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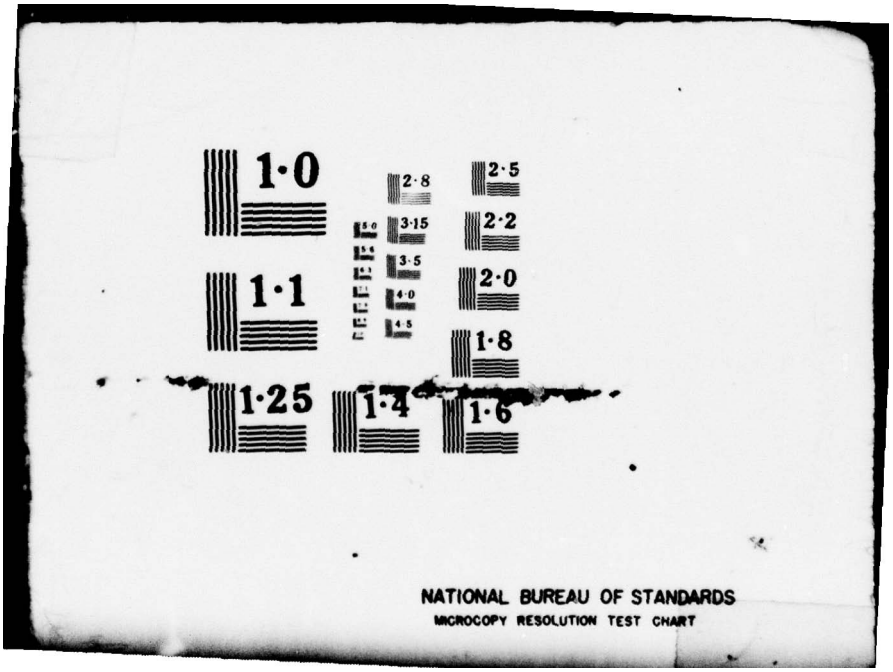
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This is Volume I of six volumes of training material prepared for an experimental course of maintenace instruction of the AAFCS M33. This material was developed during research conducted by the US Army Air Defense Human Research Unit at Fort Bliss, Texas, in cooperation with the US Army Air Defense School. A detailed account of the research, the results, and recommendations emerging from the experiment, and the rationale by which these materials were prepared is included in HumRRO Technical Report 46, AD-200 850.

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Technical Supplementary Material

for

HumRRO Technical Report 46: DEVELOPMENT AND EVALUATION OF AN EXPERIMENTAL PROGRAM OF INSTRUCTION FOR FIRE CONTROL TECHNICIANS (RADAR VI)

AD-200 850

Lesson Plans
Practical Exercises
Suggested Operating Procedures
Dictionary of Radar Terms

Prepared By
US Army Air Defense Human Research Unit

Under the Technical Supervision of
The George Washington University
Human Resources Research Office
operating under contract with
The Department of the Army

Fort Bliss, Texas
June, 1958

FOREWORD

This is Volume I of six volumes of training material prepared for an experimental course of maintenance instruction of the AAFCS M33. This material was developed during research conducted by the US Army Air Defense Human Research Unit at Fort Bliss, Texas, in cooperation with the US Army Air Defense School. A detailed account of the research, the results, and recommendations emerging from the experiment, and the rationale by which these materials were prepared and used, is included in HumRRO Technical Report 46, "Development and Evaluation of an Experimental Program of Instruction for Fire Control Technicians." It is recommended that readers familiarize themselves with the contents of this report before attempting to use the training materials contained in these volumes. A copy of this report may be obtained by writing to the Director, Human Resources Research Office, The George Washington University, Washington 7, D. C.

VOLUME I

OPERATION ORIENTATION

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TABLES

DIAGRAMS [1/]

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PLATES (continued)

1/ Diagrams refer to drawings which have been specially prepared by the authors.

2/ Figures are direct references to figures in the AAFCS M33 Schematics. These carry the same figure number as in that book.

3/ Plates are photographs taken from Air Defense School Publications or prepared especially for these volumes.

INTRODUCTION

This volume contains instructional material for the Operation Orientation subcourse of a program of fire control radar instruction that consists of the following subcourses:

I Operation Orientation
II Electronic Fundamentals
III Acquisition Radar
IV Track Radar
V Computer
VI Maintenance and Supply

It includes lesson plans and practical exercises, a manual of suggested operating procedures, and a dictionary of radar terms. This material was designed to be covered in 38 periods of instruction: 16 periods of conference, and 22 periods of practical exercises. Each instructional period was approximately 50 minutes in length. A detailed breakdown of instructional topics and time allotment is presented ~~in Table 1, page 3~~.

Instructional material contained herein is that issued to instructors. Material issued to students was identical with two exceptions: (1) copies of practical exercises were not issued, and (2) instructor's notes, suggested explanations, and problems (shown in boxes in the lesson plans) were deleted.

A difference in format exists between material in this volume and that used during the research, in that the experimental lesson plans were printed only on the left-hand pages of the volumes. This arrangement provided student and instructor with convenient and appropriate space for notes.

It will be noted that each page of lesson plans and practical exercises is coded at the top of the page. This code is interpreted as follows: the first letter "I" indicates that these publications were issued to instructors, the second letter indicates the volume (in this case, "O" for Operation Orientation), and the number following the dash indicates the number of the lesson plan in the volume. The code found on practical exercises is similar except that the number following the dash is preceded by a "P".

Experience gained during the course of an experiment frequently enables researchers to suggest modifications in design and/or materials that should lead to significant improvement of the product. Such modifications have been incorporated into these volumes to the possible benefit of the user and are indicated in two ways:

1. Changes relating to content are described in the introduction to each volume. No such changes have been recommended for Volume I.

2. Changes relating to topic time allotments are indicated in Table 1. Numbers indicate recommended hours of instruction for each topic; where recommended time differs from time actually allotted during the experiment, actual time consumed during the experiment is indicated in parentheses.

Although material in this volume has been carefully prepared, imperfections may still exist. Your cooperation in eliminating them is requested. Notification of errors and suggestions for improvement should be forwarded to the Director of Research, US Army Air Defense Human Research Unit, Fort Bliss, Texas.

Table 1

SUMMARY OF INSTRUCTIONAL *PERIODS
ALLOTTED TO TOPICS INCLUDED IN OPERATION
ORIENTATION SUBCOURSE

TOPIC	CONFERENCE	PRACTICAL EXERCISE
Orientation	1	0
Introduction to and Description of AAFCS M33	1	2
Nomenclature, Function, and Location of Components	2	1
Start-Stop, Stop, and Safety Precautions	1	2
Normal Acquisition Operations	1	1
Normal Track Operations	1	1
Normal Operation of Computer and Monitor Control	1	1
System Operations	2	6
Preoperational Checks, First Echelon Maintenance	2	3
System Cabling	2	3
Trouble Shooting	0	2
Examination	1	0
Critique	1	0
Total	16	22

* Does not include two hours of nonacademic time: Commander's time, physical training, etc.

PRACTICAL EXERCISE

SYSTEM OPERATION

AAFCS M33 SETUP: Completely de-energized.

EQUIPMENT NECESSARY: None.

DEMONSTRATION:

INSTRUCTOR'S NOTE: This exercise will be devoted to complete system operation. All students should perform the duties of each of the various operations, and should occasionally be shifted from one operator's position to another. This exercise is provided for the sole purpose of developing the student's proficiency at acquiring, designating, and tracking moving targets as well as operation of the computer and monitor controls. The "Suggested Operating Procedures (Appendix A) should be used as a guide for this exercise when applicable.

LESSON PLAN

INTRODUCTION TO THE AAFCS M33

OBJECTIVE:

To explain the major characteristics and capabilities of the AAFCS M33.

INTRODUCTION:

The AAFCS M33 is a completely integrated fire control system consisting of an acquisition or search radar, a track or gunlaying radar, and a computer. The AAFCS M33 consists of the following major components:

1. Acquisition radar,
2. Tracking radar,
3. Computer,
4. A control unit, and
5. IFF radar.

PRESENTATION:

1. The Air Defense Battery Mission.
   a. Destroy the enemy,
   b. Nullify their effectiveness, and
   c. Force them to abandon their mission.

2. Normal Targets Include:

   a. Conventional aircraft, and

   b. Guided missiles.

3. General Characteristics and Capabilities of the AAFCS M33.

   a. The Acquisition Radar.

      1) The acquisition radar has a maximum range of 120,000 yards,

      2) Will detect targets to an average altitude of 75,000 feet, and

      3) Has a variable S-band frequency coverage from 3,100 to 3,500 mc.

   b. The Track Radar.

      1) The tracking radar has automatic tracking in azimuth, elevation, and slant range to 99,500 yards,

      2) Is accurate to ±10 yards in slant range, and

      3) Has a variable X-bank frequency coverage of from 8,500 to 9,600 mc.

   c. The Computer.

      1) The computer is an electromechanical analog type.

      2) It can predict for either linear or curvilinear courses with rates up to 500 yd/sec.

      3) It is almost fully ballistic.

      4) The computer has provisions for automatic zero-set and servo-gain adjustments.

5) It has a data-smoothing capability of either 4 or 8 seconds.

6) It will compute out to 40,000 yards range and furnish valid prediction out to 36 seconds time of flight.

d. Plotting Boards Incorporated in the AAFCS M33.

1) The present and predicted horizontal plotting board,

2) The present altitude plotting board,

3) The predicted altitude plotting board, and

4) The early warning plotting board.

e. The Tactical Control Console.

1) The tactical control console (TCC) provides a primary means of operating the acquisition radar and locating and identifying targets.

2) The TCC incorporates a signal system.

3) As the nerve center of the battery, the TCC provides a means of communication, through a switchboard, with the entire battery.

f. The Tracking Console.

1) The tracking console provides a means of operating the track radar and an alternate means of operating the acquisition radar.

2) It incorporates a trial fire indicator for use in preparatory fire.

g. The Radar Cabinet.

1) The radar cabinet contains the power supplies and voltage regulators for both radars.

2) It also contains the tracking radar range unit.

h. The Heater Cabinet.

1) The heater cabinet provides a means of heating the interior of the trailer.

2) It contains two 12-volt wet-cell batteries for operating heater, trailer brakes, and emergency ceiling lights.

i. The Switchboard Cabinet.

1) The switchboard cabinet contains a BD 91 and an SB-100.

2) The cabinet provides telephone communication within the battery and trunk lines for early warning nets and higher echelons.

3) It can be used with dial-system exchange.

4) It provides a means of automatically establishing hot loops.

4. Characteristics of AAFCS M33 Trailers.

a. The Trailer M242.

1) The trailer M242 is a 4-wheel van type,

2) Houses nine major components,

3) Is air-transportable,

4) Is watertight and lightproof, and

5) Is towed by a 5-ton cargo truck M54.

b. The Trailer M243.

1) The trailer M243 is a 4-wheel flat-bed type,

2) Used to transport the acquisition antenna and associated equipment, and

3) Towed by a $2\frac{1}{2}$-ton cargo truck M35.

c. The Trailer M244.

1) The trailer M244 is 4-wheel van type.

2) It houses the spare parts and serves as a maintenance trailer.

3) The trailer transports certain components of the acquisition radar when traveling.

4) It is towed by a $2\frac{1}{2}$-ton cargo truck M35.

5. The AAFCS M33 Power Source.

a. The AAFCS M33 power source is a 35-kva, 400-cycle generating unit (H-F 30-G).

6. The AAFCS M33 and the AAA Air Defense Battery Problem.

a. Observe with the acquisition radar.

b. Identify the target with the aid of the IFF radar.

c. Designate for transfer of target from acquisition to tracking radar.

d. Pick up target with the track radar.

e. Track for at least 4 seconds to allow sufficient data smoothing time for the computer.

f. Compute the target's future position and apply ballistic corrections.

g. Destroy.

IO-P1

PRACTICAL EXERCISE

INTRODUCTION TO THE AAFCS M33

AAFCS M33 SETUP: Completely de-energized.

EQUIPMENT NECESSARY: None.

DEMONSTRATION:

> INSTRUCTOR'S NOTE: Review the major components of the AAFCS M33 presented in the lecture prior to this exercise. Explain to the students the function of each of these major components. Discuss the general over-all operation of the set, and explain the major characteristics, capabilities, and limitations of the system.

LESSON PLAN

DESCRIPTION OF THE AAFCS M33[1/]

OBJECTIVE:

To explain the various components and controls used in the operation of the AAFCS M33.

INTRODUCTION:

The AAFCS M33 is the latest piece of fire control equipment for medium and heavy air defense guns. The basic system contains three major components; acquisition radar, track radar, and computer. For the purpose of description, however, the system will be divided into other components according to their physical location. There are five separate external units of the AAFCS M33; the M242 fire control trailer, the acquisition antenna assembly, the M244 maintenance and spare parts trailer, the M243 flat-bed trailer, and the power generator. This class will cover only the interior of the fire control trailer M242, which will be divided into nine major components; computer, automatic plotting boards, tractical control console, tracking console, radar cabinet, heater cabinet, lower section of tracker periscope, early warning plotting board, and switchboard.

As asterisk (*) after the name of a particular unit refers to the data on the differences between the AAFCS M33 and AAFCS T33 models (Par. 10).

PRESENTATION:

1. Computer.

The computer receives present position data from the track radar, computes the predicted position of the target, adds ballistic and parallax corrections, and transmits firing data to the guns.

4/ Taken from Lesson Plan 2307, Department of Gunnery and Materiel, The Artillery School, Antiaircraft and Guided Missile Branch, Fort Bliss, Texas, November, 1953. Some of the plates used are from new photographs.

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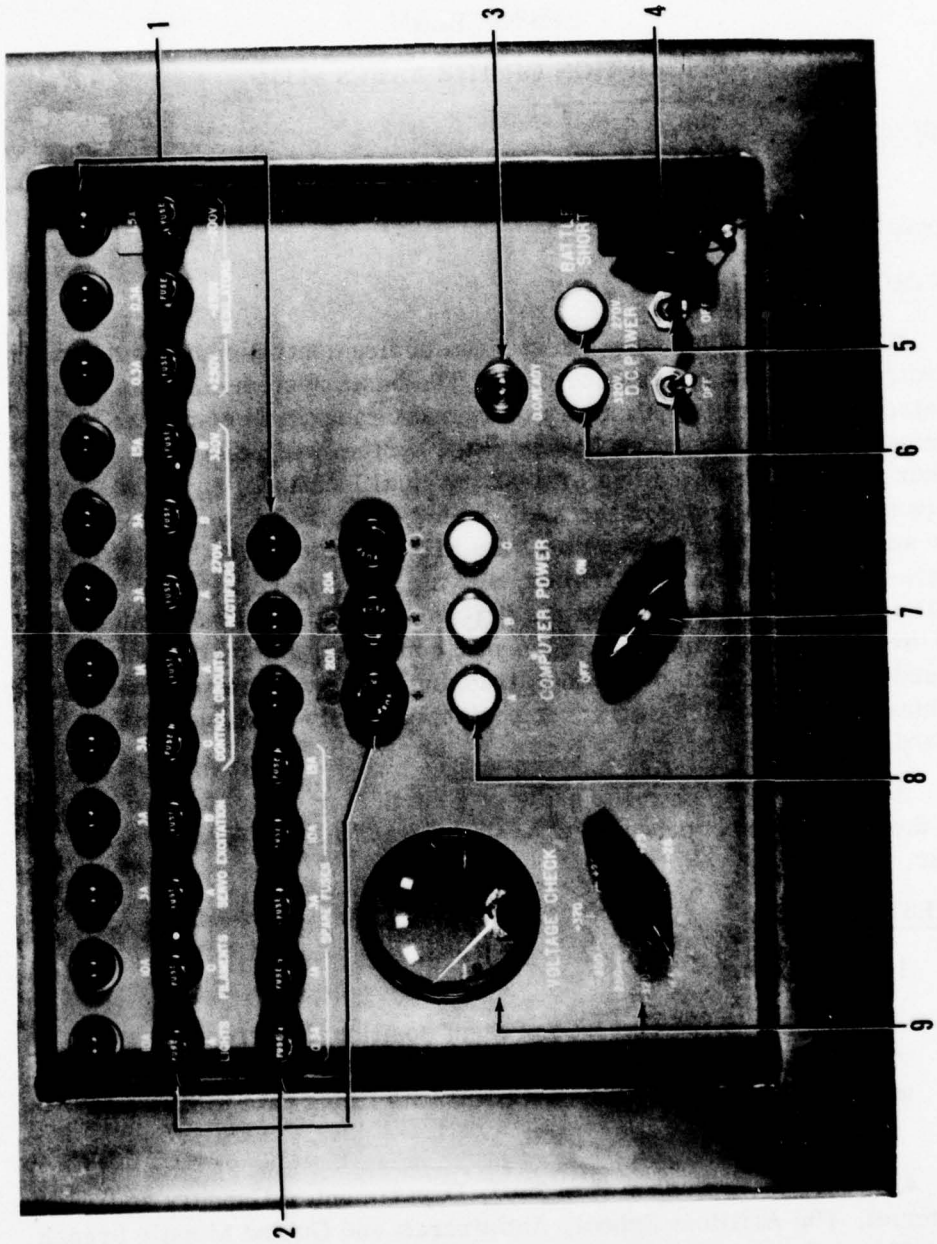

Plate 1. Computer power control panel.

NOTE: Numbers on this plate refer to numbered items in par 1a.

a. Power Control Panel (Plate 1). Contains all controls used to energize the computer.

1) Blown fuse indicator lamps. Illuminate when the associated fuse burns out, enabling maintenance personnel to locate the source of trouble quickly.

2) Fuse holders. Contain fuses for the various circuits of the computer.

3) DC READY lamp. When illuminated, indicates that the 30-second time delay has elapsed and DC power may be applied to the computer.

4) BATTLE SHORT switch. Toggle switch bypasses the time delay and the computer door interlocks. The switch cover is normally wired down and sealed.

5) 270V DC POWER switch and lamp. The toggle switch applies 270V DC power to the computer. The lamp illuminates when the switch has been placed in the ON position.

6) 320V DC POWER switch and lamp. The toggle switch applies 320V DC power to the computer. The lamp illuminates when the switch has been placed in the ON position.

7) COMPUTER POWER switch. The 2-position rotary switch applies AC power to the computer and activates the 30-second time delay

8) COMPUTER POWER lamps, A, B, and C. When illuminated, indicate that the associated phases of the AC power have been applied to the computer.

9) VOLTAGE CHECK meter and switch. The meter serves as a reference for checking the DC voltages in the computer. The 9-position rotary switch selects the voltage to be checked on the meter.

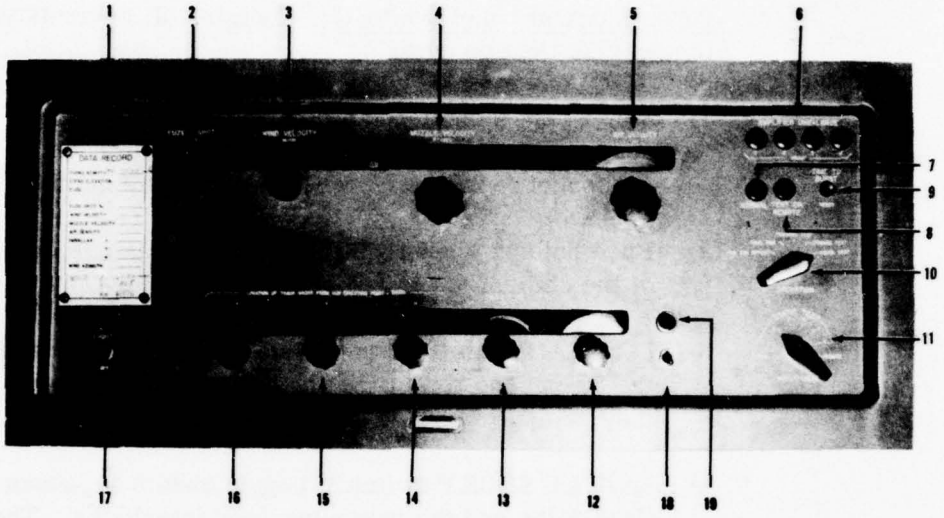

Plate 2. Correction panel.

Note: The numbers on this plate refer to numbered items under Par. 1b.

b. Correction Panel (Plate 2). Contains dials and knobs for making ballistic corrections to compensate for nonstandard conditions. All dial settings are continuous. The panel also contains controls for selecting the type of operation desired.

1) DATA RECORD card. Used for recording dial settings for trial-shot point data, fuze spot, meteorological data, muzzle velocity, and battery parallax.

2) FUZE SPOT knob and dial. Provide a correction to fuze from +5 per cent to -5 per cent. Dial is calibrated in increments of 0.5 per cent.

3) WIND VELOCITY knob and dial. Correct for the effects of wind speeds from 0 to 70 mph. Dial is calibrated in 1-mph increments.

4) MUZZLE VELOCITY knob and dial. Used to set in corrected DMV. Dial is calibrated in 5-f/s increments.

   a) M33C dial reads from 2, 450 to 2, 900 f/s for 90-mm guns.

   b) M33D dial reads from 2, 800 to 3, 300 f/s for 120-mm guns.

5) AIR DENSITY knob and dial. Correct for the effects of nonstandard air density from 80 per cent to 120 per cent. Dial is calibrated in increments of 1 per cent.

6) AMPLIFIER UNBALANCE lamps. When flickering, indicate unbalance or trouble in the associated DC amplifiers.

7) NORMAL lamp. Lights when the OPERATION switch is in FIRE FOR EFFECT and the INPUT DATA switch is in LOCAL.

8) TEST OR REMOTE lamp. Lights when the OPERATION and INPUT DATA switches are in any position other than FIRE FOR EFFECT and LOCAL.

9) TIME TO BURST RESET button. Resets the time-to-burst integrator to its starting position.

10) OPERATION switch. Five-position rotary switch determines the type of operation of the computer.

   a) FIRE FOR EFFECT. Includes all prediction, correction, rate, and acceleration circuits.

   b) TRIAL FIRE. Includes the correction circuits and those circuits necessary to operate the time-to-burst integrator.

c) TRACKING TEST. Includes only the parallax correction circuits. Causes the servo dials to indicate the present position of the target.

d) DYNAMIC TEST. Includes all prediction, rate, and acceleration circuits, but no correction circuits.

e) STATIC TEST. Includes only correction circuits and built-in problems for the servos.

11) INPUT DATA switch. Eight-position rotary switch selects the type of input applied to the computer.

a) LOCAL. Input data is from the tracking radar.

b) STATIC TEST 1 through 6. Input data is from built-in problems.

c) REMOTE. Input data is from some external source.

12) MINIMUM ALTITUDE knob and dial. Provide minimum predicted altitude limits from -500 to +1, 000 yards. Dial is calibrated in 25-yard increments.

13) DEAD TIME knob and dial. Used to correct for the effects of materiel and personnel dead time from 0 to 4 seconds. Dial is calibrated in increments of 0.1 second.

14) H PARALLAX knob and dial. Apply vertical parallax correction from down 500 yards to up 500 yards. Dial is calibrated in 10-yard increments.

15) Y PARALLAX knob and dial. Apply horizontal parallax correction from north 500 yards to south 500 yards. Dial is calibrated in 10-yard increments.

16) X PARALLAX knob and dial. Apply horizontal parallax correction from east 500 yards to west 500 yards. Dial is calibrated in 10-yard increments.

17) LIGHTS switch. Turns on the panel dial lights.

18) SURFACE-AIR switch.* When in the SURFACE position, eliminates altitude prediction for firing at surface targets.

19) TARGET lamp.* Illuminates when the SURFACE-AIR switch is in the SURFACE position.

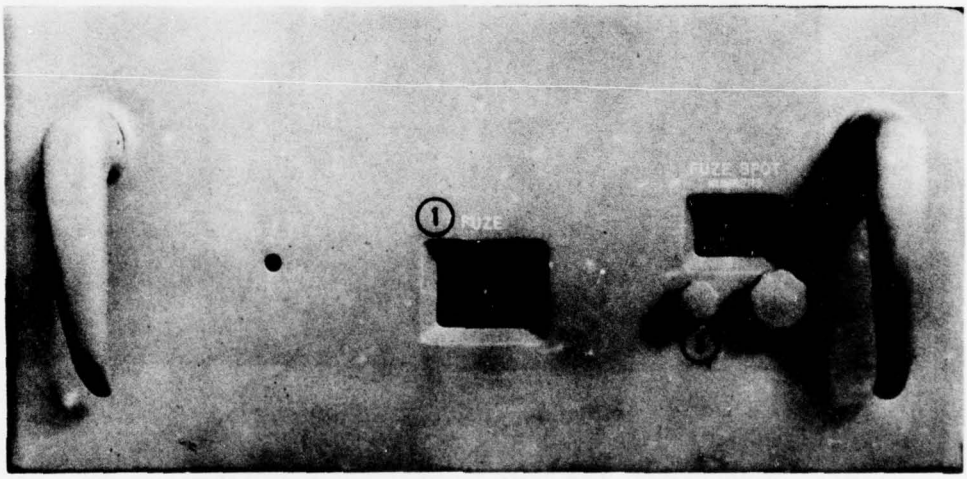

Plate 3. Fuze servo.

Note: Numbers on this plate refer to numbered items in Par 1c.

c. Fuze Servo (Plate 3). Computes and transmits fuze settings for use at the guns.

1) FUZE dial. Indicates fuze settings from 0 to 32 fuze number. Dial is calibrated in increments of 0.01 fuze number.

2) FUZE SPOT dial and knob. Knob adjusts dial to provide a correction in fuze from +1 to -1 fuze number. Dial is calibrated in 0.05 fuze number increments.

3) CONTROL LOCK knob. Locks the FUZE SPOT dial in the 0 position.

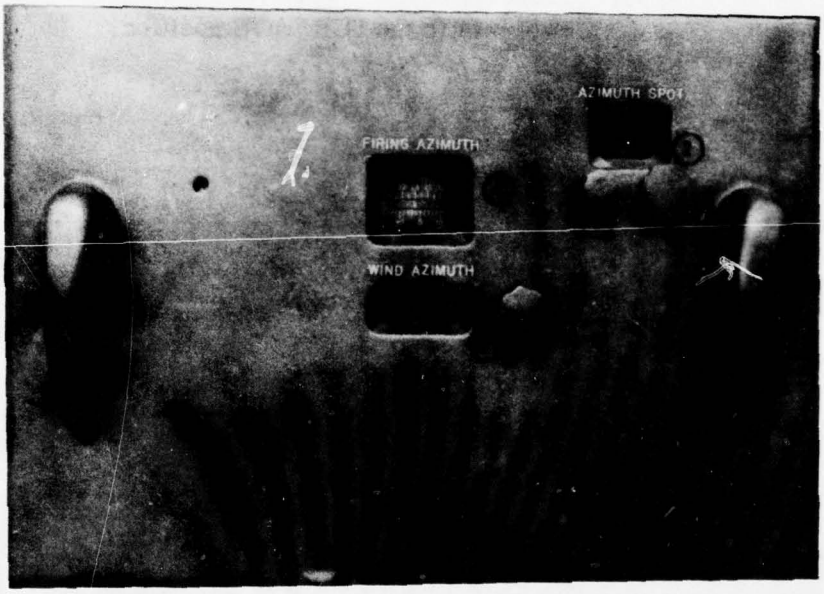

Plate 4. Firing azimuth servo.

Note: Numbers on this plate refer to numbered items in Par. 1d.

d. Firing Azimuth Servo (Plate 4). Computes and transmits firing azimuth of the guns.

1) FIRING AZIMUTH dial. Indicates firing azimuth through 6,400 mils. Dial is calibrated in 2-mil increments.

2) AZIMUTH SPOT dial and knob. Knob adjusts dial to provide a correction in azimuth from -20 to +20 mils. Dial is calibrated in 1-mil increments.

3) CONTROL LOCK knob. Locks the AZIMUTH SPOT dial in the 0 position.

4) WIND AZIMUTH dial and knob. Knob adjusts the wind azimuth dial setting through 6, 400 mils. Dial is calibrated in 100-mil increments.

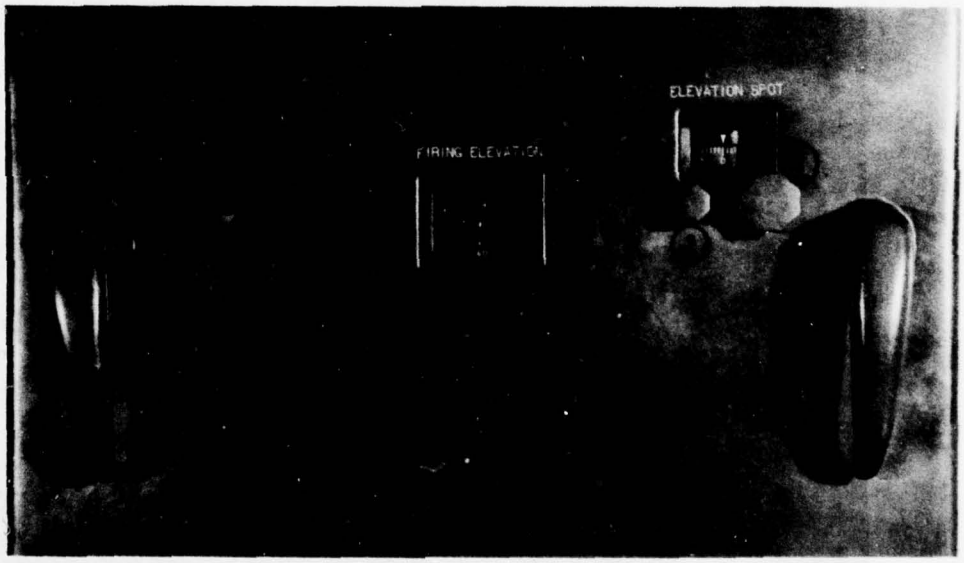

Plate 5. Firing elevation servo

Note: Numbers refer to numbered items in Par. 1e.

e. Firing Elevation Servo (Plate 5). Computes and transmits firing elevation to the guns.

1) FIRING ELEVATION dial. Indicates firing elevation from -200 to +1, 600 mils. Dial is calibrated in 2-mil increments.

2) ELEVATION SPOT dial and knob. Knob adjusts dial to provide a correction in elevation from -20 to +20 mils. Dial is calibrated in 1-mil increments.

3) CONTROL LOCK knob. Locks in ELEVATION SPOT dial in the 0 position.

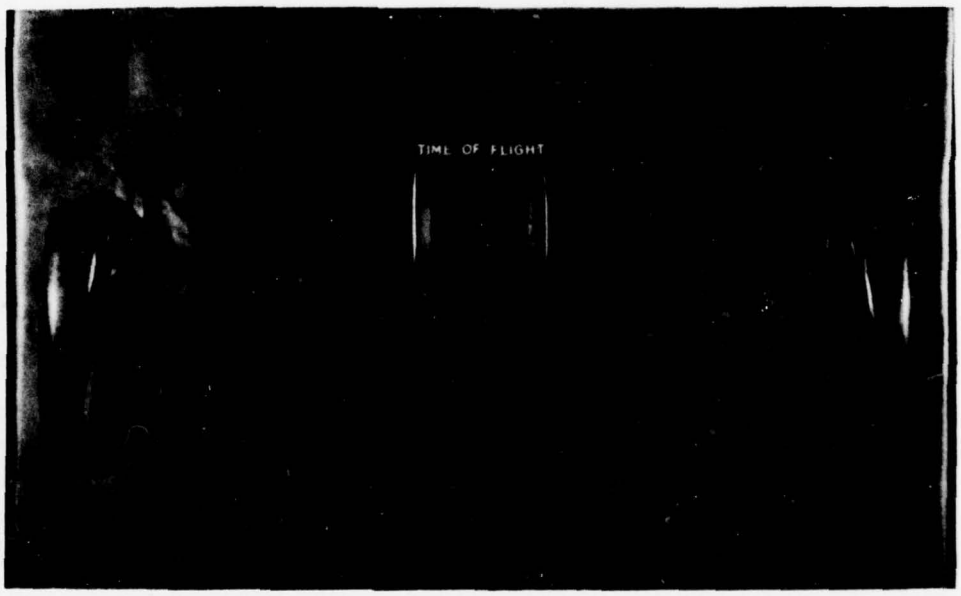

Plate 6. Time-of-flight servo.

Note: Numbers refer to numbered items in Par. 1f.

f. Time of Flight Servo (Plate 6). Computes the time of flight on which the computer bases its prediction. The TIME OF FLIGHT dial indicates time from 0 to 36 seconds and is calibrated in 0.05-second increments.

2. Automatic Plotting Boards.

Three automatic plotting boards make a continuous plot of the target's horizontal position and altitude in terms of both present and predicted data.

a. Horizontal Plotting Board. Plots the target's present horizontal position to a radius of 40,000 yards, and predicted horizontal position to approximately 14,000 yards. Scale of the board is 1:100,000; range is indicated by 5,000-yard circles; azimuth is indicated by 200-mil rays.

b. Predicted Altitude Plotting Board. Plots the target's predicted altitude to 36 seconds time of flight and from -500 to +14,260 yards in altitude. Scale of the board is 1 inch = 1,000 yards: time of flight is indicated by 5-second arcs; trajectories are indicated by 200-mil arcs.

c. Present Altitude Plotting Board. Plots the target's present altitude to 40,000 yards in range and from -500 to +20,000 yards in altitude. Scale of the board is 1:100,000; range is indicated by 5,000-yard arcs; altitude is indicated by 2,000-yard lines.

3. Tactical Control Console.

The tactical control console contains controls for operating the computer, the automatic plotting boards, the reference marks of the PPI and precision indicator, the acquisition antenna, and the signal system.

a. Target Rate Indicator (Plate 7). Contains controls for operation of the computer, automatic plotting boards, and trailer lights.

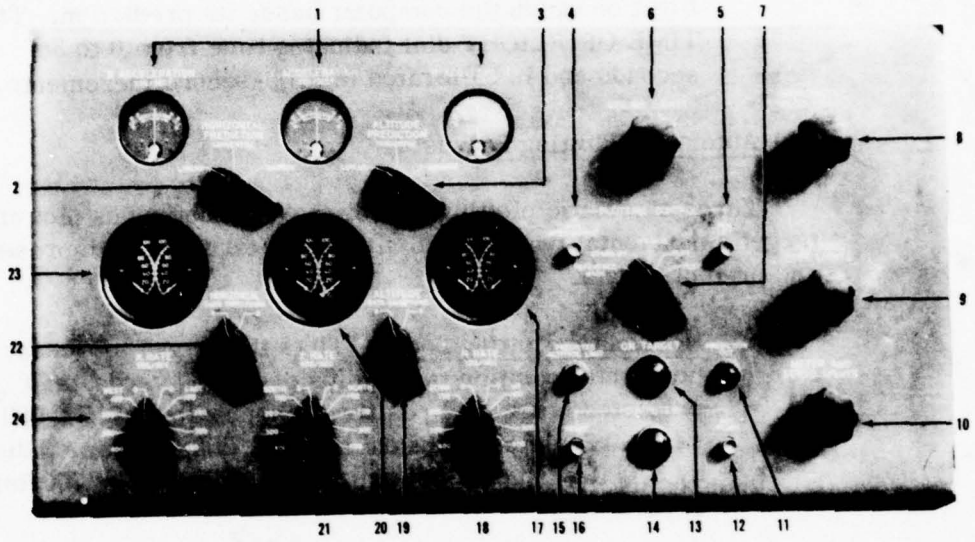

Plate 7. Target rate indicator.

Note: Numbers refer to numbered items in Par. 3a.

1) X, Y, and H ACCELERATION meters. Indicate the target's acceleration from +30 to -30 yd/sec^2 along the associated X, Y, or H coordinate.

2) HORIZONTAL PREDICTION switch. Three-position rotary switch selects either LINEAR, TANGENTIAL, or QUADRATIC prediction in the horizontal plane.

3) ALTITUDE PREDICTION switch. Three-position rotary switch selects either LINEAR, TANGENTIAL, or QUADRATIC prediction in the vertical plane.

4) PEN INTERCHANCE pushbutton. When button is depressed, horizontal plotting board pens change their functions.

5) PEN LIFT pushbutton. When button is depressed, all pens lift from the plotting boards.

6) CEILING LIGHTS control knob. Controls the intensity of the ceiling lights in the vicinity of the tactical control console and the computer.

7) PLOTTING CONTROL switch. The 5-position rotary switch determines the type of operation of the plotting board pens. The positions are REFERENCE MARK, STANDBY, OPERATE, PLOT, and TEST.

8) HORIZONTAL PLOT LIGHTS control knob. Controls the intensity of the horizontal plotting board lights.

9) ALTITUDE PLOT LIGHTS control knob. Controls the intensity of the altitude plotting board lights.

10) METER AND SERVO LIGHTS control knob. Controls the intensity of the lights in the rate and acceleration meters and servo dials.

11) COMPUTER NOT READY pushbutton. When depressed, signals the tactical control officer that the computer is not furnishing usable data and gives the cease fire signal at the guns.

12) PREDICTION OUT lamp. When lit, indicates that computer prediction is invalid for some reason.

13) ON TARGET lamp. When lit, indicates that the track radar is tracking the target.

14) COMPUTER lamp. When lit, indicates that the computer is furnishing usable data.

15) PREDICTED ALTITUDE LIMIT lamp. When lit, indicates that the target' s predicted altitude is below the limit set in on the MINIMUM ALTITUDE dial on the computer correction panel.

16) COMPUTER READY pushbutton. When depressed, signals the tactical control officer that the computer is furnishing usable data.

17) H RATE meter. Indicates the target's velocity in yards per second up or down. Dial is calibrated in 2-yd/sec increments to 100 yd/sec.

18) H RATE switch. Ten-position rotary switch extends the range of the H RATE meter to 500 yd/sec up or down.

19) ALTITUDE DATA SMOOTHING switch. Enables the computer operator to select either 4- or 8-second data smoothing on the H coordinate.

20) Y RATE meter. Indicates the target's velocity in yards per second north or south. Dial is calibrated in 2-yd/sec increments to 100 yd/sec.

21) Y RATE switch. Ten-position rotary switch extends the range of the Y RATE meter to 500 yd/sec north or south.

22) HORIZONTAL DATA SMOOTHING switch. Enables the computer operator to select either 4- or 8-second data smoothing in the X and Y coordinates.

23) X RATE meter. Indicates the target's velocity in yards per second east or west. Dial is calibrated in 2-yd/sec increments to 100 yd/sec.

24) X RATE switch. Ten-position rotary switch extends the range of the X RATE meter to 500 yd/sec east or west.

b. PPI (Plate 8). The tactical control officer and acquisition operator employ the plan position indicator (PPI) in selecting and designating targets to be tracked. The PPI located

on the tracking console is identical with this one and can be used in the same way. All targets within range are displayed on both indicators.

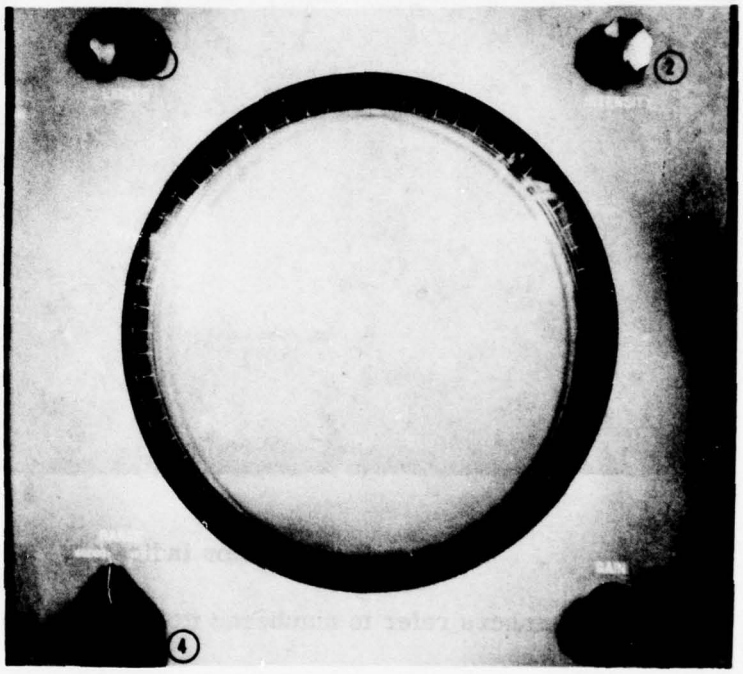

Plate 8. Plan position indicator (PPI).

Note: Numbers refer to numbered items in Par. 3b.

1) LIGHTS control knob. Controls the intensity of the lights around the azimuth scale of the indicator.

2) INTENSITY control knob. Controls the brightness of the sweep that illuminates all presentation on the PPI.

3) GAIN control knob. Controls the intensity of the reference marks (range circle, steerable azimuth line, and electronic cross) displayed on the PPI.

4) RANGE switch.* The two-position rotary switch determines either 60,000- or 120,000-yard presentation on the PPI.

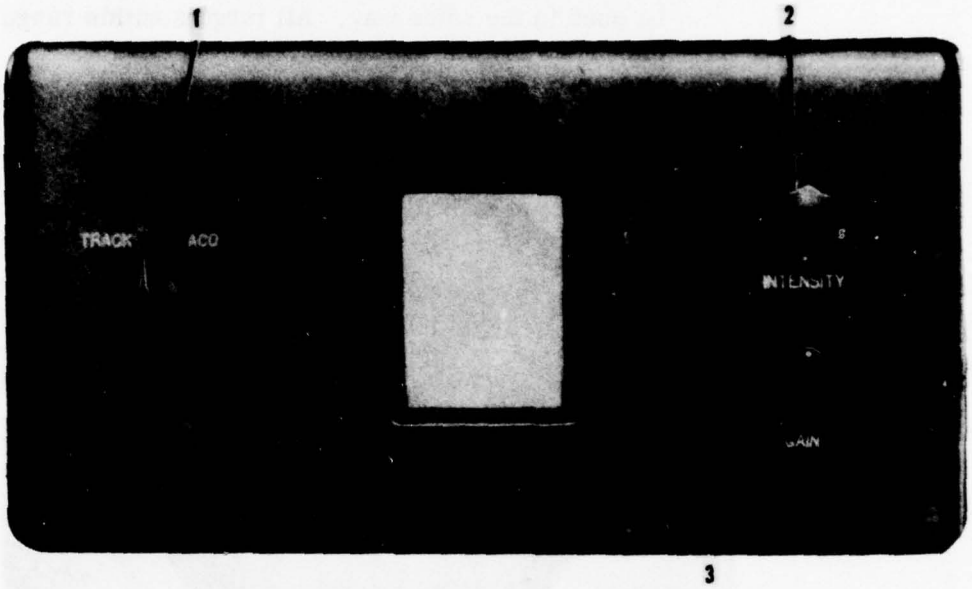

Plate 9. Precision indicator.

Note: Numbers refer to numbered items in Par. 3c.

c. Precision Indicator (Plate 9). Presents an enlarged 5,000-yard by 500-mil sector of the PPI display centered about the intersection of the range circle and steerable azimuth line or about the electronic cross. The precision indicator located on the tracking console is identical to this one and may be used in the same way.

1) TRACK-ACQ switch. Two-position switch determines the sector to be presented on the precision indicator.

2) INTENSITY control knob. Controls the brightness of the sweep that illuminates all presentation on the precision indicator.

3) GAIN control knob. Controls the intensity of the reference marks displayed on the precision indicator.

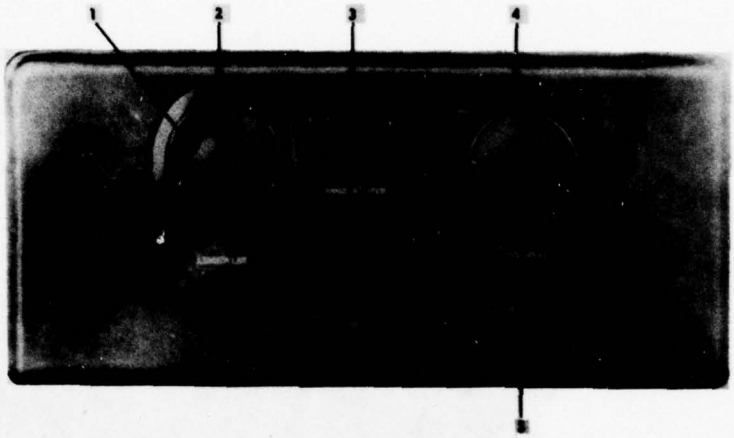

Plate 10. Acquisition antenna control panel.

Note: Numbers refer to numbered item in Par. 3d.

d. Acquisition Antenna Control Panel (Plate 10). Contains controls for utilizing the range circle and steerable azimuth line to designate targets to the track radar operators.

1) AZIMUTH LINE control knob. Rotates the steerable azimuth line on the PPI.

2) AZIMUTH LINE ring. When depressed, blanks the sweep and displays the steerable azimuth line on the PPI.

3) RANGE IN YARDS dial. Indicates the range in yards to which the range circle is set. Dial reads from 0 to 99, 500 yards in 100-yard increments.

4) RANGE CIRCLE handwheel. Adjusts the radius of the range circle on the PPI.

5) RANGE CIRCLE RELEASE pushbutton. When depressed, places control of the range circle at the tactical control console.

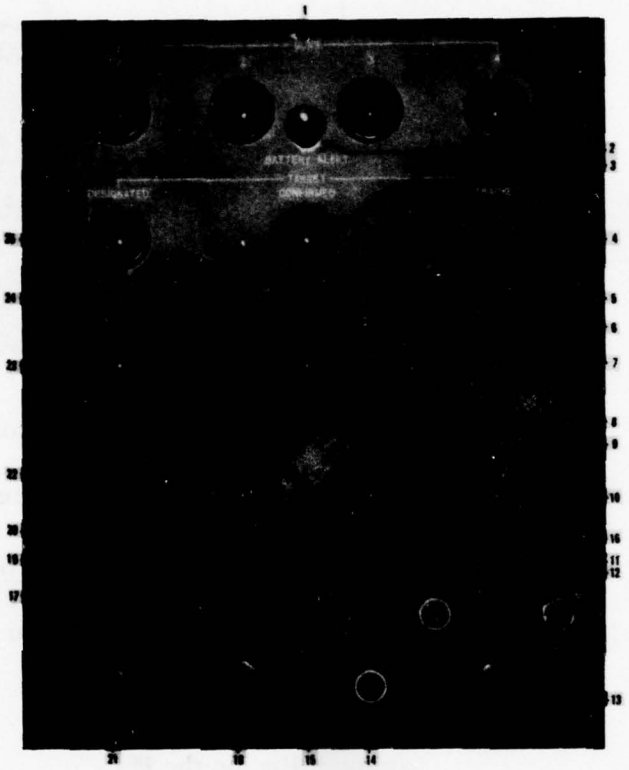

Plate 11: Monitor control panel.

Note: Numbers refer to numbered items in Par. 3e.

e. Monitor Control Panel (Plate 11). Provides the tactical control officer with a signal system by which he can determine the readiness of the guns and the AAFCS M33 system to engage a target and by which he can transmit orders to the AAFCS M33 operators and the gun commanders.

1) GUNS 1, 2, 3, 4 lamps. When lit, indicate that the associated gun is ready to fire.

2) BATTERY ALERT pushbutton. When depressed, sounds the siren, signaling the entire battery to

prepare to fire, and establishes the two hot-loop battery communication systems. A 3-position toggle switch under the shelf of the tactical control console allows the tactical control officer to select either of the two loops or the switchboard.

3) TARGET CONFIRMED lamp. When lit, indicates that the track radar operators are in the process of acquiring the designated target.

4) TARGET TRACKED lamp. When lit, indicates that the target is being tracked by the track radar.

5) CEASE TRACKING pushbutton. When depressed, sounds the buzzer at the tracking console, signaling the track radar operators to cease tracking. It gives all cease fire signals, including the horns at the guns.

6) BATTERY lamp. When lit, indicates that the battery is ready to fire.

7) HOSTILE lamp. When lit, indicates that the target has been identified as hostile.

8) FRIENDLY pushbutton. When depressed, extinguishes the HOSTILE lamps at the monitor control panel and the signal panel and gives all cease fire signals.

9) HOSTILE pushbutton. When depressed, lights the HOSTILE lamps at the monitor control panel and the signal panel, indicating that the target has been identified as hostile.

10) CHALLENGE lamp. When lit, indicates that the IFF equipment has been operated to challenge the target.

11) CHALLENGE pushbutton. When depressed, causes the IFF equipment to operate and lights the CHALLENGE lamp.

12) MODE toggle switch. Determines the mode of operation of the IFF equipment.

13) GAIN control knob. Adjusts the intensity of the IFF presentation on the PPI.

14) GTC toggle switch. Determines the gain time constant being used in the IFF equipment.

15) FIRE pushbutton. When depressed, sounds the horn to commence firing of the guns, engages the firing levers on the guns, and lights the FIRE lamp.

16) FIRE lamp. When lit, indicates that the fire signal has been given.

17) OVERRIDE pushbutton. When depressed simultaneously with the FIRE pushbutton, allows the fire signal to be given, even though the BATTERY lamp is not lit.

18) ACQUISITION AZIMUTH SCAN switch.* The 5-position rotary switch, marked OFF, 1, 2, 3 and REMOTE, determines the control and speed of rotation of the acquisition antenna (10, 20, or 30 rpm).

19) CEASE FIRE pushbutton. When depressed, sounds the horn to cease fire at the guns, locks the firing levers, extinguishes the FIRE lamp, and lights the CEASE FIRE lamp.

20) CEASE FIRE lamp. When lit, indicates that the cease fire signal has been given.

21) ACQUISITION ELEVATION SCAN switch. Controls the elevation coverage of the acquisition radar beam.

22) ACQUISITION ELEVATION COVERAGE dial.* Indicates the vertical position of the axis of the acquisition radar beam from 2° to 20°. On later systems this dial

may be called the ACQUISITION BEAM ELEVATION dial (see Plate 16).

23) Computer lamp. When lit, indicates that the computer is furnishing usable data.

24) TARGET DESIGNATED pushbutton. When depressed, lights the DESIGNATED lamp at the tracking console; sounds a buzzer, signaling the track radar operators to acquire the designated target; sounds the bells at the guns, warning the crews that the track radar is about to slew; and lights the TARGET DESIGNATED lamp on the monitor control panel.

25) TARGET DESIGNATED lamp. When lit, indicates that the target has been designated to the track radar operators.

4. Tracking Console.

The tracking console contains controls and indicators for both the track and acquisition radars.

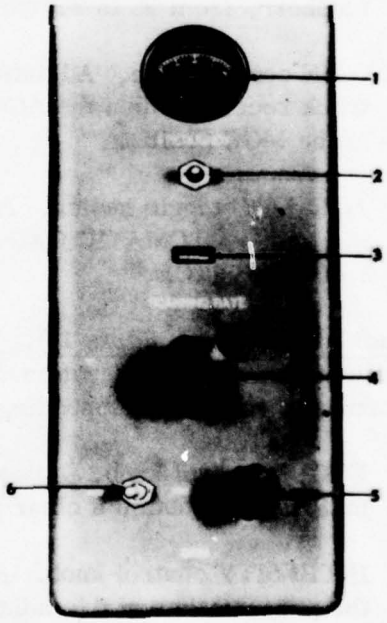

Plate 12. Track receiver control panel.

Note: Numbers refer to numbered items in Par. 4a.

a. Track Receiver Control Panel (Plate 12). Contains controls for adjusting the track transmitter frequency, the scanner motor rpm, and the track receiver gain.

1) FREQUENCY meter. Indicates the relative frequency at which the track magnetron is transmitting. (The dial reads from 0 to 100 giving a relative indication of the 8, 500- to 9, 600-mc range of the magnetron.)

2) FREQUENCY toggle switch. Spring-loaded toggle switch adjusts the frequency of the track magnetron from 8, 500 to 9, 600 mc.

3) SCANNING RATE meter. Vibrating reed-type meter indicates the rate at which the scanner motor is rotating the track radar feedhorn.

4) SCANNING RATE control knob. Adjusts the rate at which the scanner motor is rotating the track radar feedhorn, from 28 to 32 cycles per second.

5) GAIN control knob. Adjusts the sensitivity of the track receiver when the AGC-MGC toggle switch is in the MGC position.

6) AGC-MGC toggle switch. Places the track receiver in either AUTOMATIC GAIN CONTROL or MANUAL GAIN CONTROL.

b. Tracking Indicators (Plate 13). Three identical A-type oscilloscopes furnish elevation, azimuth, and range information to the corresponding operators.

1) FOCUS control knob. Adjusts the focus of the indicators to obtain a clear image.

2) INTENSITY control knob. Adjusts the intensity of the presentation on the indicators.

Plate 13. Tracking indicators (Range).

Note: Numbers refer to numbered items in Par. 4b.

3) SWEEP LENGTH control knob. Adjusts the sweep length visible on the indicators from 20,000 to 100,000 yards.

4) ELEVATION dial. Indicates the angle of elevation at which the track radar is pointed. Dial is identical to the AZIMUTH dial but can only be positioned from -180 to +1,500 mils.

5) AZIMUTH dial. Indicates the azimuth at which the track radar is pointed. Dial reads through 6,400 mils and is calibrated in 5-mil increments.

6) RANGE dial. Indicates the slant range to a target being tracked by the track radar. Dial reads from 0 to 100,000 yards and is calibrated in 10-yard increments.

7) IMAGE SPACING switch. Three-position rotary switch (OFF, NOR, SEL SIG) determines the type of presentation visible on the corresponding track indicator.

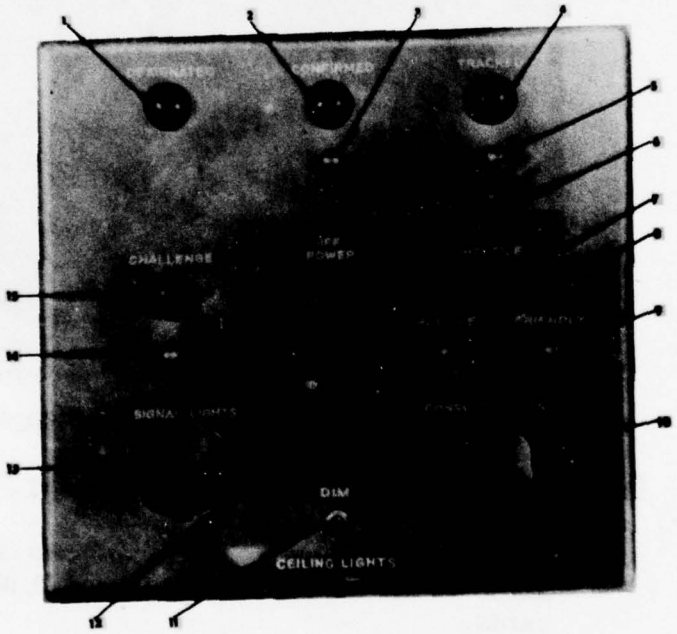

Plate 14. Signal panel.

Note: Numbers refer to numbered items in Par. 4c.

c. Signal Panel (Plate 14). Contains lights and controls for the signal system and various lights at the tracking console.

1) DESIGNATED lamp. When lit, indicates that the tactical control officer has designated a target to be tracked.

2) CONFIRMED lamp. When lit, indicates that the track radar operators are in the process of picking up the designated target or, if the tracked signal has been given previously, that they have lost the target.

3) CONFIRMED pushbutton. When depressed, lights the CONFIRMED lamps at the signal panel and monitor control panel, indicating that the track radar operators have lost the target.

4) TRACKED lamp. When lit, indicates that the track radar is tracking the target.

5) TRACKED pushbutton. When depressed, lights the TRACKED lamps at the signal panel and monitor control panel, lights the ON TARGET lamp at the target rate indicator panel, and allows the computer to begin predicting.

6) IFF POWER lamp. When lit, indicates that the IFF system has been energized.

7) HOSTILE lamp. When lit, indicates that the target has been identified as hostile.

8) HOSTILE pushbutton. When depressed, lights the HOSTILE lamps at the signal panel and the monitor control panel; indicating that the target has been identified as hostile.

9) FRIENDLY pushbutton. When depressed, extinguishes the HOSTILE lamps at the signal panel and the monitor control panel and gives all cease fire signals.

10) CONSOLE LIGHTS control knob. Adjusts the intensity of the dial lights at the tracking console.

11) CEILING LIGHTS toggle switch. When in the DIM position, permits all ceiling lights to be varied in intensity.

12) CEILING LIGHTS control knob. Adjusts the intensity of the ceiling lights in the vicinity of the tracking console.

13) SIGNAL LIGHTS control knob. Adjusts the intensity of all signal lights.

14) CHALLENGE pushbutton. When depressed, causes the IFF equipment to operate and lights the CHALLENGE lamp.

15) CHALLENGE lamp. When lit, indicates that the IFF equipment has been operated to challenge the target.

d. PPI. Refer to paragraph 3b.

e. Precision Indicator. Refer to paragraph 3c.

f. Trial Fire Indicator (Plate 15). Used to obtain range deviations during preparatory fire. The indicator presents 500 yards in range, centered around the trial-shot point.

1) RESET pushbutton. Prepares the trial fire indicator for each round.

2) INTENSITY control knob. Controls the intensity of the presentation on the trial fire indicator.

3) READY lamp. When lit, indicates that the trial fire indicator has been prepared for the next round.

4) LIGHTS control knob. Adjusts the intensity of the light on the scale of the trial fire indicator.

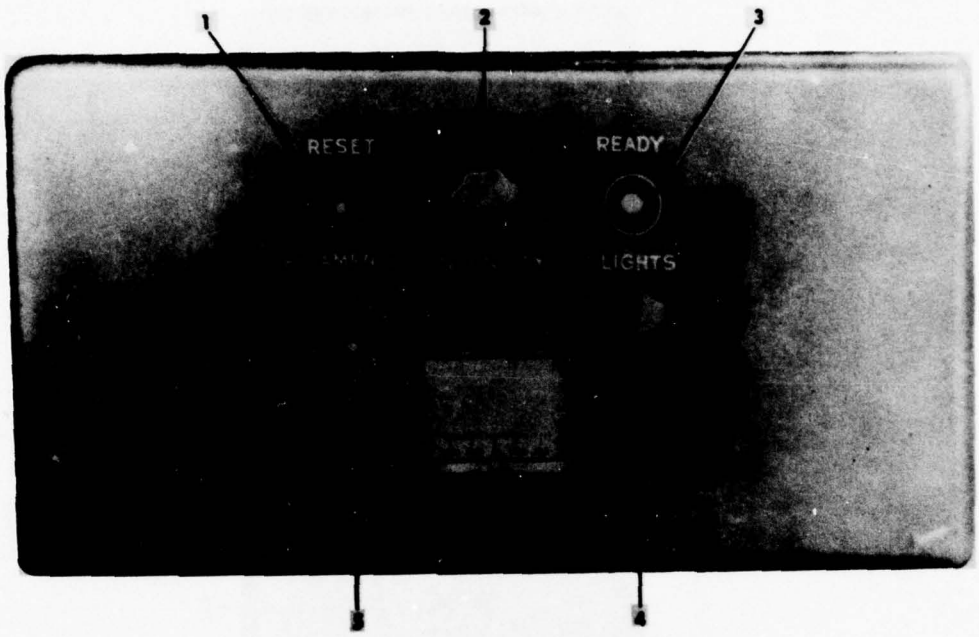

Plate 15. Trial fire indicator.

Note: Numbers refer to numbered items in Par. 4f.

5) FILAMENTS toggle switch. Applies power to trial fire indicator filaments.

g. Acquisition Receiver Control Panel (Plate 16). Contains controls for adjusting the acquisition transmitter and receiver.

1) FREQUENCY meter. Indicates the relative frequency at which the acquisition magnetron is transmitting. (The dial reads from 0 to 100, giving a relative indication of the 3, 100- to 3, 500-mc range of the magnetron.)

2) FREQUENCY toggle switch. Adjusts the frequency of the acquisition magnetron from 3, 100 to 3, 500 mc.

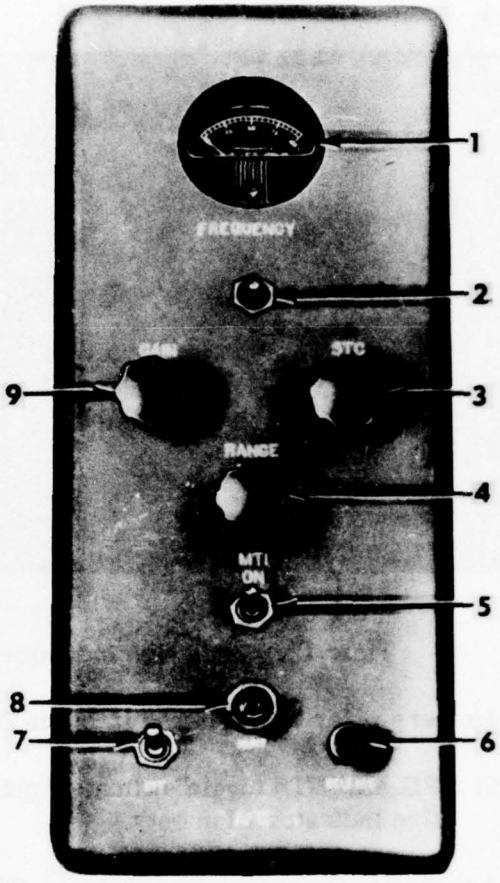

Plate 16. Acquisition receiver control panel.

Note: Numbers refer to numbered items in Par. 4g.

3) STC (Sensitivity Time Control) knob. Reduces the blossoming at the center of the PPI to a radius of about 20, 000 yards; i.e., reduces the gain of the receiver at short ranges where target echoes are extremely brilliant.

4) MTI (Moving Target Indicator) RANGE control knob. Varies the range at which the moving target indicator eliminates fixed echoes and presents moving echoes from 0 to 40, 000 yards.

5) MTI toggle switch. Places the MTI system in operation.

6) AFC RELEASE pushbutton. When depressed, causes the automatic frequency control of the receiver to hunt for the proper frequency; i.e., the frequency at which the magnetron is transmitting.

7) AFC toggle switch. When in the ON position, causes the automatic frequency control to operate. When in the OFF position, allows manual tuning of the receiver.

8) AFC HUNT lamp. When glowing steadily, indicates that the AFC is hunting for the proper frequency. When flickering or when video is presented on the PPI, indicates that the receiver is locked to the proper frequency. When flickering slowly and there is no video on the PPI, indicates that the receiver is locked to an improper frequency.

9) GAIN control knob. Adjusts the gain of the acquisition receiver, controlling the intensity of the video presented on the PPI's and precision indicators.

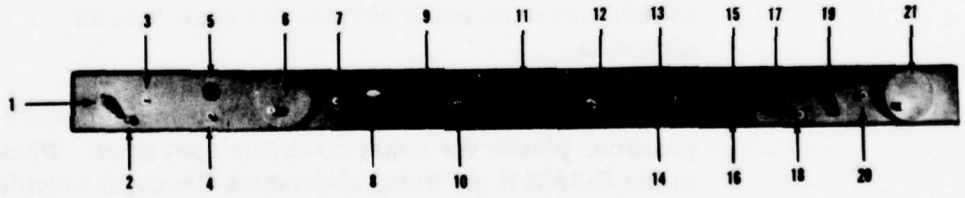

Plate 17. Control drawer.

Note: Numbers refer to items numbered in Par. 4h.

h. Control Drawer (Plate 17). Contains controls for operating both the track and acquisition radars.

1) ELEVATION MAN-AID-AUTO-ELEV AID switch. Four-position rotary switch determines the type of elevation tracking.

a) MAN position. Allows the operator to position the antenna manually in elevation by turning the ELEVATION handwheel.

b) AID position. Allows the operator to set in an aid rate in elevation up to 500 mil/sec with the ELEVATION handwheel.

c) AUTO position. Causes the track radar to lock on to the target and track automatically in elevation.

d) ELEV AID position. Action identical to AID position except that ELEV AID allows azimuth and range to utilize automatic tracking, which AID position does not.

2) RESET pushbutton. When depressed, removes any aided rates that have been set in elevation.

3) ELEV SLEW toggle switch. Spring-loaded toggle switch slews the track antenna for searching in elevation.

4) COAST-DISABLE toggle switch. When in the COAST position, places the coast circuit in operation. When in the DISABLE position, eliminates the coast circuit.

5) COAST lamp. When lit, indicates that the system is no longer in automatic, and that the track radar is coasting at an aided rate.

6) ELEVATION handwheel. Used to elevate or depress the track antenna.

7) ACQUISITION ELEVATION SCAN toggle switch. Controls the elevation coverage of the acquisition radar if the ACQUISITION AZIMUTH SCAN switch on the monitor control panel is in REMOTE.

8) ACQUISITION ELEVATION COVERAGE dial. Indicates the vertical position of the axis of the acquisition radar beam.

9) Azimuth MAN-AID-AUTO switch. Three-position rotary switch determines the type of azimuth tracking; either manual, aided to a maximum rate of 700 mil/sec, or automatic.

10) ACQUISITION toggle switch. Slews the track radar and electronic cross in range and azimuth to the point designated by the intersection of the range circle and the steerable azimuth line.

11) ACQUISITION AZIMUTH SCAN switch.* Four-position rotary determines the speed of rotation of the acquisition antenna if the corresponding switch on the monitor control panel is in REMOTE.

12) AZIMUTH handwheel. Used to position the track antenna in azimuth.

13) AZIMUTH LINE control knob. Rotates the steerable azimuth line on the PPI.

14) AZIMUTH LINE ring. When depressed, blanks the sweep and displays the steerable azimuth line on the PPI.

15) RANGE IN YARDS dial. Indicates the range in yards to which the range circle is set.

16) RANGE CIRCLE RELEASE pushbutton. When depressed, places control of the range circle at the tracking console.

17) RANGE CIRCLE handwheel. Adjusts the radius of the range circle on the PPI.

18) RANGE SLEW toggle switch. Slews the track radar range unit at the rate of 6,000 yd/sec.

19) Range MAN-AID-AUTO switch. Three-position rotary switch determines the type of range tracking: manual, aided to a maximum rate of 600 yd/sec, or automatic.

20) RANGE CALIBRATE toggle switch. Presents calibration pips on the track radar indicators for testing the accuracy of the track range computer.

21) RANGE handwheel. Used to position the track range unit.

5. Radar Cabinet.

The radar cabinet contains elements of both the acquisition and track radars, and controls for energizing both radars.

a. Range Servo. Indicates the slant range to the target as measured by the track range computer. Dial reads from 0 to 100,000 yards and is calibrated in 5-yard increments.

b. Radar Power Control Panel (Plate 18). Contains all controls for energizing both the acquisition and track radars.

1) BLOWN FUSE INDICATOR lamps. Light when the associated fuse burns out.

2) Fuse holders. Contain fuses for the various circuits of the radar systems.

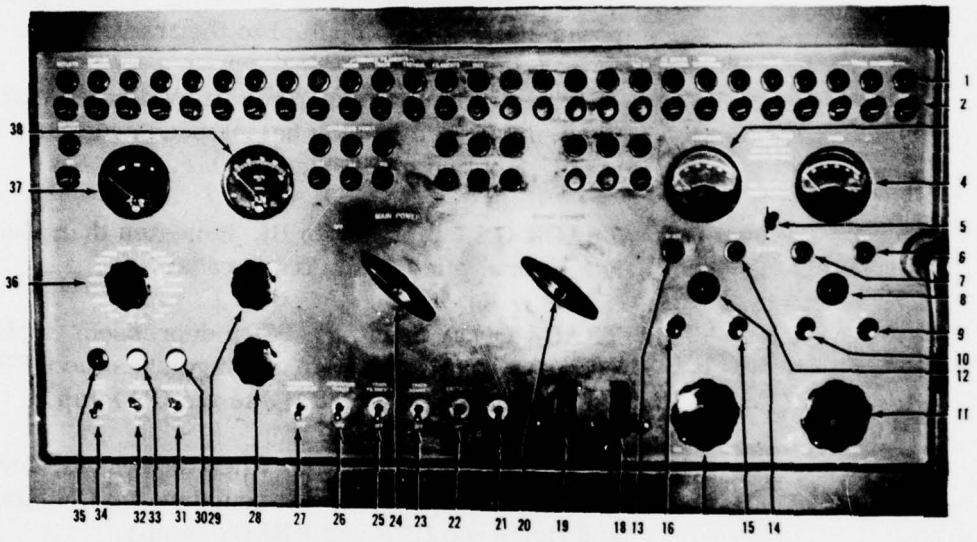

Plate 18. Radar power control panel.

Note: Numbers refer to items numbered in Par. 5b.

3) ACQUISITION meter. Indicates the amplitude of the acquisition high voltage, magnetron current, or high-voltage power supply current, depending on the position of the MAGNETRON CURRENT switch.

4) TRACK meter. Indicates the amplitude of the track high voltage, magnetron current, or high-voltage power supply current, depending on the position of the MAGNETRON CURRENT switch.

5) MAGNETRON CURRENT switch.* Causes the ACQUISITION and TRACK meters to indicate high voltage when in the DOWN position, magnetron current when in the CENTER position, and high-voltage power supply current when in the UP position.

6) TRACK OFF lamp. When lit, indicates that the track heater filaments have been energized but power has not been applied to the track radar.

7) TRACK READY lamp. When lit, indicates that the 5-minute time delay has elapsed and that power may be applied to the track radar.

8) TRACK ON lamp. When lit, indicates that power has been applied to the track radar.

9) TRACK ON pushbutton. When depressed, applies power to the track radar, extinguishes the OFF and READY lamps, and lights the ON lamp.

10) TRACK OFF pushbutton. When depressed, deenergizes the track radar, extinguishes the ON lamp, and lights the OFF and READY lamps.

11) TRACK MIN-MAX knob. Adjusts the amplitude of the track high-voltage.

12) ACQUISITION OFF lamp. When lit, indicates that the acquisition heater filaments have been energized, but that power has not been applied to the acquisition radar.

13) ACQUISITION READY lamp. When lit, indicates that the 15-minute time delay has elapsed, and that power may be applied to the acquisition radar.

14) ACQUISITION ON lamp. When lit, indicates that power has been applied to the acquisition radar.

15) ACQUISITION ON pushbutton. When depressed, applies power to the acquisition radar, extinguishes the OFF and READY lamps, and lights the ON lamp.

16) ACQUISITION OFF pushbutton. When depressed, de-energizes the acquisition radar, extinguishes the ON lamp, and lights the OFF and READY lamps.

17) ACQUISITION MIN-MAX knob. Adjusts the amplitude of the acquisition high voltage.

18) TRACK BATTLE SHORT switch. Toggle switch bypasses the 5-minute and 30-second time delays and door interlocks. The switch cover is normally wired down and sealed.

19) ACQ BATTLE SHORT switch. Toggle switch bypasses the 15-minute and 30-second time delays and door interlocks. The switch cover is normally wired down and sealed.

20) RADAR POWER switch. Two-position rotary switch applies 120-volt power to the radar systems and energizes the 30-second time delay.

21) HP SERVO toggle switch. Applies power to the high power azimuth and elevation servos.

22) EXCITATION toggle switch. Applies power to the fixed phase of the servomotors, motor tachometers, and resolvers in the radars.

23) TRACK SCANNER toggle switch. Applies power to the track scanner motor.

24) MAIN POWER switch. Two-position rotary switch, applies generator output throughout the system to energize all 400-cycle circuits.

25) TRACK FILAMENTS toggle switch. Applies power to all track radar filaments and activates the 5-minute time delay.

26) ACQUISITION POWER toggle switch. Applies power to all acquisition radar filaments and activates the 15-minute time delay.

27) PERSONNEL VENTILATION toggle switch. Applies power to the personnel ventilation system blower motors.

28) ADJUST control knob. Adjusts the amplitude of the line voltage supplied by the generator.

29) A-B-C switch. Three-position rotary switch determines the generator phase to be checked on the LINE VOLTAGE meter.

30) INDICATOR HV ON lamp. When lit, indicates that high voltage has been applied to all indicators.

31) INDICATOR HV toggle switch. Applies high voltage to all track and acquisition indicators.

32) LOW VOLTAGE ON lamp. When lit, indicates that power has been applied to all low-voltage circuits.

33) LOW VOLTAGE toggle switch. Applies power to all low-voltage circuits.

34) OVERRIDE switch.* Spring-loaded toggle switch overrides certain door interlocks in the radar cabinet, track console, and tactical control console.

35) LOW VOLTAGE READY lamp. When lit, indicates that the 30-second time delay has elapsed and that power may be applied to the low-voltage circuits.

36) VOLTAGE CHECK switch. Twenty-position rotary switch determines the voltage to be checked on the VOLTAGE CHECK meter.

37) VOLTAGE CHECK meter. Serves as a reference for checking the DC voltages in the radar circuits.

38) LINE VOLTAGE meter. Indicates the amplitude of the three phases of the generator output.

6. Heater Cabinet.

Contains controls for operating heating and ventilation equipment. Also contains batteries for operation of the heater, trailer brakes, siren, lights, switchboard and telephones, and a battery charger for these batteries.

7. T34 Tracker Periscope, Lower Section, and Azimuth Drive Components.

a. Azimuth Data Converter. Converts azimuth (A_O) and horizontal range (R_O) to rectangular coordinates in terms of X_O and Y_O. Located in the base of the azimuth drive.

1) AZIMUTH dial. Indicates the azimuth at which the track antenna is pointed. Dial reads through 6, 400 mils in increments of 2 mils.

2) Clutch release. Releases the dial from the azimuth drive so that the two may be turned independently.

3) Dial adjust. Used to position the AZIMUTH dial once it has been freed by the clutch release.

b. T34 Tracker Periscope, Lower Section. Contains three 8-power periscopes for use in optical tracking and in orientation.

8. Early Warning Plotting Board.

The early warning plotting board is used to plot data from early warning nets. These data can be plotted in grease pencil on the plastic cover of the board out to a maximum of 250,000 yards.

9. Switchboard Cabinet.

The switchboard cabinet contains switchboards BD-91 and SB-100. It provides line and hot-loop communication within the battery, lines to units outside the battery, and trunk lines to early warning nets or higher echelons through a dial system. A total of 24 lines are available.

10. Differences Between the AAFCS M33 and the AAFCS T33.

The first 131 units built were AAFCS T33's. Starting with set number 132, the equipment was modified and redesignated the AAFCS M33. The following list of differences between the two types is cross-referenced to the paragraphs in this lesson plan. Many of these differences may have been corrected by field modification work orders, but all initial differences will be listed here.

a. SURFACE-AIR switch and TARGET lamp (Par. 2b 18) and 19) page 14). The SURFACE-AIR switch and TARGET lamp were not included in the production of the AAFCS T33, but have been added by a field modification.

b. PPI RANGE switch (Par. 3b 4) page 24). The maximum range of the AAFCS T33 acquisition radar is 90,000 yards. The ranges available on the PPI are 20,000, 60,000, and 90,000 yards.

c. ACQUISITION AZIMUTH SCAN switch (Par. 3e 18) page 30). The switches are identical on both the AAFCS M33 and AAFCS T33. However, on the AAFCS T33, the 1, 2, and 3 positions correspond to 20, 40, and 60 rpm, respectively.

d. ACQUISITION ELEVATION COVERAGE dial (Par. 3e 22) page 30). The coverage dial on the AAFCS T33 reads LOW, MEDIUM, and HIGH.

e. MAGNETRON CURRENT switch (Par. 5b 5) page 54). This switch is not found on the AAFCS T33. Instead, there is a magnetron current pushbutton which allows high voltage to be read on the meters when depressed. Normally, the meters read magnetron current.

f. OVERRIDE switch (Par. 5b 34) page 46). The override switch was not included in the production of the AAFCS T33, but has been added by a field modification.

IO-P2

PRACTICAL EXERCISE

NOMENCLATURE, FUNCTION, AND LOCATION OF COMPONENTS

AAFCS M33 SETUP: Completely de-energized.

EQUIPMENT NECESSARY: None.

DEMONSTRATION:

> INSTRUCTOR'S NOTE: The purpose of this exercise is to familiarize the student with the nomenclature of various components, controls, and meters. The location and functions of the components mentioned in the lecture prior to this exercise should be stressed. Just a brief description concerning the functioning of components and switches should be given. Use the lesson plan on this subject matter as a guide for the presentation of this class.

LESSON PLAN

START-STOP PROCEDURE AND SAFETY PRECAUTIONS

OBJECTIVE:

To explain:

1. The start-stop procedure for the AAFCS M33, and

2. Some of the more important safety precautions.

INTRODUCTION:

In any piece of mechanical or electrical equipment, it is vitally important that certain rules pertaining to starting and stopping the equipment be followed. These rules, if closely followed, will prolong the life of the components that make up the equipment.

Whereas *start-stop procedures* are designed to prolong the life of the equipment, safety precautions are designed to prolong the life of the technician. The safety precautions associated with the AAFCS M33 should be fully understood and rigidly followed.

PRESENTATION:

1. Start-Stop Procedure.

> INSTRUCTOR'S NOTE: For the segment of this conference devoted to the start-stop procedure, refer to pages 90 through 94 of the HumRRO Suggested Operating Procedures (Appendix A).

2. Safety Precautions (General).

   a. The technician should develop an awareness of the of the times and places where extreme caution is called

for. For example, by glancing at Diagram 1 the technician might note that the voltage going through the filaments of the tube is 6.3 volts. If he touched one of the filament pins, however, he would be dangerously shocked because a closer inspection would have shown him that the cathode of the tube was being operated at -800 volts and is connected to the filaments.

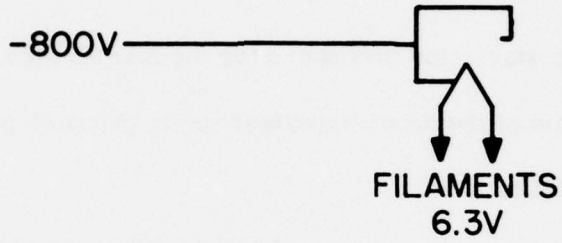

Diagram 1. Cathode-Ray Tube Circuit.

Rule No. 1. Stay out of circuits with which you are not completely familiar and in which high potentials may exist. (Acquisition and track modulators and HV power supplies and the indicator high voltage supply (are some examples.)

b. When a person is shocked, just about every muscle in his body contracts. It is because of this muscular reaction that a person jumps or falls when he is shocked. This reaction many times will cause more damage than the shock which originated it because he will tear his arm or hand or bump his head getting away from the shock.

Rule No. 2. Try to keep your arms and head in the clear and away from sharp objects when you are working in areas where you might receive a shock.

c. If your feet or clothes are wet, your total resistance to electric current decreases, and as a result even a low voltage will give you a nasty jolt.

Rule No. 3. Keep your feet as dry as possible and avoid trouble shooting with wet sweaty hands.

d. Electricity has a peculiar habit of arcing across space to the nearest sharply pointed object. This is why lightning usually strikes a tree or telephone pole.

Rule No. 4. Do not point at components on which high potentials exist.

e. Many people have been painfully burned, if not electrocuted, by placing their hands near a high voltage source in such a way that when shocked the muscles in their hand contracted and caused them to grab the high-voltage source.

Rule No. 5. Hold your hands so that the back of your hand is toward HV source so if you do get shocked the muscle contraction in your hands pulls you away from the high voltage source.

3. Safety Precautions, (AAFCS M33).

a. Check the frequency of the three-phase power at the generator. Maintain it at 400 cycles at all times.

INSTRUCTOR'S NOTE: Explain what would happen in a 400-cycle transformer if the frequency of the input voltage dropped to 250 or 300 cycles.

b. Make certain there is sufficient gasoline in the generator to last for the period of radar operation.

INSTRUCTOR'S NOTE: Explain what would happen if the generator ran out of gas and the main breaker relay didn't open.

c. Do not rotate the acquisition antenna before making sure no one is working on it.

INSTRUCTOR'S NOTE: Explain the use of the SAFETY switch at the barbette.

d. Make sure no one is on the roof before moving the track antenna.

INSTRUCTOR'S NOTE: Explain the use of the ROOF SAFETY switch.

e. Before working in the modulators or HV power supplies, make certain that all input voltages are removed and that all shorting bars are operating properly.

INSTURCTOR'S NOTE: Explain the operation of the door-operated shorting bars.

f. Some cables carrying high voltages are red color-coded in the same color as low potential cables. Make sure you know where these are.

INSTRUCTOR'S NOTE: Explain that both preknock cables and the -2,000 volt cable leaving the indicator HV supply are marked in red.

g. Make certain the HV cables are tightly connected.

INSTRUCTOR'S NOTE: Explain how an arc can carbonize a cable connection and ruin it.

PRACTICAL EXERCISE

START-STOP PROCEDURE AND SAFETY PRECAUTIONS

AAFCS M33 SETUP: Completely de-energized.

EQUIPMENT NECESSARY:

Suggested Operating Procedures (Appendix A).

DEMONSTRATION:

1. The instructor will demonstrate the proper starting procedure for the generator and the radar.

2. Each student should go through the start-stop procedure on both the generator and radar.

3. It may be necessary for students to repeat the procedure several times before they become sufficiently familiar with the sequence.

4. The remainder of the period should be devoted to a discussion of some of the safety measures inherent in the system, such as the:

   a. ROOF SAFETY switch,

   b. BARBETTE SAFETY switch,

   c. Underspeed cutoff on the generator, and

   d. Fuzes.

   e. Door-operated shorting bars. (Demonstrate by turning on the acquisition transmitter for a short time and then turning it off, and immediately opening the HV compartment door. The sharp crack will be due to the shorting

bar discharging the filter capacitors in the acquisition HV power supply.)

f. Inform students that in cases of power plant failure the best emergency step to take is to turn off MAIN POWER switch immediately. Explain why.

LESSON PLAN

NORMAL OPERATION OF THE ACQUISITION RADAR

OBJECTIVE:

1. To familiarize the students with the normal operation of the acquisition radar,

2. To teach the proper procedure for acquiring targets, and

3. To show the method of transferring the acquired targets to the track radar.

INTRODUCTION:

A thorough knowledge of the normal operation of the acquisition radar is a must for all operators. The acquisition radar beam is a very narrow cone, and targets can be detected in range up to 120,000 yards if they contain a reflective area of approximately 15 square meters. Azimuth coverage is unlimited and is accomplished by antenna rotation of 10, 20, and 30 rpm. Elevation coverage is done by changing the configuration of the reflactor located in the pillbox at the barbette.

PRESENTATION:

INSTRUCTOR'S NOTE: The information for this subject matter is taken from the Suggested Operating Procedures. Reference should be made to the following pages of Appendix A.

1. Pages 108 through 112 .
2. Page 125.
   a. Acquisition Receiver Control.
3. Page 129.
   a. Acquisition Receiver Control.

Additional information may be supplied by the instructor.

IO-P4

PRACTICAL EXERCISE

NORMAL OPERATION OF THE ACQUISITION RADAR

AAFCS M33 SETUP: Completely de-energized.

EQUIPMENT NECESSARY: None.

DEMONSTRATION:

INSTRUCTOR'S NOTE:

1. A review of the operation and function of the acquisition radar should be presented here.

2. Explain the method of acquiring and designating targets and present the procedure used in accomplishing this task.

3. Each student should acquire and designate as many targets as time allows.

4. Use the Suggested Operating Procedures (Appendix A) as a guide for the presentation of this exercise.

LESSON PLAN

NORMAL OPERATION OF THE TRACK RADAR

OBJECTIVE:

1. To familiarize the student with the normal operation of the track radar.

2. To teach the proper procedure for tracking targets, and

3. To present the duties of each tracking operator.

INTRODUCTION:

The tracking radar is responsible for tracking targets accurately in azimuth, elevation, and range. It supplies the computer with the information necessary to direct the gun onto the target. The tracking radar can track targets automatically to a range of 100,000 yards, and the method of antenna positioning is controlled by the MAN-AID-AUTO switch. A visual indication of the antenna's action is presented on the track presentation system. This track presentation system consists of three A-type scopes and the trial fire indicator.

PRESENTATION:

INSTRUCTOR'S NOTE: The information for this subject matter is taken from the Suggested Operating Procedures. Reference should be made to the following pages of Appendix A.

1. Page 112.

   a. Exclude paragraph on Precision Indicator.

2. Pages 113 through 124.

3. Page 124.

   a. Exclude paragraph on Acquisition Receiver Control.

4. Pages 126 through 128.

Additional information may be supplied by the instructor that will be of aid to the student.

IO-P5

PRACTICAL EXERCISE

NORMAL OPERATION OF THE TRACK RADAR

AAFCS M33 SETUP: Completely de-energized.

EQUIPMENT NECESSARY: None.

DEMONSTRATION:

INSTRUCTOR'S NOTE:

1. Review the operation and function of the track radar. Explain the method of tracking a target and the proper sequence necessary.

2. Each student must be given a chance to operate the track radar from each of the three positions.

3. Use the Suggested Operating Procedures (Appendix A) as a guide for the presentation of this exercise.

4. When not operating the track radar, the student should be performing the duties of the acquisition operator.

LESSON PLAN

NORMAL OPERATION OF THE COMPUTER AND MONITOR CONTROL

OBJECTIVE:

1. To familiarize the student with the normal operation of the computer.

2. To present the proper procedure for checking out the computer.

3. To discuss the duties of the computer operator.

INTRODUCTION:

The computer and plotting board operating controls are located on the target-rate indicator, and are used for selecting the proper data smoothing and prediction for the aircraft being encountered. The complete operation of the computer can be checked before the engagement of the enemy by using the log book section concerning the computer. The computer operator is seated at the target rate indicator panel of the tactical control console, and his responsibility is to operate the computer and plotting boards.

PRESENTATION:

INSTRUCTOR'S NOTE: The information needed for presentation of this subject is to be taken from the Suggested Operating Procedures. Reference should be made to the following pages of Appendix A.

1. Page 93.

2. Pages 102 through 108.

Additional information may be supplied by the instructor that will be of aid to the student.

IO-P6

PRACTICAL EXERCISE

NORMAL OPERATION OF THE COMPUTER AND MONITOR CONTROL

AAFCS M33 SETUP: Completely de-energized.

EQUIPMENT NECESSARY: None.

DEMONSTRATION:

INSTRUCTOR'S NOTE:

1. Review the function and operation of the computer and monitor control panel, and the duties of the computer operator.

2. Introduce to the student the sequence of events and operation of the monitor control panel.

3. Each student must be allowed to operate the computer and monitor controls.

4. When not operating these controls, the student should be operating the controls at other operators' positions. Use the Suggested Operating Procedures Appendix A as a guide for the presentation of the exercise.

LESSON PLAN

PREOPERATIONAL CHECKS AND FIRST ECHELON MAINTENANCE

OBJECTIVE:

1. To discuss preoperation checks and the method of their performance.

2. To define first echelon maintenance and to discuss the importance of such maintenance in prolonging the usefulness of the AAFCS M33.

INTRODUCTION:

The purpose of the preoperational checks and first echelon maintenance is to keep the AAFCS M33 in top performing condition. Preoperational checks are performed by both operating and maintenance personnel. The log book issued with every AAFCS M33 is used as a guide in performing preoperational checks, and the continual performance of first echelon maintenance will insure effecient operation of the equipment.

PRESENTATION:

1. List of Preoperational Checks To Be Performed By the Operator.

   a. Daily Mechanical Checks, Test II.

   b. Daily Radar Tests, Test III.

      1) Voltage check, III. A.

      2) Radar checks, III. B.

         a) Scanning rate, B. 1.

         b) Range calibrate, B. 6a through B. 6d.

c) Notch jump check, B. 6e.

d) Acquisition alinement, B. 9.

c. Daily Systems Tests, Text IV.

1) Emplacement test, IV. A.

2) Computer static test, IV. B.

d. Weekly Mechanical Checks, Test VI.

1) Acquisition antenna assembly, VI. A.

2) Tracking antenna, VI. B.

3) Storage batteries, VI. C.

e. Weekly Radar and Computer Tests, Test VII.

1) Acquisition range computer, VII. J.

2) Plotting board tests, VII M.

f. Monthly Mechanical Checks, Test VIII.

1) Air filters and acquisition antenna assembly blower, VIII. A.

2) Semiannual checks, VIII. C.2. Antifreeze in acquisition antenna drive unit.

g. Monthly System Tests, Test IX.

1) Horizontal prediction, IX. A.

2) Parallax correction, IX. B.

3) Wind azimuth correction, IX. E.

4) Computer dynamic operation, IX. F.

5) Target rate test, IX. G.

6) Dead time test, IX. H.

7) Altitude limit test, IX. I.

8) Static tests-normal ballistic conditions, IX. J.

9) Static tests-various ballistic conditions, IX. K.

h. The checks and tests referred to in a–g can be found in the log book, Ordnance No. 7610473

i. An explanation concerning the proper procedure for the performance of these tests and checks is found at the front of the log book.

INSTRUCTOR'S NOTE: The log book should be used as reference material. A brief explanation of each preoperational check and test should be given at this time.

2. First echelon maintenance consists of the continuous checking and repairing of minor items in the equipment. A list of items to check is given below:

a. Chassis and their component parts.

1) Tubes.

2) Tube shields.

3) Retaining chains.

4) Chassis fasteners.

5) Cables and cable connectors.

b. Door locks and slides.

c. See that all switches and handwheel controls are secured.

d. See that the plotting boards, plotting pens, and plotting paper are ready for operation.

e. Clean:

1) Optical lenses,

2) Scopes,

3) Meters,

4) Chassis,

5) Batteries, and

6) Floors.

f. Perform daily preoperational checks.

INSTRUCTOR'S NOTE: Only a brief explanation of the items mentioned above in necessary. TM 9-6092-1 and the log book can be used as a source of information.

PRACTICAL EXERCISE

PREOPERATIONAL CHECKS

AAFCS M33 SETUP: Completely de-energized.

EQUIPMENT NECESSARY: Log books, pencils, and screwdrivers.

DEMONSTRATION:

INSTRUCTOR'S NOTE: The lesson plan entitled "Preoperational Checks" should be used as a guide.

1. Have students complete the necessary tests and checks in their log books.

2. Impress upon students the importance and the value of keeping log books up to date. Explain where information can be acquired which will aid in the proper filling out of log books.

IO-P7b

PRACTICAL EXERCISE

FIRST ECHELON MAINTENANCE

AAFCS M33 SETUP: Completely de-energized.

EQUIPMENT NECESSARY:

Oil, rags, steel wool, crocus cloth, blade- and phillips-head screwdrivers, and broom.

DEMONSTRATION:

INSTRUCTOR'S NOTE:

1. The lesson plan on first echelon maintenance should be used as a guide for this exercise.
2. Because of the time allotted it is recommended that particular attention be paid to the cleanliness of the following:
   a. Floors,
   b. Optics,
   c. Indicators,
   d. Plotting board covers, and
   e. All console surfaces.
3. If time is available have students clean the oil from the modulator and high-voltage power supply.

LESSON PLAN

SYSTEM CABLING

OBJECTIVE:

1. To familiarize the students with the various cabling systems used in the AAFCS M33.

2. To explain the care and maintenance of cables.

INTRODUCTION:

The air defense battery consists of several units which are emplaced over a relatively wide area and connected by cables.

The system of cabling used within the battery links all components necessary for the performance of the battery's mission and sometimes consists of more than a mile of wiring. This wiring takes the form of multiconductor cables which are moisture-sealed in rubber covers and terminated at each end by metal connectors.

PRESENTATION:

1. Components Of the Battery To Be Cabled.

   a. The 400-cycle generator (H-F 30-G).

   b. The fire control trailer M242.

   c. The acquisition antenna assembly.

   d. The maintenance and spare parts trailer M244.

   e. The 60-cycle generator (M7, M18, M30).

   f. The gun junction boxes.

   g. The guns, which require power and firing data.

2. Precautions To Take When Connecting the Cables.

   a. Do not connect or disconnect the cables with the power ON.

   b. Make certain all rubber gaskets are in place.

   c. Check and insure that all plugs and receptacles are clean.

   d. Make sure that all cables are connected snugly.

3. Cables For the Fire Control Platoon.

   a. The 400-cycle power cables.

   b. The acquisition antenna assembly cables. These cables are broken down into two groups, as follows:

      1) The power and data cables, which consists of:

         a) The AC power cable,

         b) The DC power cable,

         c) The signal cable,

         d) The high-voltage cable, and

         e) The synchronizing pulse cable.

      2) The jumper cables, which consist of:

         a) The high-voltage pulse cable,

         b) The synchronizing pulse cable,

         c) The IFF data cable,

         d) The miscellaneous power cables, and

         e) The power-to-antenna cable.

c. The present position data cable. This cable runs to any outside agency.

d. The track antenna assembly jumper cables:

1) Scanner motor cable,

2) Optical unit cable,

3) Elevation drive cable,

4) High-voltage pulse cable,

5) IF cable, and

6) RF coupler cable.

4. Cables For the Gun Platoon Are Divided Into Three Systems.

a. The M1A1 system for the 90-mm gun on the M2A1 mount, consisting of:

1) The firing data cable,

2) The 60-cycle power cable, and

3) The main-junction-box-to-gun-junction-box cable.

b. The M1A2 cable system for the 90-mm gun on the M1A1 mount, consisting of:

1) The firing data cable,

2) The 60-cycle power cable,

3) The main-junction-box-to-gun-junction-box cable, and

4) The gun-junction-box-to-the-gun cable.

c. The M3A1 cable system for the 120-mm gun, consisting of:

1) The firing data cable,

2) The 60-cycle power cable, and

3) The main-junction-box-to-gun-junction-box cable.

5. Care of Cables.

a. Keep the cables and receptacles clean. Oil or grease on a cable will rot the rubber. To remove oil or grease, use warm water and soap, not gasoline. If plugs and receptacles are dirty, clean them with a brush and carbon tetrachloride. To prevent dirty receptacles and plugs, make certain they are tightly connected or capped at all times. Do not drag the cables on the ground when march-ordering or emplacing the battery.

b. Protect the cables from unusual wear. Leave extra lengths of cable on reels or rolled into extended figure-eights. Do not lay cables where there is vehicular traffic. Lay them in such a way that they will not be chafed. Bury cables if the climate is dry. If cables are to be buried for any length of time, install wooden troughs to house them. In freezing weather, fill troughs with straw to prevent the cables from freezing to the troughs. If the climate is very damp and water seepage into the buried cables is likely, elevate the cables.

c. Store unused cables in a cool, dry place.

d. Handle cables with care when disconnecting.

e. To keep cables functioning properly, the simplest rule is: KEEP THEM CLEAN AND CONNECT THEM TIGHTLY.

f. The magohmmeter, or megger, is used to check for insulation leakage between any two conductors in a

cable. This is done by hand cranking the megger to a maximum of 500 volts. This voltage is sent into two conductors and the amount of resistance measured. For this test a resistance of not less than 30 megohms should be read. This test will detect the presence of shorts between any two conductors caused by either insulation breakdown or the presence of moisture. Should such leakage or shorts be present between two conductors, the data flowing through them would mix, thereby invalidating both sets of data. Megger checks should be performed at least once a month. In any cable, each conductor must be checked against every other conductor and against the plug housing. Cable should be disconnected at both ends for this test.

g. The continuity check detects the amount of resistance in a conductor. An ohmmeter is set up with its two leads attached to opposite ends of the particular conductor being checked. The amount of resistance is read and should be not more than two ohms for a data cable. For power cables, the resistance should be zero. For example: The cables from the fire control trailer to the 400-cycle generator carry 70 amperes. If a resistance of even one ohm were allowed in this cable, a voltage drop of 70 volts would result. Therefore, the amount of resistance allowable in a power cable depends on the current flow. However, in a data cable, where current flow is measured in milliamps, a one-ohm resistance would result in a negligible loss. Each conductor in all cables should be checked once a month.

6. The cabling diagrams (Fig. VIII - XII)[2/] are for the purpose of furnishing the repairman with data pertaining to the purpose of the cable, its color code, length, number of conductors,

[2/] Taken from Antiaircraft Fire Control System M33 Schematic Diagrams, The Antiaircraft Artillery and Guided Missile School, Fort Bliss, Texas, no date, Figure VIII - Figure XII.

and function of each conductor. It should be noticed that each cable has spare conductors which can be used in the event one of the voltage- or signal-carrying conductors becomes faulty.

PRACTICAL EXERCISE

SYSTEM CABLING

AAFCS M33 SETUP: Completely de-energized.

EQUIPMENT NECESSARY: Screwdrivers and spanner wrench.

DEMONSTRATION:

INSTRUCTOR'S NOTE:

1. During this class period have the students remove the cables from the clam shell, barbette roof, and generator. Before removing the cables, however, have the students locate the various cables on their cabling system diagrams.

2. Upon completion of these steps, have the students replace the cables.

3. Emphasize that cables are frequently a cause for many troubles because of improper connections, broken wires in the cables, etc.

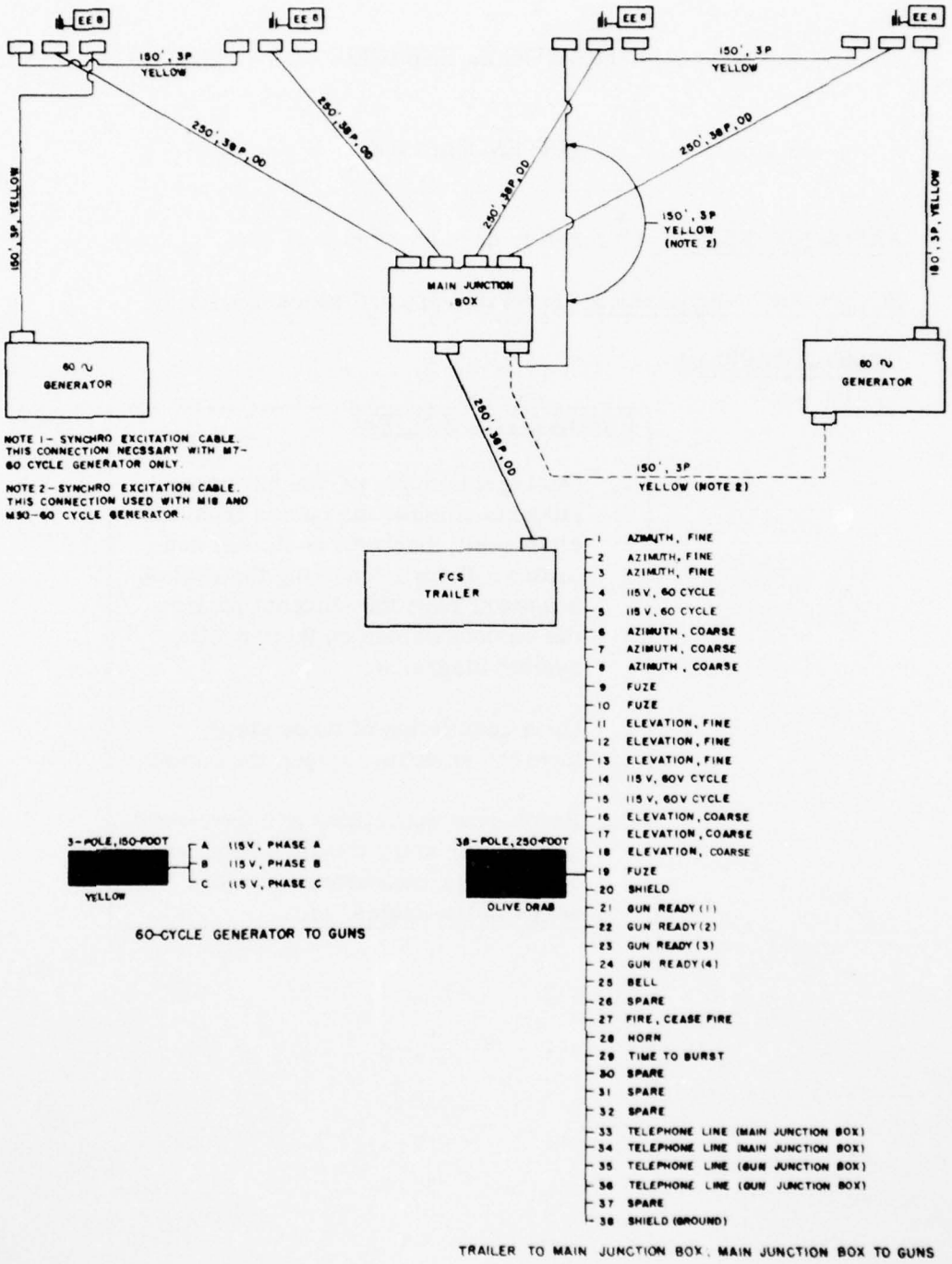

Figure VIII. Cable system for 120-mm gun battery (M3A1).

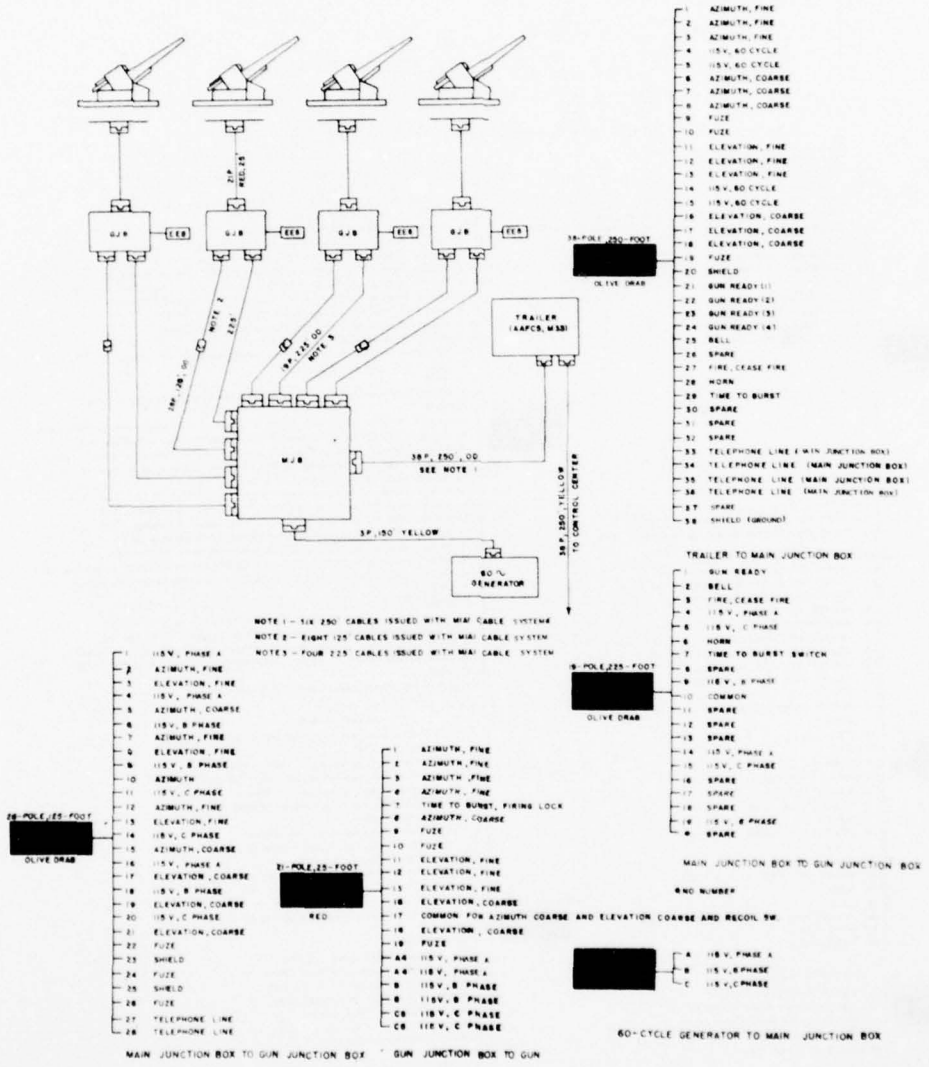

Figure IX. M1A1 cable system for 90-mm gun battery.

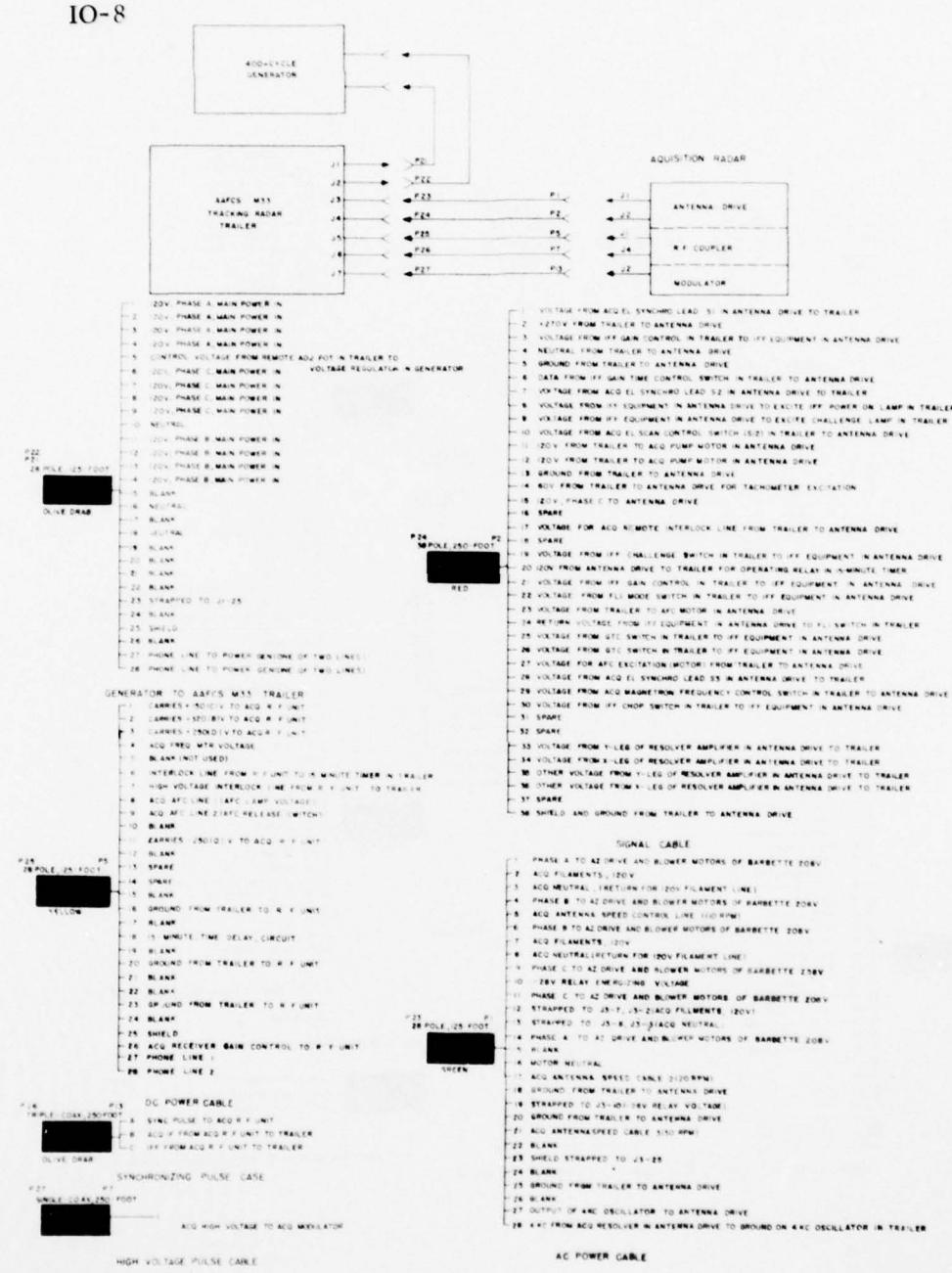

Figure X. Cables from generators to radars.

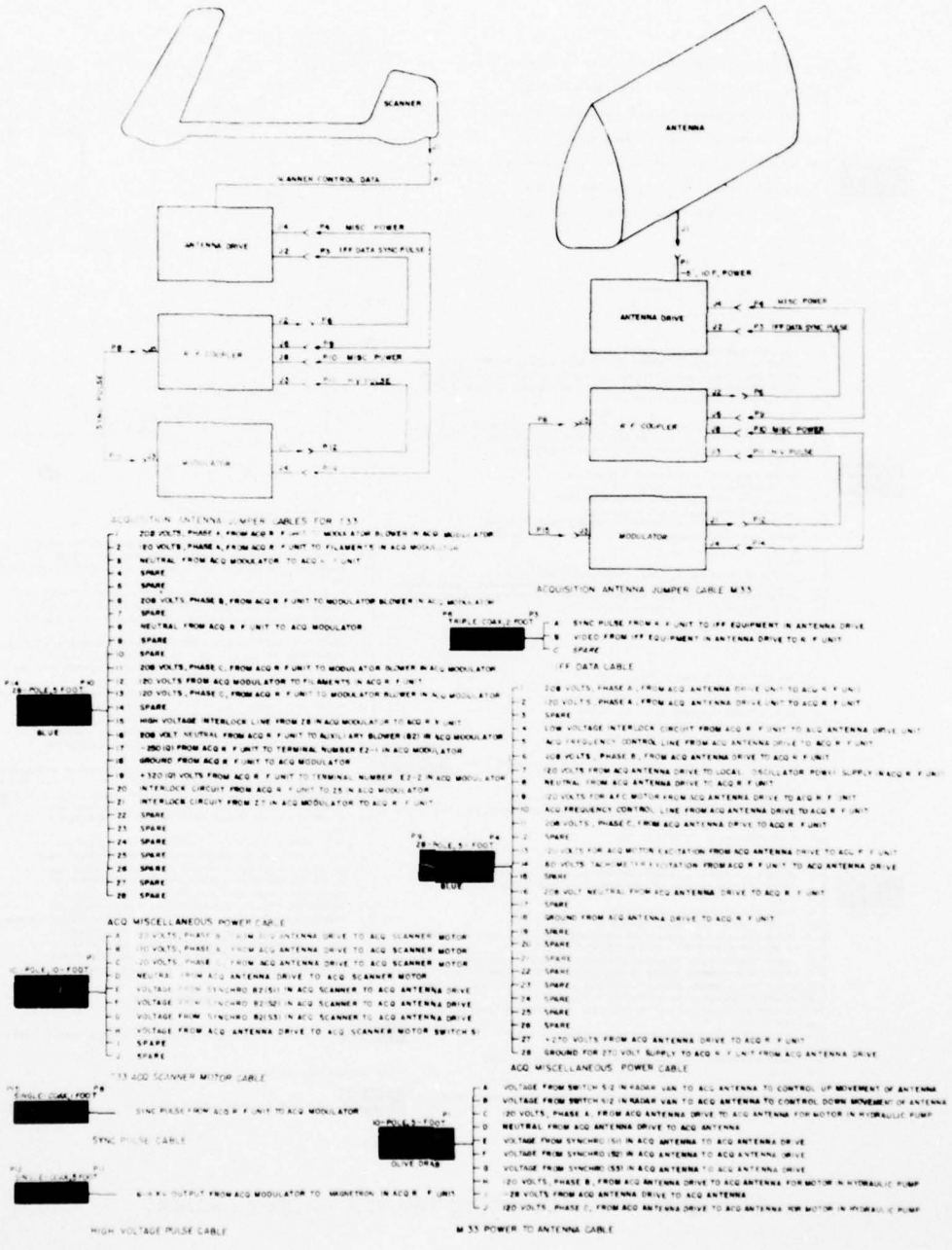

Figure XI. Cabling modulator, RF coupler, antenna drive.

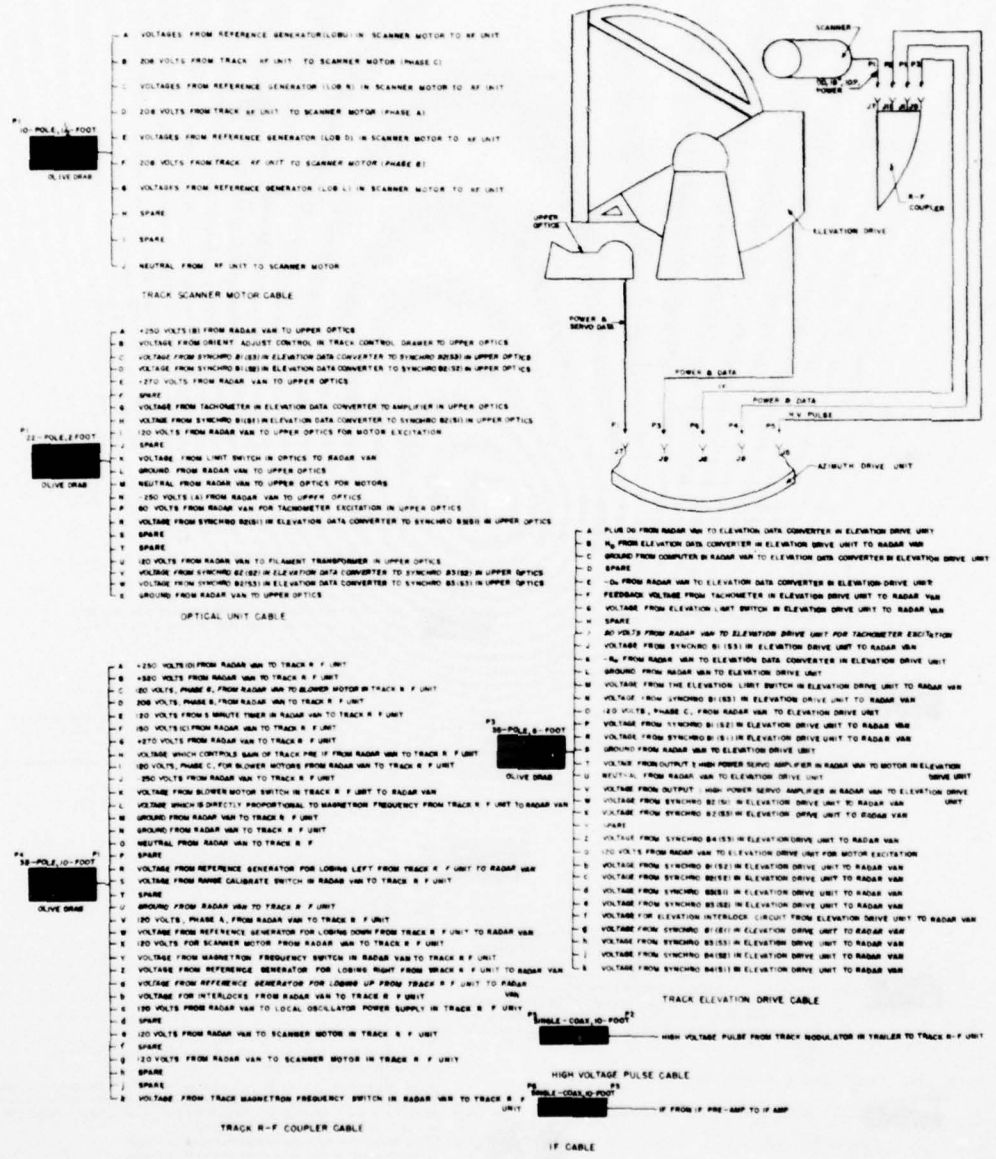

Figure XII. Tracking antenna jumper cables.

LESSON PLAN

INTRODUCTION TO TROUBLE SHOOTING

OBJECTIVE:

To furnish the student with a foundation upon which he can develop an efficient trouble shooting technique.

INTRODUCTION:

One of the important skills that an AAFCS M33 technician must have is that of localizing and eliminating troubles from the system. Since the AAFCS M33 is a relatively complex system of channels, subchannels, and components, it might appear that some standardized approach to trouble shooting must be learned in order to become a competent technician.

In general this is true, but technicians vary in their knowledge about the system; they bring different experiences and backgrounds to the trouble shooting situation. In addition, troubles vary considerably in their degree of difficulty. Some troubles are easy to spot; others are more difficult. On the basis of these facts, it would be extremely inefficient to follow exactly the same trouble shooting procedure every time a system develops a trouble.

Although the approach to the solution of each trouble may differ in detail, there are some general steps that, if followed, will lead to a more efficient trouble shooting technique. It is with the first of these steps that we are concerned in this lesson.

PRESENTATION:

1. Collection of Data: The Basic Trouble Shooting Step.

   a. The first step toward the location and repair of a trouble is the collection of data; it is the collection of all those systems and indications of abnormal operation that can be found by inspection of the system.

Example 1. A detective, when first informed of foul play, rushes to the scene of the crime, and collects clues. He does this because he knows that the more clues he collects the better are his chances of solving the crime in a short period of time.

Example 2. A physician, when presented with a symptom of illness, makes an examination in order to find as many other symptoms as possible. The more symptoms he finds, the more accurate his diagnosis.

b. There are two important reasons why the mechanic should begin his trouble shooting by symptom-gathering.

1) The collection of symptoms will lead the mechanic more accurately to the source of the trouble, and it will save time by preventing him from traveling up blind alleys.

a) Diagram 2 shows a channel of information that starts at block A and ends up on scopes 1 and 2. If a mechanic saw, for example, that video was missing from scope 2, his first act should be to look to see if the same symptom appeared on scope 1. If it did, then the trouble is common to both scopes and is probably located in blocks A, B, or C. Obviously, if the trouble were common to both scopes and the mechanic did not note this fact, he might spend a lot of time trouble shooting scope 2. If the symptom did not appear on both scopes, the trouble could not be in blocks A, B, or C, and the mechanic would then be justified in attacking scope 2 as the probable source of trouble.

2) Many troubles can be cleared during the process of collecting symptoms.

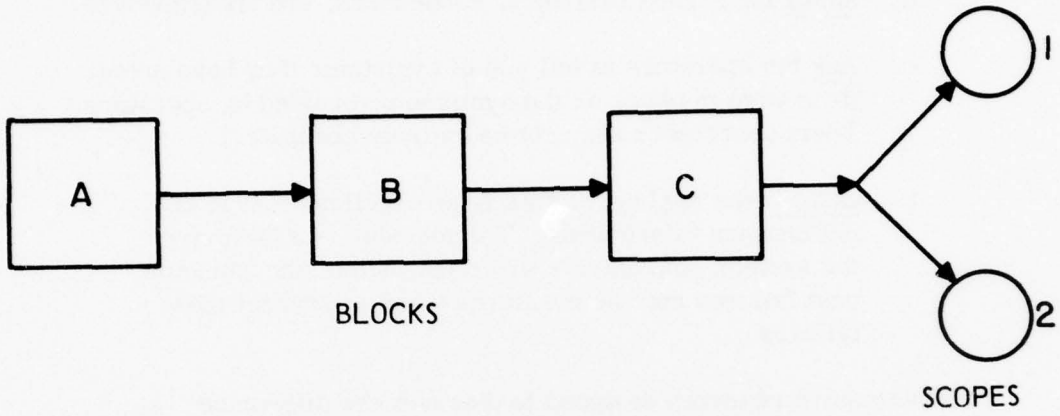

Diagram 2. Example of Information Flow.

a) Radar operators are responsible for many of the troubles which occur in the field. Time after time the operator will leave a switch in the wrong position or inadvertently move a control to a wrong setting.

b) In many cases the symptoms caused by these operator errors are exactly the same as those that would appear if the trouble were located deep within the system.

c) By checking controls and switches first, the mechanic will rapidly clear those troubles caused by improper control settings.

2. A Method of Collecting Symptoms.

a. Check the position of controls and switches.

b. Look at scopes, indicator lights, and meters.

c. Listen for abnormal sounds.

d. Smell for burned resistors, condensers, and transformers.

e. Ask the operators to tell you of symptoms they have noted. (It is wise to check on the symptoms reported by operators. Their description may not be entirely accurate.)

f. Consult the log book. This is an excellent source of malfunction information. The log book is a history of the system, and entries will often include the cause of past failures and the measures taken to correct these failures.

3. Extensive research designed to discover the difference between good and poor trouble shooters found that:

   a. Poor trouble shooters begin reading their schematic books as soon as they become aware of a symptom. They tend to use their schematic books instead of their heads.

   b. Good trouble shooters begin locating a trouble by first looking over the system in order to gather as many symptoms and clues as possible.

SUMMARY:

1. The process of trouble shooting involves the intelligent collection of data in the form of symptoms or clues.

2. Though the efficient trouble shooter must know and do a lot more than gather the symptoms available from an inspection of the system, he never neglects this all-important first-step.

PRACTICAL EXERCISE

INTRODUCTION TO TROUBLE SHOOTING

AAFCS M33 SETUP: Completely energized.

EQUIPMENT NECESSARY: None.

DEMONSTRATION:

> INSTRUCTOR'S NOTE: The purpose of this practical exercise is to impress upon the student the importance of looking for and finding as many symptoms as possible before further attempting to locate and eliminate a trouble.

1. Example 1: Remove the sync pulse input to the track trigger generator and have a student attempt to energize the track transmitter. Symptom: High voltage reading and no current reading on track transmitter. The red ON lamp goes OFF immediately upon release of the ON button.

   a. Ask students in which channel they would look for a trouble with this type of symptom, and ask why they would look in this channel.

   b. Explain that they were correct if they diagnosed the track transmitter as the faulty channel.

2. Example 2: Disconnect the sync pulse output of the pulse synchronizer. Symptoms: Both transmitters give high voltage and no current reading. Both red ON lamps go off immediately upon release of their respective ON buttons.

   a. Have students attempt to energize the track transmitter.

b. Ask students where they think the trouble is and to give reasons for their answers. Since the symptoms are the same as in Example 1, the answers will probably be the same.

c. Explain that if they diagnosed the track transmitter as the faulty channel they were wrong and that the reason for this mistake was that they did not collect sufficient data before making the diagnosis. Point out that before looking in the track transmitter for the trouble they should have made certain that the acquisition transmitter functioned correctly.

d. Have one of the students attempt to energize the acquisition transmitter at this time. Call attention to the symptoms on the acquisition transmitter and their similarity to the track transmitter symptoms. Since it is highly improbable that both transmitters would fail at the same time, it is more reasonable to suspect common input to the transmitters. This input is the sync pulse, and its absence will, of course, lead to the pulse synchronizer.

INSTRUCTOR'S NOTE:

1. The following troubles are to be put into the system to give students practice in symptom-gathering.

2. Divide the class into halves and let the first group locate a trouble.

3. When the group has located a trouble let them reinsert the trouble for the next group.

COMMON TROUBLES:

	Symptoms	Trouble
1.	No video on PPI in tracking console. Tactical control console PPI normal. Both PI's normal.	Remove video input to PPI on tracking console.
2.	Marks present but no video on both PPI's and both PI's.	Turn the acquisition receiver GAIN to minimum.
3.	Acquisition antenna does not rotate when tracking console ACQUISITION AZIMUTH switch is placed in position 1, 2, or 3.	Place the ACQUISITION AZIMUTH switch at the tactical control console to OFF.
	INSTRUCTOR'S NOTE: Indicate the location of the other switches which turn off the acquisition azimuth drive.	
4.	No movement of the antenna in either azimuth or elevation.	Turn off the high power servos.
5.	Elevation normal. Antenna will not move in azimuth.	Pull the R_H amplifier out of its Jones plug sufficiently to open the circuits.
6.	No antenna movement in either elevation or azimuth.	Turn the ROOF SAFETY switch to OFF.
	INSTRUCTOR'S NOTE: After the trouble has been localized, point out the FUZE light that indicates the ROOF SAFETY switch is OFF.	

7.	No video on either of the three track indicators.	Place the track receiver in MGC and run the GAIN control to minimum.
8.	Two of the indicators display track video, and the other displays only a sweep.	Remove video input to one of the indicators. (Disconnect J1 on the video amplifier.)
9.	No sweeps on either the track indicators or the PPI's.	Disconnect terminal no. 76 in the radar cabinet (Fig 19-18).
10.	Video at close ranges only.	Activate ACQUISITION ELEVATION SCAN toggle switch until dial reads maximum elevation.

INSTRUCTOR'S NOTE: Demonstrate the ease with which this trouble is localized by monitoring the DC voltages with the DC VOLTAGE METER switch.

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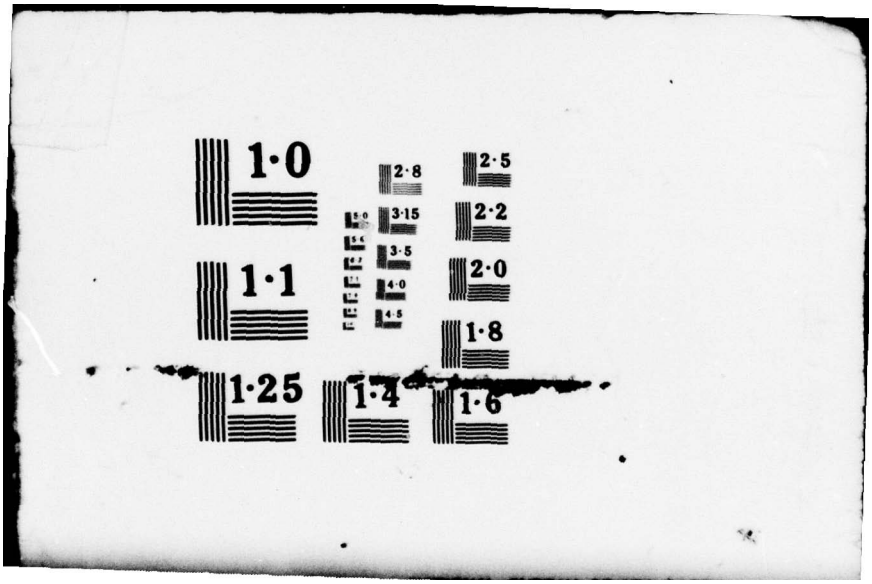
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APPENDIX A

SUGGESTED OPERATING PROCEDURES

The operating procedures presented in this booklet constitute the synthesized experiences of AAFCS M33 operators, chief radar operators (CRO's), and other technically qualified experts.

These procedures are abstracted from a report [3] published by the Training Methods Division of the Human Resources Research Office and are offered as suggested operating procedures for the tactical AAFCS M33 battery.

[3] George H. Brown, Donald F. Haggard, and J. Daniel Lyons, The AAFCS M33 Operator: A Manual of Operating Procedures. Special Report 6, Washington, D.C.: Human Resources Research Office, August, 1956.

ENERGIZING THE RADAR SET AND COMPUTER

From Shutdown to Stand-by.

Note: It is assumed that all controls were left in the correct position at the last shutdown.

1. At the Radar Cabinet Power Control Panel.

   a. Check to see that the A-B-C switch is in the C position.

   b. Check to see that the LINE VOLTAGE dial reads 120 volts.

   c. If line voltage is not 120 volts, set at 120 volts using ADJUST control knob.

   d. Turn the A-B-C switch to the B, then A position, and check that LINE VOLTAGE dial reads 120 volts in each position within a tolerance of 5 volts. (It is sometimes necessary to adjust phase C off 120 volts in order to get B and A within tolerance.)

   e. Turn the A-B-C switch to the C position.

Caution: Before turning the MAIN POWER switch to the ON position, check to see that the ventilating hatches on the left side of the trailer are open. If the MAIN POWER switch is operated to the ON position with these hatches closed, damage may be done to electrical components of the equipment.

   f. Turn the MAIN POWER switch to the ON position.

   g. Repeat line voltage check at position C only using A-B-C switch and LINE VOLTAGE dial. If not within the tolerance of 5 volts, call a repairman.

   h. Turn PERSONNEL VENTILATION switch to ON position if desired.

i. Turn the RADAR POWER switch to the ON position.

j. Turn the ACQUISITION POWER switch to the ON position.

k. Turn the ACQUISITION MOTORS switch to the ON position.

l. Check to see that the green ACQUISITION OFF lamp lights after approximately 20 seconds.

m. Turn the TRACK FILAMENTS switch to the ON position.

n. Check to see that the green TRACK OFF lamp is lit.

2. Illumination System.

a. On the signal power panel, use the CONSOLE LIGHTS control knob to adjust the dial lights to the desired brightness.

b. On the signal power panel, use the SIGNAL LIGHTS control knob to adjust the signal lights to the desired brightness.

c. On the computer correction panel, place the LIGHTS switch in the ON position.

d. Adjust the METER AND SERVO LIGHTS control knob until the lights on the target rate indicator dials and the servos are of the desired brightness.

3. At the Computer.

a. Turn the COMPUTER POWER switch on the computer power control panel to the ON position.

b. Check to see that the white A, B, and C COMPUTER POWER lamps are lit.

c. Check to see that the amber TEST OR REMOTE lamp on the correction panel is lit.

d. Check to see that the green PREDICTION OUT lamp on the target rate indicator panel is lit.

From Standby to Operate.

1. At the Radar Cabinet Power Control Panel.

a. Check to see that the amber LOW VOLTAGE READY lamp is lit. (This ready lamp is supposed to light 30 seconds after the RADAR POWER switch has been turned to the ON position.)

b. Turn the LOW VOLTAGE switch to the ON position.

c. Check to see that the white LOW VOLTAGE ON lamp is lit and that the amber LOW VOLTAGE READY lamp is extinguished.

d. Make 19 voltage checks of the low voltage power supplies using the VOLTAGE CHECK meter and switch. Turn the switch in a clockwise direction, and check to see that the needle of the meter rests within the indicated segment of the dial for each position of the switch. Upon completion, leave the switch in the OFF position.

Switch Position	Dial Segment	Switch Position	Dial Segment	Switch Position	Dial Segment
-250	3/4	+250B	3/4	+250G	3/4
-320	3/4	+250C	3/4	+450	3/4
+150A	3/4	+320A	3/4	+175	1/2
+150B	3/4	+250D	3/4	+270	1/2
+150C	3/4	+250E	3/4	-28	1/4
+220	3/4	+250F	3/4		
+250A	3/4	+320B	3/4		

e. Before setting the INDICATOR HV toggle switch to the ON position, move the ACQUISITION AZIMUTH SCAN five-position rotary switch at the tactical control console monitor control panel to position 1. The acquisition antenna will rotate in azimuth. (This prevents the scopes from being burnt out in case their intensity switches have accidentally been left in the clockwise position.)

f. Turn the INDICATOR HV toggle switch to the ON position.

g. Check to see that the white INDICATOR HV lamp lights.

h. Turn the TRACK SCANNER switch to the ON position.

i. Turn the EXCITATION switch to the ON position.

j. Turn the HP SERVOS switch to the ON position.

2. At the Computer.

a. Check to see that the amber DC READY lamp on the computer power control panel is lit. This ready lamp lights 20 to 30 seconds after the COMPUTER POWER switch has been turned to the ON position.

b. Turn the 320V DC POWER switch on the computer power control panel to the ON position.

c. Check to see that the white 320 V DC POWER lamp is lit.

d. Check the four AMPLIFIER UNBALANCE lamps on the correction panel. None of the four lamps should be lit or flickering. If any of the four lamps continues to flicker after approximately five seconds, call the technician.

Caution: Make certain that guns are out of REMOTE before turning on 270 volt power.

e. Turn the 270V DC POWER switch to the ON position.

f. Check to see that the white 270V DC POWER lamp is lit.

g. Turn the VOLTAGE CHECK SWITCH in a clockwise direction, checking to see that the needle of the VOLTAGE CHECK meter rests within the indicated segment of the dial for each position of the switch. If any of the readings are not within tolerance, call the technician.

Switch Position	Dial Segment	Switch Position	Dial Segment
-320	3/4	+250	3/4
-250	3/4	+270	1/2
-200	3/4	+75	1/2
+320	3/4	-28	1/4

h. Turn VOLTAGE CHECK switch counterclockwise to the OFF position.

Note: The set is now only partially energized. The remaining steps cannot be carried out until the acquisition radar has completed its warm up time (approximately 15 minutes). During this delay it is suggested that the orientation and synchronization be begun.

ORIENTATION AND SYNCHRONIZATION

Note: In all cases, prior to operation, it is necessary to carry out orientation and synchronization checks. These checks are usually made while waiting for the acquisition radar to complete its warm up. This O&S can be done in a variety of ways. Below one system which many batteries have found satisfactory is presented. It is possible that your battery commander may prescribe different procedures for your battery.

1. Checking the Level of the Fire Control Van.

   a. Turn the TRACKING ANTENNA DISABLE switch, on the roof of the van, to the OFF position.

   b. Manually rotate the tracking antenna until the lens face is parallel with the front or rear edges of the van and parpendicular to the roof.

   c. Station one man at each of the four trailer jacks.

   d. Adjust the trailer jacks until the bubble is perfectly centered on one of the tracking antenna spirit levels. Adjacent jacks should be adjusted in synchronism.

   e. As a check on the correctness of the spirit level calibration, rotate the spirit level 180° and note whether the readings are the same. If the readings differ, regard the midpoint between them as the true indication of level; and proceed to have the trailer jacks adjusted until the bubble is bisected by that midpoint.

   f. Rotate the tracking antenna to various positions throughout the entire 360° of azimuth, and check to see that the position of the bubble remains constant.

   g. Turn the TRACKING ANTENNA DISABLE switch back to the ON position.

2. Orientation of the Track Radar.

   a. *While looking through the optics at the tracking console,* turn the AZIMUTH and ELEVATION handwheels until the the reticle of the periscope coincides with the apex of the triangle of the Known Datum Point (KDP).

   b. Place the TEST-OPERATE switch, inside the control drawer, into the TEST position.

c. Check to see that the reading of the elevation data converter on the roof agrees with the known elevation of the KDP. If it does not, loosen clutch, and position dial to correct reading. Then tighten clutch.

d. Check to see that the reading of the azimuth data converter above the tracking console agrees with the known azimuth of the KDP. If it does not, loosen clutch, and position dial to correct reading. Then tighten clutch.

e. Place the TEST-OPERATE switch back in the OPERATE position.

Note: The range orientation of the track radar must be checked later when the radar set is completely energized.

3. Orientation of the Acquisition Radar.

a. While looking through the optics at the tracking console, turn the AZIMUTH and ELEVATION handwheels until the reticle of the periscope coincides with the center of the orient test set on the acquisition antenna.

Caution: Before climbing on the acquisition antenna assembly, insure that the ANTENNA DRIVE SAFETY switch on the top tub of the acquisition antenna assembly is in the OFF position.

b. Manually rotate the acquisition antenna until the vertical hairline of the peepsight in the orient test set is centered on the track scanner of the track radar antenna.

c. The ACQUISITION AZIMUTH dial should show the same reading as the azimuth data converter of the track radar. If it does not, loosen the clutch at the acquisition azimuth orient unit and position dial to the correct reading. Do not add 3, 200 mils to the ACQUISITION AZIMUTH dial reading. Tighten clutch.

4. Synchronization Between Computer and Track Radar.

a. Strip out all ballistic corrections, including parallax.

b. Place the OPERATION switch, on the correction panel, in the TRACKING TEST position.

c. Place the INPUT DATA switch, on the correction panel, in the LOCAL position.

d. At the tracking console, set in arbitrary value of azimuth and elevation. (Elevation is read at the elevation data converter on the roof of van; azimuth is read at the azimuth converter above the tracking console.)

e. Place the TEST-OPERATE switch in the TEST position.

f. AZIMUTH and ELEVATION SERVO dials should have read the same as the azimuth and elevation data converters.

g. Place the TEST-OPERATE switch back in the OPERATE position.

h. Place the INPUT DATA switch back in the STATIC TEST 2 position.

i. Place the OPERATION switch back in the STATIC TEST position.

5. Synchronization Between Computer and Guns.

a. Using the telephone, advise gun crews to prepare for synchronization check. They will then place their guns out of REMOTE.

b. Place the 270V DC POWER switch in the OFF position to prevent oscillation of the computer dials.

c. Using a screwdriver, set in arbitrary values in the fuze, azimuth, and elevation servos.

d. Using the telephone, ask gun crews to go into REMOTE and read to you their FUZE, AZIMUTH, and ELEVATION dial readings.

e. If agreement is not within tolerance, have the gun crews make corrections.

f. Advise gun crews to go out of REMOTE.

g. When the synchronization is complete, turn the 270V DC POWER switch back to the ON position.

Note: The remainder of the O&S checks cannot be made until the radar set is fully energized. Therefore, at this time, the remaining steps in the energizing process should be carried out.

ENERGIZING THE RADAR SET AND COMPUTER—Continued

From Standby to Operate—Continued.

1. At the Radar Cabinet Power Control Panel—Continued .

k. Check to see that the amber TRACK READY lamp is lit indicating that the 5-minute delay for warm up of the track radar is completed.

l. Depress the TRACK ON pushbutton.

m. Check to see that the red TRACK ON lamp lights and the green TRACK OFF and amber TRACK READY lamps go off.

n. Turn TRACK MIN-MAX control knob slowly in a clockwise direction to mechanical stop at MAX position.

o. (Systems 1 to 131) Check to see that the TRACK meter indicates a voltage reading to the magnetron. (Systems 132 and up) Place the CURRENT switch in the upward position, and check to see that the TRACK meter indicates power supply current.

p. (Systems 1 to 131) Depress the CURRENT pushbutton and check to see that the TRACK meter indicates a current value of 5.8 milliamps. (Systems 132 and up) Place the CURRENT switch in the midposition, and check to see that the TRACK meter indicates magnetron current.

q. (Systems 132 and up) Place the CURRENT switch in the downward position and check to see that the TRACK meter indicates HIGH VOLTAGE.

r. Check to see that the amber ACQUISITION READY lamp is lit indicating that the 15-minute delay for warm up of the acquisition radar is completed.

s. Depress the ACQUISITION ON pushbutton.

t. Check to see that the red ACQUISITION ON lamp lights, that the green ACQUISITION OFF lamp goes off, and that the amber ACQUISITION READY lamp goes off.

u. Turn the ACQUISITION MIN-MAX knob slowly clockwise to the mechanical stop at MAX position.

v. (Systems 1 to 131) Check to see that the ACQUISITION meter indicates a voltage to the magnetron. (Systems 132 and up) Place the CURRENT switch in the upward position and check to see that the ACQUISITION meter indicates power supply current.

w. (Systems 1 to 131) Depress the CURRENT pushbutton and check to see that the ACQUISITION meter indicates a current value of 70 milliamps. (System 132 and up) Place the CURRENT switch in the mid-position, and check to see that the ACQUISITION meter indicates the correct magnetron current value specified by maintenance personnel. This differs depending on type of waveguide and type of magnetron.

x. (Systems 132 and up) Place the CURRENT switch in the downward position, and check to see that the ACQUISITION meter indicates a high voltage.

Note: The set is now fully energized. It is now possible to complete the O&S checks as described in the next section.

ORIENTATION AND SYNCHRONIZATION—Continued.

Checking the Range Orientation of the Track Radar.

Note: Whenever feasible, this check should be done against a fixed target of known range. When that is not feasible, the range calibration pip test should be carried out. Both methods are presented below.

6. Against a Fixed Target of Known Range.

   a. At the tracking console, use the optics and the AZIMUTH, ELEVATION, and RANGE handwheels to position the track radar on a fixed target of known range.

   b. Place the RANGE MAN-AID-AUTO switch in AUTO.

   c. Check to see that the TRACK RANGE dial on the radar cabinet reads the same as the known range of the target.

   d. If it does not, adjust the phase shift capacitor until the correct reading is obtained. (The phase shift capacitor is in the timing wave generator which is located in the tracking range computer section of the radar cabinet.)

   e. Place the RANGE MAN-AID-AUTO switch back in MAN.

7. Using the Range Calibration Pip Test.

   a. At the control drawer of the tracking console, place the RANGE CALIBRATE switch in the ON position.

   b. At the tracking receiver control, place the AGC-MGC switch in the AGC position.

   c. Lock on to the first range calibration pip. (This is done by using the RANGE handwheel to position the range notch under the first calibration pip, and then placing the RANGE MAN-AID-AUTO switch in AUTO.)

d. Record the reading of the TRACK RANGE dial on the radar cabinet.

e. Lock on to the third calibration pip and record the reading of the TRACK RANGE dial.

f. Subtract the TRACK RANGE dial reading of the first pip from that of the third pip and divide by two. The resulting value is the actual range of the first pip.

g. Lock on to the first pip again and check to see that the TRACK RANGE dial reads the same (±3 yards) as the value computed in step f. If it does not, adjust the phase shift capacitor in the tracking computer unit of the radar cabinet until the correct reading is obtained.

h. Multiply the value computed in step f by each of the following numbers: 2, 3, 4, and 5. These values should be the readings of the TRACK RANGE dial when the radar is locked on to the 2d, 3d, 4th, and 5th calibration pips, respectively.

i. Make each of these checks. If any of the TRACK RANGE dial readings are not correct within the tolerance of 3 yards, call the technician.

j. At the tracking receiver control, place the AGC-MGC switch back in the AGC position.

k. At the control drawer, place the RANGE CALIBRATE switch back in the OFF position.

l. Place the RANGE MAN-AID-AUTO switch back in the MAN position.

Checking the Alinement of the Acquisition and Track Radars.

1. Designate a target.

2. Make certain that the radial portion of the electronic cross coincides with the flashing azimuth line of the PPI after the track antenna has been slewed to a designated point.

3. Make certain that the arc portion of the electronic cross coincides with the range circle of the PPI after the track antenna has slewed to a designated point.

4. If either does not prevail, call the technician.

5. Track a target automatically and check to see that the target coincides with the electronic cross on the precision indicator (TRACK ACQ switch in TRACK position). If it does not, call the technician.

DUTIES OF THE COMPUTER OPERATOR

Adjustments of Controls Prior to Acquiring Targets.

1. Illumination System.

   a. Adjust the HORIZONTAL PLOT LIGHTS control knob until the lights on the horizontal plotting board are of the desired brightness.

   b. Adjust the ALTITUDE PLOT LIGHTS until the lights on the altitude plotting boards are of the desired brightness.

2. At the Servos.

   a. Check to see that all computer servo spot dials are at zero.

3. At the Correction Panel.

Note: The met (meteorological) messages should always be analyzed immediately upon receipt and the appropriate data entered on the DATA RECORD card. At the same time the powder temperature should be determined by calling the gun crews. Then, using the

information on powder temperature, air temperature, and projectile weight, the developed MUZZLE VELOCITY is computed and entered on the DATA RECORD card.

a. Check to see that the MUZZLE VELOCITY dial reading agrees with that recorded on DATA RECORD card.

b. Check to see that the WIND VELOCITY and the AIR DENSITY dials agree with the latest met message.

c. On the azimuth servo, check to see that the WIND AZIMUTH dial agrees with the latest met message.

d. Check to see that the X, Y, and H parallax dials agree with the DATA RECORD card. (These dials should be checked frequently since it is common for them to be accidentally knocked out of position.)

e. Check to see that the OPERATION switch is in the STATIC TEST position.

f. Turn the INPUT DATA switch through the six static test positions.

g. Check servo dial readings against laundry sheet reading for each static test.

Note: All readings must be within tolerance before proceeding.

h. Place the OPERATION switch in the FIRE FOR EFFECT position.

i. Check to see that the AIR-SURFACE switch is in the AIR position (unless you have been alerted for a sea target).

j. Adjust the MINIMUM ALTITUDE knob until the desired predicted altitude is set on the MINIMUM ALTITUDE dial.

k. Adjust the DEAD TIME knob to the value specified by maintenance personnel.

4. At the Target Rate Indicator.

a. Place the HORIZONTAL DATA SMOOTHING and ALTITUDE DATA SMOOTHING switches in the 4 position.

b. Place the X RATE, Y RATE, and H RATE switches in either of the positions.

c. Place the HORIZONTAL PREDICTION and ALTITUDE PREDICTION switches in the LINEAR position.

d. Check to see that new plotting paper has been exposed on all plotting boards.

e. Turn the PLOTTING CONTROL switch to the REFERENCE MARK position and then back to STANDBY. (This causes a horizontal line to be drawn from the right side of each board to the origin. When the switch is returned to STANDBY, the pens will draw vertical marks about one inch long, then lift and return to the side of the board.)

Acquiring and Tracking Targets.

1. After completing the adjustments already listed, the computer operator has nothing further to do until a target has been assigned for acquiring and tracking. At that time he should take the steps described in a-k below.

a. At the target rate indicator, watch for the green ON TARGET lamp to light. (This lamp will light when the the TRACKED pushbutton at the tracking console has been pressed.)

b. When the ON TARGET lamp lights, place the PLOTTING CONTROL switch in the OPERATE position.

c. Observe the X and Y RATE meters to see which varies more rapidly.

d. Adjust the switch beneath this meter to keep the left-hand pointer on scale. Proceed as follows.

   1) If the meter pointer is against the upper stop, turn the RATE switch in an increasing direction until a meter reading between 0 and 100 is obtained.

   2) If the meter pointer is against the lower stop, turn the RATE switch in a decreasing direction, going through both zeros if necessary, until a meter reading between 0 and 100 is obtained.

e. In the same way, adjust the switch beneath the other meter until a meter reading between 0 and 100 is obtained.

f. In the same way, adjust the switch beneath the H RATE meter until a meter reading between o and 100 is obtained.

g. When present-position pen starts moving within the 40, 000-yard range limit, depress the COMPUTER READY push-button. (There will still be time enough to select the proper type of prediction and data smoothing before the guns are ready to fire.)

h. Observe the oscillations of the X and Y RATE meter pointers.

   1) If the oscillations are more than 4 yd/sec, place HORIZONTAL DATA SMOOTHING switch in the 8 position.

i. Observe the oscillations of the H RATE meter pointer.

   1) If the oscillations are more than 4 yd/sec, place the ALTITUDE DATA SMOOTHING switch in the 8 position.

j. Observe the readings of the X and Y ACCELERATION meters.

1) If the pointers oscillate around zero as a midpoint, leave the HORIZONTAL PREDICTION switch in the LINEAR position.

2) If the midpoint of the oscillations is some point between 1 and 2 yds/sec/sec, place the HORIZONTAL PREDICTION switch in the TANGENTIAL position.

3) If the midpoint of the oscillations is some point greater than 2 yds/sec/sec, place the HORIZONTAL PREDICTION switch in the QUADRATIC position.

k. Observe the readings of the H ACCELERATION meter. Place the ALTITUDE PREDICTION switch in either the LINEAR, the TANGENTIAL, or the QUADRATIC position according to the same rules as in the preceding step.

2. From this point on until the mission is over, the computer operator should more or less continuously make the following checks.

a. Watch the X, Y, and H RATE meters; and, if any pointer reaches the end of the scale, adjust the switch underneath it until an "on scale" reading is obtained.

b. Watch the X, Y, and H ACCELERATION meters; and, when necessary, change the type of prediction being used.

c. Watch the X, Y, and H RATE meters; and, when necessary, change the type of data smoothing network being used.

d. Watch the TIME OF FLIGHT dial, and inform the tactical control officer when it starts to move. At the same time, place the PLOTTING CONTROL switch in the PLOT position.

e. Watch the FUZE dial on the fuze servo, and notify the tactical control officer when it starts to move.

f. If the PREDICTED ALTITUDE LIMIT lamp starts blinking, observe the position of the predicted position pen on the horizontal plotting board. When the pen gets in a restricted area, depress the COMPUTER NOT READY pushbutton. When out of the restricted area, press the COMPUTER READY pushbutton.

Note: Blinking of the AMPLIFIER UNBALANCE lamps is normal under these circumstances.

g. If the plot becomes meaningless, depress the PEN LIFT pushbutton. Depress the PLOT pushbutton when appropriate.

h. Depress the PEN LIFT pushbutton, then the PLOT pushbutton, when you wish to indicate some critical point in an engagement.

i. At all times be alert to detect any signs of computer malfunction, such as excessive oscillation of the servo dials or flickering of the AMPLIFIER UNBALANCE lamps. When malfunction is detected, depress the COMPUTER NOT READY pushbutton.

3. Whenever the COMPUTER READY lamp goes out, CEASE FIRE or CEASE TRACKING has been ordered. The computer operator should then take the following steps.

a. Place the PLOTTING CONTROL switch in the STANDBY position.

b. Place the HORIZONTAL PREDICTION switches and the ALTITUDE PREDICTION switches in the LINEAR position.

c. Place the X, Y, and H RATE switches in either of the 0 positions.

d. Place the HORIZONTAL DATA SMOOTHING and the ALTITUDE DATA SMOOTHING switches in the 4 position.

DUTIES OF THE ACQUISITION OPERATOR

Adjustments of Controls Prior to Acquiring Targets.

1. Illumination System.

   a. Adjust the CEILING LIGHTS control knob on the target rate indicator until the ceiling lights above the tactical control console are of the desired brightness.

   b. Adjust the LIGHTS control knob on the PPI until the dial lights around the edge of the PPI are of the desired brightness.

2. Acquisition System.

   a. Before adjusting the PPI, ascertain that the acquisition receiver control has already been adjusted. Then, proceed to adjust the PPI in the following manner.

      1) Turn the GAIN control knob to the extreme counterclockwise position (gain turned down).

      2) Turn the INTENSITY control knob clockwise until the sweep is barely visible on the PPI.

      3) Turn the GAIN control knob clockwise until the three reference marks (steerable azimuth line, range circle, and electronic cross) are visible.

   b. Adjust the precision indicator in the following manner.

      1) Turn the INTENSITY control knob clockwise until the trace is barely visible.

      2) Turn the GAIN control knob clockwise until the ground clutter appears and the snow is barely visible.

3) Place the TRACK ACQ switch in the ACQ position.

c. Many of the following adjustments cannot be made until the radar set is fully warmed up and completely energized. During the delay period you can aid the tracking operators in their search for an AADCP assigned target by designating in the following way.

1) Depress the AZIMUTH LINE ring and turn the AZIMUTH LINE control knob to place the steerable azimuth line at the position where the target is expected.

2) At the same time turn the RANGE CIRCLE handwheel to place the range circle at the position where the target is expected.

3) Depress the DESIGNATE pushbutton to notify the tracking operators to search for the target.

d. Place the ACQUISITION AZIMUTH SCAN switch on the monitor control panel in position for the desired speed of rotation of the acquisition antenna. Under most conditions a speed of 20 rpm is satisfactory. However, a target at extreme range can be handled best by an antenna speed of 10 rpm; for targets at very close range, an antenna speed of 30 rpm will be most satisfactory.

e. Place the RANGE control knob on the PPI indicator in position for the desired range coverage. This should always be 120,000 yards except under certain circumstances.

1) If a difficult target has been assigned by AADCP and the target's range is less than 60,000 yards, it would be permissible to set the RANGE control knob for 60,000-yard range coverage.

2) When searching for targets at ranges less than 60,000 yards and it is desired to expand the scope presentation to better see targets in or around clutter.

Note: When the set is completely energized to the operate condition, the following adjustments can be made.

f. If there is no video on the PPI scope, have the range operator check the AFC HUNT lamp.

g. If the PPI scope shows interference, notify the range operator (who will adjust the frequency) and at the same time adjust your GAIN and INTENSITY in an effort to get the best picture.

h. Use the ACQUISITION ELEVATION SCAN switch on the control panel to set the readings on the ELEVATION COVERAGE dial at the point where the most targets can be seen.

Surveillance.

1. Search for possible targets on the PPI.

2. Notify the AADCP of possible targets located on the PPI if required to do so.

3. Designate possible targets to the tracking operators until a target is assigned by AADCP.

4. Watch the early warning plotting board for the location of targets entering the acquisition range.

Acquiring and Tracking Targets.

1. When a target has been assigned by the AADCP, pay particular attention to that part of the scope where the target is expected.

2. Use the ACQUISITION ELEVATION SCAN switch to set the ELEVATION COVERAGE dial at the best position for picking up the expected target. (At extreme ranges, the elevation coverage should be low.)

3. When the target is spotted, verify that it is correct by checking with several AADCP plots.

4. Depress the AZIMUTH LINE ring and turn the AZIMUTH LINE control knob to place the steerable azimuth line on the target pip, and, at the same time, turn the RANGE CIRCLE handwheel to place the range circle on the target pip.

5. Using the precision indicator, center the steerable azimuth line and the range circle on the target pip.

6. Depress the DESIGNATED pushbutton to notify the tracking operators that a target is to be acquired.

7. Watch for the green TARGET CONFIRMED lamp on the monitor control panel to light, indicating that the track operators are attempting to pick up the target.

8. As soon as the electronic cross appears on the PI, wait a few seconds, then move the steerable azimuth line and the range circle off the precision indicator. (This will make it easier for the tracking operators to observe the pip on their precision indicator.)

9. Observe the PPI and, if the tracking operators begin to track the wrong target, redesignate the correct target.

10. If the track radar appears to be on the target but the TRACKED lamp is not lit, notify the azimuth operator.

11. Continue to adjust the ACQUISITION ELEVATION SCAN switch to the target pip on the PPI scope until the TRACKED lamp lights.

12. Check the early warning plotting board for other targets entering the acquisition range.

13. Search for other possible targets on the PPI.

14. If the PPI shows signs of jamming, other than window jamming, vary the intensity and gain of the PPI in order to get the best video. Also, notify the range operator, who will change the frequency of the acquisition radar.

15. If a new target is assigned by AADCP, depress the CEASE TRACKING pushbutton twice (to give a double buzz) and verbally notify the tracking operators to cease tracking.

16. Proceed to designate the new target in the usual way.

Shutdown.

1. Turn the INTENSITY control knob on the PPI's to the extreme counterclockwise position (intensity turned down).

2. Turn the INTENSITY control knob on the precision indicator to the extreme counterclockwise position (intensity turned down).

3. Check to see that the tracking operators have turned down the intensity of their A-scopes.

4. Turn the ACQUISITION AZIMUTH SCAN switch to the OFF position.

DUTIES OF THE AZIMUTH OPERATOR

Adjustments of Controls Prior to Acquiring Targets.

1. Illumination System. (May be done by the elevation operator.)

   a. On the signal power panel place the CEILING LIGHTS switch in the DIM position, and use the CEILING LIGHTS control knob to adjust the ceiling lights over the tracking console to the desired brightness.

   b. On the signal power panel, use the CONSOLE LIGHTS control knob to adjust the dial lights to the desired brightness.

   c. On the signal power panel, use the SIGNAL LIGHTS control knob to adjust the signal lights to the desired brightness.

2. Plan Position Indicator.

   a. Before adjusting the PPI, ascertain that the acquisition receiver control has been adjusted.

   b. Turn the GAIN control knob to the extreme counter-clockwise position (gain turned down).

   c. Turn the INTENSITY control knob clockwise until the trace is barely visible on the PPI.

   d. Turn the GAIN control knob clockwise until the three reference marks (steerable azimuth line, range circle, and electronic cross) are visible.

3. Precision Indicator.

   a. Turn the INTENSITY control knob clockwise until the trace is barely visible.

   b. Turn the GAIN control knob clockwise until the ground clutter appears and the snow is barely visible.

   c. Place the TRACK ACQ switch in the TRACK position.

4. Tracking Azimuth Indicator.

   a. Check to see that your IMAGE SPACING switch is in NOR before adjusting the intensity of your tracking indicator.

   b. Turn the INTENSITY control knob clockwise until the trace is clearly visible.

   c. Turn the FOCUS control knob until a sharply defined trace is visible.

   d. Turn the SWEEP LENGTH control knob until the range gate appears approximately in the center of the scope.

e. If you are unable to center the range g[illegible], have the range operator use his RANGE SLEW switch to bring it in.

f. If the tracking azimuth indicator shows interference, notify the elevation operator to change the frequency, and at the same time adjust your INTENSITY and FOCUS in an effort to get the best video.

5. Control Drawer.

a. Check to see that your MAN-AID-AUTO switch is in MAN. (The track radar cannot be slewed unless all three MAN-AID-AUTO switches are in MAN.)

Acquiring and Tracking Targets.

1. When the red DESIGNATED lamp lights and the buzzer sounds, press the ACQUISITION SLEW switch until the RANGE and AZIMUTH dials stop turning.

2. The next few steps are different depending upon whether the DISABLE switch is in the COAST position or in the DISABLE position. If properly adjusted, the coast circuit can be a valuable aid to operation. Hence, it should always be used except when it is obviously malfunctioning.

In COAST Position.

a. As soon as the target pip appears in the precision indicator, place your MAN-AID-AUTO switch in AUTO. (Actually you will then be tracking in aided manual until all three tracking operators are on target and have their MAN-AID-AUTO switches in AUTO. At that time the automatic tracking will take over.)

b. Use the AZIMUTH handwheel to center the vertical line of the precision indicator on the target pip.

c. Verbally report "Search" to the elevation operator when you have the vertical line of the precision indicator centered on the pip. (If the target pip is below the horizontal line of the PI, you should call "Search, left range"; if it is above the horizontal line of the PI, you should call "Search, right range." This informs the elevation operator whether to search for the pip on the left or right side of the range notch.)

d. Use the AZIMUTH handwheel to keep the vertical line of the precision indicator centered on the target pip until the elevation operator calls "Target."

e. When the elevation operator calls "Target," direct your attention to your tracking indicator and attempt to get on target by matching the two pips for height. (It is assumed that your IMAGE SPACING switch is in NOR, which should be considered the normal mode of operation for the azimuth indicator. If the IMAGE SPACING were in the OFF position, you would attempt to get on target by maximizing the height of the single pip.)

f. Press the TRACKED pushbutton as soon as the COAST lamp goes out. The COAST lamp will go out only when the radar is tracking automatically in all three positions.

g. After the radar is tracking automatically, continue to observe your A-scope to insure that the radar is staying on target.

h. If the radar drifts completely off target for several seconds, press the CONFIRMED pushbutton and try to get back on target by using your handwheel. (You will actually be using aided manual even through your MAN-AID-AUTO switch is in AUTO.) If the radar gets back on target for all three positions, the COAST lamp will go out and your handwheel will become frozen as the automatic tracking takes over.

i. When the radar is again on target for all three positions, press the TRACKED pushbutton.

In DISABLE Position.

a. As soon as the target pip appears in the precision indicator, use the AZIMUTH handwheel to center the vertical line of the PI on the target pip.

b. Verbally report "Search" to the elevation operator when you have the vertical line of the PI centered on the target pip. (If the pip is below the horizontal line of the PI, you should call "Search, left range"; if it is above the horizontal line of the PI, you should call "Search, right range." This informs the elevation operator whether to search for the pip on the left or right side of the range notch.

c. Use the AZIMUTH handwheel to keep the vertical line of the PI centered on the target pip until the elevation operator calls "Target."

d. When the elevation operator calls "Target," direct your attention to your tracking indicator and attempt to get on target by matching the two pips for height. (It is assumed that your IMAGE SPACING switch is in the NOR position which should be considered the normal mode of operation for the azimuth indicator. If the IMAGE SPACING switch were in the OFF position, you would attempt to get on target by maximizing the height of the single pip.)

e. When the range operator calls "Lock" or "Automatic," place your MAN-AID-AUTO switch in AUTO and press the TRACKED pushbutton.

f. After the radar is tracking automatically, continue to observe your A-scope to insure that the radar is staying on target.

g. If the radar drifts completely off target for several seconds, press the CONFIRMED pushbutton, notify the other operators, place your MAN-AID-AUTO switch in AID, and attempt to get back on target by using your handwheel.

h. When all three operators are back on target, as indicated by the range operators' calling "Lock" or Automatic, " turn your MAN-AID-AUTO switch back to AUTO and press the TRACKED pushbutton.

Regardless of Position of DISABLE Switch.

j. If the radar should repeatedly lose the target while tracking in automatic, place your MAN-AID-AUTO switch in AID and proceed to track in aided manual. (Straight manual tracking should be used only when all other methods fail.) When all three operators are again on target, press the TRACKED pushbutton and continue to track in aided manual.

k. Whenever the radar is actually on target and is being maintained on target by means of aided manual tracking or automatic tracking, it is permissible to place your IMAGE SPACING switch in SEL SIG if you perfer.

l. If your A-scope shows signs of jamming, inform the elevation operator (who will then adjust the tracking receiver control), and at the same time:

1) Adjust the INTENSITY and FOCUS of your A-scope in an effort to get the best picture, and

2) Place your IMAGE SPACING switch in SEL SIG.

m. If you have difficulty tracking one plane in a formation of planes, place your IMAGE SPACING switch in SEL SIG.

n. If may be advisable to use aided manual optical tracking under certain conditions:

1) During some types of jamming, and

2) When operating against low-altitude, high-speed aircraft.

Note: When engaging this type of target, every effort should be made to use the automatic mode of operation before depending on the optics for azimuth data.

o. If the buzzer sounds twice (the cease tracking signal), or if the acquisition operator calls "Cease tracking, " place your MAN-AID-AUTO switch in MAN.

Shutdown.

1. Check to see that your MAN-AID-AUTO switch is in MAN position.

2. Turn the INTENSITY control knob on the precision indicator to the extreme counterclockwise position (intensity turned down).

3. Turn the INTENSITY control knob on the PPI to the extreme counterclockwise position (intensity turned down).

4. Turn the INTENSITY control knob on the tracking azimuth indicator to the extreme counterclockwise position (intensity turned down).

DUTIES OF THE ELEVATION OPERATOR

Adjustments of Controls Prior to Acquiring Targets.

1. Illumination System (usually done by the azimuth operator).

a. On the signal power panel, place the CEILING LIGHTS switch in the DIM position, and use the CEILING LIGHTS control knob to adjust the ceiling lights over the tracking console to the desired brightness.

b. On the signal power panel, use the CONSOLE LIGHTS control knob to adjust the dial lights to the desired brightness.

c. On the signal power panel, use the SIGNAL LIGHTS control knob to adjust the signal lights to the desired brightness.

2. Tracking Receiver Control.

   a. Turn the SCANNING RATE control knob until the SCANNING RATE meter indicates that the scanning rate is within meter range; that is, until the reeds vibrate.

   b. Place the AGC-MGC switch in the AGC position.

   c. Using the FREQUENCY switch, adjust the FREQUENCY meter to the optimal frequency reading, that is, so that the strongest pips are obtained.

3. Tracking Elevation Indicator.

   a. Check to see that your IMAGE SPACING switch is in the NOR position before adjusting the intensity of your tracking indicator.

   b. Turn the INTENSITY control knob clockwise until the trace is clearly visible.

   c. Turn the FOCUS control knob until a sharply defined trace is obtained.

   d. Turn the SWEEP LENGTH control knob until the range gate appears approximately in the center of the scope.

   e. If you are unable to center the range gate, have the range operator use his RANGE SLEW switch to bring it in.

   f. If the tracking elevation indicator shows interference or if one of the other tracking operators reports interference on his A-scope, adjust your intensity and focus in an effort to get the best video. Also, at the tracking receiver control, adjust the FREQUENCY switch and the SCANNING RATE switch until the best reception is obtained.

4. Control Drawer.

   a. Check that your MAN-AID-AUTO switch is in MAN. (The track radar should not be slewed unless all three MAN-AID-AUTO switches are in MAN.)

b. Place the DISABLE switch in the COAST position. If properly adjusted, the coast circuit can be a valuable aid to operation. Hence, it should always be used except when it is obviously malfunctioning.

Acquiring and Tracking Targets.

1. After a target has been designated and while the track radar is slewing, watch for the target pip to appear on the precision indicator.

2. The next few steps are different depending upon whether the DISABLE switch is in the COAST position or in the DISABLE position. Normally, it should be in the COAST position.

In COAST Position.

a. As soon as the target pip appears in the precision indicator, place your MAN-AID-AUTO switch in AUTO. (Actually you will then be tracking in aided manual until all tracking operators are on target and have their MAN-AID-AUTO switches in AUTO. At that time the automatic tracking will take over.)

b. If your range gate is far from the center of your scope when slewing is completed, recenter it with your SWEEP LENGTH control knob.

c. When the azimuth operator calls "Search, left range" or "Search, right range," direct your attention to the corresponding side of the range gate on your scope and search for a double pip while using your ELEVATION handwheel to search in elevation around the estimated elevation point. If you prefer, use the ELEVATION SLEW switch to search in elevation. (If your IMAGE SPACING switch is in the OFF position, you will see only a single pip for each target. However, NOR should be considered the normal mode of operation for the tracking elevation indicator.)

d. Call "Target" when the target pips appear on your A-scope. (This is the signal for the range operator to bring the pips into the range gate.)

e. Use the ELEVATION handwheel to keep the pips matched in size. (If the IMAGE SPACING switch is in the OFF position, you will attempt to keep the signal pip at maximum size.) This matching in size assures you that the radar is on target in elevation. When all three operators are on target, the COAST lamp will go out and the handwheels will lock as the automatic tracking takes over.

f. After the radar is tracking automatically continue to observe your A-scope to insure that the radar is staying on target.

g. Observe the reading of the ELEVATION dial so as to be able to find the target quickly in case of drift.

h. If the radar drifts off the target, the COAST lamp will light. Inform the other operators that the target is lost, and at the same time attempt to get back on target by using your ELEVATION handwheel. (You will actually be using aided manual even though your MAN-AID-AUTO switch is still in AUTO.) If the radar gets back on target for all three positions, your handwheel will become frozen as the automatic tracking takes over.

In DISABLE Position.

a. If your range gate is far from the center of your scope when slewing is completed, recenter it with your SWEEP LENGTH control knob.

b. When the azimuth operator calls "Search,left range" or "Search, right range, " direct your attention to the corresponding side of the range gate on your scope and search for a double pip while using your ELEVATION handwheel to search in elevation around the estimated elevation point.

If you prefer, use the ELEVATION SLEW switch to search in elevation. (If your IMAGE SPACING switch is in the OFF position, you will see only a single pip for each target. However, NOR should be considered the normal mode of operation for the tracking elevation indicator.)

c. Call "Target" when the pips appear on your A-scope. (This is the signal for the range operator to bring the pips into the range gate.)

d. Use the ELEVATION handwheel to keep the targets matched in size. (If the IMAGE SPACING switch is in the OFF position, you will attempt to keep the single pip at maximum size.) This assures you that the radar is on target in elevation. When all three operators are on target, the range operator will call "Lock" or "Automatic."

e. Place your MAN-AID-AUTO switch in AUTO when the range operator calls "Lock" or "Automatic."

f. After the radar is tracking automatically, continue to observe your A-scope to insure that the radar is staying on target.

g. Observe the reading of the ELEVATION dial so as to be able to find the target quickly in case of drift.

h. If the radar drifts off the target, inform the other operator that the target is lost and place your MAN-AID-AUTO switch in AID. Attempt to get back on target by using your ELEVATION handwheel. When the range operator calls "Lock" or "Automatic," place your MAN-AID-AUTO switch back in AUTO.

<u>Regardless of the Position of the DISABLE Switch</u>.

i. If the radar should repeatedly lose the target while tracking in automatic, place your MAN-AID-AUTO

switch in aided manual. (Straight manual tracking should be used only when all other methods fail.) When using aided manual, AGC-MGC switch should be in MGC.

j. Whenever the radar is actually on target and is being maintained on target by means of aided manual tracking or automatic tracking, it is permissible to place your IMAGE SPACING switch in SEL SIG if you prefer.

k. If your A-scope shows signs of jamming, take the following steps.

1) Adjust the intensity and focus of your A-scope in an effort to get the best video.

2) Place your IMAGE SPACING switch in SEL SIG.

3) On tracking raceiver control, place AGC-MGC switch in MGC, and manually adjust GAIN for best reception.

4) On the tracking receiver control, use the FREQUENCY switch to find the frequency which produces the least interference.

l. If you have difficulty tracking one plane in a formation of planes, place your IMAGE SPACING switch in SEL SIG.

m. It may be advisable to use aided manual optical tracking under certain conditions.

1) During some types of jamming.

2) When operating against low-altitude, high-speed aircraft. (Note that when engaging this type of target, every effort should be made to use the automatic mode of operation before depending upon the optics for elevation data.)

n. If the buzzer sounds twice (the cease tracking signal), or if the acquisition operator calls "Cease tracking, " place your MAN-AID-AUTO switch in MAN.

Shutdown.

1. Check to see that your MAN-AID-AUTO switch is in MAN.

2. Turn the INTENSITY control knob on the tracking elevation indicator to the extreme counterclockwise position (intensity turned down).

3. Place the CEILING LIGHTS switch on the signal power panel in the ON position. (This is usually done by the azimuth operator.)

DUTIES OF THE RANGE OPERATOR

Adjustments of Controls Prior to Acquiring Targets.

1. Tracking Range Indicator.

   a. Your IMAGE SPACING switch may be left permanently in the OFF position since it has no effect on the tracking range indicator.

   b. Turn the INTENSITY control knob clockwise until the trace is clearly visible.

   c. Turn the FOCUS control knob until a sharply defined trace is obtained.

   d. Turn the SWEEP LENGTH control knob until the range gate appears approximately in the center of the scope.

   e. If you are unable to center the range gate with the SWEEP LENGTH control knob, activate the RANGE SLEW switch until the range gate is centered.

   f. If the tracking range indicator shows interference, notify the elevation operator to change the frequency;

and, at the same time, adjust your intensity and focus in an effort to get the best video.

2. Control Drawer.

   a. Check to see that your MAN-AID-AUTO switch is in MAN. (The track radar should not be slewed unless all three MAN-AID-AUTO switches are in MAN.)

3. Acquisition Receiver Control.

Note: The adjustments of the acquisition receiver control are ordinarily carried out by the technician. However, the range operator should be capable of making these adjustments when the technician is not on hand.

   a. Turn the MTI toggle switch to the OFF position.

   b. Turn the STC knob to the extreme counterclockwise position. (If at any time the center of the PPI shows excessive brightness, adjust the STC to reduce that condition.)

   c. Turn the GAIN control knob clockwise until ground clutter appears and the noise (snow) is visible on the PPI.

   d. Turn the MTI toggle switch to the ON position.

   e. Turn the MTI RANGE control knob to the extreme counterclockwise position.

   f. Turn the AFC toggle switch to the ON position.

   g. If you discover or are told by the acquisition operator that there is no video on the PPI and if the AFC HUNT lamp is blinking, depress the AFC RELEASE push-button.

h. If you discover or are told by the acquisition operator that there is interference on the PPI, use the FREQUENCY switch on the acquisition receiver control to change the frequency so that the interference will be minimized.

Acquiring and Tracking Targets.

1. After a target has been designated and while the track radar is slewing, watch for the target pip to appear on the precision indicator.

2. The next few steps are different depending upon whether the DISABLE switch is in the COAST position or in the DISABLE position. If properly adjusted, the coast circuit can be a valuable aid to operation. Hence, it should always be used except when it is obviously malfunctioning.

In COAST Position.

a. As soon as the target pip appears in the precision indicator, place your MAN-AID-AUTO switch in AUTO. (Actually you will then be tracking in aided manual until all three tracking operators are on target and have their MAN-AID-AUTO switches in AUTO. At that time the automatic tracking will take over.)

b. Use the RANGE handwheel to keep the horizontal line of the precision indicator near (not centered on) the target pip. (It is easier for the elevation operator to find the pip on his A-scope if the track radar is slightly off in range.)

c. When the elevation operator calls "Target," direct your attention to your A-scope, and use your handwheel to bring the range notch under the target pip.

d. Once you have the range notch centered under the target pip, the COAST lamp will go out, your handwheel will become frozen, and the radar will then be tracking automatically.

e. After the radar is tracking automatically, continue to observe your A-scope to insure that the radar is staying on target.

f. If the radar drifts off the target, notify the other operators and use your RANGE handwheel to try to get back on target. (You will actually be using aided manual even though your MAN-AID-AUTO switch is in AUTO.) When the radar gets back on target for all three positions, your handwheel will become frozen again as the automatic tracking takes over.

In DISABLE Position.

a. As soon as the target pip appears in the precision indicator, use your handwheel to keep the horizontal line of the PI near (not centered on) the target pip. (It is easier for the elevation operator to find the pip on his A-scope if the track radar is slightly off in range.)

b. When the elevation operator calls "Target," direct your attention to your A-scope and use your handwheel to bring the range notch under the target pip.

c. Once you have the range notch centered under the target pip, call "Lock" or "Automatic" and place your MAN-AID-AUTO switch in AUTO. Your handwheel will become frozen and the radar will then be tracking automatically.

d. After the radar is tracking automatically, continue to observe your A-scope to insure that the radar is staying on target.

e. If the radar drifts off the target, notify the other operators, place your MAN-AID-AUTO switch in AID, and attempt to get back on target by using your RANGE handwheel.

f. When you again have the range notch centered under the target pip, call "Lock" or "Automatic" and place your MAN-AID-AUTO switch back in AUTO.

Regardless of the Position of the DISABLE Switch.

g. If the radar should repeatedly lose the target while tracking in automatic, place your MAN-AID-AUTO switch in AID and proceed to track in aided manual. (Straight manual tracking should be used only when all other methods fail.) When you are again on target, call "Lock" or "Automatic."

h. Whenever the radar is actually on target and is being maintained on target by means of aided manual tracking or automatic tracking, it is permissible to place your IMAGE SPACING switch in SEL SIG if you prefer.

i. If your A-scope shows signs of jamming, take the following steps.

1) Notify the elevation operator, (who will then adjust the tracking receiver control).

2) Adjust the intensity and focus of your A-scope in an effort to get the best picture.

3) Place your IMAGE SPACING switch in SEL SIG.

j. If you have difficulty tracking one plane in a formation of planes, place your IMAGE SPACING switch in SEL SIG.

k. If the buzzer sounds twice (the cease-tracking signal), or if the acquisition operator calls "Cease tracking," place your MAN-AID-AUTO switch in MAN.

Jamming Countermeasures.

1. If jamming is discovered on the PPI, the following countermeasures should be taken.

a. On the acquisition receiver control, use the FREQUENCY toggle switch in an effort to find the frequency which minimizes the jamming.

b. On the acquisition receiver control, lower the gain. This will, in many instances, cause the target echo to appear through the jamming.

c. On the acquisition receiver control, turn the MTI RANGE control knob until the jamming is minimized.

Shutdown.

1. Acquisition Receiver Control.

a. Turn the AFC toggle switch to the OFF position.

b. Turn the MTI RANGE control knob to the extreme counterclockwise position.

c. Turn the MTI toggle switch to the OFF position.

d. Turn the STC knob to the extreme counterclockwise position.

e. Turn the GAIN control knob to the extreme counterclockwise position.

2. Tracking Range Indicator.

a. Turn the INTENSITY control knob to the extreme counterclockwise position (intensity turned down).

b. Check to see that your MAN-AID-AUTO switch is in the MAN position.

DE-ENERGIZING THE RADAR SET AND COMPUTER

Note: All operating personnel are required to know this procedure.

From Operate to Stand-by.

1. At the Computer.

a. Place the OPERATION switch in the STATIC TEST position.

b. Place the INPUT DATA switch in the STATIC TEST 2 position.

c. Turn the 270V DC POWER switch to the OFF position.

d. Turn the 320V DC POWER switch to the OFF position.

2. At the Radar Cabinet Power Control Panel.

a. Turn the TRACK MIN-MAX knob slowly to the MIN position.

b. Depress the TRACK OFF pushbutton.

c. Turn the ACQUISITION MIN-MAX knob slowly to the MIN position.

d. Depress the ACQUISITION OFF pushbutton.

e. Turn HP SERVOS switch to the OFF position.

f. Turn the EXCITATION switch to the OFF position

g. Turn the TRACK SCANNER switch to the OFF position.

h. Turn the INDICATOR HV switch to the OFF position.

i. Turn the LOW VOLTAGE switch to the OFF position.

From Stand-by to Shutdown.

1. At the Computer.

a. Turn the COMPUTER POWER switch to the OFF position.

2. At the Radar Cabinet Power Control Panel.

a. Turn the TRACK FILAMENTS switch to the OFF position.

b. Turn the ACQUISITION POWER switch to the OFF position.

c. Turn the PERSONNEL VENTILATION switch to the OFF position.

Caution: Do not turn the RADAR POWER switch to the OFF position until approximately two minutes after the ACQUISITION POWER switch has been turned off.

d. Turn the RADAR POWER switch to the OFF position

e. Check that the COMPUTER POWER switch on the computer power control panel is in the OFF position.

f. Turn the MAIN POWER switch to the OFF position.

APPENDIX B

DICTIONARY OF RADAR TERMS

DICTIONARY OF RADAR TERMS

Acquisition radar.	A type of radar designed to locate targets for associated fire control equipment.
Aided tracking.	A method of tracking in which the tracking rate is established by a variable-speed motor circuit.
Alternating current.	Electrical current that regularly reverses direction.
Amplifier.	An electronic circuit that delivers a signal of increased power at its output whenever a signal is received at its input. Amplifiers are classified as voltage or current amplifiers depending on the characteristics of the load circuit.
Antenna.	The part of a radar RF system that radiates the RF signals into space and receives the reflected signals; in general, any device that is used for collecting RF energy or radiating it into space.
A-scope.	An indicator that displays range and amplitude variations on a straight base line.
Automatic tracking.	A method of tracking in which the target governs the positioning of the antenna and the range indicating devices.
Average power.	The actual power delivered to a load during a complete cycle (or period) of operation.
Bandwidth.	The difference between the highest and lowest frequencies that can be passed through a circuit or series of circuits without undue distortion and attenuation. The bandwidth is expressed in cycles, kilocycles, or megacycles depending on the application.

Base line.	The bright line which is produced on the face of a cathode-ray tube indicator. In radar uses, this line is used as a time scale because its physical length may be divided into equal divisions representing equal increments of time.
Beacon.	An automatic transmitter that, when triggered by a radar signal, transmits an answering or responding signal. The responding signal is usually dependent upon a predetermined code.
Beam width.	A measure of the angle containing the major portion of the energy radiated into space from an antenna. This angle is expressed in mils or degrees.
B-scope.	An indicator that displays target azimuth and range. Only a small sector of azimuth is displayed at any one time. Azimuth is displayed horizontally and range is displayed vertically.
Cathode-ray tube.	A type of vacuum tube used as an indicator in a radar.
Centimeter.	A unit of measure used in radar applications to express wavelength.
Circuit.	Any grouping of electronic elements which performs a single function, e.g., amplifier or rectifier.
Coaxial line.	A type of transmission line in which the conductors are concentric, rather than side by side as in conventional two-wire lines.
Control transformer.	A device that determines the difference between two angles. One of the angles is represented by the movement of a shaft, and the other is represented by an AC voltage. The output is an AC voltage proportional to the angular difference.

Countermeasure.	The name given to any techniques which are designed to reduce the effectiveness of enemy radars.
Cycle.	Alternating current completes one cycle when it has reversed its direction twice and returned to its original starting point; in general, a pair of pulses, one positive and one negative, occurring in sequence.
Detector.	A device which removes information from a signal. The information will still be represented by a signal voltage but will be in a more usable form; in general, a lower frequency.
Dipole.	A basic type of antenna that is one-half wavelength long.
Direct current.	Electrical current that flows in one direction. (See definition for alternating current.)
Directional beam.	A beam of energy, radiated from an antenna, which contains a greater amount of power in one direction than it does in another.
Doppler effect.	Apparent change in the frequency of an RF signal due to physical modulation by a moving target.
Duty cycle.	A figure that relates the time a radar is transmitting to the time of one pulse period. The figure may be used to determine peak power output after the average power has been determined.
Early warning radar.	A radar used to detect targets at great range.
Echo.	Energy returned to a radar as a result of its own transmitted pulse.

Electron.	The most elementary negative charge of electricity.
Filter circuit.	Any circuit which removes various frequency components from an alternating current or pulsating direct current. Analogous to the flywheel in a mechanical system.
Fire control radar.	Any radar which develops firing data for guns.
Fixed echo.	An echo which is returned from an object whose permanence has been established.
Fluorescent screen.	The face of a cathode-ray tube which fluoresces (emits light) when struck by a stream stream of electrons.
Frequency.	The number of cycles of alternating current that are completed in one second.
Frequency division.	The development of a new frequency which is equvalent to division of the original frequency by a whole number. A multivibrator is a circuit commonly used for frequency division.
Gain.	The ratio of output signal to input signal.
Gate.	Any signal which allows a vacuum tube to operate for a predetermined period of time.
Glass envelope.	The glass cover containing the elements of an electron tube.
Handwheel.	An adjusting handle that controls the positioning of a synchro generator.
Horizontal deflection.	A horizontal movement of the electron beam in a cathode-ray tube.

IFF.	Identification Friend or Foe. Equipment used with radar to identify targets as being friend or enemy.
Indicator.	Any device used to indicate target position, antenna position, etc.
Intermediate frequency.	The frequency to which the majority of the circuits in a receiver are tuned and to which radio frequency signals are converted by the local oscillator and mixer circuits in a receiver.
J-scope.	An indicator that displays range and amplitude variations on a circular base line.
Jamming.	Techniques that are employed to reduce the effectiveness of a radar.
Keying pulse.	The pulse which is applied to the modulator of keyer tubes.
Klystron.	A vacuum tube for converting DC energy into RF energy by varying the speed of electrons. It differs from the conventional oscillator in that the electron stream is velocity modulated instead of amplitude modulated.
Lens, RF.	A system for concentrating RF energy into a narrow beam. The theory of operation is similar to lens systems used with light waves.
Local oscillator.	The oscillator in a receiver that generates signals for converting RF signals to IF signals.
Magnetron.	A vacuum tube that is usable as a high-power, ultra high frequency oscillator. This tube uses very high voltages and has a strong magnetic field imposed on it by a magnet. Oscillations are caused by the

	interaction of the voltage and the magnetic field and the physical dimensions of the tube.
Manual tracking.	A system for positioning the antenna by the use of handwheels.
Megacycle.	One million cycles per second.
Microsecond.	The common unit of time used in radar applications, equivalent to one-millionth of a second.
Mixer.	The device in a receiver that mixes the RF and local oscillator signal to produce the IF signal.
Motor.	A device that converts electrical energy to mechanical energy.
Moving target.	An echo that moves in azimuth, elevation, or range, or any combination of these elements of position.
Optical tracker.	An item of equipment which employs telescopes for tracking targets.
Oscillator.	A device or circuit that generates an alternating current signal.
Parabolic reflector.	A bowl or dish-shaped metallic device used to focus radio energy into a narrow beam.
Peak power.	In radar applications, the maximum power generated during the transmitted pulse.
Position indicators.	Any of the several devices used to indicate target position in azimuth or elevation.
Power.	A measure of the rate at which energy is delivered.

Power supply.	A circuit that provides the operating voltages for a radar.
PPI.	Plan Position Indicator. An indicator that displays target information in terms of azimuth and slant range. The PPI paints a map of the area surrounding the radar.
PRF.	Pulse Recurrence Frequency. The frequency with which pulses are transmitted by a radar.
PRR.	Pulse Repetition Rate. See PRF.
Pulse.	A short burst of energy.
Pulse width.	A measure of the time an RF transmitter is actually producing RF energy. The width of the pulse is measured in microseconds.
Radar.	Radio detection and ranging. Electronic equipment designed to provide direction and distance to targets of interest.
Radial deflection.	A movement of an electron beam outward from the center, hence, along the radius of the circular screen.
Radio frequency.	Any of the electric frequencies usually above 15, 000 cps that may be radiated into space.
Rawin.	Radio winds. A method for determining the direction and speed of winds aloft. It consists essentially of tracking a balloon which has a reflector tied to it and of recording its speed and direction.
Receiver.	The part of a radar that detects and amplifies returned signals so that they may be displayed on an indicator.

Receiver sensitivity.	The measure of a receiver's ability to amplify a very small signal to a usable level.
Reflecting object.	Anything that interferes with the transmission of RF energy through space.
RF system.	The name given to the part of a radar that transfers RF energy from the transmitter to the antenna, radiates the energy into space, accepts the returning echoes, and transfers them to the receiver.
Servo.	See servo system.
Servo system.	A combination of electrical and/or electronic and mechanical elements for controlling a source of power accurately. The output of the system or some function of the output is fed back for comparison with the input, and the difference or error is used to control the power.
Signal.	Any varying voltage or current that conveys information.
Surveillance radar.	A radar that is designed to scan a limited area as compared to an early warning radar which searches out to extreme ranges.
Synchro.	An electromechanical indicating or controlling device, normally used in pairs, for transmitting data where little torque (turning force) is required.
Synchronizer.	A functional unit that causes all actions in a radar to have the proper time relationship.
Sweep.	The movement of an electron beam across the face of a scope.

Target discrimination.	The ability of a radar to differentiate between targets which are not widely separated.
Timer.	See synchronizer.
Transmitter.	An electronic circuit or device which generates an RF signal and delivers it to the RF system for transmission.
TR box.	A switch that allows one antenna to be used for both transmitting and receiving. TR stands for transmit-receive.
TR switch.	See TR box.
Two-wire transmission.	A two-wire or two-conductor method for transferring electrical energy.
Vacuum tube.	An electronic device used to regulate current flow to an external load. May take the form of an amplifier, detector or oscillator, depending on the circuit elements combined with it.
Vertical deflection.	A vertical movement of the electron beam in a cathode-ray tube.
Video.	Reference to the broad band of frequencies from 0 to 4 million cycles per second.
Waiting period.	The time between the end of one transmitted pulse and the beginning of the next.
Waveguide.	A pipe-like RF transmission line. May be circular or rectangular in shape, its dimensions depending upon the frequency of operation.

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