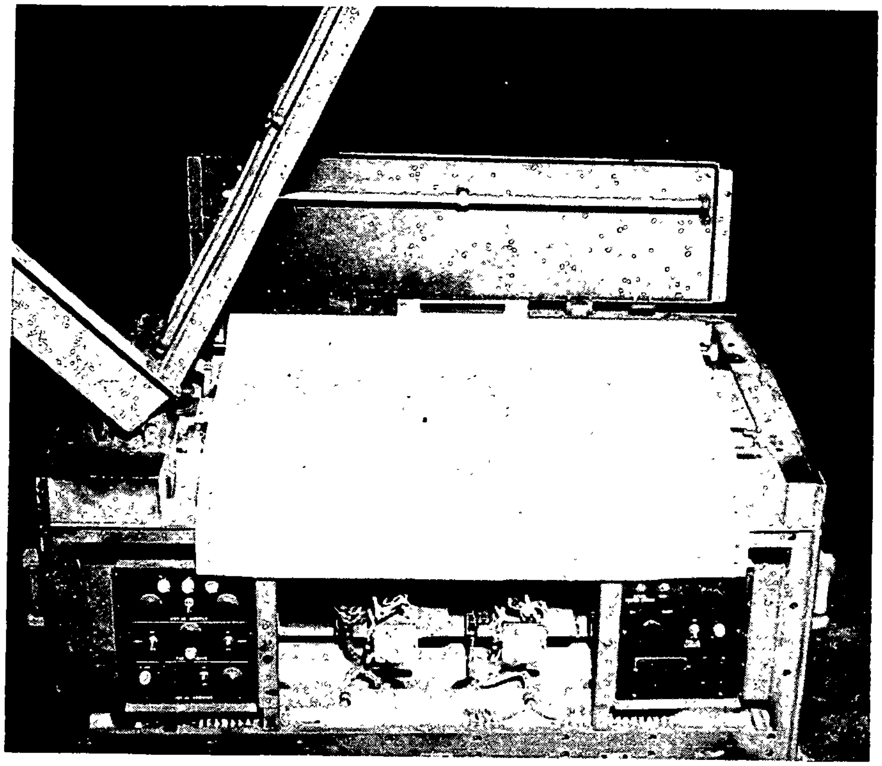


Figure 19. Installation of paper.

sion spring to be removed from the stylus carriage assembly. To increase the stylus plotting pressure, stretch the helical compression spring slightly.

c. Reassemble the stylus carriage assembly in the reverse order.

d. Replace the stylus if the plot is still too light.

34. Data Flow

a. The elevation resolver is geared to the antenna and receives two inputs. These inputs are slant range from the range unit and the antenna angle of elevation picked off by the resolver rotor connected to the elevation gear train. The resolver converts these two inputs to horizontal range and height. These data are then sent through amplifiers in the altitude converter where the signals are amplified and applied to synchro transmitters. The synchro transmitters furnish these data to the RD–54/TP recorder through a cable.

b. The azimuth synchro transmitters are geared to the azimuth gear train located in the base unit. These synchros furnish fine and coarse azimuth data to the RD–54/TP recorder through a cable.

c. The RD–54/TP recorder, using this data flow (fig. 20) plots horizontal range, azimuth, and height on paper. From this plot, data are extrapolated to determine the location of a weapon or a burst.

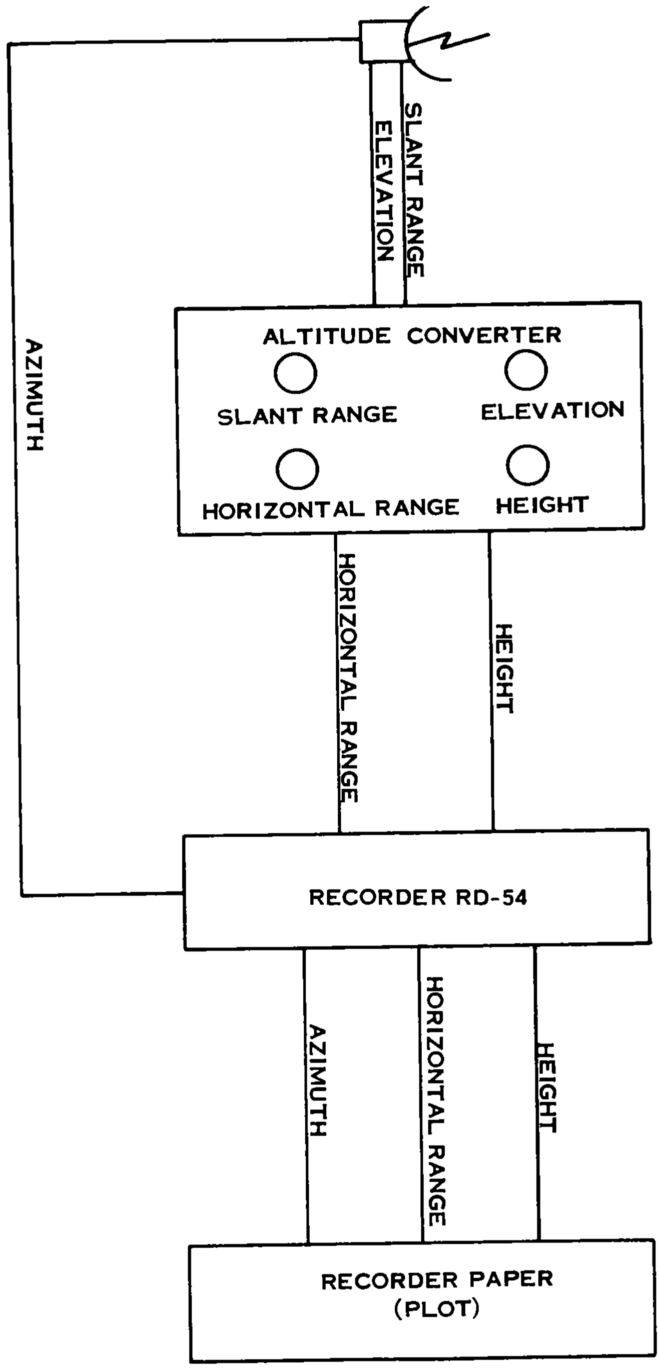


Figure 20. Data flow diagram.

Section III. PLOT INTERPRETATION

35. Assumptions For Analyzing Traces For High-Angle Plots

For the interpretation of high-angle plots, it is assumed that—

a. There is negligible drag effect.

b. The velocity of the projectile remains constant for both the ascending and the descending portions of the trajectory.

c. The projectile travels at a constant rate of speed horizontally.

36. Base Line For High-Angle Plots

a. The base line is produced on the plot by the fixed, or stationary stylus of the recorder RD–54/TP. This stylus makes a continuous trace on the paper.

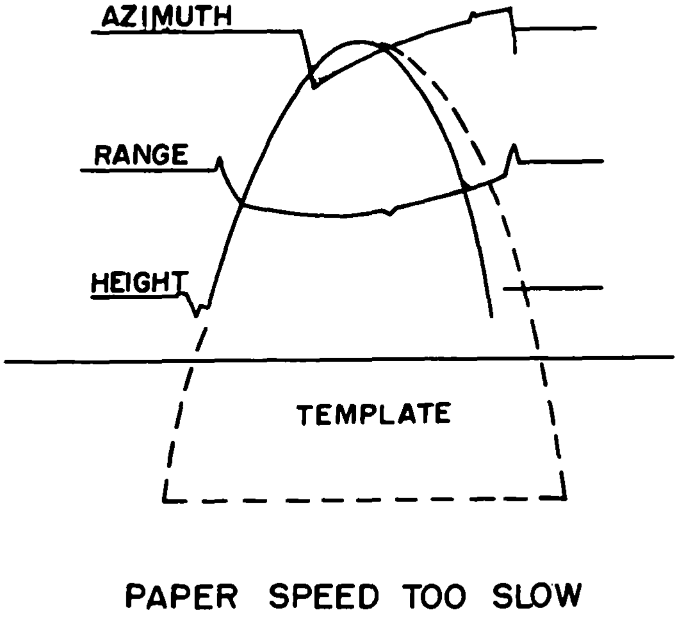


Figure 21. A mortar plot with paper speed too slow.

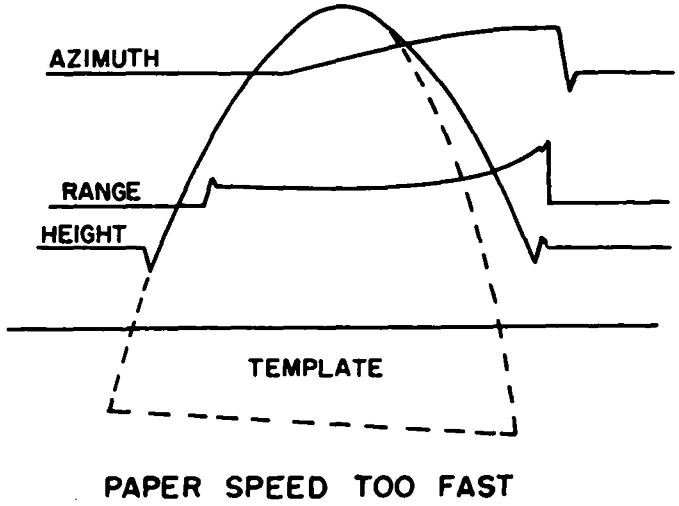


Figure 22. A mortar plot with paper speed too fast.

b. The base line represents the location of the radar: it represents zero height (the altitude of the radar), zero range, and an azimuth reference determined by synchronization.

37. Height Trace For High-Angle Plots

a. The height trace is the key to plot interpretation and is parabolic in shape. Extension of the height trace to the base line permits the determination of the point at which the projectile was at the same altitude as the radar. The range and azimuth can be measured from that point to the weapon. These data form the polar coordinates of the weapon as measured from the radar position.

b. The height of the projectile is continuously plotted by the RD–54/TP in relation to time (paper speed), and the height trace is parabolic in shape.

(1) If the paper speed is too slow, the height trace will be contracted (fig. 21).

(2) If the paper speed is too fast, the height trace will be expanded (fig. 22).

38. Range Trace For High-Angle Plots

a. The range trace is a graphical representation of the *horizontal* range from the radar to the projectile being tracked with respect to time.

b. The slope of the range trace depends on the aspect angle formed by the radar beam and the line of flight of the projectile at any instant.

(1) The greatest change in range occurs when the aspect angle approaches 0 or 3,200 mils. The smallest change in range occurs when the aspect angle is 1,600 or 4,800 mils (plot A, fig. 23 and 24).

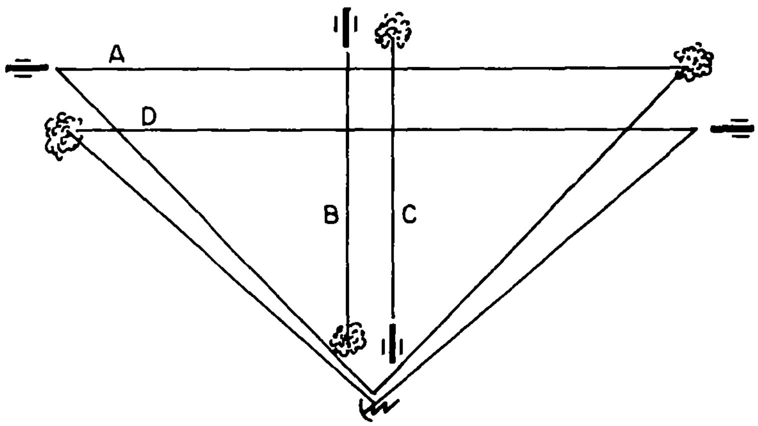


Figure 23. Relationship of weapon, burst, and radar.

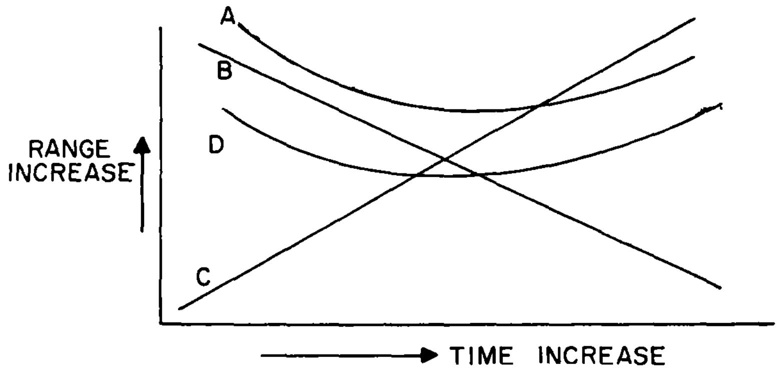


Figure 24. Corresponding range traces.

(2) A range trace that approaches the base line as time increases represents a decreasing range and indicates that the weapon is firing toward the radar. After the projectile passes the radar (point of inflection), the range trace will change direction to increasing (plot B, fig. 23 and 24).

(3) When the distance between the range trace and the base line increase with time, the trace represents an increasing range (plot C, fig. 23 and 24).

c. The length of the range trace traced on the plot depends on the length of time the projectile is tracked, the velocity of the projectile, and the aspect angle formed by the radar beam and the line of flight of the projectile (plots A and C, fig. 23 and 24).

d. The range trace *always begins* and *ends* before the azimuth trace because the *stylus is offset* on the recorder.

39. Azimuth Trace For High-Angle Plots

a. The azimuth trace represents the continuous azimuth from the radar to the projectile during automatic tracking.

b. The slope and curvature of the azimuth trace depend on the angle formed by the radar and the line of flight of the projectile.

c. For a given projectile velocity, the smallest change in azimuth occurs when the aspect angle is a constant 0 or 3,200 mils, and the greatest change occurs when the aspect angle is 1,600 or 4,800 mils.

d. The point of inflection is the point at which the azimuth curve is closest to the base line, allowing for stylus displacement.

(1) An azimuth trace that approaches the base line as time increases (decreasing azimuth) indicates that the weapon is firing from right to left with respect to the radar (plot D, fig 23 and 25).

(2) When the distance between the azimuth trace and the base line increases with time (increasing azimuth), the weapon is firing from left to right with respect to the radar (plot A, fig. 23 and 25).

(3) The azimuth trace will be a straight line parallel to the base line, when the aspect angle is a constant 0 or 3,200 mils during the tracking period (plots B and C, fig. 23 and 25).

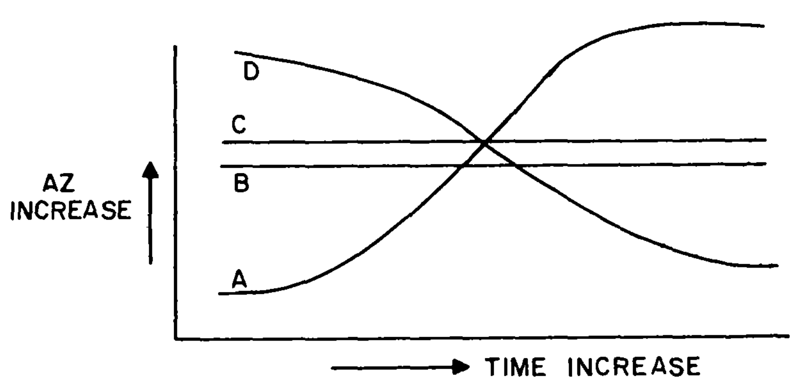


Figure 25. Corresponding azimuth traces.

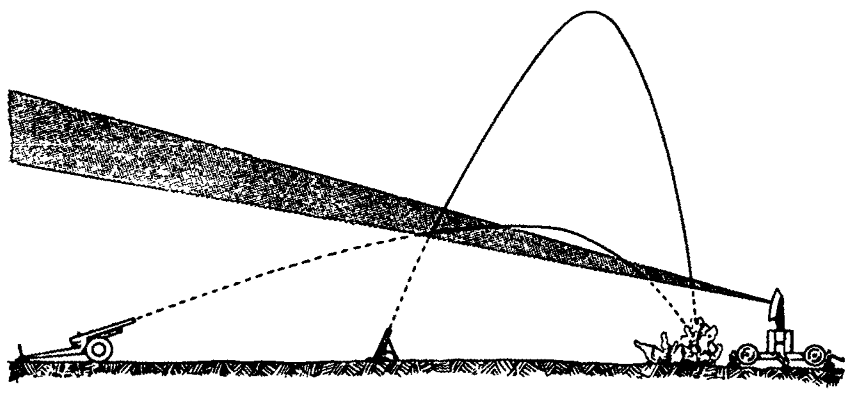


Figure 26. Comparison of mortar and gun trajectories.

e. The length of the azimuth segment traced on the plot depends on the length of time the projectile is tracked, the velocity of the projectile, and the aspect angle formed by the radar beam and the line of flight of the projectile.

f. The azimuth curve *always begins* and *ends* after the *range curve* because the *stylus is offset* on the recorder.

40. Low-Angle Plots

The procedure for interpreting mortar and high-angle artillery plots are particularly applicable to the interpretation of low-angle artillery plots. A few additional problems must be considered, however. Since the muzzle velocity of a low-angle weapon is higher than that of a mortar, and since the projectile may be fired in a lower trajectory with a relatively low maximum ordinate, the projectile is tracked by the radar for only a short time (fig. 26).

41. Detection of Low-Angle Artillery

The low angle of elevation at which artillery projectiles are fired makes it difficult to detect the projectile until it approaches its maximum ordinate. Because of the high velocity of the projectile and the slow scanning rate of the radar, the projectile echo may appear on the B-scope for only one sweep. The initial target pickup may be at a great distance from the weapon that fired it and the portion of the trajectory tracked will be small.

42. Characteristics of Low-Angle Artillery Plots

a. Because of the long range and high muzzle velocity of artillery, the resulting plots will show radical changes in range and/or azimuth (fig. 27). If the weapon is firing in the general direction of the radar location, the range changes will be great and the azimuth changes will be slight. When the weapon is firing across the front of the radar, the azimuth changes will be great and the range changes will be slight. If the weapon is firing between these extremes, both the range and azimuth traces will show a rate of change commensurate with the angle of crossing.

b. The muzzle velocity of the artillery weapon and the elevation fired will affect the shape of the height, azimuth, and range traces. Drag effects, as used herein, refer to the change in slope of the height, azimuth, and range traces caused by deceleration of the projectile from the time it leaves the muzzle and the time of impact. In general, the drag effect is greater for a high muzzle velocity

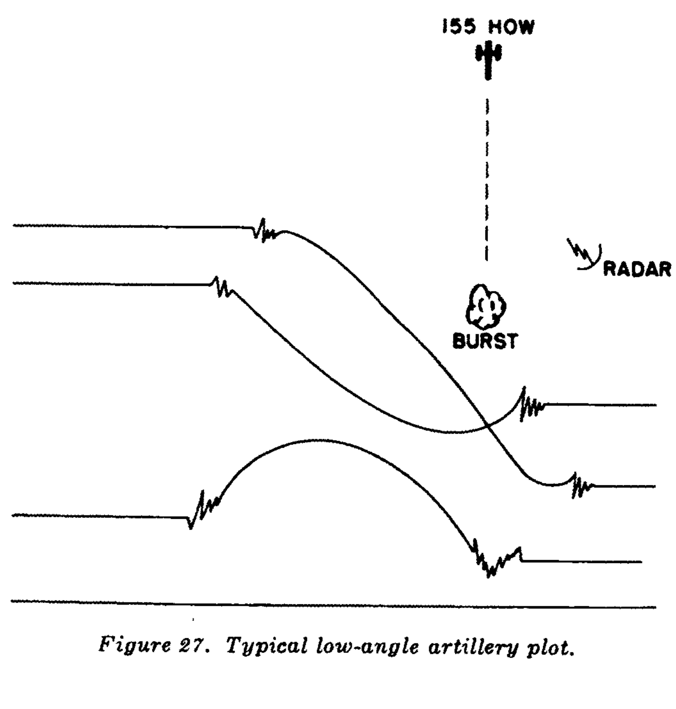


Figure 27. Typical low-angle artillery plot.

and long range than it is for a low muzzle velocity and short range. The drag effect is readily apparent in the height trace (fig. 27). A howitzer projectile will arrive at its maximum ordinate in less time than it will travel from the maximum ordinate to impact. A height plot obtained in this situation will have a steep ascending portion as compared to the descending portion shown.

Section IV. PLOT EXTRAPOLATION

43. Identifying the Traces

The recorder RD–54/TP has three movable styluses and one stationary, or fixed, stylus. The three movable stylus pens produce height, range, and azimuth traces. The stationary stylus produces the base of reference trace. The different stylus traces can very readily be identified by placing the base line of the plot-reading scale coincident with the base line of the plot. With the base lines coincident, the plot-reading scale is moved right or left until the height scale on the plot-reading scale intersects the starting point of the height trace (fig. 28). Since the scales on the plot-reading scale are laterally displaced in the same manner as the stylus carriages of the recorder (fig. 18), the range and azimuth traces can be identified by comparing the appropriate scales on the plot-reading scales with the starting points of the traces.

44. Base Line

The base line, or reference line (fig. 28) is produced on the plot by a fixed or a stationary stylus making a continuous trace on the plotting paper. The base line represents the location of the radar; therefore, it represents zero height (the altitude of the radar), zero range, and an azimuth determined by synchronization (para 21). When the plot-reading scale is used to measure range and azimuth from a plot (fig. 34), the base line of the plot-reading scale must be in coincidence with the base line of the plot.

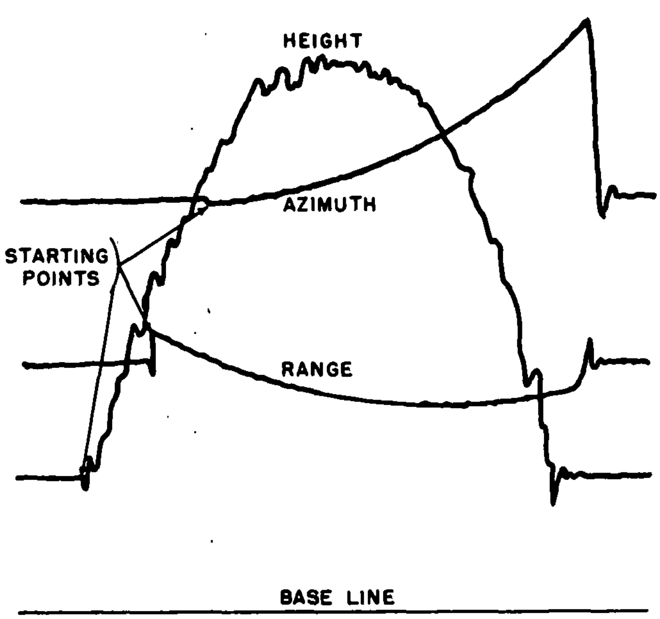


Figure 28. A typical mortar plot.

45. Height Trace

The height trace is the key to plot interpretation. Extension of the height trace to the base line will permit determination of the exact position of the projectile when it was at the same height as the radar. From that point, the range and azimuth to the projectile can be measured. These measurements are the polar coordinates from the radar to the weapon, excluding any difference in height.

a. Shape of the Height Trace. The projectile height is plotted by the recorder RD–54/TP in relation to time (paper speed) causing the height trace to be parabolic in shape (fig. 29). The size of the parabolic height trace depends on the maximum ordinate (height) of the projectile tracked. The HEIGHT FEET switch on the recorder RD–54/TP has two positions for the counterbattery AN/MPQ–10A radar: The MPQ 10 7,500 position is used for the lower trajectory weapons, and the MPQ 10 30,000 position is used for the higher trajectory weapons. The parabolic template (fig. 16), to be used to extend the height trace is determined by the position of the HEIGHT FEET switch (fig. 17).

b. Extending the Height Trace Plot. When the starting point has been determined, any pickup jump is eliminated, and the top of the parabolic template is fitted to the top of the height trace with the base of the template parallel to the base line of the plot (fig. 30). Place the thumb on the vertex of the template and the height trace and rotate the template about the vertex until the edge of the parabolic template coincides with the mean of the oscillations on the desired side of the height trace. With a hard, wedge-pointed pencil, draw a line along the edge of the template from the starting point to at least 2 inches below the base line of the plot (fig. 30).

c. Nonstandard Height Traces. If the radar tracking in range or elevation is not smooth, the

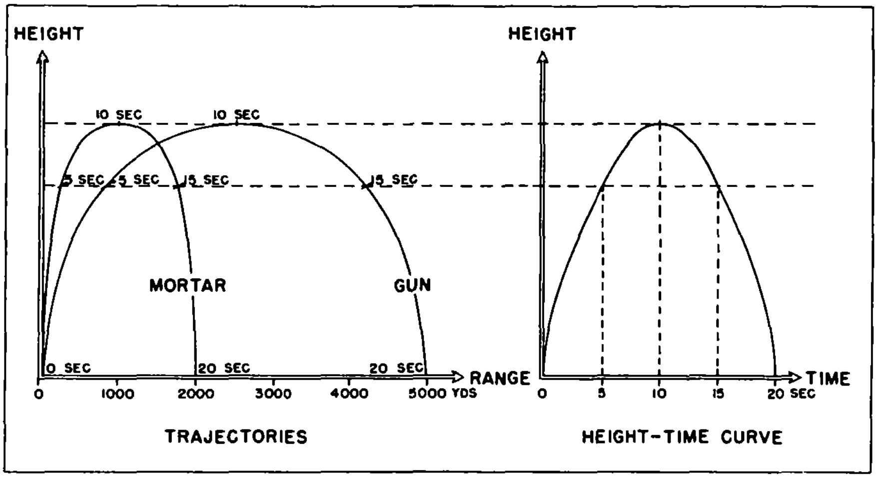


Figure 29. The relation between the projectile trajectories and a height-time trace.

height-trace may be erratic or contain excessive oscillations. This effect may be caused by poor pickup data, effect of clouds or ground clutter, or improper adjustment of the radar or the recorder RD–54/TP. Poor pickup data can be improved by increasing or decreasing the elevation, range, or azimuth as determined by analyzing the plot. Little can be done to eliminate the effect of clouds. At times, ground clutter can be eliminated by a slight increase in elevation. The radar mechanic normally can correct any maladjustments of the radar or recorder RD–54/TP. When the height trace obtained by tracking a mortar projectile is not parabolic in shape, the paper speed of the recorder RD–54/TP should be checked. Although some plots are considered nonstandard, they can still be extrapolated with accuracy. In these instances, the parabolic template is used as an aid in extending the height trace to best fit the erratic trace. Therefore, instead of the parabolic template being fitted to the height trace as a whole, it is fitted to the usable portion of the trace. Then the trace is extended along the edge of the template.

46. Range Trace

The range trace produced by the recorder RD–54/TP is a graphical representation of the

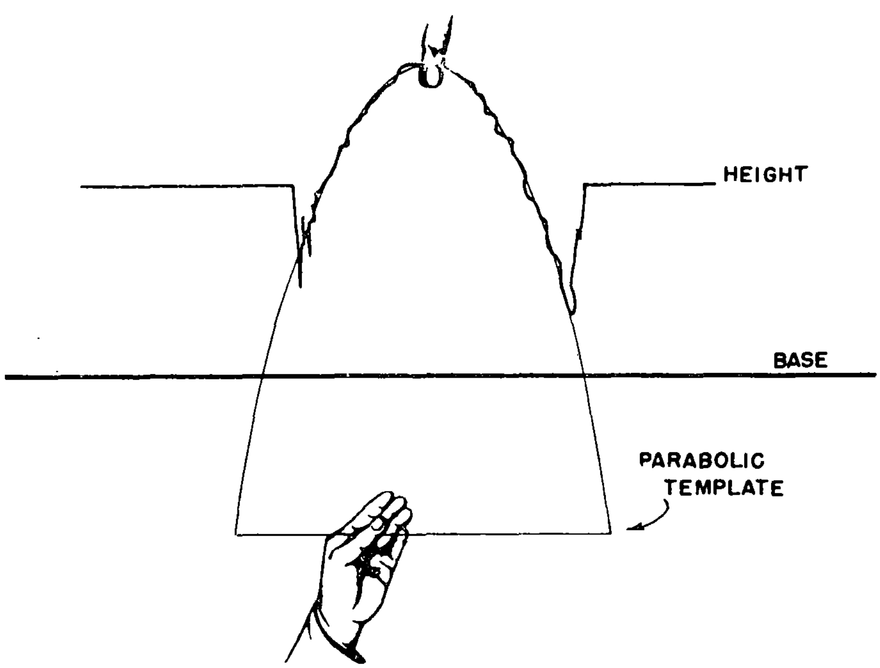


Figure 30. Extending the height trace.

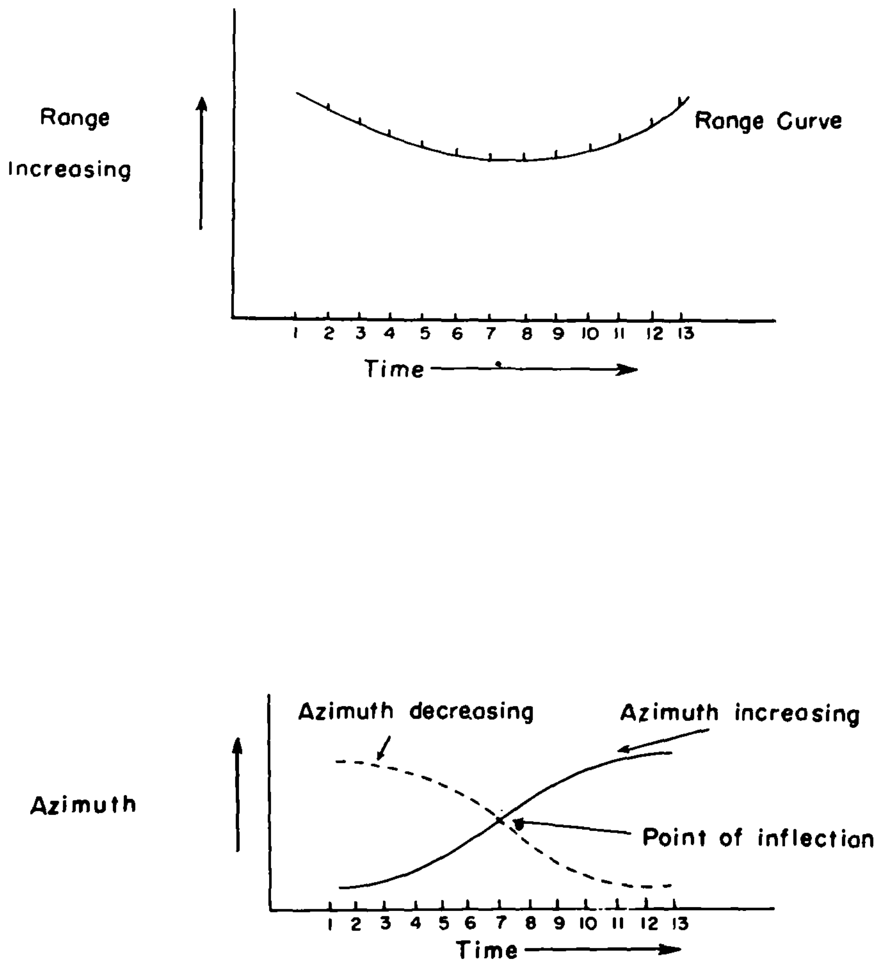


Figure 31. Typical range and azimuth traces.

horizontal range from the radar to the projectile being tracked. It is plotted against time. The horizontal range from the radar to the projectile at any given instant is represented by the vertical displacement of the range trace above the base line at that particular instant (fig. 31).

a. Shape of the Range Trace. The range trace may be a straight line (when the aspect angle is a constant 0 or 3,200 mils and the horizontal component of the velocity of the projectile is essentially constant during the tracking period), but it usually conforms to one of the traces shown in figure 24. The slope and curvature of the range trace depend on the velocity of the projectile and the angle formed by the radar beam and the line of flight of the projectile. The slope of the range trace represents the rate of change in horizontal range. For a specific velocity, the greatest rate of change in range (the steepest slope on the range trace) occurs when the aspect angle approaches 0 to 3,200 mils; the smallest rate of change in range (the flattest slope on the range trace) occurs when the aspect angle is 1,600 or 4,800 mils. When the aspect angle is 1,600 or 4,800 mils, the rate of change in range is zero, and a line tangent to the range trace at that point will be parallel to the base line (zero slope). Similarly, the slope of the range trace will be steeper for high velocity projectiles than for low-velocity projectiles. A change in the velocity of the projectile will cause the slope of the range trace to change. In the case of mortar projectiles, the change in curvature of the range trace caused by a decrease in the velocity of the projectile is negligible.

b. Extending the Range Trace. Any pickup jump present is eliminated and the starting point is determined. The parabolic template that best fits the range trace is fitted to as much of the range trace as possible so that the edge of the template coincides with the mean of the oscillations (fig. 32). When a parabolic template is used as a French curve to extend the range curve for a weapon location, the base of the template is always to the left. For a burst location, the base of the template is always to the right. With a hard, wedge-pointed pencil, draw a line along the edge

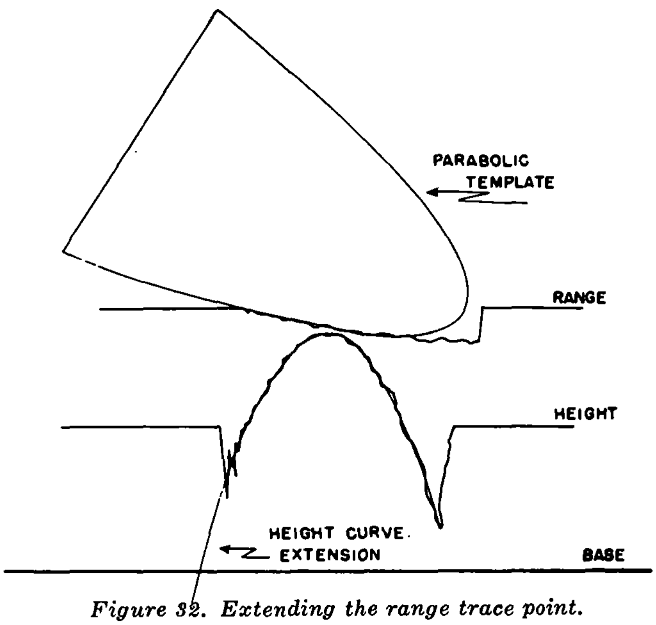


Figure 32. Extending the range trace point.

of the template continuing the same general curvature of the range curve plot. The curve is extended a sufficient distance to read the range with the plot-reading scale.

c. Nonstandard Range Curve Plots. The causes of a nonstandard range trace are similar to those of nonstandard height-curve plots (para 45*c*) and are dealt with similarly. Even though the range curve is erratic or contains excessive oscillations, it can still be extended with accuracy by following the procedure in *b* above.

47. Azimuth Trace

The azimuth curve produced by the recorder RD–54/TP is a graphical representation of the azimuth from the radar to the projectile being tracked. It is plotted against time. The azimuth from the radar to the projectile at any given instant is represented by the vertical displacement of the azimuth trace above the base line at that particular instant.

a. Shape of the Azimuth Trace. The azimuth trace may be a straight line parallel to the base line (when the aspect angle is a constant 0 or 3,200 mils during the tracking period), but it usually conforms to one of the traces shown in figure 25. The slope and curvature of the azimuth trace depend on the velocity of the projectile and the angle formed by the radar beam and the line of flight of the projectile. The slope of the azimuth trace represents the rate of change in azimuth. For a specific velocity, the smallest rate of change in azimuth (the flattest slope on the azimuth trace) occurs when the aspect angle approaches 0 or 3,200 mils; the greatest rate of change in azimuth (the steepest slope on the azimuth trace) occurs when the aspect angle is 1,600 or 4,800 mils. When the aspect angle is 0 or 3,200 mils, the rate of change in azimuth is zero, and the azimuth curve will be parallel to the base line (zero slope). Similarly, the slope of the azimuth trace will be steeper for high-velocity projectiles than for low-velocity projectiles.

b. Extending the Azimuth Trace. Any pickup jump present is eliminated and the starting point (fig. 28) is determined. The parabolic template that best fits the azimuth trace is used as a straightedge or French curve and the template is fitted to as much as possible of the azimuth trace so that the edge of the template coincides with the mean of the oscillations. In extending the azimuth trace for a weapon location, the base of the template is always to the left. With a hard, wedge-pointed pencil, a line is drawn along the edge of the template, continuing the same general curvature of the azimuth trace. The trace is extended a sufficient distance to read the azimuth with the plot-reading scale.

c. Nonstandard Azimuth Traces. The causes of nonstandard azimuth traces are similar to those which result in nonstandard height traces (para 45*c*) and are dealt with similarly. Even though the azimuth trace is erratic or contains excessive oscillations, it can still be extended with accuracy by following the procedure in *b* above.

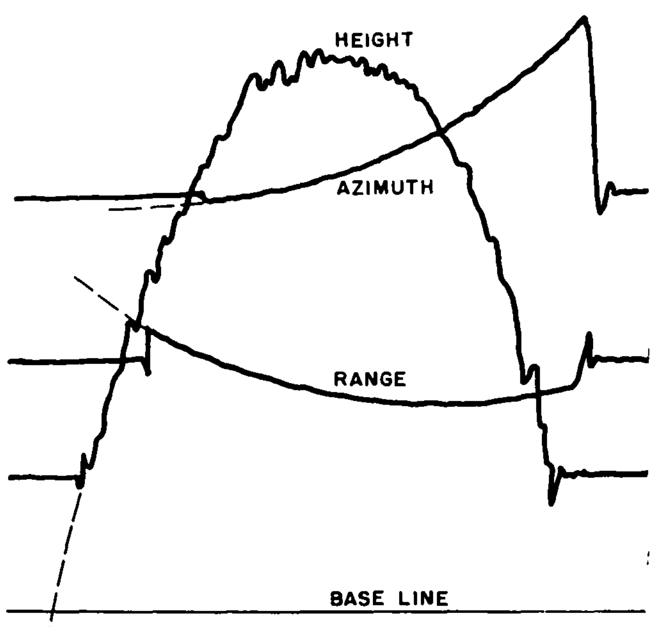


Figure 33. A typical extrapolated motar plot.

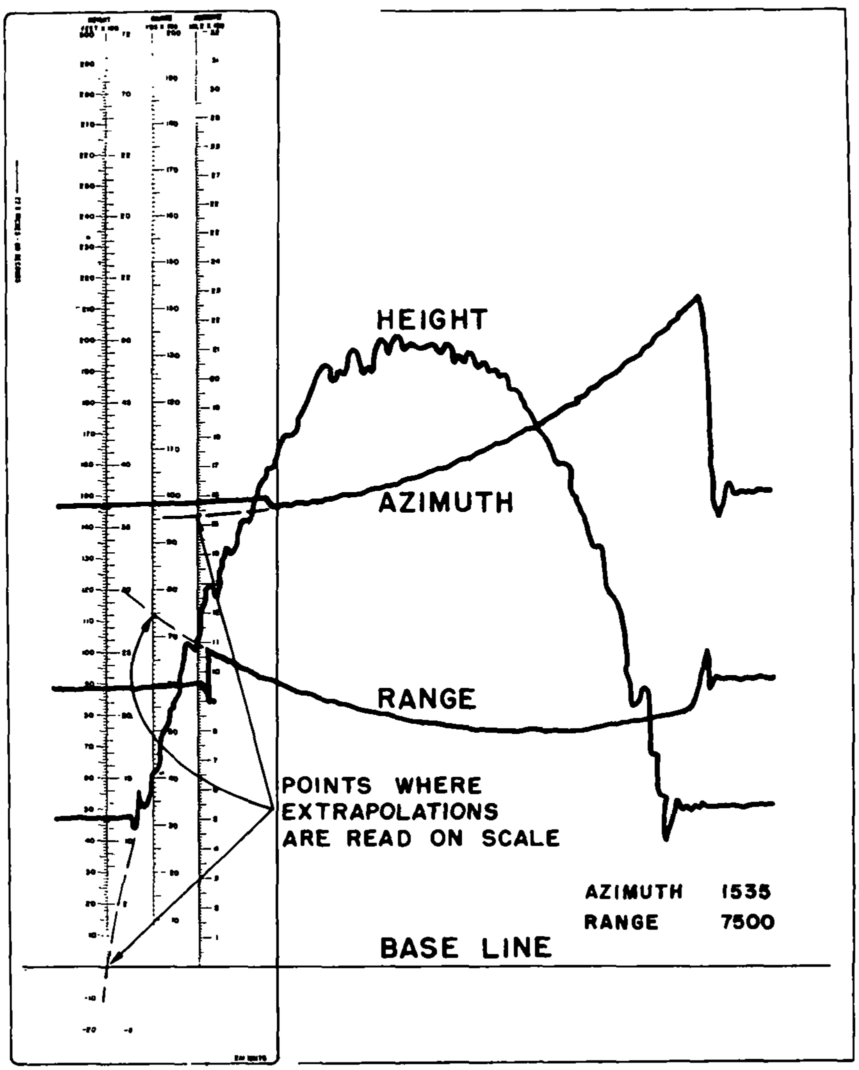


Figure 34. Weapon location data from plot made by recorder.

48. Plot Reading

a. The traces are extrapolated to the left (for weapon locations) to the point where time is zero. (The extrapolations are shown in figure 33 as broken lines.)

b. The plot-reading scale is fitted to the plot so that the height index (zero height) coincides with the point where the extended height trace intersects the base line (fig. 34). If there is a height calibration correction, the extended height trace must intersect the height scale at the height indicated by the correction.

c. The range and azimuth to the weapon are read under their respective scale (fig. 34). Calibration corrections are applied.

d. The range and azimuth read from the recorder plot are plotted on a contour map to determine the altitude of the weapon location.

e. If there is a significant difference (more than 20 feet on the 7,500-foot height scale or more than 50 feet on the 30,000-foot height scale) between the altitude of the weapon and the altitude of the radar, a corrected location must be determined (para 49) for the weapon.

f. The corrected range and azimuth are read under their respective scales after the plot-reading scale is adjusted to compensate for the difference in altitude between the weapon and the radar.

g. The weapon is replotted at the corrected range and azimuth.

h. The corrected altitude of the weapon location is then determined from the map.

i. The procedure in *f* through *h* above must be repeated until there is no significant difference between the last altitude of the weapon deter-

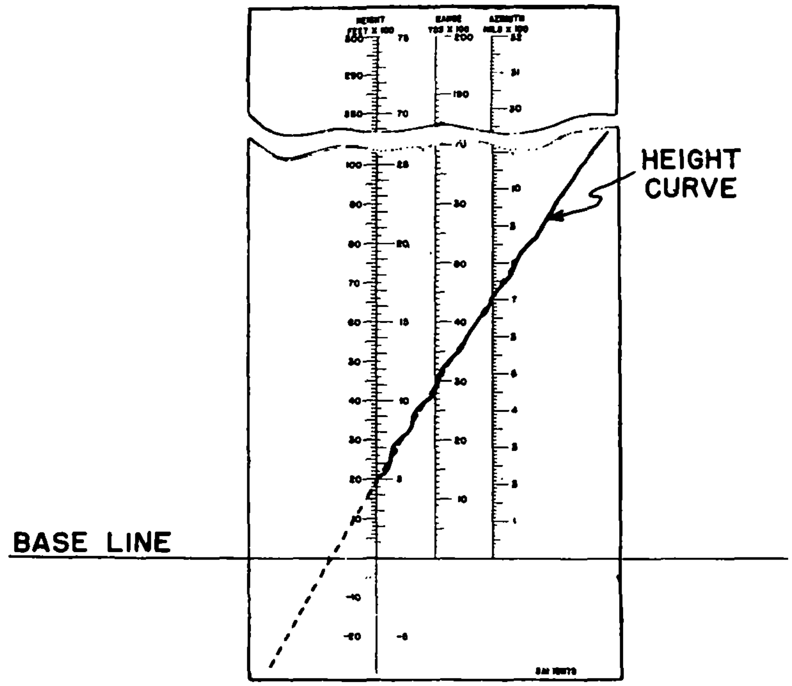


Figure 35. Plot and plot-reading scale with positive correction applied.

mined from the map plot and the previously determined altitude of the weapon.

49. Correcting for Difference in Height

a. General. The base line, or reference line, that appears on the plot produced by the recorder represents the height of the radar at any given point along the trajectory. The height trace is extended along the ascending portion to establish its point of intersection with the base line (fig. 32). This point of intersection is the point at which the zero height index of the plot-reading scale is positioned to read the plot. The range and azimuth that are read from the plot initially are accurate only if the radar and the weapon are at the same height.

b. Correcting for Height Difference. After the range and azimuth have been initially determined

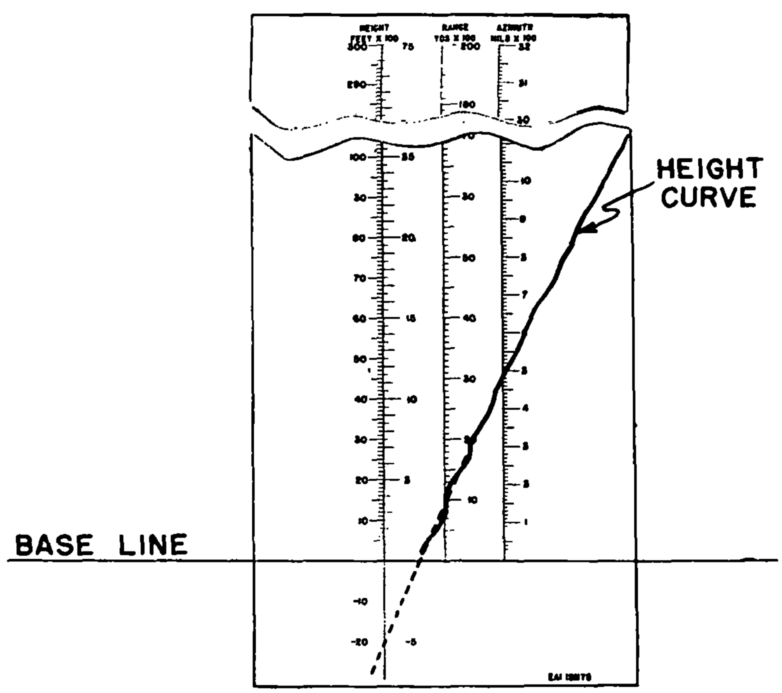


Figure 36. Plot and plot-reading scale with negative correction applied.

on the plot, the location is polar plotted on a contour map. The height of the plotted location is determined and compared with the height of the radar. If there is a substantial difference in successive readings (20 feet on the 7,500-foot height scale, 50 feet on the 30,000-foot height scale), the plot must be reread.

c. Application of Height Correction. The base line of the plot-reading scale is positioned coincident with the base line of the plot. To apply the difference in height to the plot-reading scale when the weapon is above the radar, the plot-reading scale is moved laterally to the right until the height scale intersects the height trace of the plot at the value of the difference (fig. 35). For a correction, when the weapon is below the radar, the plot-reading scale is moved laterally to the left until the negative portion of the height scale intersects the height plot (fig. 36). In either case, the azimuth and range are determined and replotted on the contour map. The number of times a plot must be reread depends on the slope or steepness of the terrain, the type of contour on the map, and the rate of range and azimuth change represented by the plot. If the plot indicates a rapid rate of change in azimuth and range, it is particularly important to reread the plot until the height difference between the assumed height and final height is within specified tolerances.

d. Example of a 7,500 Foot Height Scale.

	Az	Rg	Height of loc in ft	Height of radar in ft	Difference in height
1st reading	586	4,000	1,290	1,170	+120
The plus 120-foot correction is applied with the plot-reading scale, and the plot is reread.					
2d reading	596	3,960	1,275	1,170	+105

The second difference in height (+105 feet) is compared to the first difference in height (+120 feet). The difference is 15 feet, which is within the 20-foot allowable difference; therefore, the second azimuth and range are the polar coordinates to the weapon.

50. Accuracy of High-Angle Locations

Under normal operating conditions, high-angle locations can be determined with an expected radial accuracy of 0 to 50 meters. These standards of accuracy can be expected when a plot depicts as much as two thirds of the trajectory and the rate of change in the range and azimuth curves is small. Training and experience will enable the plot reader to estimate the accuracy of the weapon location with reasonable reliability. All weapon locations are reported, regardless of the estimated accuracy, together with a statement of the estimated accuracy.

51. Extension of Low-Angle Plots

a. Height Trace

(1) The speed of the artillery projectile decreases at a fairly constant rate of change until it is near the last third of the trajectory. At this point the force of gravity tends to compensate for the drag effect, causing the projectile to travel at an almost constant rate of speed.

(2) In the analysis of the traces for high angle plots, it is assumed that no drag effect exists and that the velocity of the projectile remains constant throughout its entire trajectory, producing a height trace that is parabolic in shape. The height traces produced by tracking projectiles fired at low angles are not exactly parabolic in shape because of the visible effects of drag and the fact that the velocity of the projectile does not remain constant throughout its trajectory. In order to extend the height trace through the base line, the parabolic template must be tilted slightly to best fit the appropriate side of the height trace.

(3) Because of the lower maximum ordinate, the initial pickup point will be near the maximum ordinate (highest point) of the trajectory; very little of the ascending portion of the height trace will be present. Therefore, the extension of the height trace through the base line will be difficult.

b. Range Trace. Since the artillery projectiles being tracked travel a great distance in a relatively short time, the range trace generally indicates a large rate of change. The exact degree of change is determined by the relation between the line of fire of the weapon and the position of the radar. The principle of extending the range trace is similar to that for high-angle plots. However, the extension of the range trace is more critical because of the large rate of change that usually is present. The range trace should be extended carefully from the curvature of the trace and proper plot analysis, since a slight variation will cause considerable error in the range determination. Correct plot analysis will make it possible to accurately extend the range trace.

c. Azimuth Trace. As in the case of high-angle plots, the extension of the azimuth trace is the most difficult to determine. The same general procedure used for high-angle plots is used for the extension of low-angle azimuth trace. However, the greater rate of change in the azimuth trace requires extreme care and skill in properly extending the azimuth trace. Drag and other effects of velocity are visibly present and only through correct plot analysis can an accurate extension be made. The location of the point of inflection must be determined and considered in the extension of the azimuth trace. If the point of inflection is not visibly present on the plot, an educated guess regarding its location will aid in the extension of the azimuth trace.

52. Improvement of Pickup Data

a. Since the height trace of a projectile tracked from a high point on its trajectory shows only a small portion of the ascending portion, an accurate location is impossible because of the necessity of extending the height, range, and azimuth traces. To record as much of the ascending portion of the trajectory as possible, the projectile must be tracked through a larger portion of its trajectory. Then a longer portion of the parabolic template can be applied to the traces and the accuracy of the plot data will be improved. To accomplish this, the operator must move the beam back along the trajectory in order to start tracking the projectile at a point closer to its origin. This method is called improvement of pickup, data.

b. To improve the pickup data, the height, range, and azimuth traces are extended the same as for the weapon location. The plot-reading scale is then repositioned along the base line of the plot so that the desired pickup height on the height scale is directly over the extension of the height trace. The distance that the scale is moved to the left to decrease the height of the original pickup point depends on the quality of the plot received (the shape and the amount of the ascending portion of the height trace) and the angle of elevation to the screening crest. When a new pickup height has been selected, the range and azimuth are read to this point and are set on the radar set control unit. The angle of elevation necessary for the new pickup point is obtained by the mil relation or determined graphically (fig. 37).

c. The graphical determination of data is the preferred method. The azimuth read from the plot at the new selected pickup height is set on the radar set control unit without any modification. The operator may use either a gridded map or a grid sheet and a range-deflection protractor to determine the elevation and slant range (fig. 38). He selects an arbitrary grid intersection and plots the range in meters along a horizontal grid line. The height read from the plot in feet is con-

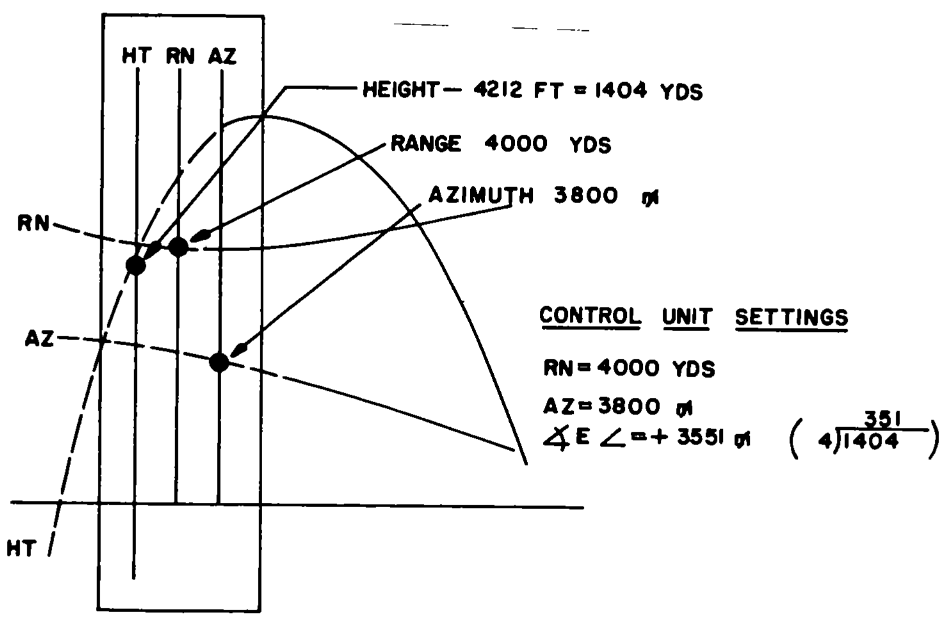


Figure 37. Improvement of pickup data.

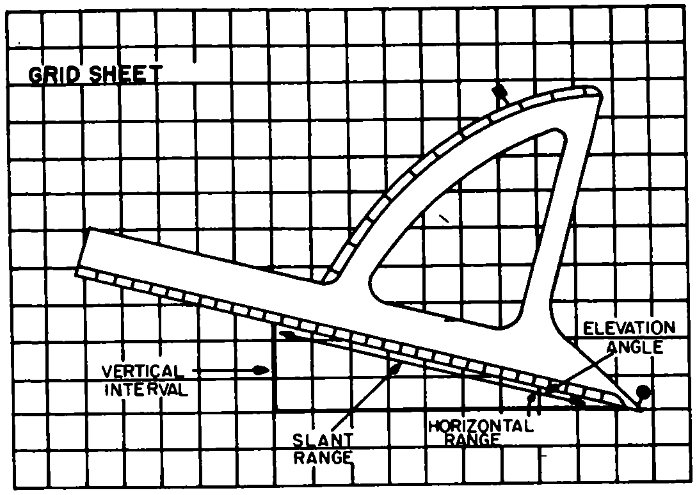


Figure 38. Graphic method of data determination.

verted into meters and plotted along the vertical grid line from the selected grid intersection. Then the range-deflection protractor is placed on the end of the range line and a plot is drawn away from the grad intersection. The angle from this horizontal range line to the top of the vertically plotted height is measured. This angle is the angle of elevation that is set on the control unit for the new pickup data. The slant range must be determined in yards and set on the radar set control unit.

53. Radial Line Method of Location

a. The radial line method is a substitute method of weapon location which has certain advantages when a desired degree of accuracy can not otherwise be obtained. A fairly accurate location can be made by using the radial line method, since it is possible to construct the line of fire of the weapon with only a small portion of the trajectory being tracked. With this information it is also possible to extrapolate the plot and determine the polar plot data. The procedure for the radial line method is as follows:

(1) Place the height scale of the plot-reading scale on the height trace at a point where the set actually tracked the projectile and near the pickup point.

(2) Read the range and azimuth at this point.

(3) Place the height scale of the plot-reading scale over a point on the height trace near the end of the plot, and again determine the range and azimuth.

(4) Plot from the radar position on the chart the range and azimuth to each of these two points on the chart from the radar position. Draw a straight line between these two points and extend the line in the direction to the weapon.

(5) Extend the range and height traces as for a weapon location. Read the range corresponding to zero height.

(6) With a pencil, mark the range read on the range-deflection protractor.

(7) Place the range-deflection protractor on the radar position and rotate it until the mark indicating the range intersects the line of fire constructed from the weapon. This point of intersection represents the location of the weapon. The accuracy of the line of fire is greatly improved by making additional readings on the plot between the two points mentioned.

b. Sometimes the azimuth trace will be extremely difficult to extrapolate. When great changes occur in azimuth and the point of inflection and the other elements make it almost impossible to accurately extend the azimuth trace, the radial line method can be used to determine an approximate azimuth.

54. Accuracy of Low-Angle Artillery Locations

The nature of a plot made in tracking a projectile in flight determines the accuracy of an artillery location determined by the use of the counterbattery radar set AN/MPO-10A. Low-angle weapon locations can be determined with an expected radial accuracy of 0 to 400 meters. Good accuracy may be expected from a plot in which the height curve depicts approximately two-thirds of the projectile's trajectory including a substantial portion of the ascending branch, and in which the range and azimuth curves change gradually.

The error of location is directly proportional to the amount of curvature in the range and azimuth traces and is inversely proportional to the amount of the trajectory depicted. Training and experience will enable the plot reader to estimate the accuracy of the weapon location with reasonable reliability. All weapon locations are reported with a statement of the estimated accuracy, regardless of the accuracy.

CHAPTER 5

RADAR GUNNERY

Section I. GENERAL

55. Types of Gunnery Missions Assigned to Counterbattery Radars

The counterbattery radar set AN/MPQ–10A can be used in an observer capacity to conduct high-burst and mean-point-of-impact registrations. The radar is also capable of locating the impact of a friendly artillery round and determining the shift necessary to move the round to a target.

56. Purpose of Registrations

a. If all conditions of materiel and weather were standard, an artillery weapon fired at a specific elevation would cause the projectile to travel a known distance as listed in the firing tables. A similar situation exists in the direction of fire for the weapons. However, the standard conditions of materiel and weather seldom exist at the same time and the projectile will rarely hit the target when fired with these standard data. The size of the error can be determined by firing either a mean-point-of-impact or a high burst registration.

b. For the *mean-point-of-impact (MPI) registration,* the fire direction center (FDC) selects a point of known location and designates it as a registration point. The location of this point is then sent to the radar section, where it is plotted on the radar chart. Since the counterbattery radar AN/MPQ–10A must track the projectiles to determine their impact locations, the point along the gun-target line at which the radar set will pick up the projectiles in flight must be determined from the radar chart. The mission of the radar section is to determine the average location (azimuth, range, and altitude) of the registration point at a selected datum plane, and send this information to the fire direction center.

c. For the high-burst (HB) registration, a time fuze is placed on each projectile so that it will detonate at a predetermined height above the ground. Since the bursts will be visible from the radar set, they can be observed through the optical telescope on the radar set. Pointing data must be determined so that the bursts will be visible through the telescope. Again the mission of the radar section is to determine the average location of the registration point (azimuth, range, and altitude) and report it to the fire direction center.

Section II. HIGH-BURST REGISTRATION

57. General

a. Purpose of a Radar Observed High-Burst Registration. The purpose of conducting a high-burst registration, as for any type of registration, is to obtain corrections for nonstandard conditions. The values of the elevation and the fuze setting given in the firing tables for a given range and charge are based upon standard conditions for air density, air temperature, powder temperature, weight of projectile, and wind. If these standard conditions do not exist at the time of firing, a projectile fired with a specific charge and a specific elevation will not burst at the range given in the firing tables. Because of this deviation, corrections are obtained so that the projectile will burst at a predetermined point. A radar observed high-burst registration is one method of determining these corrections.

b. Function of Radar in a High-Burst Registration, Radar-Visual Method. For the high-burst registration, six valid rounds are fired at a selected point in the air. Then the average of the slant range, the azimuth, and the elevation from the radar to the six air bursts are determined. The slant range and elevation are then used to determine the altitude of the mean-point-of-burst. The radar set electronically determines the ranges to the bursts, and the azimuth and elevation deviations are determined by looking through the telescope on the radar set.

c. Function of Radar in a High-Burst Registration Radar-Recorder Method. For the high-burst registration, six rounds with time fuzes are fired at a point in the air. Each round is automatically tracked by the radar to the point of burst, and a plot is produced by the recorder. Each plot is examined to determine the range and azimuth from the radar to the point of burst and the altitude of the point of burst above the ground. By averaging the six ranges, azimuths, and altitudes obtained from the plots, the location of the mean-point-of-burst is determined. Corrections are then computed in the same manner as they are for the radar-visual method of high-burst registration.

58. Prerequisites to Firing a Radar-Observed High-Burst Registration, Radar-Visual Method

The prerequisites for firing a radar-observed high-burst registration to be conducted by the radar-visual method are as follows:

a. The radar must be collimated, oriented, and range calibrated.

b. The locations of the radar and the registration point must be known.

c. The bursts must be visible through the radar telescope. To insure this, the radar is sited so that the angle of elevation to the screening crest is not more than 40 mils. In general, the smaller the angle of elevation to the screening crest, the better the registration; however, to reduce clutter, the angle of elevation to the screening crest should be at least 15 mils.

d. The selected location of the high burst must be in a clutter free area.

e. The RECEIVER GAIN switch on the radar set control unit is set in the MANUAL position.

f. Pointing data are determined by the radar section.

g. The operator manually positions the radar antenna (reading the dials on the tracker mount) in azimuth and elevation so that the antenna and orienting telescope are pointing at the point in the air where the rounds are expected to burst. The anticipated range to the bursts is set on the SLANT RANGE dial on the radar set control unit, and the cursor is positioned −500 yards on the J-scope.

59. Message to Observer

When the fire direction center (FDC) decides to fire a high-burst registration observed by radar, the mission is initiated by transmitting to the radar section a message-to-observer. This is a standard message which furnishes to the radar section the information needed to conduct the mission. The elements of the message are explained below:

a. Warning Order. The warning order consists of the phrase OBSERVE HIGH BURST. It orders the radar section to begin preparations to observe and indicates the type of registration that will be fired.

b. Unit to Fire. The unit to fire consists of the word FOR followed by the call sign or other identification of the unit that will fire the mission. The identification of the unit to fire may include the type of unit and its location, if this information is not otherwise available to the radar section.

c. Location. The location consists of the word GRID followed by the coordinates of the announced registration point.

d. Minimum Altitude. The minimum altitude consists of the words MINIMUM ALTITUDE, followed by the minimum altitude, in meters, which the FDC will accept for the registration. (The radar section will compute the altitude at which the registration will be fired.) The minimum altitude will normally be 2 probable errors in height above the terrain.

e. Altitude Report. The altitude report consists of the phrase REPORT ALTITUDE. This reminds the radar section to report the altitude of the announced high-burst point as soon as it is computed. The FDC needs this information to determine the fuze setting.

f. Report Order. The report order consists of the phrase REPORT WHEN READY TO OBSERVE. This order directs the radar section to report to FDC when all preparations have been made and the radar section is ready to conduct the mission.

60. Pointing Data and Altitude of the Announced High-Burst

a. When a message to observer is received by the radar section, it is recorded in the upper left margin of DA Form 3526.

b. The pointing data consist of the azimuth, range, and elevation from the radar set to the announced high-burst location. The coordinates announced in the message to observer are plotted on the radar chart.

(1) The azimuth is measured directly from the chart to the nearest mil and recorded on DA Form 3526.

(2) The range is measured directly from the chart to the nearest 10 meters, the nearest 10 yards and both are recorded on DA Form 3526. The range in yards is set on the radar set as the pointing range. The range in meters is used in computing the altitude of the high burst.

(3) The elevation is 10 mils above the screening crest along the pointing azimuth. It is determined by sighting through the telescope and is recorded on DA Form 3526.

c. The altitude of the announced high burst location is computed as soon as the pointing data are employed by adding the radar altitude to the vertical interval (VI). The vertical interval is obtained by multiplying the angle of elevation times the range in thousands of meters.

(1) The computed altitude is reported to the FDC. This message consists of the word ALTITUDE, followed by the altitude.

(2) If the computed altitude is below the announced minimum, the minimum altitude will be used. A new pointing elevation must be computed and entered on DA Form 3526. The VI is the difference between the announced minimum altitude and the radar altitude. The mil relation is employed (VI divided by range in thousands of meters) to compute the new pointing elevation.

61. Conduct of a Radar-Observed High-Burst Registration, Radar-Visual Method

a. Personnel. The four crewmen required for a high-burst registration are the—

(1) Radar set control unit operator.

(2) Telescope observer.

(3) Radar plotter.

(4) Recorder.

b. Preparation Phase.

(1) The preparation phase begins when the radar section receives the message to observer and ends when the section reports READY TO OBSERVE.

(2) The radar plotter—

(*a*) Records the message to observer on DA Form 3526 (fig. 39).

(*b*) Plots the announced registration point.

(*c*) Determines and records the pointing data (para 60*b*).

1. Measures the azimuth and announces it to the telescope observer.

2. Measures the range (yards and meters) and announces the range in yards to the radar set control unit operator.

3. Adds 10 mils to the screening crest elevation announced by the recorder.

(*d*) Determines the altitude of the high-burst location (para 60*c*) and immediately reports it to the FDC.

(*e*) When all members of the section have completed the required checks and preparations, transmits REQUEST SPLASH, AT MY COMMAND, READY TO OBSERVE to the FDC.

(3) The telescope observer and the recorder position themselves at the tracker mount. The telescope observer takes a position on top of the range computer. The recorder takes a position where he can observe the azimuth, elevation, horizontal range, and altitude dials.

(*a*) The recorder places the ANTENNA RELEASED-NORMAL switch in the RELEASED position.

(*b*) The recorder manually elevates the antenna to allow the telescope observer to check the level of the radar set.

(*c*) The telescope observer checks the level of the radar set.

(*d*) The recorder and telescope observer check the orientation (para 17) of the radar set.

(*e*) The recorder and telescope observer determine the elevation to the screening crest along the pointing azimuth. The recorder announces this elevation to the radar plotter and positions the antenna 10 mils above the screening crest.

(*f*) When the pointing azimuth and elevation have been set on the antenna and both the recorder and telescope observer are ready, the recorder announces READY TO OBSERVE to the radar plotter.

(4) The radar set control unit operator will set the pointing range on the radar set control unit.

c. Orientation Phase.

(1) The orientation phase begins when the first round is fired and ends when REPEAT is sent to the FDC to cause the second round to be loaded. The objective is to insure that the center of the telescope is pointed near the point where the rounds will burst. If the deviation is more than 10 mils left, right, or above the center of the telescope, the antenna will be moved to the burst (in both azimuth and elevation). The antenna will never be lowered. If the burst appears more

RADAR-OBSERVED HIGH-BURST (*RADAR VISUAL*) REGISTRATION

For use of this form, see FM 6-160; the proponent agency is the U.S. Continental Army Command.

STEP 1: MESSAGE TO OBSERVER	STEP 2: INITIAL POINTING DATA	STEP 3: ALTITUDE OF INITIAL REGISTRATION POINT
1. RADAR (CALL SIGN)	8. AZIMUTH (Nearest 1 mil) 685	14. RANGE (9) (In thousands) 7.84
2. OBSERVE HB	9. RANGE (Nearest 10 meters) 7840	15. ELEVATION (13) 29
3. FOR Loud Thunder 18	10. RANGE (Nearest 10 yards) (9) X 1.094 8580	16. VI (14 X 15) 227
4. GRID 6540	11. ELEVATION TO SCREENING CREST 19	
5. MINIMUM ACCEPTABLE ALTITUDE 420	12. + 10 MILS 10	17. ALTITUDE OF RADAR (Meters) 380
6. REPORT ALTITUDE	13. ELEVATION (Nearest 1 mil) (11+12) 29	18. ALTITUDE OF REGISTRATION POINT (16+17) 607
7. REPORT WHEN READY TO OBSERVE		

STEP 4: REPORT TO FDC

ALTITUDE (18) 607 , AT MY COMMAND, REQUEST SPLASH, READY TO OBSERVE

STEP 5: RECORDING AND COMPUTATION

RD NO.	FROM J-SCOPE RANGE DEVIATION SHORT (−)	OVER (+)	FROM TELESCOPE AZIMUTH DEVIATION LEFT (−)	RIGHT (+)	ELEVATION DEVIATION BELOW (−)	ABOVE (+)
1	160		4		4	

If necessary, adjust pointing data and correct blocks 8, 9, 10, and 13.
Note 1: If the pointing range (10) in yards was changed due to the orienting round, the pointing range (9) in meters must be corrected.

RD NO.	SHORT (−)	OVER (+)	LEFT (−)	RIGHT (+)	BELOW (−)	ABOVE (+)
2	90			5		5
3	140			9	2	
4	90			7		5
5	80		1			6
6	130			5	1	

Note 2: After six valid rounds, report END OF MISSION to FDC

	TOTAL SHORT (−)	TOTAL OVER (+)	TOTAL LEFT (−)	TOTAL RIGHT (+)	TOTAL BELOW (−)	TOTAL ABOVE (+)
	690		5	26	7	16

19. RANGE DEVIATION = ALGEBRAIC TOTAL OF SHORTS (−) AND OVERS (+) −690	20. AZIMUTH DEVIATION = ALGEBRAIC TOTAL LEFT (−) AND RIGHT (+) +21	21. ELEVATION DEVIATION = ALGEBRAIC TOTAL BELOW (−) AND ABOVE (+) +9
22. ± 115 (Yards) 6/690 (19)	26. ± 3.5 6/21 (20)	30. ± 1.5 6/9 (21)
	27. (26) (Nearest 1 mil) +4	31. (30) (Nearest 1 mil) +2
23. (22) X 0.914 (Meters) −105	28. (8) 685	32. (13) 29
24. (9) (See note 1) 7840	29. HB AZIMUTH (Algebraically add 27 and 28) 689	33. HB ELEVATION (Algebraically add 31 and 32) 31
25. HB RANGE (Algebraically add 23 and 24) 7740		

STEP 6: FINAL REGISTRATION POINT ALTITUDE	STEP 7: REPORT TO FDC
34. HB RANGE (25) (In thousands) 7.740	39. REPORT ON RADAR-OBSERVED HIGH-BURST FOR Loud Thunder 18
35. HB ELEVATION (33) 31	40. TIME OBSERVED 1300 hrs
36. VERTICAL INTERVAL (34 X 35) 240	41. DIRECTION (HB azimuth) (29) 689
	42. DISTANCE (HB range) (25) (Nearest 10 meters) 7740
37. ALTITUDE OF RADAR (Meters) (17) 380	43. GRID OF REG PT (Nearest 10 meters) 6488 3995
38. ALTITUDE OF REGISTRATION POINT (36 + 37) 620	44. ALTITUDE (38) 620

DA FORM 1 AUG 59 3526 REPLACES DA FORM 6-39, 1 NOV 55, WHICH IS OBSOLETE.

Figure 39. A completed DA Form 3526.

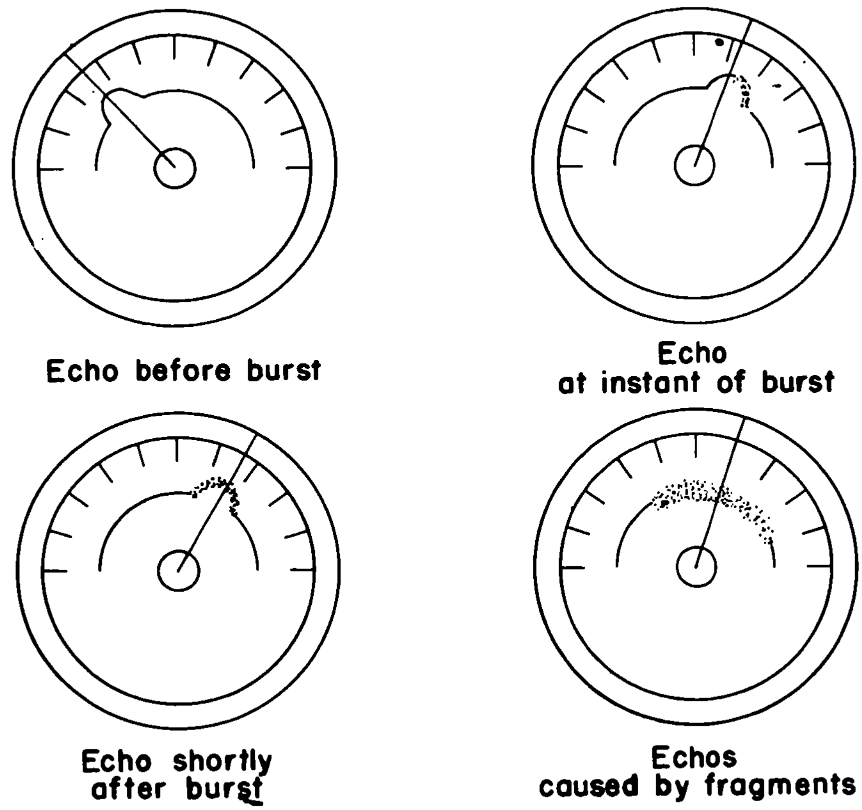


Figure 40. J-scope presentation of projectile echo.

than 5 mils below the center of the telescope, the FDC must be notified that the burst is too low.

(2) The radar plotter

(*a*) Relays SHOT, OVER and SPLASH to the telescope observer.

(*b*) Records the range deviation reported by the radar set control unit operator.

(3) The telescope observer observes the round and announces the deviations to the recorder, who enters them on DA Form 3526. If new pointing data are required, the recorder

(*a*) Announces the new pointing data to the radar plotter.

(*b*) Changes the pointing data on the DA Form 3526.

(c) Repositions the antenna on the new pointing data.

(4) The radar set control unit operator tracks the echo on the J-scope, using the J-scope cursor. He must insure that the cursor is over the center of the echo when the round bursts (fig. 40). The range deviation is read from the J-scope and announced to the radar plotter.

d. Observation Phase.

(1) The observation phase begins when the pointing data are changed or are determined to be correct and ends when the radar section has recorded the required number (normally six) of usable rounds. If the antenna or the range handwheel has been repositioned, the orientation round cannot be used in subsequent computations.

(2) As the radar set control unit operator determines and announces the range deviation for each round, the radar plotter records these deviations on DA Form 3526. As the telescope observer determines and announces the azimuth and elevation deviations for each round, the recorder records these deviations on DA Form 3526. The recorder continually checks the azimuth and elevation dials to insure that the antenna has not been moved off the pointing data.

(3) The recorder and the radar plotter examine their data to determine if an erractic round exists. If one round differs greatly in azimuth, elevation, or range from the remaining rounds, it will be eliminated. After six usable rounds have been obtained, END OF MISSION is transmitted to the FDC.

e. Computation Phase.

(1) The computation phase begins when data for six usable rounds have been recorded. Only the radar plotter and the recorder are in-

volved in computing the location of the registration point. Both crewmen, working separately, compute the average azimuth, the average range, and the altitude (in meters) for the high-burst registration point (fig. 39).

(2) The average azimuth deviation is algebraically added to the pointing azimuth to obtain the azimuth to the high burst.

(3) The average range elevation is algebraically added to the pointing range to obtain the range, in yards, to the high burst. This range must be converted in meters before it is reported to the FDC.

(4) The average elevation deviation is algebraically added to the pointing elevation to obtain the angle of elevation to the high burst. The mil relation is employed (elevation times range in thousands of meters) to compute the VI. The altitude of the radar plus the VI equals the altitude of the high burst.

(5) When both crewmen have agreed on the computations, the radar plotter polar-plots the location of the high burst registration point on the radar chart and determines the grid coordinates. Radar can provide the location of the high burst either by grid coordinates and altitude; by direction, distance, and altitude from the radar; or by direction, distance, and vertical angle to each

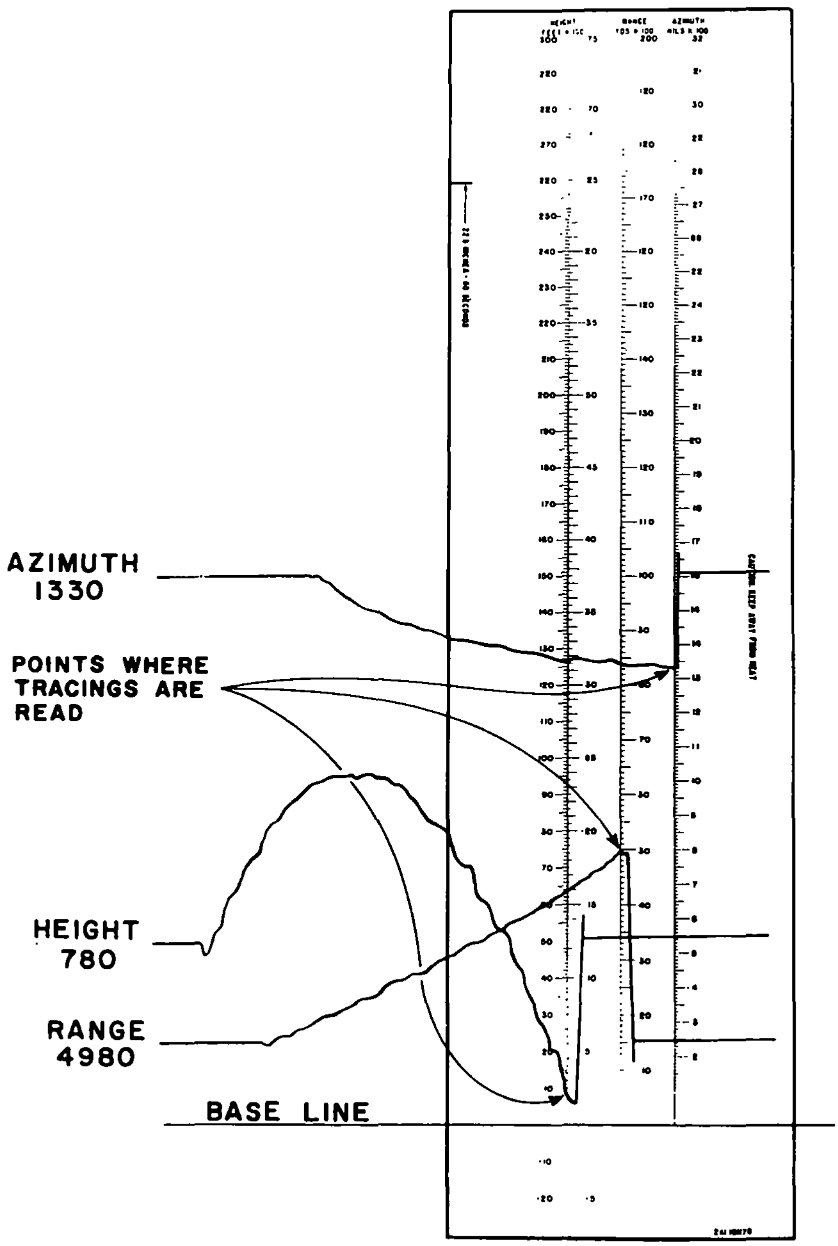


Figure 41. High-burst location data from plot made by recorder.

burst. The radar plotter reports the location of the high burst registration point to the FDC as follows:

(*a*) REPORT ON HIGH BURST.

(*b*) FOR (unit call sign) ____.

(*c*) TIME (time of completion of firing) ____.

(*d*) GRID (coordinates) ____________.

(*e*) ALTITUDE ________________.

62. Radar-Observed High-Burst Registration, Radar-Recorded Method

a. When the radar section is unable to observe a high-burst registration, the azimuth, range, and vertical interval to the high burst may be determined from the recorder RD–54/TP plots.

b. Each round must be tracked. Pickup data are determined as described in paragraph 67.

c. In addition to the radar preparations listed in paragraph 58, the recorder RD–54/TP must be synchronized and calibrated.

d. Duties of the crewmen are very similar to those described in paragraph 68. The radar set control unit operator must place the MASTER AUTO-MANUAL switch in the MANUAL position at the instant the round bursts. DA Form 3527 is used to compute the radar-observed high burst registration, radar-recorder method.

e. Plots are read at the point of burst to determine the height, range, and azimuth (fig. 41). Calibration corrections are applied to the averages computed.

63. Advantages and Disadvantages

a. Advantages. The radar observed high burst registration has certain advantages over a visually observed high burst registration. These advantages are that less survey, communication, and coordination, are necessary and, consequently, less time, and fewer personnel are required. In addition, the radar recorder method can be employed during periods of poor visibility.

b. Disadvantages. In the radar-visual method, the bursts must be visible from the radar. In the radar-recorder method, the radar must have a line of sight to the point of burst. There is also a requirement for a screening crest of 15 to 40 mils to reduce clutter. These requirements limit the position areas, particularly in mountainous terrain.

Section III. MEAN-POINT-OF-IMPACT REGISTRATION

64. General

a. Purpose of a Radar-Observed Mean-Point-of-Impact Registration. The purpose of conducting a mean-point-of-impact registration at a selected datum plane, as for a high-burst registration, is to obtain corrections for the transfer of fire. Radar observation is one method of determining these corrections.

b. Function of Radar in a Mean-Point-of-Impact Registration. During a mean-point-of-impact registration at a selected datum plane, six rounds with impact fuze are fired at a selected point on the ground. Each of the six rounds is automatically tracked by the radar, and a plot is produced by the recorder. Each of the plots is examined to determine the range and azimuth from the radar to the projectile at a selected height above the radar. This selected height is called the selected datum plane. By averaging the ranges and azimuths obtained from the plots, the location of the mean of the six rounds fired is determined. Corrections are then computed in the same manner as for a radar-observed high-burst registration.

65. Prerequisites for Firing a Radar-Observed Mean-Point-of-Impact Registration

The prerequisites for firing a radar-observed mean-point-of-impact registration are as follows:

a. The radar must be collimated, oriented, and range calibrated.

b. The relative location of the radar, the registering weapon, and the registration point must be known.

c. In general, the accuracy of corrections obtained by a radar-observed mean-point-of-impact registration is increased by tracking each projectile to the lowest height possible along its trajectory. Since ground clutter renders automatic tracking ineffective as the projectile approaches the screening crest, the angle of site to the screening crest should be between 15 and 40 mils.

d. The control settings and switch positions are the same as those for a weapon location.

e. Pickup data are determined by the radar section. Automatic tracking is facilitated by firing the projectiles at a high angle of elevation and with a low charge. Generally, the artillery fire direction officer (FDO) will desire to register with a high charge and at a low angle of elevation. A compromise is effected so that the mean-point-of-impact registration is fired at the highest angle of elevation and the lowest charge possible to meet both the requirements of the radar set and the fire direction officer (FDO). It is necessary to track the projectile only throughout the descending portion of its trajectory. The pickup data (para 67) are determined by plotting.

66. Message to Observer

As for a high-burst registration, the mission is initiated by a message to observer. The elements of the message are—

a. Warning Order. The warning order consists of the phrase OBSERVE MEAN-POINT-OF-IMPACT.

b. Unit to fire. The unit to fire consists of the word FOR followed by the identification of the unit to fire.

c. Location. The location consists of the word GRID followed by the coordinates of the announced registration point.

d. Calibre of weapon. The calibre of weapon is needed for the radar section to select the proper tabular firing table.

e. Charge. The charge consists of the word CHARGE, followed by the charge to be fired. The radar section uses the charge to select the proper trajectory chart.

f. Quadrant. The quadrant consists of the word QUADRANT followed by the quadrant to be fired by the base piece. The radar section uses the quadrant to enter the trajectory chart.

g. Report Order. The report order consists of the phrase REPORT WHEN READY TO OBSERVE.

67. Pickup Data

a. The pickup point is the point along the trajectory at which the radar will begin tracking. It should be as close to the muzzle of the weapon as possible. It must be "visible" to the radar, and it must be in a clutter-free area. A point which will generally meet these requirements is 1,000 meters along the trajectory.

b. Pickup data consist of the azimuth, range, and elevation to the pickup point.

c. The six items of information needed to determine pickup data are—

(1) Location of the radar.

(2) Location of the battery to fire.

(3) Location of the announced registration point.

(4) Type of weapon to fire.

(5) Charge to be fired.

(6) Quadrant elevation to be fired.

d. The radar, battery, and registration point must be plotted on the chart. A line from the battery to the registration point represents the trajectory. The pickup point is plotted 1,000 meters from the battery along this line.

e. The azimuth and range (yards and meters) from the radar to the pickup point are measured directly from the chart and recorded on DA Form 3527 (fig. 42).

f. To compute the angle of elevation to the pickup point, the altitude of the pickup point must be known. The height of the projectile at a point 1,000 meters along the trajectory may be determined from the trajectory chart. The sum of this vertical interval (VI) and the altitude of the firing battery is the altitude of the pickup point. This altitude may be provided by FDC. The difference between the altitude of the pickup point and the altitude of the radar is the VI used to determine the elevation. The mil relation formula is used (VI divided by range in thousands of meters) to compute the elevation of the pickup point, which is recorded on DA Form 3527. If the angle of elevation exceeds 600 mils, this solution is inaccurate and the elevation must be determined by graphical plotting (FM 6–40).

68. Conduct of a Radar-Observed Mean-Point-of-Impact Registration

a. Personnel. The four crewmen required for a mean-point-of-impact registration are the:

(1) Radar set control unit operator.

(2) Recorder operator.

(3) Radar plotter.

(4) Plot reader.

b. Preparation Phase.

(1) The preparation phase begins when the radar section receives the message to observe and ends when the section reports READY TO OBSERVE.

(2) The radar plotter

(*a*) Records the message to observer on DA Form 3527 (fig. 42).

RADAR OBSERVED MEAN POINT-OF-IMPACT OR HIGH-BURST (*RADAR-RECORDER*) REGISTRATION

For use of this form, see FM 6-160; the proponent agency is the U.S. Continental Army Command.

Step 1: MESSAGE TO OBSERVER	Step 2: INITIAL PICKUP DATA	
1. Observe (check applicable box) ☐ HB ☒ MPI	10. Azimuth (nearest 1 mil) 662	17. Pickup elevation 288.8 1.62) 468 (Block 16) (Block 11 in thousands)
2. For (unit or call sign) A Btry	11. Range (nearest 10 meters) 1620	
3. Grid 5940	12. Altitude of gun (meters) 368	
4. Minimum acceptable altitude (HB only)	13. Height of projectile above gun 450	18. If block 17 exceeds 600 mils, recompute using the graphical or trigonometric solution.
5. Caliber of weapon 105	14. Altitude of pickup point (block 12 + block 13) 818	
6. Charge 6	15. Altitude of radar (meters) 350	19 Pickup data set on control unit: Azimuth (block 10) 662 mils Elevation (block 17) 289 mils Range (see note 1) 1770 yards
7. Quadrant 420	16. Height of pickup above radar (block 14 – block 15) 468	
8. Report altitude (HB only)		
9. Report when ready to observe	Note 1: Obtained by multiplying block 11 times 1 094 or measuring directly off grid sheet using plotting scale.	

Step 3: REPORT TO FDC

Altitude (HB only) ______, AT MY COMMAND, REQUEST SPLASH (HB ONLY), READY TO OBSERVE

Step 4: COLLECTING AND RECORDING DATA

Round number	Height deviation: Lowest height tracked (MPI only)	Height deviation: Height (HB only)	From Radar Plots: Azimuth — Read at selected datum plane height 300 (block 20) (MPI only)	From Radar Plots: Range
1	290		143	6710
2	270		146	6720
3	280		144	6730
4	260		145	6760
5	290		148	6720
6	280		149	6710

Note 2: After six valid rounds, report END OF MISSION to FDC

20 SDP height	21. Total height	22. Total azimuth	23 Total range
300 (See note 3)		875	40350

Note 3: When the recorder is set on the 7,500-foot scale, determine the highest height recorded in column 20. If not an even multiple of 50 feet, round up to the next higher 50 feet. Example: Highest height recorded is 320 feet, round up to 350 feet When the recorder is set on the 30,000-foot scale, determine the highest height recorded in column 20. If not an even multiple of 100 feet, round up to the next higher 100 feet. Example: Highest height recorded is 420 feet, round up to 500 feet. Enter the result as the SDP height (block 20).

Step 5: COMPUTATION

24. Azimuth 6) 875 (block 22) = 146
25. Block 24 146
26. Recorder azimuth calibration correction –1
27. RP azimuth (algebraically add blocks 25 and 26) 145
28. Range 6) 40350 (block 23) = 6725
29. Block 28 6725
30. Recorder range calibration correction –20
31. RP range (yards) (algebraically add blocks 29 and 30) 6705
32. RP range (meters) (block 31 x 0.914) 6128

Altitude (HB only)	Altitude (MPI only)	Step 6: REPORT TO FDC
33. Altitude (HB only) 6) ___ (block 21)	41. Selected datum plane height (20) 300	48. Report on radar observed HB (MPI)
	42. Recorder zero height calibration correction –30	49. Time observed 0930
34. Block 33	43. Algebraically subtract block 42 from block 41 330	50. For A Btry
35. Recorder zero height calibration correction	44. SDP height (feet) (block 43) 330	51 Direction (RP azimuth) (block 27) 145
36. Algebraically subtract block 35 from block block 34	45 RP height (meters) (block 44 x 0.305) 101	52. Distance (RP range) (nearest 10 meters) (block 32) 6130
37. RP height (feet) (block 36)		
38. RP height (meters) (block 37 x 0 305)	46. Radar altitude (meters) 350	53. Grid of RP (nearest 10 meters) 5381048250
39. Radar altitude (meters)	47. RP altitude (block 45 + block 46) 451	
40. RP altitude (block 38 + block 39)		54. RP altitude (HB, block 40, MPI, block 47) 451

DA FORM 1 AUG 69 3527 REPLACES DA FORM 6-40, 1 NOV 55, WHICH IS OBSOLETE.

Figure 42. A completed DA Form 3527.

(*b*) Plots the firing battery on the radar chart.

(*c*) Plots the announced registration point.

(*d*) Determines and records the pickup data (para 67) and announces the pickup data to the radar set control unit operator.

(*e*) If the maximum ordinate is greater than 2,000 meters, the plot reader must be informed so that he can shift the recorder RD–54/TP to the 30,000 foot scale.

(*f*) When all required checks have been completed, reports AT MY COMMAND, READY TO OBSERVE to the FDC.

(3) The radar set control unit operator

(*a*) Checks the range calibration.

(*b*) Assists the recorder operator in calibrating the recorder RD–54/TP (unless it has been calibrated within the past 4 hours).

(*c*) Sets the pickup data on the radar set control unit. If clutter appears at the pickup point, he notifies the radar plotter.

(4) The recorder operator

(*a*) Calibrates the recorder RD–54/TP (unless it has been calibrated within the past 4 hours).

(*b*) Records the calibration corrections on the plot-reading scale.

(*c*) Checks the paper speed.

(*d*) Insures that sufficient paper is on the roll to produce 10 plots.

(5) The plot reader assists the other operators, as required.

c. Orientation Phase. The orientation phase begins when the first round is fired and ends when the round has been tracked and a usable plot has been produced. If the first round is not tracked or if a usable plot is not produced, immediate corrective action must be initiated.

d. Observation Phase.

(1) The observation phase begins when the first usable plot has been produced and ends when six usable plots are labeled, examined, and smoothed. After six usable rounds have been observed, END OF MISSION is sent to the FDC.

(2) The radar set control unit operator tracks each round.

(3) The recorder operator removes each plot from the recorder.

(4) The radar plotter relays commands and messages between the FDC and the radar section.

(5) The plot reader labels and smooths the three traces on each plot.

e. Plot Reading Phase.

(1) The plot reading phase consists of two distinct phases. The first is the determination of the selected datum plane (SDP) and the second is the determination of the range and azimuth from the radar to the point of impact in the selected datum plane for each round.

(2) Using the plot-reading scale, the plot reader determines for each plot the lowest heights at which the radar was still tracking in the height, range, and azimuth channels. He announces the round number and the lowest height tracked to the radar plotter and to the recorder operator, who records it on DA Form 3527.

(3) The lowest height common to all rounds is the highest of the six low heights recorded. The lowest height common to all rounds is rounded upward (to the next higher 50 feet when using the 7,500-foot scale and to the next higher 100 feet when using the 30,000-foot scale) to determine the height of the SDP.

(4) The plot reader reads the range and azimuth at the height of the SDP from each plot. Calibration corrections are ignored. The radar plotter and the recorder operator record the range and azimuth from each plot on the DA Form 3527.

(5) The altitude of the SDP is computed as follows:

(*a*) Algebraically *subtract* the zero height decreasing correction from the rounded off value of the lowest common height. Convert the height to meters.

(*b*) Add the altitude of the radar to obtain the altitude of the SDP.

f. Computation Phase.

(1) The radar plotter and the recorder independently compute the direction and range to the registration point.

(2) Calibration corrections are added algebraically to the average range and average azimuth.

(3) The corrected range must be converted to meters.

(4) When both crewmen have agreed on the computations, the radar plotter polar-plots the location on the radar chart, obtains the grid coordinates, and reports the location of the mean-point-of-impact registration point to the FDC. This report will contain the following elements:

(*a*) REPORT ON CENTER-OF-IMPACT.

(*b*) FOR (unit call sign)

(*c*) TIME (time firing completed)

(*d*) GRID (coordinates)

(*e*) ALTITUDE (meters)

69. Advantages and Disadvantages

a. Advantages. When visibility is poor, the radar-observed mean-point-of-impact registration may be the only available method of registering the artillery. The radar-observed mean-point-of-impact registration has the same advantages over solely visual methods as the radar-observed high-burst registration (para 63).

b. Disadvantages. When the recorder RD–54/TP is used, additional errors are introduced. These errors result from inherent errors in the recorder RD–54/TP and from human errors in smoothing out the traces and reading the plot. More time is required to conduct a mean-point-of-impact registration at a selected datum plane than a radar-observed high burst registration. Suitable position areas a may be difficult to locate since the screening crest (15 to 40 mils) must be as low as possible to achieve the best registration results.

Section IV. ADJUSTMENT OF FIRE

70. Radar Preliminaries

a. Since the radar set will be used for adjustment of fire in essentially the same manner as it is used in a weapon location, the preliminaries are similar. However, the radar set does not have to be collimated or oriented with survey data.

b. The pickup data are determined by placing the antenna in sector scan, as it is for a weapon location mission.

71. Conduct of the Mission

a. When the radar section is to be employed in a fire adjustment role, the call for fire and subsequent corrections sent to the fire direction center (FDC) will contain all the information that is needed to process the fire mission. The elements of the message should be sent in the order discussed in the following sample mission.

(1) *Observer identification.* RED BANNER 18, THIS IS RED BANNER 28.

(2) *Warning order.* FIRE MISSION.

(3) *Location of target.*

(*a*) The direction from the radar to the target, to the nearest 10 mils, is sent.

(*b*) The location of the target can be expressed in several ways.

1. Polar data. When the target location is given as polar coordinates, the direction and distance (in meters) from the radar to the target are sent in this order; e.g. DIRECTION 4,310, DISTANCE 6,800.

2. Mark center-of-sector. If the radar and the firing battery are not located by survey, an accurate target location cannot be sent to the fire direction center. To establish a point of known location from which a shift can be made, the firing battery is requested to fire a round at the center of the sector of fire. The observer requests MARK CENTER-OF-SECTOR, DIRECTION (so much).

3. Shift from a known point. If no map is available and the FDC does not know the location of the radar, the next preferred method is a shift from a known point. In order to qualify as a known point, the exact location of the point must be known to the radar and the FDC and the point must be plotted on the radar chart and on the firing chart at the FDC. A shift from a known point is given as LEFT or RIGHT and as ADD or DROP to move the point of impact from the known point to the target. The shift may be determined by computation or from the target grid on the radar chart. When a target location is announced as a shift from a known point, the sequence begins with the point from which the shift is being made, then the DIRECTION, then the movement in deviation to the right or left, and finally the movement in range to add or drop. For example, FROM REGISTRATION POINT 1, DIRECTION 6,300, LEFT 2,000, ADD 3,060.

4. Mark registration point. If the radar is not on survey control, the FDC can be requested to mark the registration point. To mark a registration point for a radar, one weapon of the battery will fire single rounds at the registration point. The radar section must know the general direction of the registration point and the time the weapon is to fire on the registration point. By pointing the radar set in the general direction of the battery and tracking the rounds, the point of impact of the projectile can be determined. This location, which is the registration point, should be plotted on the radar chart. It is a point of known location and can be used during the radar adjustment of fire on future target locations. The mark registration point method is better than the mark center-of-sector method because of the determination of firing data. The FDC has the firing data used to hit the registration point. When a round must be fired to provide a point of known location from which a shift can be made, a request to mark the registration point should be sent to the FDC. The DIRECTION to the target must also be announced; for example, MARK REGISTRATION POINT, DIRECTION 6,300.

5. Grid coordinates. Radar is used to adjust fire on a point of known coordinates only in isolated situations, since the procedure is time consuming. If available other faster observation means are utilized. When a target location is sent by coordinates, the coordinates and azimuth are sent in the following order: GRID 23456789, DIRECTION 6,300.

(4) *Nature of target.* A weapon located by radar should be described as a mortar or as high- or low-angle artillery. The radar section would indicate HIGH-ANGLE ARTILLERY FIRING.

(5) *Type of adjustment.* An artillery adjustment normally is conducted with two guns of the battery firing at the same time. When the adjustment is conducted with radar, only one round is needed and the command ONE GUN is always included in the type of adjustment. Depending on the quadrant elevation applied to the tube of the weapon, there are two types of trajectories—low angle and high angle. A low-angle trajectory will be fired unless the radar section specifies high-angle fire.

(6) *Control.* Since the radar section must track the rounds to determine their burst locations, it is essential that they control the firing. They transmit AT MY COMMAND to indicate to the fire direction center that the weapons are to fire only when commanded by the radar section. The radar section also indicates that they will adjust the fire to the target by announcing ADJUST FIRE.

b. An example of the procedure and the prowords used in a call for fire request is shown below:

Radar: RED BANNER 18, THIS IS RED BANNER 28, FIRE MISSION, OVER.

FDC: FIRE MISSION, OUT.

Radar: MARK CENTER-OF-SECTOR, DIRECTION 4,960, OVER.

FDC: MARK CENTER-OF-SECTOR, DIRECTION 4,960, OUT.

Radar: MORTAR FIRING, ONE GUN, HIGH ANGLE, AT MY COMMAND, ADJUST FIRE, OVER.

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

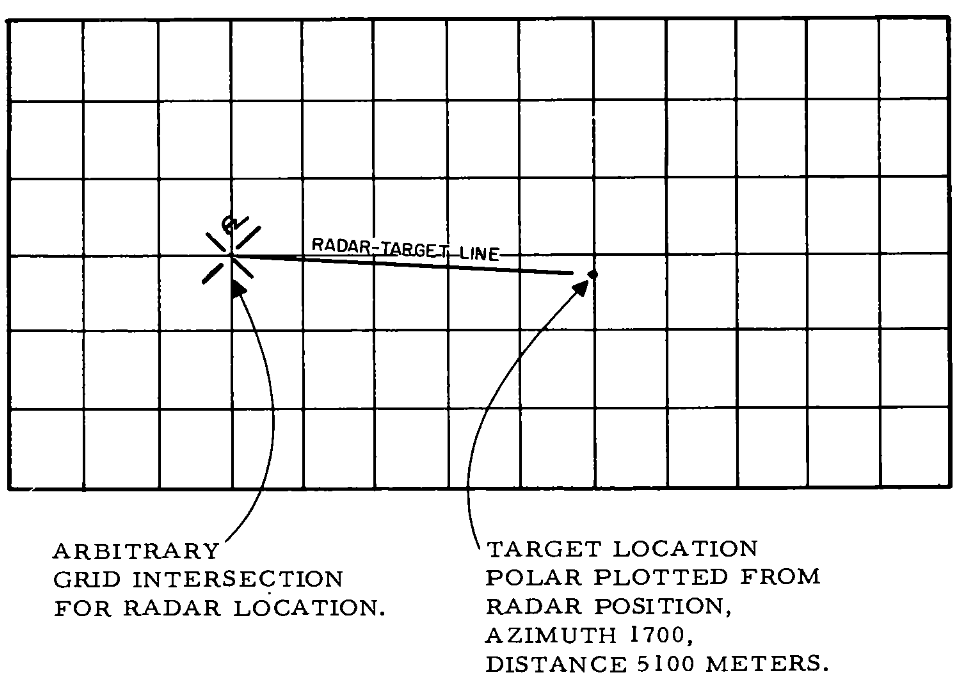


Figure 43. Plotting the target location on the radar chart.

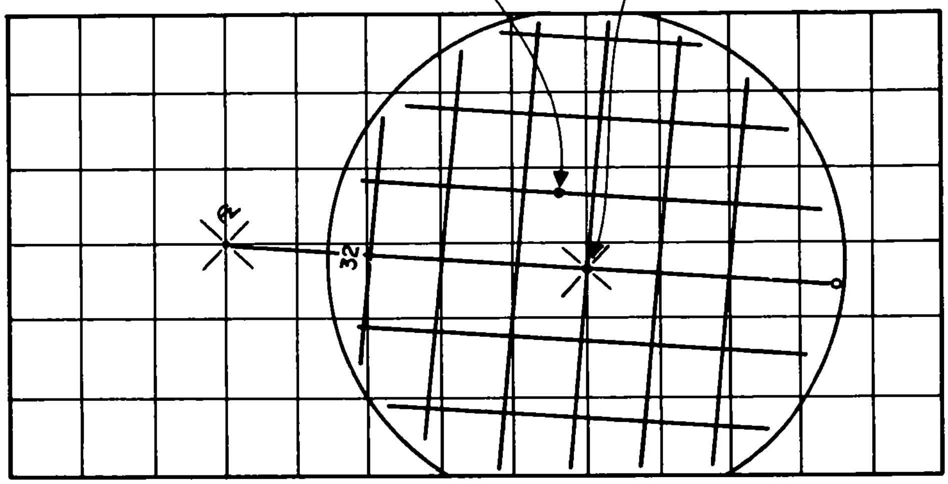


Figure 44. Orientation and use of target grid.

c. The FDC computes the necessary data to fire as requested in the call for fire request and sends this information to the battery to fire. The FDC also sends a message to the radar section containing the three elements described below and any modification to the call for fire request.

(1) *Batteries to fire for effect*—An element which tells the radar section which firing batteries will fire in the fire for effect phase.

(2) *Rounds in fire for effect*—An element which tells the radar section the number of rounds that will be fired by each piece in fire for effect.

(3) *Target number*—An element which assigns the target number to the target. The target should be plotted on the radar chart for future reference as a point of known location.

d. An example of a message to the observer is shown below. In the fire direction center, the decision was made to fire shell, white phosphorous instead of shell, high explosive.

FDC: BATTALION, ONE ROUND, SHELL WP, TARGET RQ502, OVER.

Radar: BATTALION, ONE ROUND, SHELL WP, TARGET RQ502, OUT.

e. When the weapons have been loaded and are ready to fire, the FDC transmits the following message to the radar section: BATTERY IS READY. When the radar is prepared and ready, the radar section commands FIRE, and the weapons are fired. The radar set control unit operator detects the projectile echo on the B-scope and determines the pickup point. The radar section reports to the FDC: REPEAT. Upon receiving the report READY, the radar section chief alerts the radar set control unit operator and then commands FIRE. (The command FIRE must be given to the FDC each time a round is requested.) This round is tracked, and, by extrapolating the plot, the plot reader determines the burst location of the projectile. The location of this burst (direction and range) is compared with the location of the target, and corrections are computed to place subsequent rounds on the target. After the corrections have been computed by the radar section, they are sent to the FDC in the following manner:

(1) Corrections are given for lateral deviation from the radar-target line to the nearest 10 meters; e.g., LEFT (RIGHT) 200.

(2) Corrections are given to increase or decrease the range along the radar-target line to the nearest 10 meters; e.g., ADD (DROP) 200. If no change in range is desired, the command REPEAT is sent.

f. When the burst is within 100 meters of the target, the radar section gives a final correction and requests FIRE FOR EFFECT. On receipt of this request, the weapons are fired to destroy or neutralize the target. When the rounds have burst END OF MISSION is sent to the FDC.

72. Determining Corrections

A target grid is used to determine the corrections to be sent to the fire direction center.

a. It is not necessary to know the location of the radar to use the target grid. An arbitrary grid intersection can be used as the location of the radar. Care must be used in selecting the grid intersection to insure that the locations of targets and subsequent corrections can be plotted on the chart (fig. 43).

b. When a target is located with the radar set AN/MPQ10A, the polar plot data from the radar are plotted on the grid sheet (fig. 43).

c. The target grid is placed over the target location with the center of the target grid coinciding with the target location.

d. To determine corrections, it is necessary to orient the 0–3200 line on the target grid along the radar-target line. After the target grid has been oriented, it will not be moved during the mission.

e. When a burst has been located, it is polar plotted on the grid sheet. Corrections are determined by counting the meters left (right) and over (short) with reference to the radar-target line (fig. 44).

73. Advantages and Limitations

The advantages and limitations of adjusting fire by radar are as follows?

a. Advantages.

(1) Radar can be used to adjust artillery fire when visibility is limited.

(2) No survey is required.

b. Limitations.

(1) Radar adjustment of fire is slow, since the plots from the recorder RD–54/TP must be extrapolated and read and the burst location must be plotted on a grid sheet before corrections can be determined.

(2) The effect of the friendly artillery rounds on the target cannot be seen.

(3) The radar must be located so that the angle of elevation to the screening crest is between 15 or 40 mils.

CHAPTER 6

MOVING TARGET DETECTION

74. General

When the mission of the radar section is moving-target detection, the radar must have a line of sight to the areas of suspected enemy activity. Since the required line of sight is not a characteristic of a position suitable for locating weapons, the radar section must occupy a new position. The new position is occupied at night or during periods of poor visibility. After the occupation of the position has been completed, the radar is oriented on a predetermined orienting point. If a known point is not available, it is necessary to use an aiming circle equipped with a night lighting device.

75. Technical Considerations

a. General. When the radar is automatically tracking an aerial target, the spinner motor is rotating the antenna dipole and producing a conical beam. The conical beam is not desirable for moving target detection. Before the radar can be used for moving target direction, the spinner motor must be turned off by the radar mechanic. This step is performed prior to occupation of position.

b. Beam Offset. During collimation, the optical axis of the telescope is positioned within the center and parallel to the conical beam. When the spinner motor is inoperative, the dipole is automatically polarized horizontally with the outer dipole to the right (fig. 45). This effect causes an offset of approximately 27 mils between the optical axis and the electrical axis of the radar beam. The optical axis is used to orient the radar, and the electrical axis is used to detect the moving target. Compensation is made for the 27-mil offset by adding 27 mils to the orienting azimuth.

c. Example. The azimuth to a night orienting stake is 4,000 mils. The chief of sections sets 4,027 mils on the azimuth dials of the tracker mount and refers to the orienting stake with the orienting telescope. When orientation has been completed, the azimuth dial on the control unit indicates the azimuth of the radar beam.

76. Operation

a. While performing moving-target detection, the spinner motor is inoperative and the antenna is stationary; therefore, only one limited area can be observed at a time. If surveillance of more than one area is desired, the radar beam is directed at one area for a short time and then shifted to another area until all likely areas have been covered. To conduct surveillance over a designated area, the radar set control unit operator sets the predetermined range, azimuth, and elevation on the appropriate dials. The AUTO-MANUAL switch must be in the MANUAL position and the RECEIVER GAIN control must be adjusted to a point where the ground clutter is at a minimum. The RECEIVER GAIN control setting should not be altered during the surveillance of a target area.

b. Since the radar beam is directed into the ground at the point where surveillance is desired considerable clutter or ground echoes will appear on the J-scope (range) (fig. 46). The operator has no ways of knowing whether these echoes represent terrain features or manmade stationary objects. However, if something moves in the area under surveillance, a target echo appears. The characteristic pip representing the target contains within it a large number of fine "cobweb-like" lines fluttering back and forth. Only moving targets produce the spiderweb effect.

c. By close study, an experienced operator can extract information from a moving target echo. The approximate range, azimuth, and elevation to the moving target can be read directly from the dials. The operator can tell in which direction the target is moving by manually tracking it. If the target is moving away from the radar, the echo moves clockwise about the range scope; if the target is moving toward the radar, the echo moves counterclockwise about the range scope. An indication of target speed can be obtained by noting the range or azimuth change in a given pe-

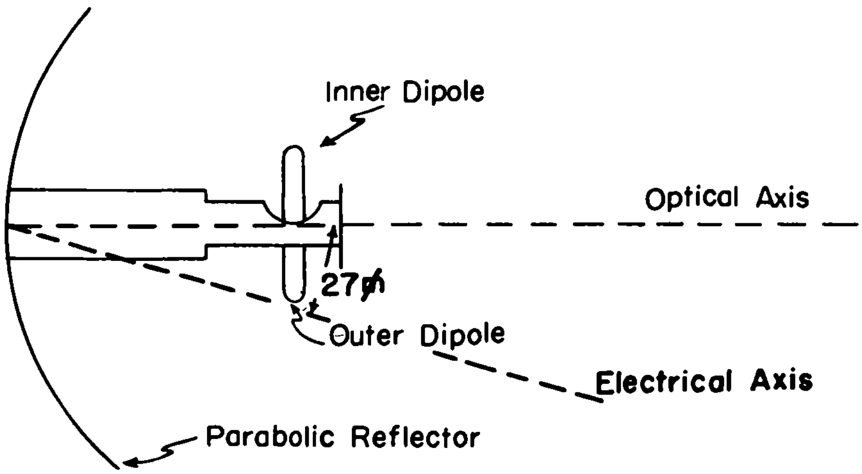


Figure 45. Top view of antenna system with the dipole at rest.

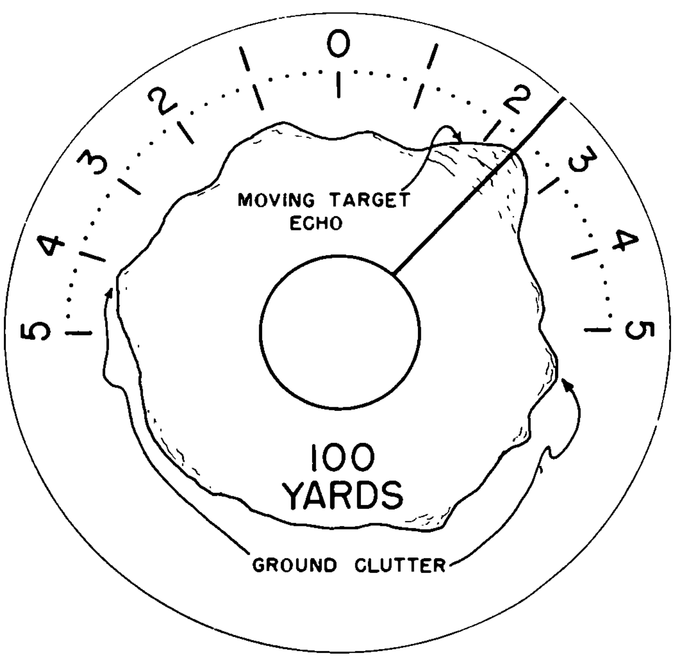


Figure 46. J-scope presentation of target area showing ground clutter.

riod of time. If the target is moving in a direction perpendicular to the beam, the echo presents a change in azimuth. It is necessary for the radar set control unit operator to track the target manually by making small azimuth movements with the azimuth handwheel, keeping the target echo maximized on the range scope. If several moving targets are spaced from 40 to 50 yards apart in range, several echoes will appear on the J-scope and the radar operator should be able to count them. In some cases, the operator may be able to determine the relative size of the targets by studying the relative size of the echoes from targets at approximately the same range. An experienced operator may be able to tell whether the moving targets are vehicles or personnel, or both, by a close study of the speed and size of the echoes. Moving personnel will cause a coarse fluctuating echo; a faster moving target will cause a fine-grained cobweb echo.

77. False Indications

a. Some characteristic moving-target echoes appearing on the range scope will be false indications or tricks of nature. Any one of the following conditions may cause false indications: wet or snow-covered foliage in a breeze, rain or snow, or heat waves and other atmospheric conditions.

b. The false indications will not fool the experienced operator. An echo that is intermittent and presents no change in range or direction is probably a false indication. A target that "jumps" in range and direction could be caused by certain atmospheric conditions but not by vehicles or personnel. Rain or snow will cause the entire range scope to be covered with moving-target echoes.

CHAPTER 7

POSITION FIXING AND VECTORING OF AIRCRAFT

Section I. POSITION FIXING

78. General

The accuracy of analysis and restitution of aerial photographs is considerably improved by the successful position fixing of the Army photographic aircraft at the exact moment the photographs are taken. The AN/MPQ-10A counterbattery radar can be employed to determine position fixes without altering the normal organization or equipment of the radar section. Position fixing can be conducted by direct communication between the radar section and the aircraft with no other operational agencies involved. The radar sites used for locating weapons can also be used for position fixing.

79. Prerequisites for Position Fixing

a. The tracker mount is leveled, oriented, collimated if possible, and located by survey.

b. Range calibration is checked (para 18 and 19).

c. The recorder is synchronized and calibrated. The 115V AC ON-OFF switch on the height servo amplifier is placed in the OFF position and the stylus carriage is positioned at the 7,000-foot mark on the 7,500-foot scale.

d. Individual range corrections are applied to the plot-reading scale (para 22*b*). Azimuth corrections are applied at the center of sector (para 22*c*).

e. Control settings are the same as those for a weapon location mission (chap 4) TARGET SELECTOR except that the AIRCRAFT-MISSILE switch on the radar set control unit is placed in the AIRCRAFT position.

80. Conduct of Position Fixing

a. Determination of Pickup Data. The request for a position fixing mission contains the grid reference and altitude of the aircraft orbit point and the number of photographic missions to be

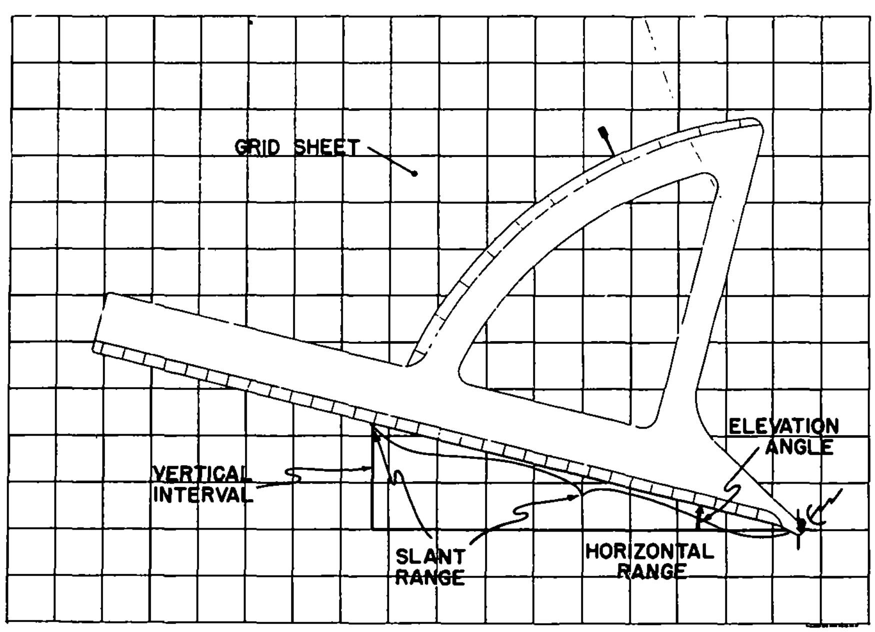


Figure 47. Determination of slant range by a graphic method.

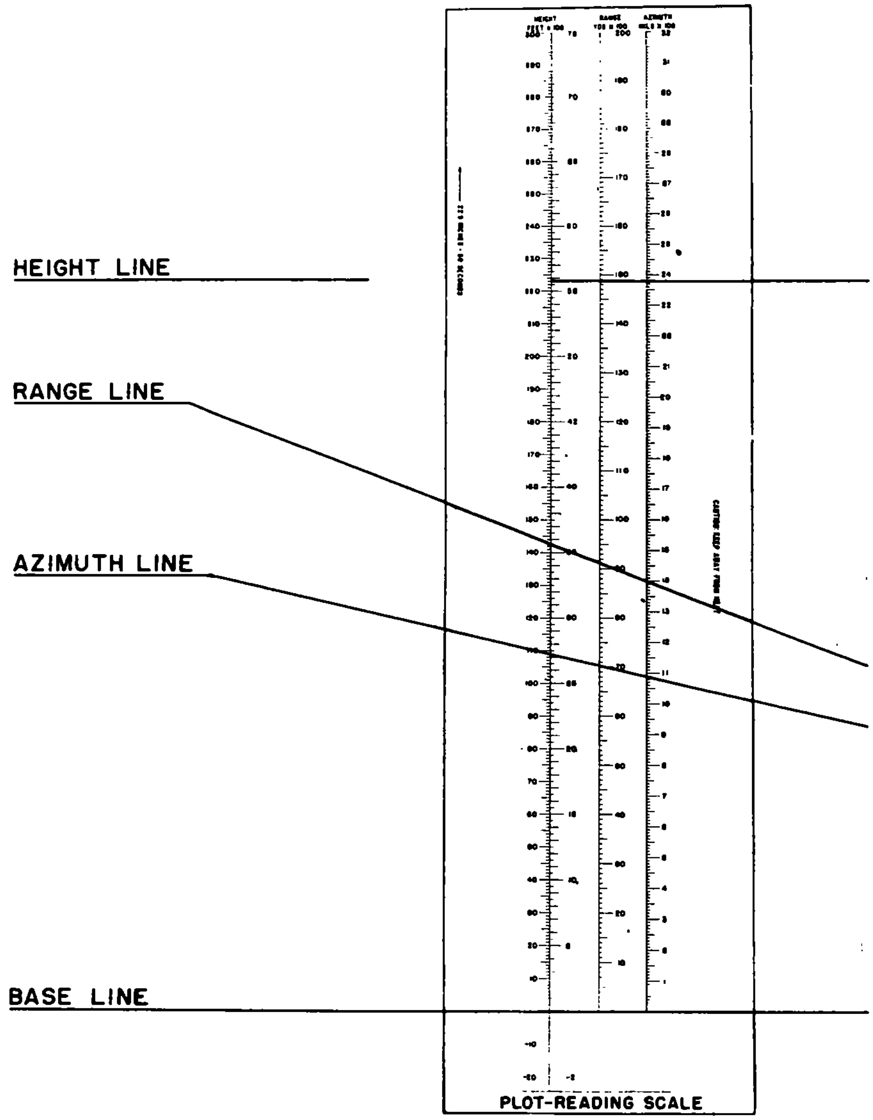


Figure 48. A typical position fixing plot.

conducted. Using a map or grid sheet, the radar plotter computes the initial pickup data of the aircraft by measuring the azimuth and horizontal range from the radar to the aircraft orbit point. The slant range and elevation to the orbit point are determined by a graphic method (fig. 47). The control unit operator applies these data to the control unit.

b. Aircraft Pickup. When the aircraft approaches the orbit point and appears on the indicating scopes, the control unit operator gates the aircraft echo on the J-scope and places the MASTER AUTO-MANUAL switch on the AUTO position. The radar tracks the aircraft along the approach to the target area.

c. Operation of the Recorder. When the aircraft approaches the target area for its photographic mission, the aircraft pilot alerts the radar and at the appropriate time begins a countdown to facilitate timely marking of the zero point by the recorder operator. When the pilot starts the countdown, the recorder operator places the PAPER DRIVE AUTO-OFF-LOCAL switch in the LOCAL position, causing the paper to pass through the recorder. The recorder operator then lifts the height stylus to prevent it from marking the paper. At the exact moment that the pilot reaches the zero or "mark" count, the recorder operator drops the height stylus. This causes the height stylus to start marking on the paper at the exact instant the photograph is taken.

d. Determining the Aircraft Position. When the plot has been recorded, the PAPER DRIVE AUTO-OFF-LOCAL switch is placed in the OFF position, and the recorder portion of the paper is removed from the recorder. The range and azimuth to the designated point are measured by placing the plot-reading scale over the plot with the height scale touching the leading edge of the height trace (fig. 48). The range and direction corrections (para 82*d*) are included in the final data. These data are plotted on a map or grid sheet and the grid reference of the position is determined.

Section II. VECTORING

81. General

When visual methods cannot be used or when Air Force target director posts are not available, the AN/MPQ–10A counterbattery radar can be used to guide (vector) Army aircraft to predetermined points for airdropping supplies, for night photography, for electronic surveillance or for providing illumination by aircraft flares. Difficulties arise when continuous illumination by aircraft flares is desired. Since aircraft flares have a limited burning time (approximately 3½ minutes), the aircraft must return over the target or drop point approximately every 3 minutes to provide continuous illumination. No alterations in organization or equipment are necessary to use the AN/MPQ–10A counterbattery radar in a vectoring mission.

82. Prerequisites to Vectoring

a. The tracker mount is leveled, oriented, collimated if possible, and located by survey.

b. Range calibration is checked (para 18 and 19).

c. The recorder is synchronized and calibrated.

d. Control settings are the same as those for a weapon location mission except that the TARGET SELECTOR AIRCRAFT-MISSILE switch on the control unit is placed in the AIRCRAFT position.

e. A grease pencil is used to mark the recorder azimuth scale from 3,200 and 6,400 mils. The sliding range indicator is marked in 1-second increments to allow a 10-second countdown (fig. 50). The spacing of the 1-second increments is computed by utilizing the known average ground speed of the aircraft employed. The azimuth sliding scale is marked in 1° increments with 0° in the center of the scale (fig. 49). The zero line of the sliding azimuth and range indicators are placed directly over the azimuth and range to the predetermined point (para 86) on the recorder data scales. Taping the sliding indicator scales to the recorder top cover prevents their being moved accidentally.

83. Conduct of Vectoring

Vectoring of Army aircraft is conducted in three phases.

a. *Determination of Pickup Data*. The request for a vectoring mission contains the grid reference and altitude for the aircraft orbit point. It also contains the location of the predetermined drop point (or target). Using a map or grid sheet, the radar plotter computes the initial pickup data by measuring the azimuth and horizontal range from the radar to the aircraft orbit point. The slant range and elevation to the orbit point are determined by a graphic method (fig. 47). The radar set control unit operator applies these data to the control unit. The drop point or target is plotted on the map or grid sheet, and the precise azimuth and range are determined. The orbit and drop points or target are then polar plotted on the special plot-reading board (fig. 50).

b. *Aircraft Pickup*. When the aircraft approaches the orbit point and appears on the indicating scopes, the radar set control unit operator gates the aircraft echo on the J-scope and places the MASTER AUTO-MANUAL switch in the AUTO position. The radar tracks the aircraft automatically.

c. *Aircraft Guidance*. Communication is established between the aircraft and the controller at the radar. After initial contact has been established and the aircraft has been tracked automatically about its orbit point a predetermined heading is announced to the pilot to head the aircraft in the direction of the radar-target line. After this announcement, the position of the aircraft is continuously plotted. The position data are read by two operators who observe the recorder azimuth and range styluses. When the command READ is given by the plotter, one operator reads the indicated azimuth and the other operator reads the indicated range. The general bearing of the aircraft is then established by successive plots of the aircraft's position. These locations are plotted on the special plot-reading board (fig. 50) and a correction is estimated to guide the aircraft to the radar-target line. Corrections are given in degrees, not in mils. As the aircraft ap-

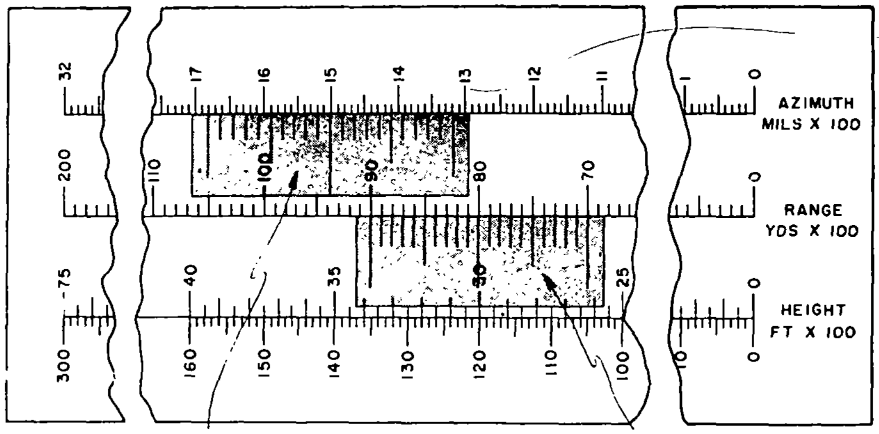


Figure 49. Improvised sliding indicators.

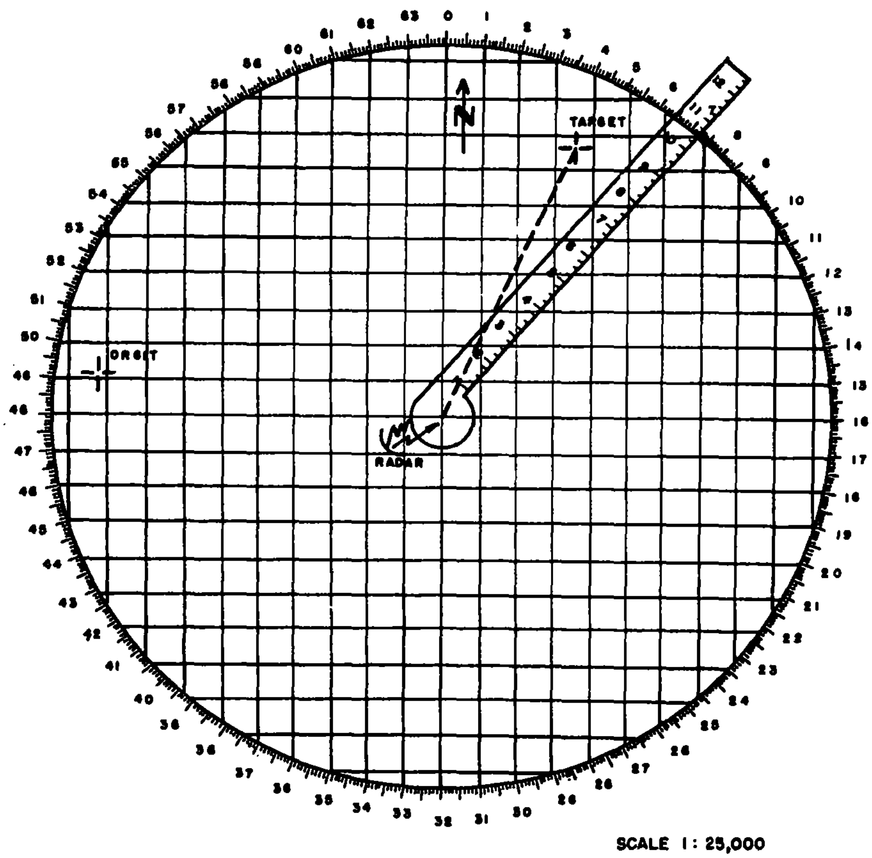


Figure 50. Special plot-reading board.

proaches the radar-target line, an offset correction to compensate for wind is given to position the aircraft astride the radar-target line. Additional corrections are then transmitted to cause the aircraft to proceed toward the target along the radar-target line. The amount of these corrections can be determined by observing the relation of the recorder azimuth stylus to the zero line of the sliding azimuth indicator (fig. 49). Applied corrections of less than 10° are not transmitted.

d. Identifying Target or Drop Time. As the aircraft approaches the predetermined point, a short countdown is transmitted to the pilot. The zero time or drop point corresponds to the instant that the range stylus is directly under the zero line of the sliding range indicator scale (fig. 49).

e. Corrections. During resupply or illumination operations when the initial drop is not sufficiently accurate, adjustments can be transmitted to the radar by an observing agency. The plotter applies these corrections to the location of the drop point on the special plot-reading board, using a target grid (FM 6–40). The new azimuth and range from the radar to the drop point are determined, and the sliding azimuth and range indicators on the recorder are placed over the new data. The procedures in *c* and *d* above are repeated until the mission is accomplished.

f. Effect of Wind and Pitch on Drop Point Location. The point at which the aircraft should release the flare is not necessarily directly over the point at which illumination is required. This is due to pitch—the distance the flare will be carried by its own momentum before the parachute opens—and wind drift—the distance the flare will travel due to the wind acting on the parachute. When the flare is released from the air craft, it drops some distance before the parachute opens and the flare ignites. A time fuze set for a specified number of seconds ignites the flare. As the flare falls, its momentum will carry it horizontally in the direction of flight of the aircraft. This distance can be computed and corrections can be applied. When the chute opens, it will act as a brake and stop the movement of the flare caused by its momentum. However as the flare descends with the chute open it will move horizontally because of the effect of the wind on the chute. This distance can also be computed, and corrections can be applied. The drop point is located so that the center of the distance the flare travels while burning is directly over the point where illumination is required. Thus the flare will provide maximum illumination at this point.

(1) *Required information.* The following information must be known to compute the corrections for wind and pitch.

(*a*) Aircraft altitude and speed.

(*b*) Speed and direction of wind at altitude of the aircraft.

(*c*) Altitude of target (point to be illuminated).

(*d*) Burning time and rate of descent of the flare.

(*e*) Desired height above target at burnout.

(2) *Formulas.*

(*a*) *Burning distance.*

Burning distance = burning time × rate of descent.

(*b*) *Altitude of ignition point.*

Altitude of ignition point = altitude of target + desired height of burnout + burning distance.

(*c*) *Freefall distance.*

Freefall distance (dv) = altitude of aircraft − altitude of ignition point.

(*d*) *Fuze setting.*

$$\text{Fuze setting } (+) = \sqrt{\frac{\text{freefall distance } (dv)}{16}}$$

(*e*) *Constant factor.* The constant factor (k) is dependent on the fuze-setting (t) as follows:

1. If fuze setting (t) is from 3 to 5, K = 0.8

2. If fuze setting (t) is from 6 to 8, K = 0.7.

3. If fuze setting (t) is over 8, K = 0.6

(*f*) *Pitch*

Pitch (dH) = fuze setting (t) × speed of the aircraft in yards per second (Vp) × K.

(*g*) *Drift*

Drift (dH) = wind speed in yards per second (W) × burning time of the flare (t) × K.

84. Continuous Illumination

To provide continuous illumination, the aircraft must be returned over the drop point approximately every 3 minutes. This is accomplished by directing the aircraft to proceed along a racetrack pattern or a figure-eight pattern (fig. 51). Close coordination is required to insure that the aircraft arrives at the drop point at the correct time.

a. Racetrack Pattern. The pilot makes a 180° turn, without command, immediately after releasing the initial flare. This turn is flown at double the normal rate, 6° per second, and takes 30 seconds to complete. The pilot then proceeds for 1 minute and again executes another 180° double rate turn. The controller has approximately 1 minute remaining to again direct the aircraft over the target or drop point.

b. Figure-Eight Pattern. The pilot continues on course for 15 seconds after releasing the initial flare. When command LEFT 45 is given, he follows course for 1 minute. Then he executes a 225° right turn at double rate. This turn requires 37.5 seconds and brings the aircraft parallel to the radar-target line. The controller has 15 seconds remaining to again direct the aircraft over the target or drop point.

c. High Wind Procedure. The frequency and magniture of corrections required to return the aircraft to the drop point or target after its initial flight will vary directly with the wind velocity and direction. In the absence of wind or, in the presence of only light wind, the corrections will be minor if any are required. Under high wind conditions, it will prove desirable to plan the long axis of the racetrack or figure-eight pattern parallel to the wind direction. This will serve to minimize the approach leg correction. When the approach leg to the drop point or target is planned into the wind and the receding leg is planned downwind, the controller will be afforded the maximum correction time. This procedure may be further refined by reducing the flight time on the receding leg and increasing the flight time on the approach leg, depending on the wind velocity, to equalize the ground distance traveled on each leg. The results will be a truer pattern and an increased approach leg flight time without increasing the total pattern flight time.

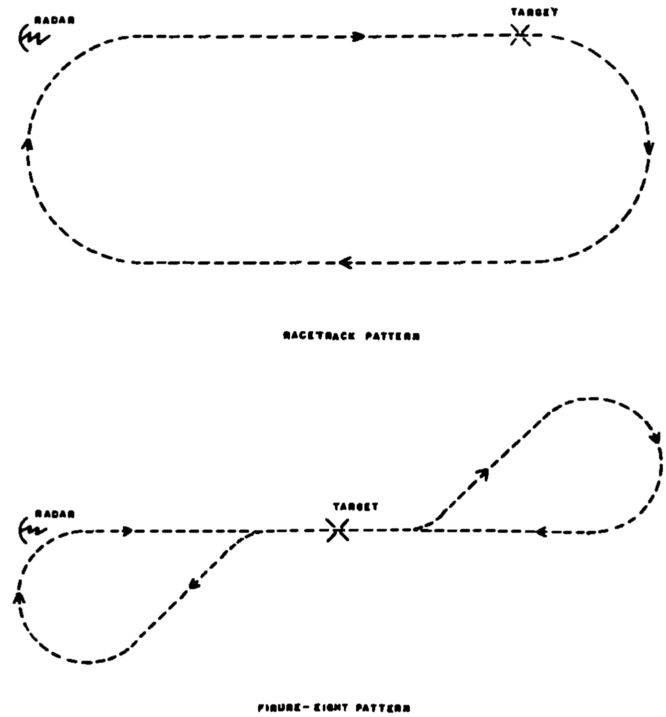


Figure 51. Racetrack and figure-eight patterns.

CHAPTER 8

EMPLOYMENT

Section I. SITE SELECTION FOR WEAPON LOCATION AND RADAR GUNNERY

85. General

The type of position selected for the radar set depends on the tactical mission that may be assigned to the radar section. Consideration must be given to the technical factors which influence the operation of the tracking-type radar. The complete suitability of a site can be determined only by successful operation of the radar from it.

86. Responsibility for Selection of Radar Positions

The battery commander of the target acquisition battery designates the general position area for the two radar sets of his battery. The radar platoon leader or radar section chief makes the final selection of the radar sites.

87. Tactical Considerations

The tactical considerations in selecting a radar site are identical with those considered in choosing a position for a field artillery firing battery or similar unit. Normally these considerations are as follows:

a. Cover. The radar should be emplaced in defilade which will afford protection from hostile fire for the personnel and equipment without adversely affecting the operation of the radar.

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

c. Security. If possible, a site should be selected within an established defense perimeter. This will lighten the additional duty of security for radar personnel.

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

e. Survey. The closer the radar site is to a battery or a known survey point, the more rapidly survey personnel can determine the azimuth and elevation angle to a known point for orientation of the radar and the grid reference and altitude of the radar.

f. Communications. The amount of wire that must be laid and maintained and the transmitting capabilities of the radios must be considered.

88. Technical Considerations

a. General. Because radars operate at high radio frequencies (RF), the RF energy travels essentially in a straight line and the energy is returned from a target in a straight line in much the same way as light. Any object within the range limits of the radar scopes, that enters the radar beam causes an echo to appear on the scopes. Permanent features, such as towers, tall buildings, and land masses in the radar beam cause fixed echoes (clutter) to appear on the scopes. Clutter from terrain features below the line of sight of the radar position may appear on the scopes of the radar owing to reflections received from the secondary lobes, various atmospheric conditions, and other factors that affect the transmitted radio energy. Interference by strong fixed echoes may cause a radar position to be unsuitable even though a clear line of sight exists.

b. Electrical Screening. One of the primary considerations in selecting a radar site for weapon location is locating the radar in proper relation to the immediate surrounding terrain features. The radar should be emplaced in shallow defilade. The ideal site is one in which a mask completely encircles the radar. This mask is called the screening crest, because it restricts

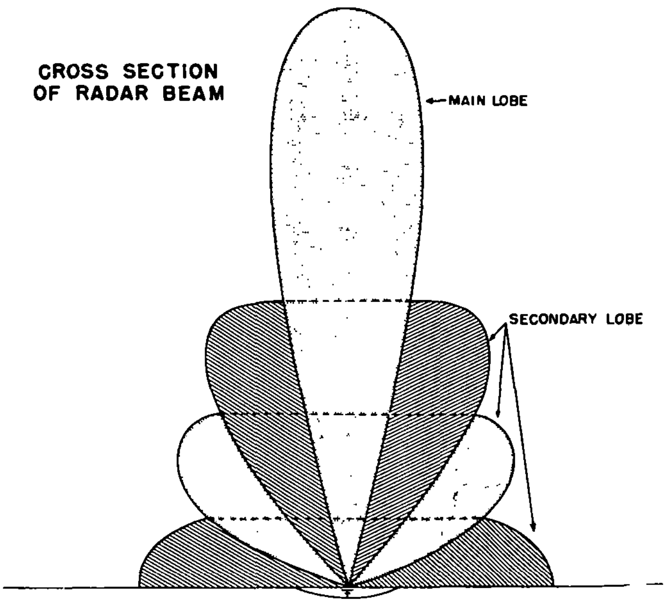


Figure 52. The radar beam (with secondary lobes).

the fixed echoes or clutter caused by the radio energy being returned from the main and secondary lobes (fig. 52) and causes the clutter to appear at close ranges where it will not interfere with the detection of hostile weapons. The vertical angle measured from the radar to the screening crest should not exceed 40 mils. The distance between the screening crest and the radar site varies. The factors that determine the correct location for the radar with respect to the screening crest are the vertical angle to the screening crest and the distance from the radar to the area in which the projectiles are to be detected and tracked.

c. Projectile Aspect. The strength of the signals reflected and returned to a radar set from different projectiles in flight varies considerably. The strength of a reflected signal depends on the size of the projectile and, to the great extent, on the aspect (or view) (fig. 53) which the projectile presents to the radar beam. The aspect presenting the greatest reflecting surface to the radar beam returns the strongest signal to the radar. The aspect of the projectile to the radar beam is similar to the view of the projectile in flight as seen through the telescope. The best view of the projectile (best reflecting surface) is obtained when it presents a side aspect to the radar beam (observer). When the projectile presents a nose or tail aspect to the radar beam, the reflecting surface is smaller and a weaker signal is returned. The aspect angle is the angle formed by the radar beam and the line of flight of the projectile. The aspect angle is not an important consideration in siting the radar set for a mission of locating mortars. Because of the relatively high trajectory of mortar projectiles, much of their trajectory is vertical, and they present a side aspect to the radar beam. Artillery projectiles fired at low angles of elevation frequently present a nose or tail aspect to the radar beam. Therefore, when a radar section has the mission of locating artillery weapons, the radar set should be emplaced near a flank of the zone of action. This location insures an adequate aspect angle and also increase coverage of the zone of action.

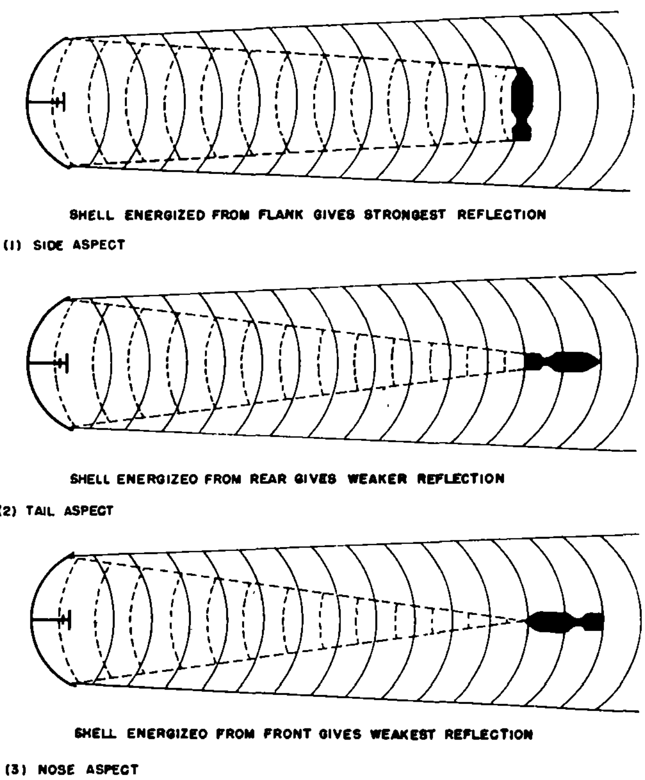


Figure 53. Aspect angle of a projectile in flight.

Table 2. Maximum Detecting and Tracking Ranges

Type of projectile to be tracked	Maximum tracking range from radar to projectile under optimum conditions
Light mortar (60-mm)	6,500 meters
Medium mortar (81-mm)	7,000 meters
Heavy mortar (4.2-inch)	7,500 meters
Light artillery (105-mm)	8,000 meters
Medium artillery (155-mm)	9,000 meters
Heavy artillery (8-inch)	11,000 meters
Very heavy artillery (240-mm)	12,000 meters
Rocket (762-mm) Honest John	18,000 meters (limited by range of radar)

d. Effective Detecting and Tracking Ranges. All other things being equal, the larger the target the greater the range at which a radar can detect and track the target. (The larger target offers more reflecting surface to the radar beam and returns a stronger signal.) Table 2 indicates the approximate maximum ranges at which the AN/MPQ–10A radar set can be employed to detect and track various projectiles and is to be used only as a guide in selecting radar sites.

Section II. SITE SELECTION FOR MOVING TARGET DETECTION

89. General

Normally, the radar set is used to detect moving targets only during periods of poor visibility. For weapons location and radar gunnery, the radar must be in defilade to eliminate or minimize ground clutter. For moving target detection, the radar must be moved to a position which provides line of sight to the area or terrain over which surveillance is desired.

90. Selection of Site

a. General. When the radar section is assigned a mission of moving target detection, the radar officer must be briefed on the key terrain features and the likely target areas that are to be observed by radar.

b. Reconnaissance. During daylight hours, a thorough reconnaissance must be made to insure a smooth and orderly night occupation of the position. The following factors must be considered during the reconnaissance:

(1) Line of sight to target areas.

(2) Accessibility to radar.

(3) Availability to survey.

(4) Communication.

(5) Protection for personnel and equipment.

(6) Security.

c. Selection of Site. The only absolute requirement of a radar site for moving target detection is a line of sight to the target area. Since the nature of the target may vary from an enemy patrol to a moving tank column and detection is dependent on the size of the targets, the radar may be emplaced as far as 6,000 meters from the target area for the detection of small targets and up to 10,000 meters from the target area for the detection of large targets.

Section III. EVALUATION OF A RADAR SITE

91. General

a. Many uncontrollable factors influence the detection and tracking capabilities of a radar. Even if every requirement has been fulfilled the suitability of a radar site cannot actually be determined until the radar is operated in it. A radar site is evaluated to determine its suitability for the assigned mission and to inform higher echelons of the capabilities and limitations of the radar set in that site.

b. A screening crest profile and clutter diagram should be prepared for the sector of responsibility as soon as possible after occupying position. The screening crest profile and the clutter diagram are combined on a site evaluation chart (fig. 54) to depict all areas in which the radar set will not give proper coverage. This chart shows the limitations imposed on the radar by the screening crest, which limits the angle of elevation for scanning, and the clutter caused by reflection of the main or secondary lobes by the terrain features. When additional time is available, a site evaluation chart is prepared for both flanks of the sector of responsibility, until the charts include all hostile areas in which projectiles can be detected. The number of evaluation charts to be prepared is established by unit SOP. One copy must be available to the radar operators at each radar site.

92. Screening Crest Profile

a. General. Collimation and orientation must be performed before securing the data for a screening crest profile. The screening crest profile depicts the screening crest in a simple diagram that can be interpreted at higher echelons (fig. 54). Using the screening crest profile, the mil relation, and the trajectory charts, the higher echelons can determine which areas cannot be covered for weapon location and radar gunnery. The screening crest profile also enables the radar set control unit operator to determine the elevation angle at which he must scan any portion of his sector of search.

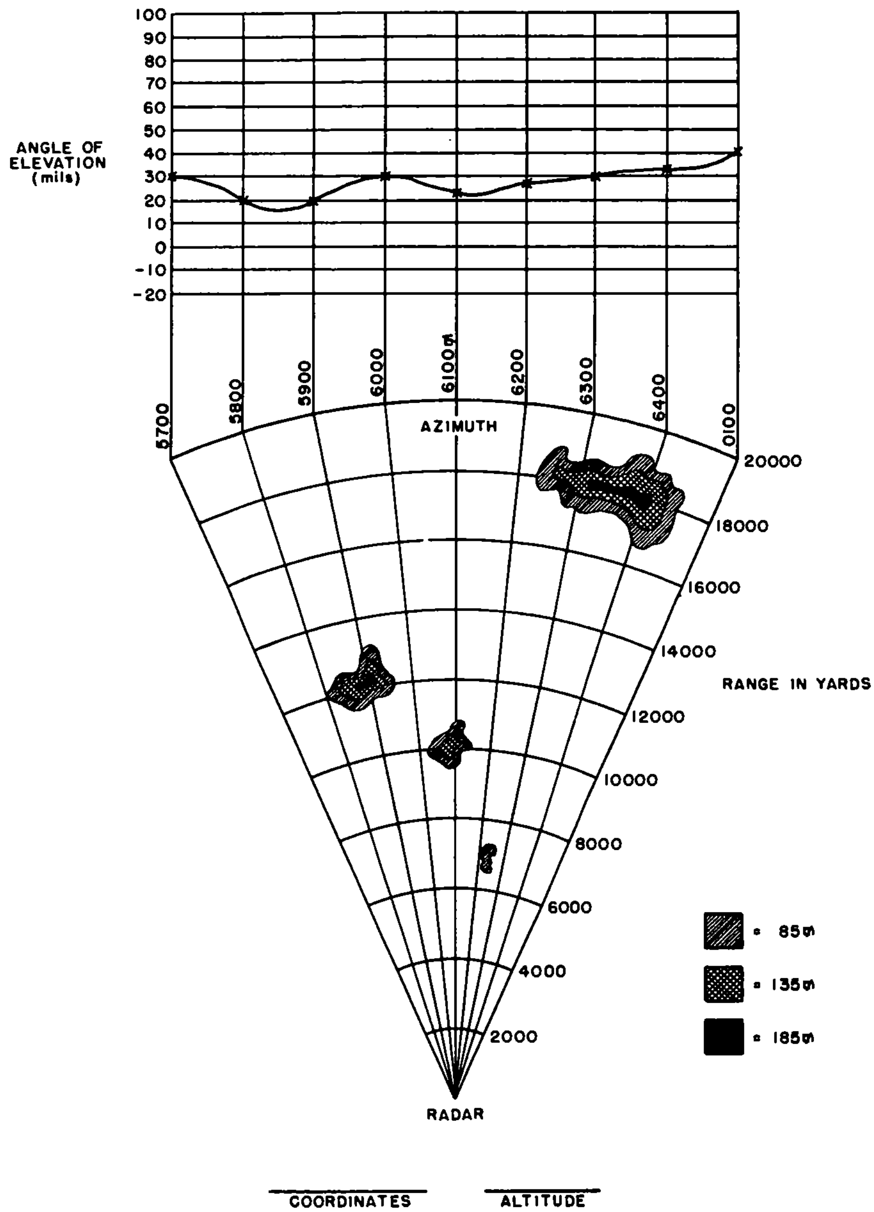


Figure 54. Site evaluation chart.

b. Construction.

(1) The transmitter should be off while obtaining readings for the screening crest profile to preclude RF burns.

(2) Two operators are required to obtain readings for the screening crest profile. One operator traverses the antenna by hand and records the readings announced by the other operators who observes through the optical telescope on the radar mount. The operator must insure that the ANTENNA RELEASED-NORMAL switch is in the RELEASED position.

(3) The antenna is positioned at zero mils elevation.

(4) The angle of elevation to the screening crest is read (using the graduations in the telescope) and recorded at each 100 mils of azimuth throughout the assigned sector. If the screening crest is very irregular or if the elevation changes drastically the interval between readings must be reduced and additional readings must be taken.

(5) The elevation readings are plotted on the screening crest profile (fig. 54) of the site evaluation chart and connected with a continuous line.

93. Clutter Diagram

a. General. The purpose of the clutter diagram is to show the areas in which projectiles cannot be detected because of clutter on the radar scope.

Since clutter usually is the result of echoes from prominent terrain features, the amount of clutter will gradually disappear as the angle of elevation is increased.

b. Construction. The procedure for constructing the clutter diagram is as follows:

(1) The transmitter must be on.

(2) The antenna is positioned in elevation to 20 mils above the lower angle of elevation to the screening crest within the assigned sector.

(3) The antenna is positioned in azimuth to the center of the assigned sector and placed in sector scan. If the assigned sector is greater than 800 mils, it must be subdivided for the purpose of sketching the clutter diagram.

(4) The stationary clutter is outlined on the B-scope; clutter caused by clouds is disregarded.

(5) Using the SLANT range and AZIMUTH handwheels, the range and azimuth are measured at several points around the circumference of each patch of clutter. The points are plotted on the clutter diagram of the site evaluation chart, and the points for each patch of clutter are connected by a solid line.

(6) The elevation is increased in increments of 50 mils until all clutter disappears. The clutter is plotted at each elevation. The area for each elevation is color coded for easier evaluation.

94. Site Evaluation Chart

When the site evaluation chart is completed, certain other data must be entered on it. These data are:

a. Organization.

b. Coordinates and altitude of the radar.

c. Weather conditions.

d. Color code legend.

CHAPTER 9

SAFETY

95. Principles

Personnel using the radar equipment will not perform maintenance or inspections beyond those specifically enumerated and outlined in this manual and in the appropriate technical manual. Specific safety precautions are set forth in the discussion of each item of equipment described in this manual.

96. High Voltage

Warning: **High voltage is used in the operation of this equipment. Death on contact may result if personnel fail to observe safety precautions. Be careful not to contact high-voltage connections or 115-volt input connections when working on or near this equipment. When working inside the equipment, after the power has been turned off, always short circuit the high-voltage capacitors.** ***Extremely dangerous potentials*** **exist in the following units:**

Radar modulator MD–142/MPQ–10

Frame MT–900/MPQ–10

Radar set group OA–465/MPQ–10A

97. Microwave Radiation Hazard

The transmitted energy can cause severe RF burns. Personnel should avoid direct exposure to the radiated beam when the antenna is stationary. At 50 feet from the antenna, exposure to the stationary beam should be limited to 10 minutes. Exposure at shorter distances should be limited accordingly and avoided entirely, if possible. At a distance of 160 feet or more from the antenna, the radiation level is not injurious to personnel. The radar set should not be installed within 160 feet of a fixed working area without proper authority.

98. Radioactive Tubes

Tubes OB2 and 1B27 contain radioactive material. These tubes are potentially hazardous if broken.

a. Never remove radioactive tubes from their cartons until ready to use them.

b. Use extreme care not to break the radioactive tubes while handling them. Never place radioactive tubes in your pocket.

c. Report immediately to qualified medical personnel if you are exposed to, or cut by, a broken radioactive tube.

99. Gasoline

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

100. Electric Shock

Electric shock accidents may cause breathing to cease. A casualty may recover if artificial respiration is applied promptly and efficiently. Principles and procedures for emergency treatment of electric shock are described in FM 21–11.

CHAPTER 10

ELECTRONIC COUNTER-COUNTERMEASURES

101. Recognition of Jamming

To minimize the effect of enemy jamming, the radar operator's first step is to learn to recognize the different forms of interference and to distinguish unintentional interference from 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 may produce patterns on the radar scope similar to those caused by enemy jamming. Enemy jamming is indicated when the interference pattern remains on the scope after interference from all friendly sources has been eliminated. When the operator has observed the interference and determined that it is the result of enemy jamming, the next step is to take all possible action to minimize its effects and to continue operations. If, because of enemy jamming, an untrained operator shuts down his set with the mistaken idea that the set is defective, he is accomplishing the very effect the enemy desires. With training and practice, the operator can learn to distinguish unintentional interference from that caused by enemy jamming and take the necessary counteraction.

102. Types of Jamming

There are two types of jamming. One type is transmission jamming which is produced by a transmitter radiating a modulated or an unmodulated radio-frequency signal. The other type is mechanical 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. Transmission jamming, depending on the type of transmission used, will produce either strobe lines (extreme brightening of the sweep) or sector blanking (complete blanking of all indications) in the direction from which the jamming is arriving. However, if the jamming signal is extremely strong, transmission jamming can completely saturate the radar scope and the direction from which the jamming is being received cannot be determined. From the counter-countermeasure viewpoint, it is important to note the direction of the jamming indication, when the jamming does have discernible directional characteristics, so that the jammer may be located and steps may be taken to reduce its effectiveness.

b. Mechanical Jamming. Mechanical jamming is produced by means other than active transmitters. Generally, mechanical jamming is produced by reflecting items called window, rope, chaff, and straws. Usually, these reflecting items are in the form of various types, shapes, and sizes of metallic strips and metallic coated papers and 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 the signals from actual aircraft or missiles. Mechanical jamming is also produced by corner reflectors and metallicized mesh and by stable, rotating, or oscillating dipoles. The dipoles are intended to produce strong false echoes which will obscure the true target echoes or will capture the tracking radars by causing them to lock in on the false echoes. False echo interference may be called deception instead of 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 the true target echoes and the echoes produced by window jamming devices.

103. Location of Jamming Source

When interference is received and it appears to the radar operator that it is deliberate enemy jamming, he reports immediately to his superior the type of jamming received and the direction from which it is received. The operator also keeps a 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 displacing the radar equipment or they may be used as fire direction data to place the site of the jammer under active fire. As long as the jamming is observed, it must be reported and recorded.

104. Siting Considerations

The radar set AN/MPQ-10A is difficult to jam unless *line of sight* orientation exists between the jammer and the radar. Therefore, it is important that the radar be emplaced in a defilade position. Proper siting may make it difficult for the enemy to locate a position from which the radar can be jammed effectively. Siting the radar set in defilade also will reduce the possibility of interference from other friendly radars.

105. Procedure for Operation Against Transmission Jamming

After the radar operator has determined the type and direction of the jamming, he should use the following procedures to reduce the effectiveness of the jammer:

a. Antijamming (AJ) Circuit: The AJ switch is placed in the ON position to limit the width of the target signal pulse that can pass on to the video circuits. The AJ circuitry is effective against modulated jamming in general and particularly effective against noise jamming when the frequency of the modulating noise is low. It is also effective against pulse jamming when the pulses are long in comparison to the radar pulse. The AJ circuitry is effective against CW (continuous wave) jamming if the jamming signal is weak. As the strength of the CW jamming signal increases, the AJ circuitry becomes less effective because the circuit attenuates the target echoes along with the jamming signal so that only the very strong target returns are discernible on the radar scopes.

b. Pulse Repetition Rate. The REP RATE switch is placed in the 2 position to cause the pulse repetition frequency (PRF) of the radar set to be jittered. Jittered RPF operation uses a repetition rate varying around 1,000 pulses per second instead of the normal PRF of 1,100 pulses per second. Jittered PRF operation may be effective against interference encountered from nearby radar sets that have the same repetition rate or one equal to a harmonic of the repetition rate used in the AN/MPQ-10A. Synchronized jamming (the jamming pulses synchronized with the radar set PRF) also may be made less effective by the use of the jittered PRF.

c. Gain Control. In continuous wave (CW) jamming, a gain setting less than that used for normal operation usually is more effective. A reduced gain setting prevents overloading the receiver and allows the target pip to appear on top of the jamming signal. The GAIN control is varied over its entire range to find the setting at which the target echo is strongest. When CW jamming is strong enough to block the receiver completely, neither the GAIN control nor the AJ circuitry is effective in reducing the jamming effects. Automatic gain control may be an effective AJ measure against CW jamming.

d. Local Oscillator. Varying the local oscillator tuning a small amount may help in reducing the effects of CW jamming if the jamming signal is confined to a narrow frequency band. However, modulated jamming usually results in a signal of sufficient bandwidth that varying the local oscillator is ineffective as an antijamming measure.

e. Antenna Elevation. If jamming occurs only when the jammer is in the main lobe of the radar antenna, some relief from jamming may be obtained if the vertical angle of the antenna is increased. Even though the tracking time and distance will be lessened considerably by the increased anetenna elevation, the information obtained from the resultant plots will still be of appreciable value.

f. Slide Screening. If the jammer is located outside the sector assigned to the radar, some jamming may be received through the radar antenna side lobes. It may be possible to decrease the effectiveness of the jamming by placing a shield of metal screening or other material that will absorb the radar signal between the radar and the jammer.

106. Procedure for Operating Against Window Jamming

To operate against window jamming, the INTENSITY, FOCUS, and GAIN control are adjusted for maximum definition. Window jamming indications usually appear as many closely spaced targets (clutter). Good definition helps in separating the 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. The AJ circuitry also is effective in obtaining better definition in cluttered areas.

CHAPTER 11

DECONTAMINATION OF EQUIPMENT

107. General

a. This chapter touches only briefly on the subject of decontamination of equipment. In order to understand precisely how to accomplish these operations the radar section should become thoroughly familiar with the procedures outlined in FM 3-10, TM 5-225, and FM 21-40.

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

108. Chemical Decontamination

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

109. Biological Decontamination

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

110. Radiological Decontamination

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

CHAPTER 12

TRAINING

111. Purpose and Scope

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

112. Objectives

The objectives are to train radar crewmen rapidly in their individual duties and, through drill, to weld them into a coordinated team that will function effectively in combat. During training, supervisors should keep in mind the proficiency sought by appropriate Army training tests. Optimum efficiency is attained through frequent drills.

113. 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 standards set forth in FM 6–125 and AR 611–201.

b. MOS qualification training is prescribed in ASubjScd 6–156. Section training is prescribed in ASubjScd 6–10.

c. 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.

d. Throughout training, the application of prior instruction to current training must be emphasized.

e. A record of the training received by each individual is kept. Each chief of section may keep a progress card for each man in his section. On this card are shown each period of instruction attended, tests taken, and remarks pertaining to progress. Progress cards are inspected frequently by the radar platoon leader to make sure that they are being kept properly and to determine the state of training. *Requiring the chief of section to keep these records emphasizes his responsibility toward his section.*

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

114. Standards to be Attained

In a well-trained radar section, each crewman must know the duties of all other crewmen and be able to perform efficiently in all positions. This goal is attained by rotating the duties during training.

115. Electronic Counter-Countermeasure Training

Radar training AN/ULT–T3 is a portable S-band jammer trainer which will simulate enemy electronic countermeasures. Operating instructions are given in TM 11–6940–208–15.

CHAPTER 13

DESTRUCTION OF EQUIPMENT

116. General

a. Tactical situations may arise in which it is 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 on abandonment in the combat zone will be undertaken only upon authority delegated by a division or higher commander.

117. Principles

All sections will prepare plans for destroying their equipment in order to reduce the time required if destruction becomes necessary. The principles to be applied are as follows:

a. Plans for destruction of equipment must be adequate, uniform, and easily performed 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 undamaged parts.

d. Spare parts and accessories must be given the same priorities as the parts installed on the equipment.

118. Methods

To destroy equipment adequately and uniformly, all personnel of the unit must know the plan and priority of destruction.

119. References

For detailed information on destruction of the counterbattery radar set AN/MPQ–10A, see TM 11–1303; for destruction of the recorder RD–54/TP see TM 11–5534; for destruction of the generator set MS model SF–10–MD, see TM 5–6115–275–12 for destruction of ammunition, see TM 9–1900; for destruction of communication equipment, see the TM appropriate to the authorized equipment; for the destruction of a vehicle, see the TM appropriate to the vehicle.

CHAPTER 14

QUALIFICATION TESTS FOR COUNTERBATTERY RADAR SPECIALISTS

120. Purpose and Scope

This chapter describes the tests to be given in the qualification of the counterbattery radar set AN/MPQ–10A radar specialists. Tests based upon these outlines are designed to measure an individual's skill in the emplacement and operation of counterbattery radar set AN/MPQ–10A. Tests based upon these outlines are designed to determine the relative proficiency of an individual artillery soldier in the performance of duties as a radar specialist and are not intended for use in determining the relative proficiency of batteries or higher units. These tests are designed to serve as an incentive for these individuals to expand their knowledge to cover all duties in the radar section, thereby increasing their value to the unit.

121. Preparation of Tests

The tests will be prepared under the direction of the battalion commander and should include the following:

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

b. Each specialist interested is a prospective candidate and the tests should be available upon his request.

122. Test Organization

The qualification tests are organized to follow a logical sequence of events. The tests start at the parking or rendezvous area; then they move to the position area. Tests at the position area cover selection of site, emplacement of the radar, starting of the power unit, collimation, orientation, synchronization and calibration of the recorder RD–54/TP, evaluation of site, weapon location, and radar gunnery. The tests should be conducted in the sequence in which they are presented in the text.

123. Administration of Tests

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

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

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

(2) Each portion of the qualification test may be administered over a period of time that will be standardized throughout the battalion.

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

(4) Assistance will be furnished to the candidate as required for each test. If a candidate fails any test because of the examiner or any assistant, the test will be disregarded and the candidate will be given another test.

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

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

124. Qualification Scores

A total maximum score of 100 is possible upon completion of the tests. The point breakdown to determine expert, first class specialist, and second class specialist is as follows:

Individual Classification	*Points*
Expert	90–100
First class specialist	80–89
Second class specialist	70–79

125. Outline of Tests

Para number	Subject	Number of tests	Points each	Maximum credit
126.	Nomenclature of counter-battery set AN/MPQ–10A and recorder RD-54/TP	2	..	5
	Test 1 (AN/MPQ–10A)	(1)	3	(3)
	Test 2 (RD–54/TP)	(1)	2	(2)
127.	Selection of site	1	8	8
128.	Operation of power unit PU619M	2	..	5
	Test 1 (Nomenclature)	(1)	2	(2)
	Test 2 (Starting procedure)	(1)	3	(2)
129.	Emplacement and starting procedure for radar set	1	10	10
130.	Operation of the radar set	4	4	16
131.	Operation of recorder RD–54/TP	2	5	10
132.	Evaluation of site	1	8	8
133.	Map reading and use of plotting equipment	1	6	6
134.	Weapon location	4	6	24
135.	Radar gunnery	2	4	8
	Total			100

126. Nomenclature of the Counterbattery Radar Set AN/MPQ–10A and Recorder RD–54/TP

a. Scope of Tests. Two tests will be conducted in which the candidate will be required to locate, name, and/or state the purpose of various parts and units of the counterbattery radar set AN/MPQ–10A and recorder RD–54/TP.

b. Special Instructions.

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

(*a*) Counterbattery radar set AN/MPQ–10A.

(*b*) Recorder RD–54/TP.

(2) The nomenclature printed on the parts on which the candidate is to be questioned will be covered with masking tape or similar material.

c. Outline of Tests.

Test number	Examiner commands—	Action of candidate
1.	LOCATE, NAME, AND/OR STATE THE PURPOSE OF EACH PART DESIGNATED. (The examiner will select 20 of the following parts of the radar set; Parabolic antenna, elbow telescope, main junction box, radar modulator, range computer, metallic rectifier, level assembly, spinner motor, outriggers, dipole drawbar, compensating spring lock, switch and meter panel, emergency ON-OFF switch, trunnion, base unit, leveling jacks, lowering bar, echo box, orienting clutch, azimuth lock plunger, MAIN POWER switch, TRANS switch, RECEIVER GAIN (variable) control, TUNING (AFC–MFC) switch, REP-RATE (1–2) switch, METER (AB–AC–BC) switch, RANGE ONLY AUTO switch (CALIBRATE NORMAL), TARGET SELECTOR (AIRCRAFT-MISSILE) switch, SECTOR WIDTH MILS (200–300–400–500–600–700–800) switch, SLANT RANGE handwheel, AZIMUTH handwheel, B-scope, J-scope, SWEEP LENGTH switch, A–J (ON-OFF) switch, B-scope FOCUS CONTROL, RANGE MARKERS (ON-OFF) switch, ELEVATION dial, CURSOR control, and dial graduations.)	Locates, names, and/or states the purpose of the parts designated. Reference TM 11–1303, paragraphs 3–5, 7, 10–19, 31–39, 44–45.1, 47, 49–53, 64–78.
2.	LOCATE, NAME, AND/OR STATE THE PURPOSE OF THE PARTS DESIGNATED. (Examiner will select 10 of the following parts of the recorder RD–54/TP. Height servoamplifier, azimuth servoamplifier, power distribution panel, control panel, paper well clutch, 115V–AC supply ON-OFF switch, PAPER DRIVE AUTO OFF LOCAL switch, HEIGHT FEET switch, range servo, azimuth servo, height servo, azimuth C–F SWITCHING control, DIMMER control, SLEW switch, PAPER DRIVE MOTOR ON-OFF switch,	Locates, names, and/or states the purpose of each part designated. Reference TM 11–5534, paragraphs 8, 9, 14, 15, 17, 20–27, 47–50.

Test number	Examiner commands—	Action of candidate
	range SYNCHRO DATA switch, base line stylus, height stylus, paper well cover. PANEL LIGHT ON-OFF switch, and test cable.	

d. Penalties.

(1) For test 1, a penalty of 0.15 point will be assessed for each error in nomenclature or statement of purpose and for each failure to locate a specified item.

(2) For test 2, a penalty of 0.2 point will be assessed for each error in nomenclature or statement of purpose and for each failure to locate a specified item.

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

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 128.

127. Selection of Site

a. Scope of Test. A test will be conducted in which the candidate will be required to select a radar site.

b. Special Instructions.

(1) The examiner will prepare for the candidate's use a situation map of the area showing the following elements of an assumed situation:

(*a*) Location of an established survey control point in the area.

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

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

(*d*) Suspected area of enemy activity.

(2) The examiner must bear in mind when assessing penalities that any selected position is a compromise.

(3) The following equipment should be furnished:

(*a*) Aiming circle.

(*b*) Binoculars.

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

(*d*) Plotting equipment.

(*e*) Compass M2.

(4) A mission of either a mortar location, an artillery location, or both should be assigned to the candidate.

c. Outline of Test.

Examiner commands—	Action of candidate
SELECT A RADAR SITE	Selects a radar site within the designated area, as prescribed in paragraphs 88 through 91.

d. Penalties.

(1) A maximum penalty of 4 points will be assessed for failure to select a position where the terrain will provide electrical screening to minimize ground clutter and at the same time provide an acceptable screening angle of elevation (15 to 100 mils for weapon location and 15 to 40 mils for radar gunnery).

(2) A maximum penalty of 2 points will be assessed for failure to select a position which provides ready access, cover, and concealment.

(3) A maximum penalty of 1 point will be assessed for failure to consider the proximity of survey control.

(4) A maximum penalty of 1 point will be assessed for failure to consider the proximity of friendly units.

(5) All penalties will be assessed in proportion to the candidate's success.

e. Credit. If the test is performed correctly, a maximum credit of 8 points will be awarded.

128. Operation of Generator Set SF–10–MD

e. Scope of Tests. Two tests will be conducted in which the candidate will be required to name and/or state the purpose of components of the generator set SF–10–MD, make preliminary checks and start the power unit.

b. Special Instructions.

(1) The following equipment should be furnished the candidate:

(*a*) One generator set SF–10–MD.

(*b*) One power cable.

(2) The examiner should check the battery before starting the test.

c. Outline of Test.

Test number	Examiner commands—	Action of candidate
1.	NAME AND/OR STATE THE PURPOSE OF THE PARTS DESIGNATED. (The examiner will point out the following parts of the power unit: BATTERY	Names and/or states purpose of each part designated. Reference TM 5–6115–275–12, figure 8.

Test number	Examiner commands—	Action of candidate
	charge indicator, oil PRESSure meter, HOURmeter, REMOTE-LOCAL switch, EMERgency STOP-RUN switch, START-STOP switch, CURRENT SELector switch, VOLTage ADJusting knob, VOLTage SELector switch, VOLT meter, FREQUENCY meter, AMMETER, circuit breaker.)	
2.	START THE POWER UNIT ELECTRICALLY. (The examiner will ascertain that the student does the following: Circuit breaker in OFF position, REMOTE-LOCAL switch in LOCAL position, EMERgency STOP-RUN switch in NORMAL position, turns VOLTage ADJusting knob fully counterclockwise, sets VOLTage SELector switch for desired output, sets CURRENT SELector for desired output, presses the START-STOP switch to the START position and releases when the engine starts.)	Completes checks and starts power unit as prescribed in TM 5–6115–275–12, figure 9.
3.	STOP THE POWER UNIT. (The examiner will ascertain that the student does the following: Place the circuit breaker in the OFF position, turns the START-STOP switch to the STOP position and release, turn the fuel selector valve to OFF, and place the EMERgency STOP-RUN switch in the EMERgency STOP position.	Stops the power unit as prescribed in TM 11–6115–275–12.
4.	START THE POWER UNIT MANUALLY. (The examiner will ascertain that the student does the following: places EMERgency STOP-RUN switch in EMERgency RUN position, places REMOTE-LOCAL switch in LOCAL position, wrap starter rope on pulley and pull with quick steady motion until engine starts, when engine reaches operating pressure, place START-STOP switch to START position and release.)	Completes checks and starts the power unit as prescribed in TM 5–6115–275–12, figure 9.
5.	STOP THE POWER UNIT. (The examiner will ascertain that the student does the following: Place the circuit breaker in the OFF position, turns the START-STOP switch to the STOP position and release, turn the fuel selector valve to OFF, and place the EMERgency STOP-RUN switch in the EMERgency STOP position. Examiner should be sure that he and the candidate are both using the same method.)	Stops the power unit as prescribed in TM 11–6115–275–12.

d. Penalties.

(1) For test 1, a penalty of 0.1 point will be assessed for each error in nomenclature of statement of purpose.

(2) For test 2, 3, 4, and 5 a penalty of 0.3 will be assessed for each preliminary check the candidate fails to make.

(3) If the total penalties exceed 3.5 points, no credit will be awarded.

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 128.

129. Emplacement and Starting Procedure

a. Scope of Test. One test will be conducted in which the radar set is in position with the tracker mount rough-leveled only, and the candidate will be required to complete the emplacement and start the radar set.

b. Special Insructions.

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

(*a*) One counterbattery radar set AN/MPQ–10A in position with the tracker mount rough-leveled only.

(*b*) One recorder RD–54/TP.

(*c*) One generator set SF–10–MD (PUG-19M) operating with cable connected.

(2) Assistants will be available to help the candidate (at the discretion of the examiner).

(3) Assistants will perform tasks only on specific instructions from candidate (at the discretion of the examiner).

(4) Prior to starting the tests, the examiner will prepare the radar as follows:

(*a*) MAIN POWER switch OFF.

(*b*) SERVOS switch OFF.

(*c*) RECEIVER GAIN control knob, maximum counterclockwise position.

(*d*) TUNING AFC–MFC switch to MFC

(*e*) A–J switch ON.

(*f*) MASTER AUTO-MANUAL switch to MANUAL.

(*g*) AZIMUTH handwheel in.

(*h*) RANGE MANUAL-AUTO switch to MANUAL.

(*i*) At the recorder RD–54/TP.

1. PAPER DRIVE AUTO-OFF LOCAL switch ON.

2. PAPER DRIVE MOTOR switch ON.

3. HEIGHT FEET switch at MPQ–10, 30,000 position.

4. 115VAC ON-OFF switch OFF.

5. Cable connected to recorder but not to radar.

(*j*) At the tracker mount—

1. All blower vents closed.

2. All intake vents closed.

3. Antenna RELEASED-NORMAL switch in NORMAL position.

4. Azimuth lock plunger engaged.

5. Orientation clutch engaged.

c. Outline of Test.

Examiner commands—	Action of candidate
COMPLETE EMPLACEMENT AND START THE RADAR SET AN/MPQ–10A.	Completes the emplacement and starts the counterbattery radar set AN/MPQ–10A as prescribed in TM 11–1303, paragraphs 45, 45.1, 50, 52, 53; FM 6–160, paragraphs 5, 7, 8.

d. Penalties.

(1) A penalty of 0.4 point will be assessed for each step of the procedure omitted.

(2) A penalty of 0.7 point will be assessed for each of the following errors:

(*a*) During emplacement, any violation of safety.

(*b*) Incorrect leveling procedure.

(*c*) Failure to rotate the tracker mount 180°, after leveling it, to insure that it is level.

(*d*) Incorrect cabling procedure.

(*e*) Attempting to turn on the transmitter before allowing the set to warm up.

(*f*) Failure to check the radar set control unit three-phase meter.

(*g*) Failure to have either the 115VAC ON-OFF switch OFF or the PAPER DRIVE AUTO-OFF-LOCAL switch in the OFF position on the recorder RD–54/TP.

(3) Time penalties will be assessed as follows (taken to nearest minute):

20 minutes or less	21 to 30 minutes	Over 30 minutes
0	3.5	10

(4) If the total penalties exceed 6.5 points, no credit will be awarded.

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 128.

130. Operation of the Radar Set

a. Scope of Test. Four tests will be conducted in which the candidate will tune the receiver and will collimate, orient, and range calibrate the counterbattery radar set AN/MPQ–10A.

b. Special Instructions.

(1) The following equipment will be furnished the candidate:

(*a*) One generator set SF–10–MD (operating).

(*b*) One counterbattery radar set AN/MPQ–10A (emplaced, cabled, and voltage applied).

(*c*) One 100-gram balloon with a reflector or one light Army aircraft.

(*d*) One preselected orienting point (at least 1,000 meters from the radar) with known azimuth and elevation.

(*e*) One preselected range calibration point with known azimuth and slant range.

(2) Three assistants will be available to the candidate, but they will perform operations only on the candidate's instruction (at the discretion of the examiner).

(3) The examiner will physically point out the orienting point to the candidate.

(4) Mechanic's adjustment of orienting telescope, radar beam, or tracking sensitivity of radar should not be charged to the candidate in determining the accuracy of collimation.

c. Outline of Tests.

Test number	Examiner commands—	Action of candidate
1.	TUNE RECEIVER AND DETERMINE TRANSMITTER EFFICIENCY BY THE ECHO-BOX METHOD.	Tunes receiver as prescribed in paragraph 8*b*(3).
2.	COLLIMATE THE RADAR SET.	Collimates the radar set as prescribed in paragraphs 10–14.
3.	ORIENT THE RADAR SET.	Orients the radar set as prescribed in paragraphs 15–17.

Test number	Examiner commands—	Action of candidate
4.	RANGE CALIBRATE THE RADAR SET USING THE FIXED TARGET METHOD AND THE RANGE MARKER METHOD.	Range calibrates the radar set as prescribed in paragraphs 18 and 19.

d. Penalties.

(1) For test 1, a penalty of 1 point will be assessed for each failure to—

(*a*) Tune the echo box to the maximum deflection of the indicator.

(*b*) Maximize the ringtime by adjustment of the RECEIVER GAIN and TUNING controls.

(*c*) Correctly aline the range mark on the B-scope.

(2) For test 2—

(*a*) A penalty of 2 points will be assessed if the accuracy of collimation in elevation is not within ± 1 mil.

(*b*) A penalty of 2 points will be assessed if the accuracy of collimation in azimuth is not within ± 1 mil.

(*c*) All penalties should be assessed in proportion to the degree of accuracy of collimation.

(3) For test 3—

(*a*) A penalty of 2 points will be assessed for failure to orient the radar set within ± 1 mil in azimuth.

(*b*) A penalty of 2 points will be assessed for failure to orient the radar set within ± 1 mil in elevation.

(4) For test 4, a penalty of 1 point will be assessed for each failure to—

(*a*) Set off the correct slant range and azimuth to the range calibration point (fixed target).

(*b*) Select the appropriate range markers.

(*c*) Determine the average range marker interval.

(*d*) Move the RANGE MANUAL-AUTO switch to the AUTO position.

(*e*) Report all deviations.

(5) No credit will be given if the total penalties for the four tests exceed 11 points.

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 128.

131. Operation of the Recorder RD-54/TP

a. Scope of Tests. Two tests will be conducted in which the candidate will be required to synchronize and calibrate the recorder RD-54/TP.

b. Special Instructions.

(1) The following equipment will be furnished the candidate

(*a*) One counterbattery radar AN/MPQ-10A (operational and tuned).

(*b*) One recorder RD-54/TP.

(*c*) One power unit PU-26A/U (operational).

(*d*) One plot-reading scale.

(*e*) One stopwatch.

(*f*) One screwdriver.

(2) Two assistants will be available to the candidate, but they will perform operations only on his instruction (at discretion of examiner).

(3) The examiner will designate the center of sector.

c. Outline of Tests.

Test number	Examiner commands—	Action of candidate
1.	SYNCHRONIZE THE RECORDER RD-54/TP.	Synchronizes the recorder RD-54/TP as prescribed in paragraphs 20 and 21.
2.	CALIBRATE THE RECORDER RD-54/TP.	Calibrates the recorder RD-54/TP as prescribed in paragraph 22.

d. Penalties.

(1) For test 1—

(*a*) A penalty of 0.7 point will be assessed for each of the following errors in synchronization of the recorder RD-54/TP.

1. Incorrect adjustment of the gain, damping, or CF-switching controls on any of the amplifiers.

2. Failure to synchronize the range at the approximate expected range of operation. (Use 3,000 yards.)

3. Failure to synchronize the azimuth at the center of sector.

4. Incorrect positioning of the synchro data switch while adjusting the synchros.

5. Failure to displace the stylus carriage the appropriate amount while adjusting the CF switching.

(*b*) Time penalities (taken to nearest minute):

20 minutes or less	21–25 minutes	Over 25 minutes
0	1.5	3.0

(2) For test 2—

(*a*) A penalty of 0.7 point will be assessed for each of the following errors in calibration.

1. Failure to calibrate height, range, or azimuth.

2. Failure to determine zero height or the corrections in range and azimuth and apply them to the plot-reading scale.

3. Failure to report excessive deviations during successive steps in calibration.

4. Failure to calibrate at the correct intervals.

5. Each incorrect command given to the assistant at the tracker mount or control unit.

(*b*) Time penalties (taken to nearest minute):

25 minutes or less	26 to 30 minutes	Over 30 minutes
0	1.7	3.4

(3) No credit will be awarded if the total penalties for the two tests exceed 6 points.

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 128.

132. Evaluation of Site

a. Scope of Test. One test will be conducted in which the candidate will be required to evaluate by means of clutter and coverage diagrams the radar site previously selected.

b. Special Instructions.

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

(*a*) One radar set AN/MPQ–10A.

(*b*) One generator set SF–10–MD.

(*c*) Radar site evaluation chart.

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

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

c. Outline of Test.

CONSTRUCT RADAR SITE EVALUATION CHART	Constructs radar site evaluation chart as prescribed in paragraphs 94 through 97.

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

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 128.

133. Map Reading and Use of Plotting Equipment

a. Scope of Test. One test will be conducted in which the candidate will be required to set up a grid sheet and plot the known friendly and enemy positions.

b. Special Instructions.

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

(*a*) One mapboard.

(*b*) One grid sheet.

(*c*) One aluminum range-deflection protractor.

(*d*) One coordinate scale.

(*e*) One plotting scale.

(*f*) One protractor.

(*g*) One 4H pencil and one 6H pencil.

(*h*) Pencils with red, blue, and green hard lead.

(*i*) Two map pins and two plotting needles.

(*j*) One contour map of the area.

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

c. Outline of Test.

PLOT ALL KNOWN LOCATIONS ON GRID SHEET. (The locations and designations of adjacent units will be given to the candidate. Information may be in the form of polar coordinates or grid references. Candidate will have a map of the area to determine all additional information such as height locations, and information for labeling the lower left corner of grid sheet.)	Constructs grid sheet as prescribed in FM 6–2, chapter 2, and FM 6–40, chapter 16.

d. Penalties.

(1) A penalty of 0.6 point will be assessed for the incorrect—

(*a*) Labeling of the grid sheet.

(*b*) Establishment of the indexes.

(*c*) Labeling of a known location.

(*d*) Use or reading of the range-deflection protractor.

(*e*) Use or reading of the coordinate scale.

(*f*) Use or reading of the plotting scale.

(*g*) Use of map pins or plotting needles.

(*h*) Use of 4H or 6H pencil.

(*i*) Use of colored pencils.

(*j*) Use of height from the contour map.

(2) No credit will be given if the total penalties exceed 6 points.

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 128.

134. Weapon Location

a. Scope of Tests. Four tests will be conducted in which the candidate will be required to act as radar set control unit operator, recorder operator, plot reader, and plotter during the detection, tracking, and location phases.

b. Special Instructions.

(1) The counterbattery radar set AN/MPQ–10A with recorder RD–54/TP and generator set SF–10–MD will be emplaced in a favorable position for detecting and tracking projectiles fired from a mortar or artillery weapon, preferably the site previously selected by the candidate.

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

(3) The examiner will make necessary arrangements to provide a mortar or an artillery piece with sufficient ammunition to represent the enemy. He will also establish communication between the weapon and the radar site.

(4) When sending fire commands to the weapon, the examiner will insure that the commands are audible to the candidate.

(5) If an artillery weapon is used, it should be located so that the projectile will present a side aspect to the radar set.

(6) A plot-reading scale, parabolic template (7,500 feet), grid sheet, and contour map of the area should be available.

(7) If the center of sector is different from the one for which the candidate synchronized the recorder RD–54/TP initially, he should be notified of the new center of sector.

c. Outline of Tests.

Test number	Examiner commands—	Action of candidate
1.	SECTOR SCAN AND DETERMINE PICKUP DATA FOR WEAPON LOCATION. (Examiner will have a maximum of five rounds fired at approximately 1-minute intervals.)	Performs duties of radar set control unit operator as prescribed in paragraphs 24 and 25.
2.	TRACK PROJECTILES AND CORRECT PICKUP DATA. (Five rounds will be fired to provide for locking on and tracking automatically; then five more rounds will be fired with the candidate at the recorder RD–54/TP and an assistant at the radar set control unit. The candidate is then instructed to improve the pickup data.)	Tracks projectiles and improves pickup data as prescribed in FM 6–160, paragraphs 24 and 25.
3.	INTERPRET THE PLOT. (On completion of test 2 and after a plot has been obtained from the recorder RD–54/TP, the candidate is to draw a diagram of the weapon and burst with respect to the radar position. Grid north is to be indicated on the diagram and the positions are to be drawn accordingly.)	Interprets the plot and draws diagrams as prescribed in paragraphs 35 through 42.
4.	EXTRAPOLATE THE PLOT. (The plot will be extrapolated to determine both the weapon and the burst locations. The polar plot data obtained will be plotted on the grid sheet or map to obtain the grid coordinates. The coordinates and the heights of the weapon and the burst are to be determined. An assistant should be available to aid in obtaining the difference in height.)	Extrapolates the plot as prescribed in paragraphs 43 through 54.

d. Penalties.

(1) For test 1, a penalty of 2 points will be assessed for each failure to—

(*a*) Adjust the radar so that it scans the proper sector in azimuth.

(*b*) Set the elevation about 20 mils above the highest point of the screening crest in the sector.

(*c*) Detect the projectile echo on the upward portion of the trajectory (assessed for each undetected echo).

(2) For test 2, a penalty of 2 points will be assessed for each failure to—

(*a*) Gate the echo on the J-scope with the

SLANT RANGE handwheel and track the projectile automatically (assessed for each echo missed).

(*b*) Return the MASTER AUTO-MANUAL switch to MANUAL when the projectile reaches the screening crest elevation on the descending portion of its flight path.

(*c*) Improve pickup data (while acting as recorder operator) and eliminate most of the pickup jump on the height, range, and azimuth trace.

(3) For test 3, a penalty of 1.5 points will be assessed for each failure to—

(*a*) Determine whether the weapon is firing from right to left or from left to right.

(*b*) Accurately determine the degree and direction of range change with respect to the radar.

(*c*) Locate accurately the weapon with respect to the radar.

(*d*) Locate accurately the burst with respect to the radar.

(4) For test 4, a penalty of 1 point will be assessed for each incorrect—

(*a*) Extension of the traces.

(*b*) Use of the parabolic template.

(*c*) Reading of the range and azimuth traces.

(*d*) Compensation for difference in height.

(*e*) Polar plotting of the weapon.

(*f*) Determination of the coordinates.

(5) No credit will be given if the total penalties for the four tests exceed 14 points.

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 128.

135. Radar Gunnery

a. Scope of Tests. Two tests will be conducted in which the candidate will be required to determine the grid reference from a high burst registration and from a mean-point-of-impact registration.

b. Special Instructions.

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

(*a*) One plot-reading scale.

(*b*) One parabolic template.

(*c*) One grid sheet and the necessary plotting equipment.

(*d*) One DA Form 3526 (for the radar-observed high burst registration).

(*e*) Six scaled sketches of the J-scope, representing the range to each burst.

(*f*) Six mean-point-of-impact plots.

(*g*) One sketch of the telescope reticle with six rounds representing the high bursts placed at random around the center.

(*h*) One DA Form 3527 (for the radar-observed mean-point-of-impact registration).

(*i*) One tabular firing tables for the appropriate weapon.

(2) During the test on the high burst registration, the candidate will use DA Form 3526. He will determine and record the pointing data, the deviations indicated on the sketch of the reticle, and the range deviations indicated on sketches of the J-scope. He must also be furnished the coordinates and altitude of the radar and the elevation to the screening crest at the pointing azimuth. He will then compute the average range, elevation, and azimuth to the center of burst and determine the grid reference and altitude of the high burst registration point.

(3) During the test on the mean-point-of-impact registration, the candidate will use DA Form 3527. He must be furnished the coordinates and altitude of the radar and the registering piece. He will determine and record the pickup data and the range and azimuth derived from the six plots. He will then compute the average range and azimuth to the center of burst and determine the grid reference and altitude of the selected datum plane to the mean-point-of-impact registration.

c. Outline of Tests.

Test number	Examiner commands—	Action of candidate
1.	OBSERVE HIGH BURST FOR (Examiner designates unit) GRID (examiner designates coordinates), MINIMUM ALTITUDE (examiner gives minimum acceptable altitude), REPORT ALTITUDE REPORT WHEN READY TO OBSERVE.	Conducts radar observed high burst registration as outlined in paragraphs 57 through 63.
2.	OBSERVE MEAN-POINT-OF-IMPACT FOR (examiner designates unit) GRID (examiner designates coordinates), 105 HOWITZER CHARGE (examiner gives caliber and charge), QUADRANT (examiner gives quadrant), REPORT WHEN READY TO OBSERVE.	Conducts radar-observed mean-point-of-impact registration as outlined in paragraphs 64 through 69.

d. Penalties.

(1) For test 1, a penalty of 0.4 point will be assessed for each of the following errors:

(*a*) Each mistake made in determining pointing data.

(*b*) Each mistake made in entering data on the form.

(*c*) The candidate should be asked what data he would send to the FDC for the registration. Penalties will be assessed according to his answer.

(2) For test 2, a penalty of 0.4 point will be assessed for each of the following errors:

(*a*) Each mistake made in determining pickup data.

(*b*) Any procedural error made in reading the plots.

(*c*) Each mistake in entering data on the form.

(*d*) The candidate should be asked what data he would send to the FDC for the registration. Penalties will be assessed according to his answer.

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 128.

APPENDIX

REGULATIONS

1. Army Regulations

AR 611–201	MOS Listings for Enlisted Men.

2. Field Manual

FM 6–15	Artillery Meteorology.
FM 6–20–1	Field Artillery Tactics.
FM 6–20–2	Field Artillery Techniques.
FM 6–40	Field Artillery Cannon Gunnery.
FM 6–120	Field Artillery Target Acquisition Battalion and Batteries.
FM 6–121	Field Artillery Target Acquisition.
FM 6–125	Qualification Tests for Specialist, Field Artillery.
FM 21–5	Military Training Management.
FM 21–6	Techniques of Military Instruction.
FM 21–11	First Aid for Soldiers.
FM 21–30	Military Symbols.
FM 21–40	Chemical, Biological, Radiological, and Nuclear Defense.

3. Army Training Program

ATP 6–575	Field Artillery Target Acquisition Battalion.

4. Army Subject Schedule

ASubjScd 6–10	Field Artillery Radar Operations.

5. Tables of Organization and Equipment

TOE 6–575	Field Artillery Target Acquisition Battalion.
TOE 6–577	Field Artillery Target Acquisition Battery.

6. Technical Manuals

TM 3–220	Chemical, Biological, and Radiological (CBR) Decontaminants.
TM 5–225	Radiological and Disaster Recovery at Fixed Military Installations.
TM 5–2805–204–14	Organizational, DS and GS Maintenance Manual: Engine, Gasoline; Military Standard Models.
TM 5–2805–204–24P	Organizational, DS and GS Maintenance Repair Parts and Special Tool Lists: Engine, Gasoline; Military Standard.
TM 5–6115–275–12	Organizational Maintenance Generator Set, Gasoline Engine: 10KW.
TM 5–6115–275–25P	Organizational Maintenance Repair Parts and Special Tool Lists: Generator Set, Gasoline Engine: 10KW.

TM 5-6115-365-15	Organizational, DS, GS, and Depot Maintenance Manual Including Repair Parts: Generator Set, Gasoline and Diesel Engines Driven PU 5640 AG FSN 6115-738-6341.
TM 9-1900	Ammunition, general.
TM 11-1303	Installation and Operations: Radar Sets AN/MPQ-10 and Q-10A.
TM 11-1303-ESC	Equipment Serviceability Criteria for Radar Set MPQ 10A.
TM 11-5534	Azimuth Elevation Range Recorder RD-54/TP and Azimuth Elevation Range Recorder RD-3/MPQ.
TM 11-6940-208-15	Organizational, DS, GS, and Depot Maintenance Manual including Repair Parts and Special Tools: Radar Signal Interference Trainer.
TM 38-750	Army Equipment Record Procedure.

7. Technical Bulletin

TB 11-1303-2	Fording Kit MK-143 for AN/MPQ-10.

8. Training Film

TF 6-1757	Field Artillery Radar.

9. Lubricating Order

LO 5-2805-258-12	Engine, Gasoline, 10HP Military Standard Models (Model 2A042-2 and 2A042-3).

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By Order of the Secretary of the Army:

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